

Description

Title of Invention: METHODS AND APPARATUSES OF MRO IN AN LTM PROCEDURE

Rule 91,
07.11.2023

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 L1/L2-Triggered Mobility (LTM) cell switch procedure, including an LTM primary secondary cell group cell (PS Cell) switch procedure or an LTM primary cell (PCell) switch procedure.

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 a secondary cell group (SCG) LTM procedure or an LTM PSCell switch procedure from a source PSCell to a target PSCell in a dual connectivity scenario, a node which generates an RRC Reconfiguration message for the SCG LTM/LTM PSCell switch procedure or determines to initiate SCG LTM configuration may be a MN or an SN or a CU of the MN or a CU of the SN, furthermore, the SN may be a node which manages the serving PSCell or source PSCell (e.g. a source SN) , or the SN may be a node which manages the target PSCell for LTM (e.g. a target SN) .
- [0005] Some implementations of the present disclosure provide a secondary node (SN) . The SN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the SN to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE) , obtain failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0006] In some implementations of the SN described herein, the processor is configured to cause the SN to perform one of the following, or wherein the SN includes a centralized unit (CU) and the CU is configured to perform one of the following: receiving information of a failure type of the failure from a master node (MN) , wherein the failure type is detected by the MN; or detecting the failure type of the failure.
- [0007] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to verify the failure type after receiving the information of the failure type of the failure from the MN.
- [0008] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to: if the failure type is correct, transmit, to the MN, first information indicating that the failure type detected by the MN is correct; or if the failure type is wrong, transmit, to the MN, second information indicating that the failure type detected by the MN is wrong.
- [0009] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU) , the CU is configured to transmit at least one of the following to the at least one DU: the failure information related to the LTM PSCell switch procedure; the information of the failure type of the failure received from the MN; or the information of the failure type of the failure detected by the CU.

- [0010] In some implementations of the SN described herein, the at least one DU is configured to: detect the failure type of the failure; or verify the failure type detected by the MN or by the CU.
- [0011] In some implementations of the SN described herein, the at least one DU is configured to: transmit, to the CU, the failure type of the failure detected by the at least one DU; or if the failure type detected by the MN or by the CU is correct, transmit information indicating that the failure type detected by the MN or by the CU is correct to the CU; or if the failure type detected by the MN or by the CU is wrong, transmit information indicating that the failure type detected by the MN or by the CU is wrong to the CU.
- [0012] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to indicate the failure type detected by the SN or the CU, or the failure type verified by the SN or the CU, or the failure type detected by the at least one DU, or the failure type verified by the at least one DU to the MN.
- [0013] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to transmit at least one of the following to the MN: information indicating that the failure type detected by the MN is wrong; or information indicating that the failure type detected by the MN is right.
- [0014] In some implementations of the SN described herein, the failure type includes at least one of the following: a first failure type which is defined as Too Late SCG LTM, wherein the UE has received configuration information for the LTM PSCell switch procedure, but the SCG failure occurs after the UE has stayed for a time period in the source PSCell or occurs before an LTM PSCell switch command and for the LTM PSCell switch procedure is triggered to the UE, and a suitable PSCell different from the source PSCell is found based on layer-1 (L1) or layer-3 (L3) measurement results reported from the UE; a second failure type which is defined as Too Early SCG LTM, wherein the SCG failure occurs shortly after a successful completion of LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the source PSCell is the suitable PSCell based on the L1 or L3 measurement results reported from the UE; or a third failure type which is defined as SCG LTM to wrong PSCell, wherein the SCG failure occurs shortly after the successful completion of the LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the suitable PSCell different from the source PSCell and the target PSCell is found based on the L1 or L3 measurement results reported from the UE.
- [0015] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to: in response to the occurrence

nce of the failure, receive information of a suitable PSCell or select the suitable PSCell.

- [0016] In some implementations of the SN described herein, the suitable PSCell is selected by an MN, and the information of the suitable PSCell is received from the MN.
- [0017] In some implementations of the SN described herein, the SN includes a centralized unit (CU) and at least one distributed unit (DU) , and the CU is configured to transmit the information of the suitable PSCell to the at least one DU.
- [0018] In some implementations of the SN described herein, the suitable PSCell is selected by the SN or the CU.
- [0019] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU) , the suitable PSCell is selected by the at least one DU, and the information of the suitable PSCell is received by the CU from the at least one DU.
- [0020] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to transmit the information of the suitable PSCell to an MN.
- [0021] In some implementations of the SN described herein, the failure type further includes at least one of the following: a fourth failure type in which a suitable PSCell selected in response to the occurrence of the failure is not one of a first set of LTM candidate PSCells provided by a CU of the SN to at least one DU of the SN; a fifth failure type in which the suitable PSCell is one of the first set of LTM candidate PSCells, but not one of a second set of LTM candidate PSCells selected by the at least one DU; or a sixth failure type in which the suitable PSCell is one of the second set of LTM candidate PSCells.
- [0022] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to detect whether the failure type is one of the fourth failure type, the fifth failure type, and the sixth failure type.
- [0023] In some implementations of the SN described herein, if the failure type is the fourth failure type, the processor is configured to cause the SN to or the CU is configured to determine that the first set of LTM candidate PSCells provided by the SN or the CU is improper.
- [0024] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU) , and wherein the processor is configured to cause the SN to or the CU is configured to transmit, to the MN or the at least one DU , information indicating that the first set of LTM candidate PSCells provided by the SN or the CU is improper.
- [0025] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU) , and if the failure type is the fifth failure

e type, the CU is configured to: detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or transmit, to the at least one DU, third information indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU.

- [0026] In some implementations of the SN described herein, the at least one DU is configured to verify the failure type or whether the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [0027] In some implementations of the SN described herein, the at least one DU is configured to transmit one of the following to the CU: information indicating that the CU made a right detection regarding the third information; information indicating that the CU made a wrong detection regarding the third information; or information of the failure type detected or verified by the at least one DU.
- [0028] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to transmit the information of the failure type detected or verified by the at least one DU to an MN.
- [0029] In some implementations of the SN described herein, if the failure type is the sixth failure type, the CU is configured to: detect that a wrong LTM target PSCell is selected by a source DU of the SN; or transmit, to the source DU, fourth information indicating that the wrong LTM target PSCell is selected by the source DU.
- [0030] In some implementations of the SN described herein, the source DU is configured to verify the failure type or whether the wrong LTM target PSCell is selected by the source DU.
- [0031] In some implementations of the SN described herein, the source DU is configured to transmit one of the following to the CU: information indicating that the CU made a right detection regarding the fourth information; information indicating that the CU made a wrong detection regarding the fourth information; or information of the failure type detected or verified by the source DU.
- [0032] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to transmit the information of the failure type detected or verified by the source DU to an MN.
- [0033] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU); wherein the CU is configured to transmit, to the at least one DU, at least one of the failure information or the information of the suitable PSCell; and wherein the at least one DU is configured to detect the failure type.
- [0034] In some implementations of the SN described herein, if the failure type is the fourth failure type, the at least one DU is configured to: detect that the first set of LTM candidate PSCells provided by the CU is improper; or transmit, to the CU, fifth information

rmation indicating that the first set of LTM candidate PSCells provided by the CU is improper.

- [0035] In some implementations of the SN described herein, if the failure type is the fifth failure type, the at least one DU is configured to: detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or transmit, to the CU, sixth information indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [0036] In some implementations of the SN described herein, if the failure type is the sixth failure type, a source DU is configured to: detect that a wrong LTM target PSCell is selected by the source DU; or transmit, to the CU, seventh information indicating that the wrong LTM target PSCell is selected by the source DU.
- [0037] In some implementations of the SN described herein, the processor is configured to cause the SN to or the CU is configured to transmit the fifth information, the sixth information, or the seventh information to an MN.
- [0038] In some implementations of the SN described herein, the SN includes a centralized unit (CU) , to obtain the failure information, the processor is configured to cause the SN to or the CU is configured to derive the failure information by itself or to receive the failure information which is stored or transmitted by the UE, wherein the failure information includes at least one of the following: information regarding the source PSCell; information regarding a PSCell where the failure happens; information regarding a selected beam in the target PSCell; information regarding one or more neighbour cells; L1 or L3 measurement results of the source PSCell; L1 or L3 measurement results of the PSCell where the failure happens; L1 or L3 measurement results of the neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate PSCell; information indicating that the failure happens in the LTM PSCell switch procedure; information regarding at least one LTM candidate PSCell configured for the LTM PSCell switch procedure; cell configuration information for the at least one LTM candidate PSCell; a set of channel state information (CSI) resources for the LTM PSCell switch procedure; a reference configuration for the LTM PSCell switch procedure; time elapsed between reception of an LTM PSCell switch command and reception of a latest RRC reconfiguration message for the LTM PSCell switch procedure; time elapsed between the reception of the LTM PSCell switch command and the occurrence of the failure; time elapsed between the occurrence of the failure and the failure information is transmitted by the UE; a time alignment (TA) value for a random access channel (RACH) -less SCG LTM; or a TA value derived in an early RACH procedure for early TA acquisition.

- [0039] In some implementations of the SN described herein, the SN also includes at least one distributed unit (DU) , and the CU is configured to transmit the failure information to the at least one DU after obtaining the failure information.
- [0040] In some implementations of the SN described herein, the SN includes a centralized unit (CU) and at least one distributed unit (DU) , and wherein the processor is configured to cause the SN to or the CU is configured to detect whether a ping-pong event occurs, and wherein for the ping-pong event, after a successful completion of LTM PSCell switch from a first PSCell to a second PSCell, the UE is switched back to the first PSCell within a predefined time period or the UE successfully performs another LTM PSCell switch from the second PSCell back to the first PSCell.
- [0041] In some implementations of the SN described herein, the CU is configured to transmit, to the at least one DU, information indicating an occurrence of the ping-pong event.
- [0042] In some implementations of the SN described herein, the ping-pong event is detected based on: history information of the UE; time duration between receiving two LTM cell change notification messages for a same PSCell; or time duration between receiving two access success messages for a same PSCell.
- [0043] In some implementations of the SN described herein, the at least one DU of the SN is at least one of the following: a source DU; a target DU; or at least one candidate target DU.
- [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: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE) , obtain failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0045] Some implementations of the present disclosure provide a method performed by a secondary node (SN) . The method includes: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE) , obtaining failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0046] Some implementations of the present disclosure provide a secondary node (SN) . The SN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the SN to receive or transmit physical

al random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure from or to a master node (MN) .

[0047] Some implementations of the present disclosure provide a processor for or wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to receive or transmit physical random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure from or to a master node (MN) .

[0048] Some implementations of the present disclosure provide a method performed by a secondary node (SN) . The method includes: receiving or transmitting physical random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure from or to a master node (MN) .

[0049] Some implementations of the present disclosure provide a secondary node (SN) . The SN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the SN to receive a random access (RA) report from a user equipment (UE) or a master node (MN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.

[0050] Some implementations of the present disclosure provide a processor for or wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to: receive a random access (RA) report from a user equipment (UE) or a master node (MN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.

[0051] Some implementations of the present disclosure provide a method performed by a secondary node (SN) . The method includes: receiving a random access (RA) report from a user equipment (UE) or a master node (MN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.

- [0052] Some implementations of the present disclosure provide a master node (MN). The MN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the MN to: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE), perform at least one of the following: receiving failure information related to the LTM PSCell switch procedure from the UE; or obtaining information of a failure type of the failure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0053] In some implementations of the MN described herein, the processor is configured to cause the MN to transmit the failure information to the SN.
- [0054] In some implementations of the MN described herein, the failure information includes at least one of the following: information regarding the source PSCell; information regarding a PSCell where the failure happens; information regarding a selected beam in the target PSCell; information regarding one or more neighbour cells; L1 or L3 measurement results of the source PSCell; L1 or L3 measurement results of the PSCell where the failure happens; L1 or L3 measurement results of the neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate PSCell; information indicating that the failure happens in the LTM PSCell switch procedure; information regarding at least one LTM candidate PSCell configured for the LTM PSCell switch procedure; cell configuration information for the at least one LTM candidate PSCell; a set of channel state information (CSI) resources for the LTM PSCell switch procedure; a reference configuration for the LTM PSCell switch procedure; time elapsed between reception of an LTM PSCell switch command and reception of a latest RRC reconfiguration message for the LTM PSCell switch procedure; time elapsed between the reception of the LTM PSCell switch command and the occurrence of the failure; time elapsed between the occurrence of the failure and the failure information is transmitted by the UE; a time alignment (TA) value for a random access channel (RACH)-less SCG LTM; or a TA value derived in an early RACH procedure for early TA acquisition.
- [0055] In some implementations of the MN described herein, to obtain the information of the failure type of the failure, the processor is configured to cause the MN to perform at least one of the following: detecting the failure type; receiving the information of the failure type from the SN; or transmitting the information of the failure type detected by the MN to the SN.

- [0056] In some implementations of the MN described herein, the processor is configured to cause the MN to receive one of the following from the SN: information indicating that the failure type detected by the MN is correct; information indicating that the failure type detected by the MN is wrong; information indicating the failure type detected by the SN; or information indicating the failure type verified by the SN.
- [0057] In some implementations of the MN described herein, the failure type includes at least one of the following: a first failure type which is defined as Too Late SCG LTM, wherein the UE has received configuration information for the LTM PSCell switch procedure, but the SCG failure occurs after the UE has stayed for a time period in the source PSCell or occurs before an LTM PSCell switch command and for the LTM PSCell switch procedure is triggered to the UE, and a suitable PSCell different from the source PSCell is found based on layer-1 (L1) or layer-3 (L3) measurement results reported from the UE; a second failure type which is defined as Too Early SCG LTM, wherein the SCG failure occurs shortly after a successful completion of LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the source PSCell is the suitable PSCell based on the L1 or L3 measurement results reported from the UE; or a third failure type which is defined as SCG LTM to wrong PSCell, wherein the SCG failure occurs shortly after the successful completion of the LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the suitable PSCell different from the source PSCell and the target PSCell is found based on the L1 or L3 measurement results reported from the UE.
- [0058] In some implementations of the MN described herein, the processor is configured to cause the MN to: in response to the occurrence of the failure, select a suitable PSCell; and transmit information of the suitable PSCell to the SN.
- [0059] In some implementations of the MN described herein, the MN includes a centralized unit (CU) and at least one distributed unit (DU), the CU or the at least one DU is configured to select the suitable PSCell.
- [0060] In some implementations of the MN described herein, the processor is configured to cause the MN to receive information of a suitable PSCell from the SN, and the suitable PSCell is selected by the SN.
- [0061] In some implementations of the MN described herein, 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 suitable PSCell selected in response to the occurrence of the failure is not one of a first set of LTM candidate PSCells provided by a CU of the SN to at least one DU of the SN; a fifth failure type in which the suitable PSCell is one of the first set of LTM candidate PSCells, but not one of a second set

of LTM candidate PSCells selected by the at least one DU of the SN; or a sixth failure type in which the suitable PSCell is one of the second set of LTM candidate PSCells.

- [0062] In some implementations of the MN described herein, the processor is configured to cause the MN to receive one of the following from the SN: information indicating that the first set of LTM candidate PSCells provided by the SN or the CU of the SN is improper; information indicating that the one or more wrong LTM candidate PSCells are selected by the SN or the at least one DU of the SN; information indicating that the wrong LTM target PSCell is selected by the SN or the source DU of the SN; information of the failure type detected or verified by the at least one DU of the SN; information of the failure type detected or verified by the source DU of the SN; or information of the failure type detected or verified by the SN.
- [0063] Some implementations of the present disclosure provide a processor for or 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) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE), perform at least one of the following: receiving failure information related to the LTM PSCell switch procedure from the UE; or obtaining information of a failure type of the failure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0064] Some implementations of the present disclosure provide a method performed by a master node (MN). The method includes: in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE), performing at least one of the following: receiving failure information related to the LTM PSCell switch procedure from the UE; or obtaining information of a failure type of the failure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [0065] Some implementations of the present disclosure provide a master node (MN). The MN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the MN to: transmit or receive physical random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure to or from a secondary node (SN).
- [0066] Some implementations of the present disclosure provide a processor for or wireless communication, comprising at least one controller coupled with at least one memory and configured to cause the processor to: transmit or receive physical random

om access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure to or from a secondary node (SN) .

- [0067] Some implementations of the present disclosure provide a method performed by a master node (MN) . The method includes: transmitting or receiving physical random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure to or from a source secondary node (SN) .
- [0068] Some implementations of the present disclosure provide a master node (MN) . The MN includes at least one memory; and at least one processor coupled to the at least one memory and configured to cause the MN to perform at least one of the following: receiving a random access (RA) report from a user equipment (UE) ; or transmitting the RA report to a source secondary node (SN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0069] 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 perform at least one of the following: receiving a random access (RA) report from a user equipment (UE) ; or transmitting the RA report to a source secondary node (SN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0070] Some implementations of the present disclosure provide a method performed by a master node (MN) . The method includes at least one of the following: receiving a random access (RA) report from a user equipment (UE) ; or transmitting the RA report to a source secondary node (SN) , wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0071] 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) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of the UE, store failure information related to the LTM PSCell switch procedure

, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure; and transmit the failure information.

[0072] In some implementations of the UE described herein, the failure information includes at least one of the following: information regarding the source PSCell; information regarding a PSCell where the failure happens; information regarding a selected beam in the target PSCell; information regarding one or more neighbour cells; L1 or L3 measurement results of the source PSCell; L1 or L3 measurement results of the PSCell where the failure happens; L1 or L3 measurement results of the neighbour cells; information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate PSCell; information indicating that the failure happens in the LTM PSCell switch procedure; information regarding at least one LTM candidate PSCell configured for the LTM PSCell switch procedure; cell configuration information for the at least one LTM candidate PSCell; a set of channel state information (CSI) resources for the LTM PSCell switch procedure; a reference configuration for the LTM PSCell switch procedure; time elapsed between reception of an LTM PSCell switch command and reception of a latest RRC reconfiguration message for the LTM PSCell switch procedure; time elapsed between the reception of the LTM PSCell switch command and the occurrence of the failure; time elapsed between the occurrence of the failure and the failure information is transmitted by the UE; a time alignment (TA) value for a random access channel (RACH) -less SCG LTM; or a TA value derived in an early RACH procedure for early TA acquisition.

[0073] 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) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of the UE, store failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure; and transmit the failure information.

[0074] 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) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of the UE, storing failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure; and transmitting the failure information.

- [0075] 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 store or transmit a random access (RA) report, wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0076] 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 store or transmit a random access (RA) report, wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0077] Some implementations of the present disclosure provide a method performed by a user equipment (UE). The method includes: storing or transmitting a random access (RA) report, wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.

BRIEF DESCRIPTION OF THE DRAWINGS

- [0078] Figure 1 illustrates an example of a wireless communications system in accordance with aspects of the present disclosure.
- [0079] Figure 2 illustrates an example of a user equipment (UE) 200 in accordance with aspects of the present disclosure.
- [0080] Figure 3 illustrates an example of a processor 300 in accordance with aspects of the present disclosure.
- [0081] Figure 4 illustrates an example of a network equipment (NE) 400 in accordance with aspects of the present disclosure.
- [0082] Figure 5A illustrates a schematic diagram of an intra-CU intra-DU mobility scenario in accordance with aspects of the present disclosure.
- [0083] Figure 5B illustrates a schematic diagram of an intra-CU inter-DU mobility scenario in accordance with aspects of the present disclosure.
- [0084] Figure 5C illustrates a schematic diagram of an inter-CU mobility scenario in accordance with aspects of the present disclosure.
- [0085] 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.

- [0086] Figure 7 illustrates a flowchart of a method related to an LTM PSCell switch procedure in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

- [0087] 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.
- [0088] 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.
- [0089] 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.
- [0090] 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 supervise the LTM cell switch procedure.
- [0091] "LTM candidate PSCell" refers to a candidate PSCell configured to the UE for SCG LTM or LTM PSCell switch. There may be multiple LTM candidate PSCells prepared for the UE, where the LTM candidate PSCells may belong to the same or different candidate DUs of the CU of the SN. The SN may be a source SN or a target SN or a candidate target SN. A source SN is a node which manages a source PSCell, a target SN is a node which manages an LTM target PSCell, and a candidate target SN is a node which manages one or more LTM candidate PSCells.
- [0092] "LTM candidate PSCell configuration" refers to a configuration associated with an LTM candidate PSCell. An LTM candidate PSCell configuration

ation can be a complete LTM candidate PSCell configuration or a delta (difference) configuration with respect to an LTM reference configuration. Each LTM candidate PSCell configuration is identified by an index, called as LTM candidate PSCell configuration index, LTM candidate configuration index, or other names. In one example, the LTM candidate PSCell configuration index is LTM-CandidateId, which is used to identify an LTM candidate PSCell configuration.

- [0093] "LTM Reference Configuration" refers to a configuration provided by the network to the UE that is common to all the configured LTM candidate PSCells. It is used by the UE to generate a complete LTM candidate PSCell configuration (i.e., by applying an LTM candidate PSCell configuration on top of an LTM reference configuration) .
- [0094] "Complete LTM Candidate PSCell Configuration" refers to a configuration that contains all the necessary fields needed to perform an LTM PSCell switch procedure. This configuration can be an LTM candidate PSCell configuration itself or be generated by applying an LTM candidate PSCell configuration on top of an LTM reference configuration.
- [0095] SCG LTM or LTM PSCell switch in a dual connectivity scenario is a PSCell switch procedure that the network triggers via a MAC CE based on L1 measurements. In 3GPP Rel-18, intra-SN SCG LTM without MN involvement is supported. In later 3GPP release, intra-SN SCG LTM with MN involvement and/or inter-SN SCG LTM may also be supported. The potential applicable scenarios of SCG LTM or LTM PSCell 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.
- [0096] (1) Intra-CU intra-DU mobility: a UE moves between different cells within a DU of SN (e.g. in case of intra-SN SCG LTM with or without MN involvement, the SN is a source SN) .
- [0097] (2) Intra-CU inter-DU mobility: a UE moves between different cells belonging to different DUs of SN (e.g. in case of intra-SN SCG LTM with or without MN involvement, the SN is a source SN) but within a same CU of SN (e.g. in case of intra-SN SCG LTM with or without MN involvement, the SN is a source SN) .
- [0098] (3) Inter-CU mobility: a UE moves between different cells belonging to different DUs different CUs.
- [0099] In general, a purpose of an SCG failure information procedure is to inform E-UTRAN or NR MN about an SCG failure the UE has experienced, i.e., an SCG radio link failure, a failure of SCG reconfiguration with sync, an SCG configuration failure for an RRC message on signalling radio bearer (SRB) 3, an SCG integrity

check failure, and a consistent uplink listen-before-talk (LBT) failures on PSCell for operation with shared spectrum channel access. Failure type, measurement result (s) in MCG, and/or measurement result (s) in SCG can be included in an SCG failure information message. After the network receives the SCG failure information message, it can trigger the UE to perform an SN release or modification or change procedure. The following information (e.g. SCG failure related information) can be included in the SCG failure information message in case of an SCG failure: cell information of previous PSCell; cell information of failed PSCell; time SCG failure which indicates the time elapsed since the last execution of RRC Reconfiguration with reconfigurationWithSync for the SCG until the SCG failure; RA-Information; and/or failure type. The cell information may include global cell identity, tracking area code of the cell, and/or, physical cell identifier (PCI) and carrier frequency information.

- [0100] One of the functions of self-optimization for PSCell change is to detect PSCell change failures that occur due to Too late PSCell change or Too early PSCell change, or Triggering PSCell change to wrong PSCell. These problems may be defined as follows:
- [0101] - Too late PSCell change: an SCG failure occurs after the UE has stayed for a long period of time in the PSCell; a suitable different PSCell is found based on the measurements reported from the UE.
- [0102] - Too early PSCell change: an SCG failure occurs shortly after a successful PSCell change from a source PSCell to a target PSCell or a PSCell change failure occurs during the PSCell change procedure; source PSCell is still the suitable PSCell based on the measurements reported from the UE.
- [0103] - Triggering PSCell change to wrong PSCell: an SCG failure occurs shortly after a successful PSCell change from a source PSCell to a target PSCell or a PSCell change failure occurs during the PSCell change procedure; a suitable PSCell different with source PSCell or target PSCell is found based on the measurements reported from the UE.
- [0104] In the definition above, the "successful PSCell change" refers to the UE state, namely the successful completion of the RA procedure.
- [0105] One objective for mobility enhancements in 3GPP Rel-18 is to specify an SCG LTM procedure in a dual connectivity scenario (i.e. a PSCell switch procedure triggered by a network via a MAC CE based on L1 measurement result (s)). In an SCG LTM or LTM PSCell switch procedure, an SCG LTM execution failure or an LTM PSCell switch failure or an SCG failure may happen. To improve mobility robustness, following issues regarding an MRO mechanism for an LTM PSCell switch or SCG LTM

procedure need to be considered, including, e.g., how to define failure types for an LTM PSCell switch when an LTM PSCell switch failure or an SCG LTM execution failure or an SCG failure happens, and how to define a ping-pong event when a subsequent LTM PSCell switch is supported, what information reported from a UE is needed for the network to perform MRO optimization for LTM PSCell switch related configurations, how the network performs a MRO detection or analysis, e.g. signalling exchange between an MN and an SN, as well as signalling exchange between relevant CU and relevant DU (s) , and how to enhance an RA report for an LTM PSCell switch procedure.

[0106] Currently, details regarding an MRO mechanism for a failure in an LTM PSCell switch or SCG 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 PSCell switch in case that an LTM failure recovery mechanism is applied upon a connection failure (e.g. an SCG LTM execution failure or an SCG failure) happens.

[0107] Some embodiments of the present disclosure study an MRO mechanism for an LTM PSCell switch or an SCG LTM procedure. More specifically, in some embodiments of the present disclosure, when an SCG failure happens due to an LTM PSCell switch, MN or a CU of an MN may select a suitable PSCell; or, DU (s) of the MN may select the suitable PSCell e.g. based on optional request from the CU of the MN, and then, the DU (s) of the MN may indicate the selected suitable PSCell to the CU of the MN. The CU of the MN may indicate the information of suitable PSCell to an SN or the CU of the SN, and the SN may be a source SN or a target SN or a candidate target SN. Then, the CU of the SN may indicate the information of suitable PSCell to DU (s) of the SN. Or, the CU of the SN may select a suitable PSCell; or, the DU (s) of the SN may select the suitable PSCell e.g. based on optional request from the CU of the SN, and then the DU (s) of the SN may indicate the information of the suitable PSCell to the CU of the SN. The information of the suitable PSCell may be a cell ID of the suitable PSCell, which may include a global cell identity, a tracking area code of the cell, and/or, a physical cell identifier (PCI) and carrier frequency information. The DU of the SN may be a source DU or a target DU or a candidate target DU. A source DU is a node which manages a source PSCell, a target DU is a node which manages an LTM target PSCell, and a candidate target DU is a node which manages an LTM candidate PSCell.

- [0108] Some embodiments of the present disclosure define failure type definitions for Too late SCG LTM, Too early SCG LTM or SCG LTM to wrong PSCell. Also, if subsequent PSCell switch procedures are executed, some embodiments of the present disclosure define the problem of ping-pong in subsequent SCG LTM/LTM PSCell switch procedures.
- [0109] In some embodiments of the present disclosure, to enable MRO analysis and optimization for an SCG failure due to an SCG LTM/LTM PSCell switch, a UE may store or report SCG LTM related failure information to an MN or a CU of the MN (e.g. including an indication concerning that SCG failure due to LTM PSCell switch, list of LTM candidate PSCell (s) , LTM PSCell switch related time info and etc.) . Then, the MN or the CU of the MN may send the SCG LTM related failure information to an SN or the CU of the SN. Then, the CU of the SN may send the SCG LTM related failure information to at least one DU of the SN (e.g. a source DU of the SN and/or target DU and/or at least one candidate target DU of the SN) . The SN may be a source SN or a target SN or a candidate target SN.
- [0110] In some embodiments of the present disclosure, to avoid a RACH Collision, PRACH configuration (s) for early TA acquisition-triggered RA procedure may be exchanged over an Xn interface or F1 interface. To assist the network to optimize RACH related configuration for an MCG LTM or an SCG LTM, an RA report needs to be enhanced to include LTM related information, e.g. early RACH procedure for early TA acquisition related information, or RACH-less LTM related information.
- [0111] In some embodiments of the present disclosure, for MRO detection or analysis for LTM PSCell switch, there may be following operations:
- [0112] - a CU of an SN detects and indicates occurrence of ping-pong in subsequent LTM PSCell switch procedures to its corresponding DU (e.g. a source DU or a target DU or at least a candidate target DU) , and the SN may be a source SN or a target SN or a candidate target SN;
- [0113] - a CU of an MN or the MN detects and indicates the failure type of Too late SCG LTM, Too early SCG LTM, or SCG LTM to wrong PSCell to the CU of the SN, optionally the CU or the DU (s) of the SN may further verify whether it is the MN or MN's CU detected problem, and the SN may be a source SN or a target SN or a candidate target SN;
- [0114] - the CU of the SN detects and indicates the failure type of Too late SCG LTM, Too early SCG LTM, or SCG LTM to wrong PSCell to corresponding DU (s) ; optionally, the DU (s) of the SN may further verify whether it is the S

N or the SN's CU detected problem, the SN may be a source SN or a target SN or a candidate target SN;

- [0115] - furthermore, the SN or the CU of the SN may detect whether it is im proper LTM candidate PSCell (s) provided by the SN or the CU of the SN, or wrong LTM candidate PSCell (s) selected by the (candidate) ta rget DU of the SN, or wrong LTM target PSCell selected at the source DU of the SN, the SN may be a source SN or a target SN or a candidate target SN, and then, the CU of the SN may indicate the detected problem to the corresponding DU (s) of the SN; optionally, the corresponding DU (s) may further verify whether it is the CU detected problem; or
- [0116] - the CU of the SN may forward SCG LTM related failure information to the corresponding DU (s) of the SN, the SN may be a source SN or a target SN or a ca ndidate target SN, and then the corresponding DU (s) detects and indicates the proble m to the CU of the SN.
- [0117] More details of the embodiments of the present disclosure will be illustrated in the following text in combination with the appended drawings.
- [0118] 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 implemen tations, 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 Electro nics Engineers (IEEE) 802.11 (Wi-Fi) , IEEE 802.16 (WiMAX) , IEEE 802.20. The wireless communications system 100 may support radio acce ss technologies beyond 5G, for example, 6G. Additionally, the wirele ss 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.
- [0119] The one or more NE 102 may be dispersed throughout a geographic regi on to form the wireless communications system 100. One or more of th e 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 acce

ss 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.

- [0120] 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.
- [0121] 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.
- [0122] 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.
- [0123] 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 s

ome 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 radio heads, smart radio heads, or transmission-reception points (TRPs).

[0124] 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.

[0125] 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).

[0126] 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 structure

s) . The NEs 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0127] 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.

[0128] 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.

[0129] 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 nu

merology (e.g. $\mu=0$) associated with a first subcarrier spacing (e.g. 15 kHz) may be used interchangeably between subframes and slots.

- [0130] 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.
- [0131] 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.
- [0132] 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.
- [0133] 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.

- [0134] 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.
- [0135] 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 as 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.
- [0136] 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, the processor 202 may support wireless communication at the UE 200 in accordance with examples as disclosed with respect to Figure 7. For example, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of the UE 200, the UE 200 may be configured to support means for storing failure information related to the LTM PSCell switch procedure and means for transmitting the failure information, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0137] For example, the processor 202 may support wireless communication at the UE 200, and, the UE 200 may be configured to support means for storing or transmitting an RA report, wherein the RA report includes at least one of the following: early RACH procedure related information; RACH-less LTM related information; or RACH related information for early TA acquisition.
- [0138] 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

e implementations, the controller 206 may be implemented as part of the processor 202

- [0139] 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 above mentioned in the processor 202 or the means for transmitting in the processor 202 may be implemented via at least one transceiver 208.
- [0140] 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.
- [0141] 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.
- [0142] 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

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

- [0143] 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) .
- [0144] 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.
- [0145] 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.
- [0146] 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) .

[0147] 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.

[0148] 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.

[0149] The processor 300 may support wireless communication in accordance with examples as disclosed herein.

[0150] In some implementations, the processor 300 may be configured to support means for performing operations of an SN, the SN may be a source SN or a target SN or a candidate target SN. For example, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the processor 300 may be configured to or operable to support

rt a means for obtaining failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.

- [0151] In some implementations, the processor 300 may be configured to support means for performing operations of an SN, and the SN may be a source SN or a target SN or a candidate target SN. The processor 300 may be configured to or operable to support a means for receiving or transmitting PRACH configuration information for early TA acquisition-triggered RA procedure from or to an MN.
- [0152] In some implementations, the processor 300 may be configured to support means for performing operations of an SN, and the SN may be a source SN or a target SN or a candidate target SN. The processor 300 may be configured to or operable to support a means for receiving an RA report from a UE or an MN, wherein the RA report includes at least one of the following: early RACH procedure related information; RACH-less LTM related information; or RACH related information for early TA acquisition.
- [0153] In some implementations, the processor 300 may be configured to support means for performing operations of an MN. For example, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the processor 300 may be configured to or operable to support a means for performing at least one of the following: receiving failure information related to the LTM PSCell switch procedure from the UE; or obtaining information of a failure type of the failure, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0154] In some implementations, the processor 300 may be configured to support means for performing operations of an MN. The processor 300 may be configured to or operable to support a means for transmitting or receiving PRACH configuration information for early TA acquisition-triggered RA procedure to or from an SN, and the SN may be a source SN or a target SN or a candidate target SN.
- [0155] In some implementations, the processor 300 may be configured to support means for performing operations of an MN. The processor 300 may be configured to or operable to support a means for performing at least one of the following: receiving a random access (RA) report from a user equipment (UE) ; or transmitting the RA report to the SN, wherein the RA report includes at least one of the following: early RACH procedure related information; RACH-less LTM related information; or RACH related information for early TA acquisition, and the SN may be a source SN or a target SN or a candidate target SN.
- [0156] In some additional implementations, the processor 300 may be configured to support means for performing operations of a UE. For example,

in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the processor 300 may be configured to or operable to support a means for storing failure information related to the LTM PSCell switch procedure and a means for transmitting the failure information, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.

- [0157] In some additional implementations, the processor 300 may be configured to support means for performing operations of a UE. The processor 300 may be configured to or operable to support a means for storing or transmitting a random access (RA) report, wherein the RA report includes at least one of the following: early random access channel (RACH) procedure related information; RACH-less L1/L2-Triggered Mobility (LTM) related information; or RACH related information for early timing advance (TA) acquisition.
- [0158] 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.
- [0159] 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.
- [0160] 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.
- [0161] 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 co

computer-readable instructions stored in the memory 404 to cause the NE 400 to perform various functions of the present disclosure.

- [0162] 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 as the memory 404 or another type of memory. Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer.
- [0163] 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.
- [0164] In some implementations, the NE 400 may be an SN, and the SN may be a source SN or a target SN or a candidate target SN. In response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the NE 400 may be configured to support means for obtaining failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0165] In some implementations, the NE 400 may be an SN, the SN may be a source SN or a target SN or a candidate target SN, and the NE 400 may be configured to support means for receiving or transmitting a PRACH configuration information for early TA acquisition-triggered RA procedure from or to an MN.
- [0166] In some implementations, the NE 400 may be an SN, the SN may be a source SN or a target SN or a candidate target SN, and the NE 400 may be configured to support means for receiving a random access (RA) report from a UE or an MN, wherein the RA report includes at least one of the following: early RACH procedure related information; RACH-less LTM related information; or RACH related information for early TA acquisition.
- [0167] In some implementations, the NE 400 may be an MN. In response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the NE 400 may be configured to support means for performing at least one of the following: receiving failure information

[0168] In some implementations, the NE 400 may be an MN, and the NE 400 may be configured to support means for transmitting or receiving PRACH configuration information for early TA acquisition-triggered RA procedure to or from an SN, and the SN may be a source SN or a target SN or a candidate target SN.

[0169] In some implementations, the NE 400 may be an MN, and the NE 400 may be configured to support means for performing at least one of the following: receiving an RA report from a UE; or transmitting the RA report to an SN, wherein the RA report includes at least one of the following: early RACH procedure related information; RACH-less LTM related information; or RACH related information for early TA acquisition. The SN may be a source SN or a target SN or a candidate target SN.

[0170] 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.

[0171] 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.

[0172] 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 received 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 signal. The receiver chain 410 may include at least one processor for processing the demodulated signal to receive the transmitted data.

- [0173] 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.
- [0174] 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.
- [0175] 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 PSCell #1 and PSCell #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.
- [0176] In Figure 5A, UE 101A is moving from PSCell #1 to PSCell #2, and may perform an LTM cell switch procedure from PSCell #1 to access to PSCell #2, which is an LTM PSCell 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.
- [0177] 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 PSCell #A and PSCell #B respectively. Even though there are only one UE and two DUs in Figure 5B, persons skilled in

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

- [0178] In Figure 5B, UE 101B is moving from PSCell #A to PSCell #B, and may perform an LTM PSCell switch procedure from PSCell #A to access to PSCell #B, which is an LTM PSCell 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.
- [0179] 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 PSCell #X. DU #B is controlled by CU #2 and provides services for UEs within PSCell #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.
- [0180] In Figure 5C, UE 101C is moving from PSCell #X to PSCell #Y, and may perform an LTM PSCell switch procedure from PSCell #X to access to PSCell #Y, which is an LTM PSCell switch procedure performed between different cells belonging to different DUs within different CUs. This scenario may be referred to as inter-CU mobility.
- [0181] 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.
- [0182] 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), a target DU, one or more candidate DUs (which may also be referred to as "candidate target DU(s)", "candidate target DU(s)" or "candidate DU(s)" in Figure 6), and a CU. The source DU and the target DU or the one or more candidate DUs are within the CU. The source DU and the target DU or the one or more candidate DUs are within the SN. The CU is a CU of the SN. The UE is moving from the source DU to the target DU or one of the one or more candidate DUs. The source DU may manage (or control) the serving PSCell of the UE, and one or more source PSCells. The serving PSCell and the one or more source PSCells are considered as in the source DU. Each

each candidate DU of the candidate DU (s) may manage one or more LTM candidate PSCells, and the one or more candidate PSCells are considered as in each candidate DU. One of the one or more candidate DUs manages the LTM candidate PSCell to which the UE may be switched. In some embodiments, the LTM candidate PSCell to which the UE may be switched to may be referred to as the "LTM candidate target PSCell. " When one LTM candidate PSCell is selected as a target PSCell for LTM by the network or is indicated in the LTM cell switch MAC CE, the LTM candidate PSCell can be called as an LTM target PSCell. Then, the candidate DU which manages or controls the LTM candidate PSCell can be called as a target DU, i.e. the LTM target PSCell is managed by the target DU, and the LTM candidate PSCell is managed by the candidate target DU.

- [0183] 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.
- [0184] In operation 602, the CU determines to initiate LTM configuration.
- [0185] In operation 603, the CU sends a UE context setup request message to the candidate DU, containing one target candidate PSCell ID. The CU indicates the source DU ID, and requests PRACH resources from the Candidate DU.
- [0186] 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 PSCell.
- [0187] 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 PSCell (s) in other DUs.
- [0188] 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 PSCells and the generated CSI resource configuration.
- [0189] 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 PSCell (s) and associated RS configuration for each LTM candidate PSCell in other candidate DU (s) . In some cases, the source cell may be configured as one LTM candidate PSCell.
- [0190] In operation 608, the candidate DU responds with a UE context modification response message including the generated CSI resource configuration.

- [0191] 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.
- [0192] In operation 610, the source DU forwards the received RRC reconfiguration message to the UE.
- [0193] In operation 611, the UE responds to the source DU with an RRC reconfiguration complete message.
- [0194] In operation 612, the source DU forwards the RRC reconfiguration complete message to the CU via an UL RRC message transfer message.
- [0195] In operation 613, the UE sends the lower layer measurement result e.g. L1 measurement results to the source DU.
- [0196] In operation 614, the source DU decides to execute LTM to an LTM candidate target PSCell.
- [0197] In operation 615, the source DU sends an LTM command to the UE.
- [0198] 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 PSCell ID and the selected beam information.
- [0199] In operation 617, the CU sends the target PSCell ID and the selected beam information to the target DU.
- [0200] In operation 618, the target DU detects the access of the UE.
- [0201] In operation 619, the target DU sends the access success message to the CU with the target PSCell ID.
- [0202] In operation 620 (optional), the CU may send a UE context release command message to the source DU to release the resources of prepared PSCells.
- [0203] In operation 621 (optional), the source DU responds with a UE context release complete message.
- [0204] Some embodiments of the present disclosure refer to an intra-DU intra-CU LTM procedure for intra-NR, wherein the serving or source PSCell and one or more LTM candidate PSCells 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 a target DU, or a candidate DU), and a CU. The source DU is within the CU. That is to say, different from the source DU and the target DU or the candidate DU(s) in Figure 6, the intra-DU LTM procedure only refers to one DU, i.e. the source DU and the target DU or the 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 target DU or the one or more can

didate DUs and the CU in an inter-DU LTM procedure as described in the embodiments of Figure 6.

- [0205] In some embodiments of the present disclosure, in an LTM PSCell switch procedure or in an SCG LTM procedure (e.g. a PSCell change triggered by an LTM PSCell switch MAC CE), an LTM PSCell switch failure or an SCG LTM execution failure (i.e., supervision timer T304 expiry) or an SCG failure (e.g. an RLF) may happen. Upon an SCG failure happens, the UE may transmit an SCG Failure Information message to the MN.
- [0206] Figure 7 illustrates a flowchart of a method related to an LTM PSCell 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 functional elements of the UE to perform the described functions. In some implementations, aspects of operations 702 and 704 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 702 and 704 may be performed in accordance with the examples as described herein.
- [0207] At operation 702, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of the UE, the method may include storing, by a UE, failure information related to the LTM PSCell switch procedure. The failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0208] At operation 704, the method may include transmitting the failure information by the UE. In some implementations, the failure information (denoted as "failure information #1") includes at least one of the following:
- [0209] (1) information regarding the source PSCell;
 - [0210] (2) information regarding a PSCell where the failure happens;
 - [0211] (3) information regarding a selected beam in the target PSCell;
 - [0212] (4) information regarding one or more neighbour cells;
 - [0213] (5) L1 or L3 measurement results of the source PSCell;
 - [0214] (6) L1 or L3 measurement results of the PSCell where the failure happens;
 - [0215] (7) L1 or L3 measurement results of the neighbour cells;
 - [0216] (8) information indicating whether a neighbour cell included in L1 or L3 measurement results is an LTM candidate PSCell;
 - [0217] (9) information indicating that the failure happens in the LTM PSCell switch procedure;
 - [0218] (10) information regarding at least one LTM candidate PSCell configured for the LTM PSCell switch procedure;

- [0219] (11) cell configuration information for the at least one LTM candidate PSCell;
- [0220] (12) a set of channel state information (CSI) resources for the LTM PSCell switch procedure;
- [0221] (13) a reference configuration for the LTM PSCell switch procedure;
- [0222] (14) time elapsed between reception of an LTM PSCell switch command and reception of a latest RRC reconfiguration message for the LTM PSCell switch procedure;
- [0223] (15) time elapsed between the reception of the LTM PSCell switch command and the occurrence of the failure;
- [0224] (16) time elapsed between the occurrence of the failure and the failure information is transmitted by the UE;
- [0225] (17) a TA value for a RACH-less SCG LTM; or
- [0226] (18) a TA value derived in an early RACH procedure for early TA acquisition.
- [0227] In the embodiments of the present disclosure, information regarding a cell (e.g. information regarding the source PSCell, information regarding a PSCell where the failure happens, information regarding one or more neighbour cells) may be a cell ID, which may include a global cell identity, a tracking area code of the cell, and/or a physical cell identifier (PCI) and carrier frequency information.
- [0228] 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.
- [0229] Some embodiments of the present disclosure are related to a method related to an LTM PSCell switch procedure implemented by a network node as described herein. In some implementations, the network node may be an SN (e.g. the SN may be a source SN or a target SN or a candidate target SN), and may execute a set of instructions to control the function elements of the SN to perform the described functions as follows.
- [0230] In some implementations, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the method may include obtaining, by an SN, failure information related to the LTM PSCell switch procedure, wherein the failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0231] In some implementations, the SN or a CU of the SN may perform one of the following:
- [0232] (1) receive information of a failure type of the failure from an MN, wherein the failure type is detected by the MN; or
- [0233] (2) detect the failure type of the failure.

- [0234] In an implementation, the SN or the CU of the SN may verify the failure type after receiving the information of the failure type of the failure from the MN. If the failure type is correct, the SN or the CU may transmit, to the MN, information (denoted as "information #1") indicating that the failure type detected by the MN is correct. If the failure type detected by the MN is wrong, the SN or the CU may transmit, to the MN, information (denoted as "information #2") indicating that the failure type detected by the MN is wrong.
- [0235] In some implementations, the CU of the SN may transmit at least one of the following to at least one DU of the SN:
- [0236] (1) the failure information related to the LTM PSCell switch procedure;
- [0237] (2) the information of the failure type of the failure received from the MN; or
- [0238] (3) the information of the failure type of the failure detected by the CU of the SN.
- [0239] Then, the at least one DU of the SN may detect the failure type of the failure or verify the failure type detected by the MN or by the CU of the SN.
- [0240] In an implementation, the at least one DU of the SN may transmit, to the CU of the SN, the failure type of the failure detected by the at least one DU. In an implementation, if the failure type detected by the MN or by the CU is correct, the at least one DU may transmit information indicating that the failure type detected by the MN or by the CU is correct to the CU. In another implementation, if the failure type detected by the MN or by the CU is wrong, the at least one DU may transmit information indicating that the failure type detected by the MN or by the CU is wrong to the CU, or the at least one DU may transmit information indicating the failure type verified by the at least one DU of the SN to the CU.
- [0241] In some implementations, the SN or the CU of the SN may indicate any of the following to the MN:
- [0242] (1) the failure type detected by the SN or the CU;
- [0243] (2) the failure type verified by the SN or the CU;
- [0244] (3) the failure type detected by the at least one DU of the SN; or
- [0245] (4) the failure type verified by the at least one DU of the SN.
- [0246] In some implementations, the SN or the CU of the SN may transmit at least one of the following to the MN: (1) information indicating that the failure type detected by the MN is wrong; or (2) information indicating that the failure type detected by the MN is right.
- [0247] In some implementations, the failure type includes at least one of the following:
- [0248] (1) a failure type (denoted as "failure type #1") which is defined as "Too Late SCG LTM" , wherein the UE has received configuration information for the LTM PSCell switch procedure, but the SCG failure occurs after the UE has stayed for a time period in the source PSCell or occurs before an LTM PSCell sw

itch command for the LTM PSCell switch procedure is triggered to the UE, and a suitable PSCell different from the source PSCell is found based on layer-1 (L1) or layer-3 (L3) measurement results reported from the UE, "Too Late SCG LTM" can be named as "Too Late LTM PSCell switch" or "Too Late LTM for SCG" or other name;

[0249] (2) a failure type (denoted as "failure type #2") which is defined as "Too Early SCG LTM" , wherein the SCG failure occurs shortly after a successful completion of LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the source PSCell is the suitable PSCell based on the L1 or L3 measurement results reported from the UE, "Too Early SCG LTM" can be named as "Too Early LTM PSCell switch" or "Too Early LTM for SCG" or other name; or

[0250] (3) a failure type (denoted as "failure type #3") which is defined as "SCG LTM to wrong PSCell" , wherein the SCG failure occurs shortly after the successful completion of the LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the suitable PSCell different from the source PSCell and the target PSCell is found based on the L1 or L3 measurement results reported from the UE, "SCG LTM to wrong PSCell" can be named as "LTM PSCell switch to wrong PSCell" or "LTM for SCG to wrong PSCell" or other name.

[0251] In some implementations, in response to the occurrence of the failure, the SN or the CU of the SN may receive information of a suitable PSCell. For instance, the suitable PSCell is selected by an MN, and the information of the suitable PSCell is received from the MN. In an implementation, the CU of the SN may transmit the information of the suitable PSCell received from the MN to the at least one DU of the SN.

[0252] In some other implementations, in response to the occurrence of the failure, the SN or the CU of the SN may select the suitable PSCell. In an implementation, the suitable PSCell is selected by the CU. In another implementation, the suitable PSCell is selected by at least one DU of the SN, and then the at least one DU may transmit the information of the suitable PSCell to the CU. In some embodiments, the CU of the SN requests the at least one DU of the SN to select the suitable PSCell. In some embodiments, the SN or the CU of the SN may transmit the information of the suitable PSCell to an MN. The information of the suitable PSCell may be a cell ID of the suitable PSCell, which may include a global cell identity, a tracking area code of the cell, and/or a physical cell identifier (PCI) and carrier frequency information.

- [0253] In some implementations, the failure type further includes at least one of the following:
- [0254] (1) a failure type (denoted as "failure type #4") in which a suitable PSCell selected in response to the occurrence of the failure is not one of a set of LTM candidate PSCells (denoted as "LTM candidate PSCell set #1") provided by a CU of the SN to at least one DU of the SN;
- [0255] (2) a failure type (denoted as "failure type #5") in which the suitable PSCell is one of LTM candidate PSCell set #1, but not one of a set of LTM candidate PSCells (denoted as "LTM candidate PSCell set #2") selected by the at least one DU; or
- [0256] (3) a failure type (denoted as "failure type #6") in which the suitable PSCell is one of LTM candidate PSCell set #2.
- [0257] In some implementations, the SN or the CU of the SN may detect whether the failure type is one of failure type #4, failure type #5, and failure type #6.
- [0258] If the failure type is failure type #4, the SN or the CU of the SN may determine that LTM candidate PSCell set #1 provided by the SN or the CU of the SN is improper. In an implementation, the SN or the CU of the SN may transmit, to an MN or at least one DU of the SN, information indicating that LTM candidate PSCell set #1 provided by the SN or the CU of the SN is improper.
- [0259] If the failure type is failure type #5, the CU of the SN may detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or the CU of the SN may transmit, to the at least one DU, information (denoted as "information #3") indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU. In an implementation, the at least one DU may verify the failure type or whether the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [0260] In some implementations, the at least one DU may transmit one of the following to the CU:
- [0261] (1) information indicating that the CU made a right detection regarding information #3;
- [0262] (2) information indicating that the CU made a wrong detection regarding information #3; or
- [0263] (3) information of the failure type detected or verified by the at least one DU.
- [0264] In some implementations, the SN or the CU of the SN may transmit the information of the failure type detected or verified by the SN or the at least one DU to an MN.

- [0265] If the failure type is failure type #6, the CU of the SN may detect that a wrong LTM target PSCell is selected by a source DU of the SN; or the CU may transmit, to the source DU, information (denoted as "information #4") indicating that the wrong LTM target PSCell is selected by the source DU.
- [0266] In some implementations, the source DU may verify the failure type or whether the wrong LTM target PSCell is selected by the source DU. Then, the source DU may transmit one of the following to the CU:
- [0267] (1) information indicating that the CU made a right detection regarding information #4;
- [0268] (2) information indicating that the CU made a wrong detection regarding information #4; or
- [0269] (3) information of the failure type detected or verified by the source DU.
- [0270] In some implementations, the SN or the CU of the SN may transmit the information of the failure type detected or verified by the SN or the source DU to an MN.
- [0271] In some implementations, the CU of the SN may transmit, to at least one DU of the SN, at least one of the failure information or the information of the suitable PSCell. Then, the at least one DU is configured to detect the failure type.
- [0272] If the failure type is failure type #4, the at least one DU may detect that LTM candidate PSCell set #1 provided by the CU is improper; or the at least one DU may transmit, to the CU, information (denoted as "information #5") indicating that LTM candidate PSCell set #1 provided by the CU is improper.
- [0273] If the failure type is failure type #5, the at least one DU may detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or the at least one DU may transmit, to the CU, information (denoted as "information #6") indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [0274] If the failure type is failure type #6, the source DU may detect that a wrong LTM target PSCell is selected by the source DU; or the source DU may transmit, to the CU, information (denoted as "information #7") indicating that the wrong LTM target PSCell is selected by the source DU.
- [0275] In some implementations, the SN or the CU of the SN may transmit information #5, information #6, or information #7 to an MN.
- [0276] In some implementations, to obtain the failure information, the SN or the CU of the SN may derive the failure information by itself or to receive the failure information which is stored or transmitted by the UE (e.g. failure information #1 as described in the embodiments of Figure 7) . In an implementation, the CU of the SN may transmit the failure information to the at least one DU after obtaining the failure information.

- [0277] In some implementations, the SN or the CU of the SN may detect whether a ping-pong event occurs. In some other implementations, the SN or at least one DU of the SN may detect whether a ping-pong event occurs. For the ping-pong event, after a successful completion of LTM PSCell switch from a PSCell (e.g., PSCell #1) to another PSCell (e.g., PSCell #2), the UE is switched back to PSCell #1 within a predefined time period or the UE successfully performs another LTM PSCell switch from PSCell #2 back to PSCell #1.
- [0278] In an implementation, the CU of the SN may transmit, to the at least one DU, information indicating an occurrence of the ping-pong event. In another implementation, the at least one DU of the SN may transmit, to the CU of the SN, information indicating an occurrence of the ping-pong event.
- [0279] In some implementations, the ping-pong event is detected based on: (1) history information of the UE; (2) time duration between receiving two LTM cell change notification messages for a same PSCell; or (3) time duration between receiving two access success messages for a same PSCell.
- [0280] In some implementations, the at least one DU of the SN is a source DU, a target DU, and/or at least one candidate target DU.
- [0281] Some embodiments of the present disclosure are related to a method related to an LTM PSCell switch procedure implemented by a network node as described herein. In some implementations, the network node may be an MN, and may execute a set of instructions to control the function elements of the MN to perform the described functions as follows.
- [0282] In some implementations, in response to an occurrence of a failure associated with an LTM PSCell switch procedure from a source PSCell to a target PSCell of a UE, the method may include perform at least one of the following by an MN: receiving failure information related to the LTM PSCell switch procedure from the UE; or obtaining information of a failure type of the failure. The failure includes at least one of an SCG LTM execution failure or an SCG failure.
- [0283] In an implementation, the MN may transmit the failure information to the SN (e.g. failure information #1 as described in the embodiments of Figure 7), and the SN may be a source SN, a target SN, or a candidate target SN.
- [0284] In some implementations, to obtain the information of the failure type of the failure, the MN may perform at least one of the following:
- [0285] (1) detecting the failure type;
- [0286] (2) receiving the information of the failure type from the SN; or
- [0287] (3) transmitting the information of the failure type detected by the MN to the SN; optionally, the SN may verify the failure type detected by the MN.
- [0288] In some implementations, the MN may receive one of the following from the SN:

- [0289] (1) information indicating that the failure type detected by the MN is correct;
- [0290] (2) information indicating that the failure type detected by the MN is wrong;
- [0291] (3) information indicating the failure type detected by the SN; or
- [0292] (4) information indicating the failure type verified by the SN.
- [0293] In some implementations, the failure type includes at least one of the following: failure type #1, failure type #2, failure type #3, failure type #4, failure type #5, or failure type #6 as described above.
- [0294] In some implementations, in response to the occurrence of the failure, the MN may select a suitable PSCell and transmit information of the suitable PSCell to the SN. In an implementation, a CU of the MN or at least one DU of the MN may select the suitable PSCell. In one example, the CU of the MN requests the at least one DU of the MN to select the suitable PSCell. In some implementations, the CU of the MN transmits information of the suitable PSCell to the SN.
- [0295] In some implementations, the MN may receive information of a suitable PSCell from the SN, wherein the suitable PSCell is selected by the SN.
- [0296] In some implementations, the MN may receive one of the following from the SN:
- [0297] (1) information indicating that a set of LTM candidate PSCells provided by the SN or the CU of the SN is improper;
- [0298] (2) information indicating that the one or more wrong LTM candidate PSCells are selected by the SN or the at least one DU of the SN;
- [0299] (3) information indicating that the wrong LTM target PSCell is selected by the SN or the source DU of the SN;
- [0300] (4) information of the failure type detected or verified by the at least one DU of the SN;
- [0301] (5) information of the failure type detected or verified by the source DU of the SN; or
- [0302] (6) information of the failure type detected or verified by the SN.
- [0303] The following text describes specific embodiments of the flowcharts as shown and illustrated above, i.e., Embodiments 1-4.
- [0304] Embodiment 1 (stage 2 definition for failure or ping-pong case)
- [0305] In general, there is a possibility that an SCG LTM procedure and an MCG LTM procedure may coexist. If so, a maximum number of candidate coordination between an MN and an SN (e.g. the SN may be a source SN or a target SN or a candidate target SN) is needed.
- [0306] In Embodiment 1, if an MCG LTM is triggered firstly, an MN may indicate at least one of the following to an SN (e.g. the SN may be a source SN or a target SN or a candidate target SN) :
- [0307] (1) a maximum number of LTM configurations prepared;
- [0308] (2) a maximum number of LTM candidate PCells prepared;

- [0309] (3) a maximum number of LTM configurations to be prepared; or
- [0310] (4) a maximum number of LTM candidate PSCells to be prepared.
- [0311] In Embodiment 1, if an SCG LTM procedure is triggered firstly, a SN (e.g. the SN may be a source SN or a target SN or a candidate target SN) may indicate at least one of the following to an MN:
 - [0312] (1) a maximum number of LTM configurations prepared;
 - [0313] (2) a maximum number of LTM candidate PSCells prepared;
 - [0314] (3) a maximum number of LTM configurations to be prepared; or
 - [0315] (4) a maximum number of LTM candidate PCells to be prepared.
- [0316] In some embodiments, MCG release or SCG release has a high priority than an SCG LTM procedure, and RRC re-establishment/set up/resume has a high priority than an SCG LTM procedure. While a UE has stored LTM candidate PSCell configurations, the UE can also execute any L3 PSCell change command sent by the network. It is up to the network to avoid any issue due to a collision between LTM PSCell switch and L3 PSCell change, e.g., avoiding sending LTM PSCell switch command and L3 PSCell change command simultaneously.
- [0317] In case that L3 PSCell change is triggered earlier than an SCG LTM procedure (L3 PSCell change is triggered before an SCG LTM procedure is triggered), L3 PSCell change has a high priority. In case that an SCG LTM procedure is triggered earlier than L3 PSCell change (for example, a gNB-CU receives an LTM notify message e.g. LTM CELL CHANGE NOTIFICATION message from a gNB-DU before L3 PSCell change is triggered), an SCG LTM procedure has a high priority. In case that an SCG LTM procedure and PSCell change are triggered almost simultaneously, the gNB-DU of an SN fails the L3 PSCell change by responding with a UE Context Modification Failure message with a proper cause meaning SCG LTM has a high priority.
- [0318] In an SCG LTM procedure (e.g. PSCell change triggered by an LTM cell switch MAC CE), an LTM PSCell switch failure or an SCG LTM execution failure (i.e., supervision timer T304 expiry) or an RLF may happen. Upon a connection failure happens, a UE may make the SCG LTM related failure information available to an MN, e.g. the UE stores or reports SCG LTM related failure information in a message. The message may be an existing one (e.g. an SCG Failure Information or other message) or in a new introduced message. For example, the UE may send SCG LTM related failure information to the MN e.g. via the SCG Failure Information message, after the MN receives the SCG LTM related failure information. There may be following two options in different embodiments, i.e. Option #1 and Option #2.

- [0319] Option #1: the MN may select a suitable PSCell e.g. based on L1 or L3 measurement results from the UE. For example, there may be following embodiments:
- [0320] (1) the MN or a CU of the MN may select a suitable PSCell as target PSCell for L3 PSCell change, e.g. based on L3 measurement results; or
- [0321] (2) the MN or the CU of the MN may select a suitable PSCell as target PSCell for LTM PSCell switch e.g. based on L1 measurement results; or
- [0322] (3) at least one DU of the MN may select a suitable PSCell (e.g. as an LTM target PSCell for LTM PSCell switch, based on L1 measurement results). Optionally, the CU of the MN may indicate the at least one DU of MN to select a suitable PSCell. Then, the at least one DU of the MN may indicate the information of the suitable PSCell (e.g. suitable PSCell ID, which may include a global cell identity, a tracking area code of the cell, and/or a physical cell identifier (PCI) and carrier frequency information) to the CU of the MN.
- [0323] In Option #1, the MN may indicate the information of suitable PSCell (e.g. a suitable PSCell ID) to the SN, or, the CU of the MN may indicate the information of suitable PSCell (e.g. suitable PSCell ID) to the CU of the SN. Then, the CU of the SN may indicate the information of suitable PSCell (e.g. suitable PSCell ID) to the DU(s) of the SN (e.g. a source DU of the SN, or a target DU of the SN, or at least one candidate target DU of the SN).
- [0324] In the embodiments of the present disclosure, an SN is a node which served the UE at the last initialization of an SCG LTM procedure or the LTM PSCell switch procedure or a node which triggers the SCG LTM procedure or the LTM PSCell switch procedure. For example, the SN may be a source SN or a target SN or a candidate target SN.
- [0325] Option #2: the MN may send SCG LTM related failure information to the SN. Then, the SN may select a suitable PSCell e.g. based on L1 or L3 measurement results from the UE. For example, there may be following embodiments:
- [0326] (1) the SN or the CU of the SN may select a suitable PSCell as target PSCell for L3 PSCell change, e.g. based on L3 measurement results; or
- [0327] (2) the SN or the CU of the SN may select a suitable PSCell as target PSCell for LTM PSCell switch e.g. based on L1 measurement results. Then, the CU of the SN may indicate the information of suitable PSCell (e.g. a suitable PSCell ID, which may include a global cell identity, a tracking area code of the cell, and/or a physical cell identifier (PCI) and carrier frequency information) to at least one DU of the SN (e.g. a source DU of the SN, or a target DU of the SN, or at least one candidate target DU of the SN); or

- [0328] (3) at least one DU of the SN (e.g. a source DU of the SN, or a target DU of the SN, or at least one candidate target DU of the SN) may select a suitable PSCell (e.g. as target PSCell for LTM PSCell switch, based on L1 measurement results). Optionally, the CU of the SN may indicate the at least one DU of the SN to select a suitable PSCell. Then, the at least one DU of the SN may indicate the information of the suitable PSCell (e.g. a suitable PSCell ID, which may include a global cell identity, a tracking area code of the cell, and/or a physical cell identifier (PCI) and carrier frequency information) to the CU of the SN.
- [0329] In Option #2, the SN or the CU of the SN may indicate the information of suitable PSCell (e.g. a suitable PSCell ID) to the MN or a CU of the MN. Then, the CU of the MN may indicate the information of suitable PSCell (e.g. a suitable PSCell ID) to the at least one DU of the MN (e.g. a source DU of the MN, a target DU of the MN, or at least one candidate target DU of the MN).
- [0330] In some embodiments of the present disclosure, the MN may perform an initial analysis to identify the node that caused the failure. The MN may use the SCG Failure Information Report procedure to verify whether intra-SN SCG LTM has been triggered in the last serving SN and stores the SCG Failure Information for the time needed to receive possible response from the last serving SN. If the failure is caused by a source SN, the MN then forwards the SCG Failure Information to the source SN. The node responsible for the last LTM PSCell switch (e.g. the source SN, the last serving SN, the target SN, the candidate target SN or the MN) performs the final root cause analysis.
- [0331] In some embodiments of the present disclosure, one of the functions of self-optimization for LTM PSCell switch procedure or an SCG LTM procedure is to detect failures that occur due to Too late SCG LTM or Too early SCG LTM, or SCG LTM to wrong PSCell. The failure types may also be named as "problem types" or "event types" or "case types" or the like. The failure types may be defined as follows:
- [0332] - Too late SCG LTM: UE receives configuration for an SCG LTM procedure, while an SCG failure occurs after the UE has stayed for a long period of time in the serving PSCell, or, LTM for SCG is configured but an SCG RLF occurs before LTM PSCell switch MAC CE is initiated/triggered to the UE; a suitable different PSCell is found based on the L1 or L3 measurement results reported from the UE. "Too late SCG LTM" can also be named as "Too Late LTM PSCell switch," "Too Late LTM for SCG" or other.
- [0333] - Too early SCG LTM: an SCG failure occurs shortly after a successful LTM PSCell switch from a source PSCell to a target PSCell, or an LTM PSCell switch failure/SCG LTM execution failure occurs during the

SCG LTM execution procedure; source PSCell is still the suitable PSCell based on the L1 or L3 measurement results reported from the UE. "Too early SCG LTM" can also be named as "Too Early LTM PSCell switch, " "Too Early LTM for SCG" or other.

- [0334] - SCG LTM to wrong PSCell: an SCG failure occurs shortly after a successful LTM PSCell switch from a source PSCell to a target PSCell, or an LTM PSCell switch failure/SCG LTM execution failure occurs during the SCG LTM execution procedure; a suitable PSCell different with source PSCell or target PSCell is found based on the L1 or L3 measurement results reported from the UE. "SCG LTM to wrong PSCell" can also be named as "LTM PSCell switch to wrong PSCell, " "LTM for SCG to wrong PSCell" or other.
- [0335] In the definition above, the "successful LTM PSCell switch" refers to the UE successfully completes the access procedure to the target PSCell.
- [0336] In some embodiments of the present disclosure, a failure type definition for an LTM PSCell switch procedure or an SCG LTM procedure can be defined as below (e.g. in case that a suitable PSCell is selected upon connection failure happens in intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch) :
- [0337] (1) if the suitable PSCell is not one of at least one LTM candidate PSCell provided by the CU of the SN (e.g. if the suitable PSCell is not one of at least one LTM candidate PSCell provided by the CU of the SN to a source DU or a target DU or at least one candidate target DU of the SN) , it is wrong LTM candidate PSCell list selection at the SN or the CU of the SN, and the SN may be a source SN or a target SN or a candidate target SN;
- [0338] (2) if the suitable PSCell is one of the at least one LTM candidate PSCell provided by the CU of the SN (e.g. if the suitable PSCell is not one of at least one LTM candidate PSCell provided by the CU of the SN to a source DU or a target DU or at least one candidate target DU of the SN) , but is not one of at least one LTM candidate PSCell selected by the source DU or the target DU or the at least one candidate target DU of the SN, it is wrong LTM candidate PSCell selection at the source DU or the target DU or the at least one candidate target DU of the SN of the SN;
- [0339] (3) if the suitable PSCell is one of the at least one LTM candidate PSCell selected by the source DU or the target DU or the at least one candidate target DU of the SN of the SN, it is wrong target PSCell for LTM PSCell switch decision at source DU of the SN (e.g. reference id of target PSCell i.e. "Target Configuration ID" included in the LTM PSCell switch command or LTM Command MAC CE is wrong) .
- [0340] Moreover, if subsequent SCG LTM or subsequent LTM PSCell switch procedures are executed, one of the functions of MRO is to detect ping-pong that occurs

n the subsequent SCG LTM or subsequent LTM PSCell switch procedures. Ping-pong may be named as "ping-pong event" or "ping-pong case" or the like. The event of "ping-pong (s) in subsequent SCG LTM/LTM PSCell switch procedures" may be defined as follows:

- [0341] - A UE performs LTM PSCell switch from a first PSCell to a second PSCell successfully, but within a predefined limited time, the UE is switched back to the first PSCell, or the UE performs LTM PSCell switch from the second PSCell back to the first PSCell successfully. The event may occur more than once after an RRC Reconfiguration message (e.g. which includes the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells) for LTM is received by the UE.
- [0342] Embodiment 2 (LTM PSCell switch related failure information)
- [0343] As described in Embodiment 1, in an SCG LTM procedure (e.g. PSCell change triggered by an LTM PSCell switch command or MAC CE), an LTM PSCell switch failure or an SCG LTM execution failure or an SCG RLF may happen. For any SCG failure, to enable the network to understand why the SCG LTM procedure is not successfully performed, or to help the network to know whether or how to modify the SCG LTM related configuration (e.g. optimize the list of LTM candidate PSCell(s), or RA resource(s) related information for early TA acquisition or RACH-less SCG LTM, or CFRA resource related information included in LTM PSCell switch MAC CE), LTM specific information or failure information related to the LTM PSCell switch procedure needs to be stored or reported by the UE, to enable to distinguish a failure in SCG LTM procedure from a failure in L3 PSCell change procedure. For example, the UE stores or reports SCG LTM related failure information or failure information related to the LTM PSCell switch procedure in a message. The message may be an existing report (e.g. SCG Failure Information message or other) or in a new introduced message. The SCG LTM related failure information or failure information related to the LTM PSCell switch procedure may be sent by the UE to an MN. Then, the MN may send the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the source SN or the target SN or the candidate target SN via the existing X2/Xn message (e.g. SCG FAILURE INFORMATION REPORT or other) or a new introduced X2/Xn message. For example, in case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch, the CU of the MN may send the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the CU of the source SN, and then, the CU of the source SN may send the SCG LTM related failure information to the source DU of the source SN and/or the target DU and/or at least one candidate target DU of the source SN, via a new introduced

F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . In case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch, a source SN is a node which served the UE at the last initialisation of SCG LTM/LTM PSCell switch procedure or a node which triggers the SCG LTM/LTM PSCell switch procedure, in such case, the source SN and the target SN are a same node, the source SN and the candidate target SN are a same node, and the target SN and the candidate target SN are a same node.

- [0344] In some embodiments, the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure stored or reported by the UE may include LTM specific information or LTM PSCell switch related failure information. For instance, the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure includes at least one of following:
- [0345] (1) information of source PSCell (e.g. cell ID, measurement results) . For example, the cell ID may include reference ID or index mapped with the source PSCell, PCI + carrier frequency information (e.g. ARFCN) , and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode) . For example, measurement results may include L1 measurement results or L3 measurement results;
- [0346] (2) information of failed PSCell (e.g. cell ID, measurement results) . For example, measurement results may include L1 measurement results or L3 measurement results;
- [0347] (3) information of selected beam in target PSCell (e.g. CTI state of the target PSCell) , if indicated in LTM PSCell switch MAC CE;
- [0348] (4) information of one or more neighbour cells (e.g. cell ID of each neighbour cell, measurement results of each neighbour cell, one flag to indicate whether a measured neighbour cell included in the L1 or L3 measurement results is an LTM candidate PSCell or not) ;
- [0349] (5) an indication concerning that failure happens in an SCG LTM procedure or SCG failure due to LTM PSCell switch, e.g. introduce a new failure type or failure cause of SCG failure e.g. SCG LTM failure or SCG LTM execution failure or failure shortly after successful SCG LTM execution; or introduce a new failure to indicate that failure happens in an SCG LTM procedure; or introduce an explicit indication about the type of SCG LTM cell switch; or include a new one-bit flag (add an indicator indicating whether the last executed mobility before the SCG failure was an LTM PSCell switch procedure) ;
- [0350] (6) list of LTM candidate PSCell (s) (e.g. cell ID) , for example, which are not included in the L1 or L3 measurement results;
- [0351] (7) a reference configuration for SCG LTM, e.g. which is represented by IE ltm-ReferenceConfiguration-r18 configured in the RRC Reconfiguration message

- o the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells;
- [0352] (8) a list of LTM candidate PSCell configurations, each configuration is used to configure an LTM candidate PSCell, e.g. which is represented by IE LTM-Candidate-
r18 configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells, 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 PSCell and etc.
- [0353] (9) a group of one or more CSI resources for an LTM candidate PSCell configuration, e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells;
- [0354] (10) time elapsed between reception of an LTM PSCell switch command or MAC CE (or LTM PSCell switch towards target PSCell is triggered) and the corresponding latest RRC Reconfiguration message for SCG LTM is received;
- [0355] (11) time elapsed between reception of an LTM PSCell switch command or MAC CE (or LTM PSCell switch towards target PSCell is triggered) and the occurrence of the SCG failure;
- [0356] (12) time elapsed between the occurrence of the SCG failure and the stored information or report is reported;
- [0357] (13) a TA value for a RACH-less SCG LTM; or
- [0358] (14) a TA value derived in an early RACH procedure for early TA acquisition.
- [0359] In another solution, some information can be derived by a node which triggers an SCG LTM procedure or an LTM PSCell switch procedure (e.g. in case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch, in one example, the node is a source SN, or a CU of the source SN, or at least one DU of the source SN; and in another example, the node is an MN, or the CU of the MN, or at least one DU of the MN; in case of intra-SN SCG LTM with MN involvement or in inter-SN SCG LTM, in one example, the node is a source SN, or a CU of the source SN, or at least one DU of the source SN; in another example, the CU of the node is a target SN, or a CU of the target SN, or at least one DU of the target SN; in another example, the node is an MN, or the CU of the MN, or at least one DU of the MN; and in another example, the node is a candidate target SN, or the CU of the candidate target SN, or at least one DU of the candidate target SN), even though the UE does not report them to the network. For example, in case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch, a source SN,

or a CU of the source SN, or at least one DU of the source SN can derive at least one of the following SCG LTM related failure information or failure information related to the LTM PSCell switch procedure by itself:

- [0360] (1) information about whether a measured neighbour cell included in the UE reported L1 or L3 measurement results is an LTM candidate PSCell;
- [0361] (2) information about whether failure happens in an SCG LTM or LTM PSCell switch procedure or an SCG failure due to LTM;
- [0362] (3) list of LTM candidate PSCell (s) (e.g. cell ID) ;
- [0363] (4) TA value for RACH-less SCG LTM or derived in early RACH procedure for early TA acquisition;
- [0364] (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 PSCell configurations of one or multiple LTM candidate PSCells;
- [0365] (6) a list of LTM candidate PSCell configurations, each configuration is used to configure an LTM candidate PSCell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells, 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 PSCell and etc.
- [0366] (7) a group of one or more CSI resources for an LTM candidate PSCell configuration, e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells;
- [0367] (8) time elapsed between reception of an LTM PSCell switch command or R MAC CE (or LTM PSCell switch towards target PCell is triggered) and the corresponding latest RRC Reconfiguration message for SCG 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; or
- [0368] (9) time elapsed between reception of an LTM PSCell switch command or R MAC CE (or LTM PSCell switch towards target PCell is triggered) and the SCG failure.
- [0369] In an SCG LTM or LTM PSCell switch procedure (e.g. PSCell change triggered by LTM PSCell switch command or MAC CE) , when an SCG RLF occurs before an LTM PSCell switch MAC CE is received, or when an LTM P

SCell switch failure or an SCG LTM execution failure happens (i.e., supervision timer T304 expiry) , or when an SCG failure occurs shortly after a successful LTM PSCell switch from a source PSCell to a target PSCell, the receiving node (e.g. an MN or a CU of the MN which receives SCG LTM related failure information or failure information related to the LTM PSCell switch procedure from the UE) sends the SCG LTM related failure information to the node where LTM PSCell switch is triggered (e.g. a source SN or a CU of the source SN in case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch) , e.g. via the existing X2/Xn message (e.g. SCG FAILURE INFORMATION REPORT or other) or a new introduced X2/Xn message. The CU of the source SN may send the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the source DU of the source SN and/or the target DU and/or at least one candidate target DU of the source SN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . Optionally, the CU of the MN may send the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the DU (s) of the MN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) .

[0370] In the above embodiments, a CU (e.g. a CU of an MN, or a CU of a source SN, or a CU of a target SN, or a CU of a candidate target SN) may send the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to its corresponding source DU and/or target 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 SCG LTM related failure information or failure information related to the LTM PSCell switch procedure includes at least one of the following information (the following information may be reported by the UE or derived by the CU itself) :

[0371] (1) information of source PSCell (e.g. cell ID, measurement results) . For example, the cell ID may include reference ID or index mapped with the source PSCell, PCI + carrier frequency information (e.g. ARFCN) , and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode) . For example, measurement results may include L1 measurement results or L3 measurement results;

[0372] (2) information of failed PSCell (e.g. cell ID, measurement results) . For example, measurement results may include L1 measurement results or L3 measurement results;

[0373] (3) information of selected beam in target PSCell (e.g. CTI state of the target PSCell) , if indicated in LTM PSCell switch MAC CE;

- [0374] (4) information of one or more neighbour cells (e.g. cell ID of each neighbour cell, measurement results of each neighbour cell, one flag to indicate whether a measured neighbour cell included in the L1 or L3 measurement results is an LTM candidate PSCell or not) ;
- [0375] (5) an indication concerning that failure happens in an SCG LTM procedure or SCG failure due to LTM PSCell switch, e.g. introduce a new failure type or failure cause of SCG failure e.g. SCG LTM failure or SCG LTM execution failure or failure shortly after successful SCG LTM execution; or introduce a new failure to indicate that failure happens in an SCG LTM procedure; or introduce an explicit indication about the type of SCG LTM cell switch; or include a new one-bit flag (add an indicator indicating whether the last executed mobility before the SCG failure was an LTM PSCell switch procedure) ;
- [0376] (6) list of LTM candidate PSCell (s) (e.g. cell ID) , for example, which are not included in the L1 or L3 measurement results;
- [0377] (7) 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 PSCell configurations of one or multiple LTM candidate PSCells;
- [0378] (8) a list of LTM candidate PSCell configurations, each configuration is used to configure an LTM candidate PSCell, e.g. which is represented by IE LTM-Candidate-r18 configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells, 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 PSCell and etc.
- [0379] (9) a group of one or more CSI resources for an LTM candidate PSCell configuration, e.g. which is represented by IE LTM-CSI-ResourceConfig configured in the RRC Reconfiguration message to the UE including the LTM candidate PSCell configurations of one or multiple LTM candidate PSCells;
- [0380] (10) time elapsed between reception of an LTM PSCell switch command or MAC CE (or LTM PSCell switch towards target PCell is triggered) and the corresponding latest RRC Reconfiguration message for SCG LTM is received;
- [0381] (11) time elapsed between reception of an LTM PSCell switch command or MAC CE (or LTM PSCell switch towards target PCell is triggered) and the occurrence of the SCG failure;
- [0382] (12) time elapsed between the occurrence of the SCG failure and the stored information or report is reported;
- [0383] (13) a TA value for a RACH-less SCG LTM; or

- [0384] (14) a TA value derived in an early RACH procedure for early TA acquisition.
- [0385] Embodiment 3 (MRO detection or analysis)
- [0386] Embodiment 3 provide solutions about how the network performs an MRO detection or analysis for the SCG LTM or LTM PSCell switch procedure.
- [0387] Embodiment 3-1 (mechanism for failure detection or analysis)
- [0388] In case of an intra-SN SCG LTM without MN involvement or in an SN initiated intra-SN LTM PSCell switch procedure, there may be following two solutions , i.e. Solution #1 and Solution #2.
- [0389] Solution #1: Too Late SCG LTM, or Too Early SCG LTM, or SCG LTM to wrong PSCell may be detected by an MN or a CU of the MN. The MN or the CU of the MN may indicate the failure type of Too Late SCG LTM, or Too Early SCG LTM, or SCG LTM to wrong PSCell to a source SN or a CU of the source SN, e.g. via an existing X2/Xn message (e.g. SCG FAILURE INFORMATION REPORT or other) or a new introduced X2/Xn message. Then, the CU of the source SN may indicate the failure type of Too Late SCG LTM, or Too Early SCG LTM, or SCG LTM to wrong PSCell to the source DU of the source SN and/or a target DU of the source SN and/or at least one candidate target DU of the source SN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) .
- [0390] - Optionally, the source SN or the CU of the source SN may further verify whether it is the MN or the MN's CU detected failure type or problem. If yes, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the MN or the MN's CU detected failure type or problem is correct. If no, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the MN or the MN's CU detected failure type or problem is wrong; optionally, the source SN or the CU of the source SN may transmit its verified failure type or problem to the MN or the MN's CU.
- [0391] - Optionally, the source DU of the source SN and/or target DU of the source SN and/or at least one candidate target DU of the source SN may further verify whether it is the indicated detected failure type or problem. If yes, the source DU of the source SN and/or the target DU of the source SN and/or at least one candidate target DU of the source SN may respond to the CU of the source SN that the indicated failure type or problem is correct. Then, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the MN or the MN's CU detected failure type or problem is correct. If no, the source DU of the source SN and/or the target DU of the source SN and/or the at least one candidate target DU of the source SN may respond to the CU of the source SN that the MN or the MN's CU detected failure type or problem is wrong; optionally, the source DU of the source SN and/or

the target DU of the source SN and/or the at least one candidate target DU of the source SN may transmit its verified failure type or problem to the CU of the source SN. Then, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the MN or MN's CU detected problem is wrong; optionally, the source SN or the CU of the source SN may transmit received verified failure type or problem to the MN or the MN's CU.

- [0392] Solution #2: Too Late SCG LTM, or Too Early SCG LTM, or SCG LTM to wrong PSCell may be detected by a source SN or a CU of the source SN. The CU of the source SN may indicate the failure type of Too Late SCG LTM, or Too Early SCG LTM, or SCG LTM to wrong PSCell to a source DU of the source SN and/or a target DU of the source SN and/or at least one candidate target DU of the source SN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).
- [0393] - Optionally, the relevant DU (e.g. the source DU of the source SN and/or the target DU of the source SN and/or the at least one candidate target DU of the source SN) may further verify whether it is the source SN's CU detected failure type or problem. If yes, the relevant DU may respond to the CU of the source SN that the source SN's CU detected failure type/problem is correct. If no, the relevant DU may respond to the CU of the source SN that the source SN's CU detected failure type or problem is wrong; optionally, the relevant DU may transmit its verified failure type or problem to the CU of the source SN.
- [0394] - Optionally, the source SN or the CU of the source SN may indicate the failure type to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER or other) or a new introduced X2/Xn message.
- [0395] Embodiment 3-2 (detection of ping-pong event)
- [0396] Similarly, statistics regarding ping-pong occurrences in subsequent SCG LTM or LTM PSCell switch procedures may be collected by a node. For example, the node is one which triggers SCG LTM/LTM PSCell switch or which generates the RRC Reconfiguration message for SCG LTM/LTM PSCell switch, e.g. in case of intra-SN SCG LTM without MN involvement or in SN initiated intra-SN LTM PSCell switch, the node is a source SN or the source SN's CU or an MN or the MN's CU. Then, the ping-pong in subsequent SCG LTM/LTM PSCell switch procedures may be analyzed by the source SN or the source SN's CU or the MN or the MN's CU. There may be following three options in different embodiments, i.e. Option #A, Option #B, and Option #C.
- [0397] Option #A: the ping-pong in subsequent SCG LTM/LTM PSCell switch procedures may be analyzed based on UE History Information stored by a sou

source SN or the source SN's CU or an MN or the MN's CU, or based on UE History Information received from the UE or from the MN or the CU of the MN.

- [0398] - For example, based on the time duration of UE staying in the first PSCell, or the second PSCell, or when back to the first PSCell, if within a predefined limited time the UE leaves the second PSCell and then back to the first PSCell, or if the UE stays in the second PSCell for a short predefined time, the source SN or the source SN's CU or the MN or the MN's CU detects it as a ping-pong case.
- [0399] Option #B: the ping-pong in subsequent SCG LTM/LTM PSCell switch procedures may be analyzed 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. the first PSCell where the UE was back to).
- [0400] - For example, the received LTM CELL CHANGE NOTIFICATION message indicates the initiation of the LTM PSCell switch MAC CE to the UE, based on the time duration between receiving the LTM CELL CHANGE NOTIFICATION message for the first PSCell and receiving the LTM CELL CHANGE NOTIFICATION message for the second PSCell, and/or, based on the time duration between receiving the LTM CELL CHANGE NOTIFICATION message for the second PSCell and receiving the LTM CELL CHANGE NOTIFICATION message for back to the first PSCell, if within a predefined limited time the UE is switched back to the first PSCell, or if the UE stays in the second PSCell for a short predefined time and leaves the second PSCell and then back to the first PSCell (e.g. the time duration of the UE staying in the second PSCell equals to the time between receiving the ACCESS SUCCESS message for the second PSCell, and receiving the LTM CELL CHANGE NOTIFICATION message for switching back to the first PSCell), a source SN or the source SN's CU or an MN or the MN's CU detects it as a ping-pong case.
- [0401] Option #C: the ping-pong in subsequent SCG LTM/LTM PSCell switch procedures may be analyzed 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. the first PSCell where the UE was back to).
- [0402] - For example, the received ACCESS SUCCESS message indicates the success of the LTM execution including the target PSCell ID, based on the time duration between receiving the ACCESS SUCCESS message for the first PSCell and receiving the ACCESS SUCCESS message for the second PSCell, and/or, based on the time duration between receiving the ACCESS SUCCESS message for the second PSCell and receiving the ACCESS SUCCESS message for back to the first PSCell, if within a predefined limited time the UE is switched

back to the first PSCell successfully, or if the UE stays in the second PSCell for a short predefined time and leaves the second PSCell and then back to the first PSCell successfully, the source SN or the source SN's CU or the MN or the MN's CU detects it as a ping-pong case.

- [0403] Then, the CU of the source SN or the CU of the MN may indicate the occurrence of potential ping-pong case to the corresponding DU (e.g. a source DU, or a target DU, or at least one candidate target DU except the target DU, for example, the DUs where ping-pong occurs e.g. DUs of the source SN including the DU which manages the first PSCell, or the DU which manages the second PSCell) .
- [0404] Embodiment 3-3 (F1 interface signalling)
- [0405] Based on Embodiment 3-1, in case of an intra-SN SCG LTM without MN involvement or in an SN initiated intra-SN LTM PSCell switch, when an SCG RLF occurs before LTM PSCell switch MAC CE is received, or when an LTM PSCell switch failure or SCG LTM execution failure happens (i.e., supervision timer T304 expiry) , or when an SCG failure occurs shortly after a successful LTM PSCell switch from a source PSCell to a target PSCell, an MN or a CU of the MN may receive SCG LTM related failure information or failure information related to the LTM PSCell switch procedure from the UE. Then, the MN or the CU of the MN may send the information of suitable PSCell if any and/or the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the node where LTM PSCell switch is triggered (e.g. a source SN or the CU of the source SN) , e.g. via the existing X2/Xn message (e.g. SCG FAILURE INFORMATION REPORT or other) or a new introduced X2/Xn message. There may be following two solutions, i.e. Solution #A and Solution #B.
- [0406] Solution #A: a source SN or a CU of the source SN may perform failure analysis as below:
- [0407] In Solution #A, if the suitable PSCell (e.g. the suitable PSCell as mentioned in Embodiment 1) is not contained in the at least one LTM candidate PSCell provided by the source SN, or by the CU of the source SN to a target DU or at least one candidate target DU of the source SN, the source SN or the CU of the source SN detects that the at least one LTM candidate PSCell provided by the source SN or the CU of the source SN are improper. Then, the source SN or the CU of the source SN may modify the at least one LTM candidate PSCell or the list of candidate PSCell(s) for LTM PSCell switch. Optionally, the source SN or the CU of the source SN may indicate the detected problem to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER or other) or a new introduced X2/Xn message.

- [0408] In Solution #A, if the suitable PSCell is contained in the at least one LTM candidate PSCell provided by the source SN, or by the CU of the source SN to a target DU or a candidate target DU of the source SN, but not contained in at least one LTM candidate PSCell selected or prepared by the target DU or the (candidate) target DU of the source SN (i.e. the candidate target DU of the source SN is anyone of the at least one candidate target DU of the source SN) . There may be following two options in different embodiments, i.e. Option #M and Option #N.
- [0409] Option #M: the CU of the source SN detects that it is wrong LTM candidate PSCell (s) selection or preparation at a target DU or a candidate target DU of the source SN, the CU of the source SN may indicate to the target DU or the candidate target DU of the source SN that wrong LTM candidate PSCell (s) are selected or prepared by the target DU or the candidate target DU of the source SN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . For example, one explicit or implicit indication concerning wrong LTM candidate PSCell (s) are selected or prepared may be included in the new introduced F1 message or the existing F1 message.
- [0410] In Option #M, optionally, the CU of the source SN may forward the information of the suitable PSCell (e.g., cell ID of the suitable PSCell, PCI+ carrier frequency information (e.g. ARFCN) , and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode)) and/or SCG LTM related failure information (e.g. failure information related to the LTM PSCell switch procedure as mentioned in Embodiment 2, such as the at least one LTM candidate PSCell provided by the source SN or the CU of the source SN and etc.) to the target DU or the candidate target DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) .
- [0411] In Option #M, optionally, the target DU or the candidate target DU of the source SN may further verify the CU of the source SN's detected problem is right or whether it is wrong LTM candidate PSCell (s) selected or prepared by the target DU or the candidate target DU of the source SN:
- [0412] 1) If yes, the target DU or the candidate target DU of the source SN may modify its selected or prepared one or more LTM candidate PSCells. Optionally, the target DU or the candidate target DU of the source SN may respond to the CU of the source SN that the CU of the source SN's detected problem is right or wrong LTM candidate PSCell (s) are selected or prepared by the target DU or the candidate target DU of the source SN, 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 explicit or implicit indication concerning the detected problem is right or wrong LTM candidate PSCell (s) are selected or prepared by the target DU or the candidate target DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message (e.g. GNB-DU CONFIGURATION UPDATE message or other) .

idate target DU of the source SN may be included in the new introduced F1 message or the existing F1 message.

[0413] 2) If no, optionally, the target DU or the candidate target DU of the source SN may respond to the CU of the source SN that the CU of the source SN made wrong detection, i.e. it is not wrong LTM candidate PSCell (s) selection or preparation in the target DU or the candidate target DU of the source SN, 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 explicit or implicit indication concerning the CU of the source SN made wrong detection or it is not wrong LTM candidate PSCell (s) selection or preparation in the target DU or the candidate target DU of the source SN may be included in the new introduced F1 message or the existing F1 message. Further, the target DU or the candidate target DU of the source SN may inform the detected/verified problem to the CU of the source SN, e.g. LTM candidate PSCell (s) selection or preparation in the target DU or candidate target DU of the source SN is proper.

[0414] In Option #M, optionally, the source SN or the CU of the source SN may indicate the verified or detected problem to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER or other) or a new introduced X2/Xn message.

[0415] Option #N: the CU of the source SN may forward information of the suitable PSCell and/or SCG LTM related failure information (e.g. failure information related to the LTM PSCell switch procedure as mentioned in Embodiment 2, such as the at least one LTM candidate PSCell provided by a source SN or the CU of the source SN and etc.) to the target DU or the candidate target DU of the source SN, e.g. a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . The target DU or the candidate target DU of the source SN detects that one or more wrong LTM candidate PSCells are selected or prepared at the target DU or the candidate target DU of the source SN (e.g. based on the information of suitable PSCell, the at least one LTM candidate PSCell provided by the CU of the source SN to the target DU or the (candidate) target DU of the source SN, and the at least one LTM candidate PSCell selected or prepared by the target DU or the (candidate) target DU of the source SN) . Then, the target DU or the (candidate) target DU of the source SN may modify its selected or prepared one or more LTM candidate PSCells;

[0416] In Option #N, optionally, the target DU or the (candidate) target DU of the source SN may indicate the CU of the source SN that wrong LTM candidate PSCell (s) are selected or prepared by the target DU or the (candidate) target DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message.

sage (e.g. GNB-DU CONFIGURATION UPDATE message or other) . For example, one explicit or implicit indication concerning wrong LTM candidate PSCell (s) are selected or prepared may be included in the new introduced F1 message or the existing F1 message.

- [0417] In Option #N, optionally, the source SN or the CU of the source SN may indicate the verified or detected problem to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER or other) or a new introduced X2/Xn message.
- [0418] In Solution #A, if the suitable PSCell is contained in the at least one LTM candidate PSCell selected or prepared by the target DU or one candidate target DU of the source SN (i.e. the one candidate target DU of the source SN is anyone of the at least one candidate target DU of the source SN) , there may be following two options in different embodiments, i.e. Option #X and Option #Y.
- [0419] Option #X: the CU of the source SN detects that it is wrong LTM target cell selection or decision at source DU of the source SN (e.g. reference id of target PSCell i.e. "Target Configuration ID" included in the LTM PSCell switch command or MAC CE is wrong) .
- [0420] In Option #X, the CU of the source SN may indicate the source DU of the source SN that source DU of the source SN configures/indicates wrong LTM target PSCell, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . For example, one explicit or implicit indication concerning wrong LTM target PSCell is selected or decided at source DU of the source SN may be included in the new introduced F1 message or the existing F1 message.
- [0421] In Option #X, optionally, the CU of the source SN may forward information of the suitable PSCell and/or SCG LTM related failure information (e.g. failure information related to the LTM PSCell switch procedure as mentioned in Embodiment 2, such as the at least one LTM candidate PSCell provided by the source SN or CU of the source SN, the at least one LTM candidate PSCell selected or prepared by the target DU or candidate target DU of the source SN, and etc.) to the source DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) ;
- [0422] In Option #X, optionally, the source DU of the source SN may further verify whether the CU of the source SN's detected problem is right or whether it is wrong LTM target cell selection or decision at source DU of the source SN:
- [0423] (1) If yes, the source DU of the source SN may modify target PSCell for LTM PSCell switch, optionally, the source DU of the source SN may

y respond to the CU of the source SN that the CU of the source SN's detected problem is right or wrong LTM target PSCell is selected or decided by the source DU of the source SN, 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 explicit or implicit indication concerning the detected problem is right or wrong LTM target PSCell is selected or decided by the source DU of the source SN may be included in the new introduced F1 message or the existing F1 message.

[0424] (2) If no, optionally, the source DU of the source SN may respond to the CU of the source SN that the CU of the source SN made wrong detection, i.e. it is not wrong LTM target PSCell selection or decision at source DU of the source SN, 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 explicit or implicit indication concerning the CU of the source SN made wrong detection or it is not wrong LTM target PSCell selection or decision at the source DU of the source SN may be included in the new introduced F1 message or the existing F1 message. Further, the source DU of the source SN may inform the detected/verified problem to the CU of the source SN, e.g. LTM target PSCell selection or decision at the source DU of the source SN is proper.

[0425] In Option #X, optionally, the source SN or the CU of the source SN may indicate the verified or detected problem to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER or other) or a new introduced X2/Xn message.

[0426] Option #Y: the CU of the source SN may forward information of the suitable PSCell and/or SCG LTM related failure information (e.g. failure information related to the LTM PSCell switch procedure as mentioned in Embodiment 2, such as the at least one LTM candidate PSCell provided by the source SN or the CU of the source SN to the candidate target DU of the source SN, the at least one LTM candidate PSCell selected or prepared by the candidate target DU of the source SN, and etc.) to source DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other) . The source DU of the source SN detects it is wrong LTM target PSCell selection or decision at the source DU of the source SN (e.g. reference ID of target PSCell i.e. "Target Configuration ID" included in the LTM PSCell switch command or MAC CE is wrong) (e.g. based on the information of suitable PSCell, and the at least one LTM candidate PSCell selected or prepared by the (candidate) target DU of the source SN) . Then, the source DU of the source SN may modify the target PSCell for LTM PSCell switch.

- [0427] In Option #Y, optionally, the source DU of the source SN may indicate the CU of the source SN that wrong LTM target PSCell is selected or decided by the source DU of the source SN, 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 explicit or implicit indication concerning wrong LTM target PSCell is selected or decided may be included in the new introduced F1 message or the existing F1 message. Optionally, the source SN or the CU of the source SN may indicate the detected problem (e.g. wrong LTM target PSCell is selected or decided by the source SN or the source DU of the source SN) to the MN or the CU of the MN, via the existing X2/Xn message (e.g. SCG FAILURE TRANSFER) or a new introduced X2/Xn message.
- [0428] Solution #B: an MN or a CU of the MN may perform failure analysis, e.g. detect whether it is improper LTM candidate PSCell(s) selection at the source SN or the CU of the source SN, or whether it is wrong LTM candidate PSCell(s) selection or preparation at the target DU or the candidate target DU of the source SN, or whether it is wrong LTM target PSCell selection or decision at source DU of the source SN. Then, the MN or the CU of the MN may indicate the detected problem to the source SN or the CU of the source SN, e.g. via the existing X2/Xn message (e.g. SCG FAILURE INFORMATION REPORT or other) or a new introduced X2/Xn message.
- [0429] In Solution #B, optionally, the source SN or the CU of the source SN may further verify whether it is the MN or the MN's CU detected problem. If yes, the source SN or the CU of the source SN may respond to the MN or the MN's CU that the MN or the MN's CU detected problem is correct. If no, the source SN or the CU of the source SN may respond to the MN or the MN's CU that the MN or MN's CU detected problem is wrong, optionally, the source SN or the CU of the source SN may transmit its detected/verified failure type/problem to the MN or the MN's CU. Then, the CU of the source SN may indicate the detected failure type or problem (indicated from the CU of the MN, or detected or verified by the CU of the source SN by its verification) to the source DU of the source SN and/or a target DU of the source SN and/or at least one candidate target DU of the source SN, via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other).
- [0430] In Solution #B, optionally, the source DU of the source SN and/or a target DU of the source SN and/or at least one candidate target DU of the source SN may further verify whether it is the indicated detected failure type or problem (indicated from the CU of the MN, or detected or verified by the CU of the source SN by its verification). If yes, the source DU of the source SN and/or the target DU of the source SN and/or a

t least one candidate target DU of the source SN may respond to the CU of the source SN that the indicated detected failure type or problem is correct. Optionally, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the indicated detected failure type or problem is correct. If no, the source DU of the source SN and/or the target DU of the source SN and/or at least one candidate target DU of the source SN may respond to the CU of the source SN that the indicated detected failure type or problem is wrong. Optionally, the source SN or the CU of the source SN may respond to the MN or the CU of the MN that the MN or the MN' CU detected problem is wrong.

[0431] Embodiment 3-4 (UE context identification)

[0432] When a source DU of a source SN or a target DU of the source SN or a candidate target DU of the source SN receives the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure from a CU of the source SN (e.g. in case of intra-SN SCG LTM with or without MN involvement, a source SN is a node which served the UE at the last initialisation of SCG LTM/LTM PSCell switch procedure or which triggers the SCG LTM/LTM PSCell switch procedure), the UE context (e.g. information related to a UE, for example, UE related configuration of interest, or mobility strategies) may be released. Embodiment 3-4 gives the solutions about how to enable the source DU of the source SN or a target DU of the source SN or the candidate target DU of the source SN retrieve UE context.

[0433] In order to identify the UE context in source DU of the source SN or a target DU of the source SN or the candidate target DU of the source SN when SCG LTM related failure information or failure information related to the LTM PSCell switch procedure is received from the CU of the source SN (e.g. in case of intra-SN SCG LTM with or without MN involvement, a source SN is a node which served the UE at the last initialisation of SCG LTM/LTM PSCell switch procedure or which triggers the SCG LTM/LTM PSCell switch procedure), there may be following operations:

[0434] (1) A source DU of the source SN 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 (e.g. via a source DU of the source SN implementation, the reference can be called as "Configuration Information" or "Mobility Information" or "LTM Information" or other name), and the source DU of the source SN may send this reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) to the CU of the source SN, e.g. via

a a UE Context Modification Response message or a UL RRC Message Transfer message or LTM Cell Change Notification message or other message.

- [0435] (2) A target DU or candidate target DU of the source SN 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 (e.g. via a target DU or a candidate target DU of the source SN implementation, the reference can be called as "Configuration Information" or "Mobility Information" or "LTM Information" or other name) . The target DU or the candidate target DU of the source SN may send this reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) to the CU of the source SN, e.g. via UE Context Setup Response message or UE Context Modification Response message or Access Success message or other message.
- [0436] (3) The CU of the source SN may store the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) if received from source DU of the source SN, and, the CU of the source SN may store the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) if received from the target DU of the source SN, and, the CU of the source SN may store the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) if received from candidate target DU of the source SN, respectively.
- [0437] (4) The CU of the source SN may send the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) received from source DU of the source SN back to the source DU of the source SN, when the CU of the source SN sends the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the source DU of the source SN, e.g. via a new introduced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other message) .
- [0438] (5) The CU of the source SN may send the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) received from the target DU or candidate target DU of the source SN back to the target DU or the candidate target DU of the source SN, when the CU of the source SN sends the SCG LTM related failure information or failure information related to the LTM PSCell switch procedure to the target DU or the candidate target DU of the source SN, e.g. via a new intr

duced F1 message or an existing F1 message (e.g. Access and Mobility Indication message or other message) .

- [0439] Based on the reference (which may be represented by "Configuration Information" or "Mobility Information" or "LTM Information" or other name) , the source DU of the source SN or the target DU of the source SN or the candidate target DU of the source SN can identify the UE's context.
- [0440] Embodiment 4 (RA report enhancements for LTM)
- [0441] Embodiment 4 provides enhancements for RA report in case of MCG LTM/LTM PCell switch procedure, or in case of SCG LTM/LTM PSCell switch procedure.
- [0442] To avoid RACH Collision, PRACH configuration for early TA acquisition-triggered RA procedure (or, PRACH configuration for LTM-triggered RA procedure or for early RACH procedure for early TA acquisition) can be exchanged over Xn interface (e.g. between a source CU or a source node and a candidate target CU or a candidate target node in case of inter-CU LTM, or between a source CU or a source node and a target CU or a target node in case of inter-CU LTM, or between an MN's CU and an SN's CU (or between MN and SN, the SN may be a source SN or a target SN or a candidate target SN) in case of coexistence of an MCG LTM and an SCG LTM, via a new introduced Xn message or an existing Xn message (e.g. XN SETUP REQUEST, XN SETUP RESPONSE, NG-RAN NODE CONFIGURATION UPDATE, NG-RAN NODE CONFIGURATION UPDATE ACKNOWLEDGE or other) or over F1 interface (e.g. between CU and candidate target DU (s) , or between the CU and the source DU, or between the CU and the target DU, via a new introduced F1 message or an existing F1 message (e.g. F1 SETUP REQUEST, GNB-DU CONFIGURATION UPDATE, GNB-CU CONFIGURATION UPDATE message or other) , the CU or the source DU or the target DU or the candidate target DU may be MN's or source SN's or target SN's or candidate target SN's) .
- [0443] To assist network optimize RACH related configuration for MCG LTM or SCG LTM (e.g. optimize RA resource related information for early TA acquisition or RACH-less LTM, or CFRA resource related information included in LTM cell switch command or MAC CE) , the RA report needs to be enhanced to include LTM related information, e.g. the RA report includes early RACH procedure related information, or RACH-less LTM related information, or RACH related information for early TA acquisition. The UE may store and/or report the RA report. For example, the RA report may include at least one of the following:

- [0444] (1) a new RA purpose, e.g. to indicate that the RA was initiated for early TA acquisition for LTM, or the RA procedure was triggered in an MCG or SCG LTM procedure, or the RA procedure was LTM-triggered RA or early TA acquisition-triggered RA. Or, the RA report includes an indication concerning RA was initiated for early TA acquisition for an MCG or SCG LTM procedure or the RA procedure was triggered in an MCG or SCG LTM procedure;
- [0445] (2) information of cell where RA procedure is performed, e.g. cell ID, which may include reference id/index of the cell (e.g. "Target Configuration ID" included in the LTM cell switch command or MAC CE), or PCI+ carrier frequency information (e.g. ARFCN), and/or, CGI-info (e.g. PLMN-Identity, Cell Identity and TrackingAreaCode);
- [0446] (3) TA value for RACH-less MCG or SCG LTM procedure, e.g. if included in LTM cell switch command or MAC CE;
- [0447] (4) an indication concerning whether the UE receives CFRA resource related information, e.g. in LTM cell switch command or MAC CE;
- [0448] (5) the RA resource related parameters (e.g. RA resource related information for early TA acquisition or RACH-less MCG or SCG LTM procedure, and/or CFRA resource related information, e.g. which is included in LTM cell switch command and or MAC CE, e.g. at least includes preamble index, UL/SUL indicator, SSB index, PRACH Mask index, Msg1 repetition number, frequency start, FDM, SubcarrierSpacing, start preamble or number of preambles); or
- [0449] (6) an indication concerning whether the (RACH) procedure for early TA acquisition is successful or not, or whether early RACH procedure is successful or not, or whether RACH-less MCG or SCG LTM procedure is successful or not, or an indication concerning whether the (RACH) procedure for early TA acquisition is failed or not, or whether an early RACH procedure is failed or not, or whether RACH-less MCG or SCG LTM procedure is failed or not. The RACH procedure toward a candidate cell may be considered as successful or complete once the preamble transmission is instructed to the lower layer. In case of MCG LTM, the RA report needs to be enhanced to include MCG LTM related information, the candidate cell is a candidate PCell; and in case of SCG LTM, the RA report needs to be enhanced to include SCG LTM related information, the candidate cell is a candidate PSCell.
- [0450] In case of an MCG LTM procedure or an LTM PCell switch procedure, a CU (e.g. a node which triggers an MCG LTM procedure or an LTM PCell switch procedure or a node which generates the RRC Reconfiguration message for MCG LTM procedure or an LTM PCell switch procedure, e.g. a source node or a MN or a source node's CU or a source MN's CU) may receive the RA report from the UE directly or from a third node which receives the R

A report from the UE; and then, the CU may transmit the RA report (e.g. if received from the UE directly or from the third node) to its corresponding source DU and/or target DU and/or at least one 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) .

[0451] In case of an SCG LTM procedure or an LTM PSCell switch procedure, the UE may transmit the RA report to the MN or the CU of the MN or the SN or the CU of the SN (e.g. the SN is a source SN or a target SN or a candidate target SN or a node which triggers SCG LTM/LTM PSCell switch or a node which generates the RRC Reconfiguration message for SCG LTM/LTM PSCell switch) ; and then, the MN or the CU of the MN or the SN or the CU of the SN may transmit the RA report (e.g. if received from the UE or the MN or the SN) to its corresponding source DU and/or target DU and/or at least one 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, the UE may transmit the RA report to the MN; and then the MN may transmit the RA report to a source SN and/or a target SN. For example, the UE may transmit the RA report to the source SN and/or the target SN. For another example, if the source SN's CU or the target SN's CU receives the RA report, the source SN's CU or the target SN's CU may transmit the RA report to its corresponding source DU and/or target DU and/or at least one 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) .

[0452] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

Claims

- [Claim 1] A secondary node (SN) , comprising:
at least one memory; and
at least one processor coupled to the at least one memory and configured to cause the SN to:
in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE) , obtain failure information related to the LTM PSCell switch procedure,
wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [Claim 2] The SN of Claim 1, wherein the processor is configured to cause the SN to perform one of the following, or wherein the SN includes a centralized unit (CU) and the CU is configured to perform one of the following:
receiving information of a failure type of the failure from a master node (MN) , wherein the failure type is detected by the MN; or
detecting the failure type of the failure.
- [Claim 3] The SN of Claim 2, wherein the SN also includes at least one distributed unit (DU) , the CU is configured to transmit at least one of the following to the at least one DU:
the failure information related to the LTM PSCell switch procedure;
the information of the failure type of the failure received from the MN; or
the information of the failure type of the failure detected by the CU.
- [Claim 4] The SN of Claim 3, wherein the at least one DU is configured to:
detect the failure type of the failure; or
verify the failure type detected by the MN or by the CU.
- [Claim 5] The SN of Claim 4, wherein the at least one DU is configured to:
transmit, to the CU, the failure type of the failure detected by the at least one DU; or
if the failure type detected by the MN or by the CU is correct, transmit information indicating that the failure type detected by the MN or by the CU is correct to the CU; or

if the failure type detected by the MN or by the CU is wrong, transmit information indicating that the failure type detected by the MN or by the CU is wrong to the CU.

[Claim 6]

The SN of any of Claims 2-5, wherein the failure type includes at least one of the following:

a first failure type which is defined as Too Late SCG LTM, wherein the UE has received configuration information for the LTM PSCell switch procedure, but the SCG failure occurs after the UE has stayed for a time period in the source PSCell or occurs before an LTM PSCell switch command for the LTM PSCell switch procedure is triggered to the UE, and a suitable PSCell different from the source PSCell is found based on layer-1 (L1) or layer-3 (L3) measurement results reported from the UE;

a second failure type which is defined as Too Early SCG LTM, wherein the SCG failure occurs shortly after a successful completion of LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the source PSCell is the suitable PSCell based on the L1 or L3 measurement results reported from the UE; or

a third failure type which is defined as SCG LTM to wrong PSCell, wherein the SCG failure occurs shortly after the successful completion of the LTM PSCell switch from the source PSCell to the target PSCell or the SCG LTM execution failure occurs, and the suitable PSCell different from the source PSCell and the target PSCell is found based on the L1 or L3 measurement results reported from the UE.

[Claim 7]

The SN of Claim 2, wherein the processor is configured to cause the SN to or the CU is configured to:

in response to the occurrence of the failure, receive information of a suitable PSCell or select the suitable PSCell.

[Claim 8]

The SN of any of Claims 2-5 and 7, the failure type further includes at least one of the following:

a fourth failure type in which a suitable PSCell selected in response to the occurrence of the failure is not one of a first set of LTM candidate PSCells provided by a CU of the SN to at least one DU of the SN;

a fifth failure type in which the suitable PSCell is one of the first set of LTM candidate PSCells, but not one of a second set of LTM candidate PSCells selected by the at least one DU; or

- a sixth failure type in which the suitable PSCell is one of the second set of LTM candidate PSCells.
- [Claim 9] The SN of Claim 8, wherein the processor is configured to cause the SN to or the CU is configured to detect whether the failure type is one of the fourth failure type, the fifth failure type, and the sixth failure type.
- [Claim 10] The SN of Claim 9, wherein if the failure type is the fourth failure type, the processor is configured to cause the SN to or the CU is configured to determine that the first set of LTM candidate PSCells provided by the SN or the CU is improper.
- [Claim 11] The SN of Claim 9, wherein the SN also includes at least one distributed unit (DU), and if the failure type is the fifth failure type, the CU is configured to:
detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or
transmit, to the at least one DU, third information indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [Claim 12] The SN of Claim 9, wherein if the failure type is the sixth failure type, the CU is configured to:
detect that a wrong LTM target PSCell is selected by a source DU of the SN; or
transmit, to the source DU, fourth information indicating that the wrong LTM target PSCell is selected by the source DU.
- [Claim 13] The SN of Claim 8, wherein the SN also includes at least one distributed unit (DU); wherein the CU is configured to transmit, to the at least one DU, at least one of the failure information or the information of the suitable PSCell; and wherein the at least one DU is configured to detect the failure type.
- [Claim 14] The SN of Claim 13, wherein if the failure type is the fifth failure type, the at least one DU is configured to:
detect that one or more wrong LTM candidate PSCells are selected by the at least one DU; or
transmit, to the CU, sixth information indicating that the one or more wrong LTM candidate PSCells are selected by the at least one DU.
- [Claim 15] The SN of Claim 13, wherein if the failure type is the sixth failure type, a source DU is configured to:
detect that a wrong LTM target PSCell is selected by the source DU; or

[Claim 16]

transmit, to the CU, seventh information indicating that the wrong LTM target PSCell is selected by the source DU.

The SN of Claim 1, wherein the SN includes a centralized unit (CU), to obtain the failure information, the processor is configured to cause the SN to or the CU is configured to derive the failure information by itself or to receive the failure information which is stored or transmitted by the UE, wherein the failure information includes at least one of the following:

information regarding the source PSCell;

information regarding a PSCell where the failure happens;

information regarding a selected beam in the target PSCell;

information regarding one or more neighbour cells;

L1 or L3 measurement results of the source PSCell;

L1 or L3 measurement results of the PSCell where the failure happens;

L1 or L3 measurement results of the neighbour cells;

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

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

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

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

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

a reference configuration for the LTM PSCell switch procedure;

time elapsed between reception of an LTM PSCell switch

command and reception of a latest RRC reconfiguration message for the LTM PSCell switch procedure;

time elapsed between the reception of the LTM PSCell

switch command and the occurrence of the failure;

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

a time alignment (TA) value for a random access channel (RACH) - less SCG LTM; or

a TA value derived in an early RACH procedure for early TA acquisition.

- [Claim 17] The SN of Claim 1, wherein the SN includes a centralized unit (CU) and at least one distributed unit (DU) , and wherein the processor is configured to cause the SN to or the CU is configured to detect whether a ping-pong event occurs, and wherein for the ping-pong event, after a successful completion of LTM PSCell switch from a first PSCell to a second PSCell, the UE is switched back to the first PSCell within a predefined time period or the UE successfully performs another LTM PSCell switch from the second PSCell back to the first PSCell.
- [Claim 18] A master node (MN) , comprising:
 at least one memory; and
 at least one processor coupled to the at least one memory and configured to cause the MN to:
 in response to an occurrence of a failure associated with a L1/L2-Triggered Mobility (LTM) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of a user equipment (UE) , perform at least one of the following:
 receiving failure information related to the LTM PSCell switch procedure from the UE; or
 obtaining information of a failure type of the failure,
 wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure.
- [Claim 19] A master node (MN) , comprising:
 at least one memory; and
 at least one processor coupled to the at least one memory and configured to cause the MN to:
 transmit or receive physical random access channel (PRACH) configuration information for early timing advance (TA) acquisition-triggered random access (RA) procedure to or from a secondary node (SN) .
- [Claim 20] 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) primary secondary cell group cell (PSCell) switch procedure from a source PSCell to a target PSCell of the UE,
 store failure information related to the LTM PSCell switch procedure

, wherein the failure includes at least one of a secondary cell group (SCG) LTM execution failure or an SCG failure; and transmit the failure information.