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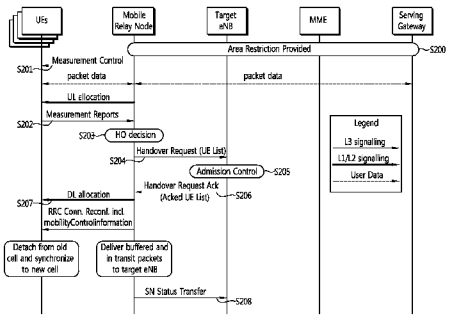
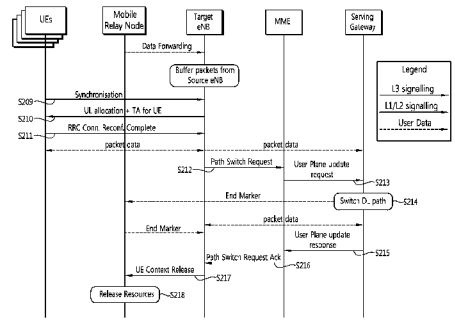
[Continued on next page]

(54) **Title**: METHOD AND APPARATUS FOR PERFORMING HANDOVER PROCEDURE IN WIRELESS COMMUNICATION SYSTEM INCLUDING MOBILE RELAY NODE

[Fig. 7a]



[Fig. 7b]



(57) **Abstract**: A method and apparatus for performing a handover procedure in a wireless communication system including a mobile relay node is provided. A target evolved NodeB (eNB) receives a handover request message containing a list of a plurality of user equipments (UEs) on the mobile relay node or a group handover indication. The target eNB performs an admission control for the plurality of UEs; and transmits a handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

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Description

Title of Invention: METHOD AND APPARATUS FOR PERFORMING HANDOVER PROCEDURE IN WIRELESS COMMUNICATION SYSTEM INCLUDING MOBILE RELAY NODE

Technical Field

[0001] The present invention relates to wireless communication, and more particularly, to a method and apparatus for performing a handover procedure in a wireless communication system including a mobile relay node.

Background Art

[0002] Universal mobile telecommunications system (UMTS) is a 3rd generation (3G) asynchronous mobile communication system operating in wideband code division multiple access (WCDMA) based on European systems, global system for mobile communications (GSM) and general packet radio services (GPRS). The long-term evolution (LTE) of UMTS is under discussion by the 3rd generation partnership project (3GPP) that standardized UMTS.

[0003] The 3GPP LTE is a technology for enabling high-speed packet communications. Many schemes have been proposed for the LTE objective including those that aim to reduce user and provider costs, improve service quality, and expand and improve coverage and system capacity. The 3GPP LTE requires reduced cost per bit, increased service availability, flexible use of a frequency band, a simple structure, an open interface, and adequate power consumption of a terminal as an upper-level requirement.

[0004] FIG. 1 shows network structure of an evolved universal mobile telecommunication system (E-UMTS). The E-UMTS may be also referred to as an LTE system. The communication network is widely deployed to provide a variety of communication services such as voice over internet protocol (VoIP) through IMS and packet data.

[0005] As illustrated in FIG. 1, the E-UMTS network includes an evolved UMTS terrestrial radio access network (E-UTRAN), an evolved packet core (EPC) and one or more user equipment. The E-UTRAN may include one or more evolved NodeB (eNB) 20, and a plurality of user equipment (UE) 10. One or more E-UTRAN mobility management entity (MME)/system architecture evolution (SAE) gateways 30 may be positioned at the end of the network and connected to an external network.

[0006] As used herein, "downlink" refers to communication from eNB 20 to UE 10, and "uplink" refers to communication from the UE to an eNB. UE 10 refers to commu-

nication equipment carried by a user and may be also referred to as a mobile station (MS), a user terminal (UT), a subscriber station (SS) or a wireless device.

[0007] An eNB 20 provides end points of a user plane and a control plane to the UE 10. MME/SAE gateway 30 provides an end point of a session and mobility management function for UE 10. The eNB and MME/SAE gateway may be connected via an S1 interface.

[0008] The eNB 20 is generally a fixed station that communicates with a UE 10, and may also be referred to as a base station (BS) or an access point. One eNB 20 may be deployed per cell. An interface for transmitting user traffic or control traffic may be used between eNBs 20.

[0009] The MME provides various functions including NAS signaling to eNBs 20, NAS signaling security, AS security control, Inter CN node signaling for mobility between 3GPP access networks, Idle mode UE reachability (including control and execution of paging retransmission), tracking area list management (for UE in idle and active mode), PDN GW and serving GW selection, MME selection for handovers with MME change, SGSN selection for handovers to 2G or 3G 3GPP access networks, roaming, authentication, bearer management functions including dedicated bearer establishment, support for PWS (which includes ETWS and CMAS) message transmission. The SAE gateway host provides assorted functions including per-user based packet filtering (by e.g. deep packet inspection), lawful interception, UE IP address allocation, transport level packet marking in the downlink, UL and DL service level charging, gating and rate enforcement, DL rate enforcement based on APN-AMBR. For clarity MME/SAE gateway 30 will be referred to herein simply as a "gateway," but it is understood that this entity includes both an MME and an SAE gateway.

[0010] A plurality of nodes may be connected between eNB 20 and gateway 30 via the S1 interface. The eNBs 20 may be connected to each other via an X2 interface and neighboring eNBs may have a meshed network structure that has the X2 interface.

[0011] FIG. 2 shows architecture of a typical E-UTRAN and a typical EPC.

[0012] As illustrated, eNB 20 may perform functions of selection for gateway 30, routing toward the gateway during a radio resource control (RRC) activation, scheduling and transmitting of paging messages, scheduling and transmitting of broadcast channel (BCCH) information, dynamic allocation of resources to UEs 10 in both uplink and downlink, configuration and provisioning of eNB measurements, radio bearer control, radio admission control (RAC), and connection mobility control in LTE_ACTIVE state. In the EPC, and as noted above, gateway 30 may perform functions of paging origination, LTE_IDLE state management, ciphering of the user plane, system architecture evolution (SAE) bearer control, and ciphering and integrity protection of non-access stratum (NAS) signaling.

[0013] FIG. 3 shows a user-plane protocol and a control-plane protocol stack for the E-UMTS.

[0014] FIG. 3(a) is block diagram depicting the user-plane protocol, and FIG. 3(b) is block diagram depicting the control-plane protocol. As illustrated, the protocol layers may be divided into a first layer (L1), a second layer (L2) and a third layer (L3) based upon the three lower layers of an open system interconnection (OSI) standard model that is well known in the art of communication systems.

[0015] The physical layer, the first layer (L1), provides an information transmission service to an upper layer by using a physical channel. The physical layer is connected with a medium access control (MAC) layer located at a higher level through a transport channel, and data between the MAC layer and the physical layer is transferred via the transport channel. Between different physical layers, namely, between physical layers of a transmission side and a reception side, data is transferred via the physical channel.

[0016] The MAC layer of Layer 2 (L2) provides services to a radio link control (RLC) layer (which is a higher layer) via a logical channel. The RLC layer of Layer 2 (L2) supports the transmission of data with reliability. It should be noted that the RLC layer illustrated in FIGS. 3(a) and 3(b) is depicted because if the RLC functions are implemented in and performed by the MAC layer, the RLC layer itself is not required. The PDCP layer of Layer 2 (L2) performs a header compression function that reduces unnecessary control information such that data being transmitted by employing internet protocol (IP) packets, such as IPv4 or IPv6, can be efficiently sent over a radio (wireless) interface that has a relatively small bandwidth.

[0017] A radio resource control (RRC) layer located at the lowest portion of the third layer (L3) is only defined in the control plane and controls logical channels, transport channels and the physical channels in relation to the configuration, reconfiguration, and release of the radio bearers (RBs). Here, the RB signifies a service provided by the second layer (L2) for data transmission between the terminal and the UTRAN.

[0018] As illustrated in FIG. 3(a), the RLC and MAC layers (terminated in an eNB 20 on the network side) may perform functions such as scheduling, automatic repeat request (ARQ), and hybrid automatic repeat request (HARQ). The PDCP layer (terminated in eNB 20 on the network side) may perform the user plane functions such as header compression, integrity protection, and ciphering.

[0019] As illustrated in FIG. 3(b), the RLC and MAC layers (terminated in an eNodeB 20 on the network side) perform the same functions for the control plane. As illustrated, the RRC layer (terminated in an eNB 20 on the network side) may perform functions such as broadcasting, paging, RRC connection management, radio bearer (RB) control, mobility functions, and UE measurement reporting and controlling. The NAS control protocol (terminated in the MME of gateway 30 on the network side) may perform

functions such as a SAE bearer management, authentication, LTE_IDLE mobility handling, paging origination in LTE_IDLE, and security control for the signaling between the gateway and UE 10.

[0020] The RRC state may be divided into two different states such as a RRC_IDLE and a RRC_CONNECTED. In RRC_IDLE state, the UE 10 may receive broadcasts of system information and paging information while the UE specifies a discontinuous reception (DRX) configured by NAS, and the UE has been allocated an identification (ID) which uniquely identifies the UE in a tracking area and may perform PLMN selection and cell re-selection. Also, in RRC_IDLE state, no RRC context is stored in the eNB.

[0021] In RRC_CONNECTED state, the UE 10 has an E-UTRAN RRC connection and a context in the E-UTRAN, such that transmitting and/or receiving data to/from the network (eNB) becomes possible. Also, the UE 10 can report channel quality information and feedback information to the eNB.

[0022] In RRC_CONNECTED state, the E-UTRAN knows the cell to which the UE 10 belongs. Therefore, the network can transmit and/or receive data to/from UE 10, the network can control mobility (handover and inter-RAT cell change order to GERAN with NACC) of the UE, and the network can perform cell measurements for a neighboring cell.

[0023] In RRC_IDLE state, the UE 10 specifies the paging DRX cycle. Specifically, the UE 10 monitors a paging signal at a specific paging occasion of every UE specific paging DRX cycle.

[0024] The paging occasion is a time interval during which a paging signal is transmitted. The UE 10 has its own paging occasion.

[0025] A paging message is transmitted over all cells belonging to the same tracking area. If the UE 10 moves from one tracking area to another tracking area, the UE will send a tracking area update message to the network to update its location.

[0026] FIG. 4 shows an example of structure of a physical channel.

[0027] The physical channel transfers signaling and data between layer L1 of a UE and eNB. As illustrated in FIG. 4, the physical channel transfers the signaling and data with a radio resource, which consists of one or more sub-carriers in frequency and one more symbols in time.

[0028] One sub-frame, which is 1 ms in length, consists of several symbols. The particular symbol(s) of the sub-frame, such as the first symbol of the sub-frame, can be used for downlink control channel (PDCCH). PDCCHs carry dynamic allocated resources, such as PRBs and MCS.

[0029] A transport channel transfers signaling and data between the L1 and MAC layers. A physical channel is mapped to a transport channel.

[0030] Downlink transport channel types include a broadcast channel (BCH), a downlink shared channel (DL-SCH), a paging channel (PCH) and a multicast channel (MCH). The BCH is used for transmitting system information. The DL-SCH supports HARQ, dynamic link adaptation by varying the modulation, coding and transmit power, and both dynamic and semi-static resource allocation. The DL-SCH also may enable broadcast in the entire cell and the use of beamforming. The PCH is used for paging a UE. The MCH is used for multicast or broadcast service transmission.

[0031] Uplink transport channel types include an uplink shared channel (UL-SCH) and random access channel(s) (RACH). The UL-SCH supports HARQ and dynamic link adaptation by varying the transmit power and potentially modulation and coding. The UL-SCH also may enable the use of beamforming. The RACH is normally used for initial access to a cell.

[0032] The MAC sublayer provides data transfer services on logical channels. A set of logical channel types is defined for different data transfer services offered by MAC. Each logical channel type is defined according to the type of information transferred.

[0033] Logical channels are generally classified into two groups. The two groups are control channels for the transfer of control plane information and traffic channels for the transfer of user plane information.

[0034] Control channels are used for transfer of control plane information only. The control channels provided by MAC include a broadcast control channel (BCCH), a paging control channel (PCCH), a common control channel (CCCH), a multicast control channel (MCCH) and a dedicated control channel (DCCH). The BCCH is a downlink channel for broadcasting system control information. The PCCH is a downlink channel that transfers paging information and is used when the network does not know the location cell of a UE. The CCCH is used by UEs having no RRC connection with the network. The MCCH is a point-to-multipoint downlink channel used for transmitting MBMS control information from the network to a UE. The DCCH is a point-to-point bi-directional channel used by UEs having an RRC connection that transmits dedicated control information between a UE and the network.

[0035] Traffic channels are used for the transfer of user plane information only. The traffic channels provided by MAC include a dedicated traffic channel (DTCH) and a multicast traffic channel (MTCH). The DTCH is a point-to-point channel, dedicated to one UE for the transfer of user information and can exist in both uplink and downlink. The MTCH is a point-to-multipoint downlink channel for transmitting traffic data from the network to the UE.

[0036] Uplink connections between logical channels and transport channels include a DCCH that can be mapped to UL-SCH, a DTCH that can be mapped to UL-SCH and a CCCH that can be mapped to UL-SCH. Downlink connections between logical channels and

transport channels include a BCCH that can be mapped to BCH or DL-SCH, a PCCH that can be mapped to PCH, a DCCH that can be mapped to DL-SCH, and a DTCH that can be mapped to DL-SCH, a MCCH that can be mapped to MCH, and a MTCH that can be mapped to MCH.

[0037] Meanwhile, 3GPP LTE-A may supports relaying by having a relay node (RN) wirelessly connect to an eNB serving the RN. It may be referred to Paragraph 4.7 of "Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (release 10)" to 3GPP (3rd generation partnership project) TS 36.300 V10.2.0 (2010-12). The eNB serving the RN may be referred as donor eNB (DeNB). The DeNB and the RN may be connected via a modified version of the E-UTRA radio interface. The modified vision may be referred as a Un interface.

[0038] The RN may support eNB functionality. It means that the RN terminates the radio protocols of the E-UTRA radio interface, and an S1 and X2 interfaces. In addition to the eNB functionality, the RN may also support a subset of UE functionality, e.g, a physical layer, layer-2, RRC, and NAS functionality, in order to wirelessly connect to the DeNB.

[0039] FIG. 5 shows a block diagram illustrating network structure of an LTE-A system introducing a relay system.

[0040] Referring to FIG. 5, the LTE-A network includes an E-UTRAN, an EPC and one or more user equipment (not described). The E-UTRAN may include one or more eNB 111, one or more donor eNB (DeNB) 110, one or more relay node (RN) 100 and a plurality of UE may be located in one cell. One or more E-UTRAN MME/S-GW 120 may be positioned at the end of the network and connected to an external network.

[0041] As used herein, “downlink” refers to communication from the eNB 111 to the UE, from the DeNB 110 to the UE or from the RN 100 to the UE, and “uplink” refers to communication from the UE to the eNB 111, from the UE to the DeNB 110 or from the UE to the RN 100. The UE refers to communication equipment carried by a user and may be also referred to as a mobile station (MS), a user terminal (UT), a subscriber station (SS) or a wireless device.

[0042] The eNB 111 and the DeNB 110 provide end points of a user plane and a control plane to the UE. MME/S-GW 120 provides an end point of a session and mobility management function for UE. The eNB 111 and the MME/S-GW 120 may be connected via an S1 interface. The DeNB 110 and MME/SAE gateway 120 may be connected via an S1 interface. The eNBs 111 may be connected to each other via an X2 interface and neighboring eNBs may have a meshed network structure that has the X2 interface. The eNB 111 and the DeNB 110 may be connected to each other via an

X2 interface.

[0043] The RN 100 may be wirelessly connected to the DeNB 110 via a modified version of the E-UTRA radio interface being called the Un interface. That is, the RN 100 may be served by the DeNB 110. The RN 100 may support the eNB functionality which means that it terminates the S1 and X2 interfaces. Functionality defined for the eNB 111 or the DeNB 110, e.g. radio network layer (RNL) and transport network layer (TNL), may also apply to RNs 100. In addition to the eNB functionality, the RN 100 may also support a subset of the UE functionality, e.g. physical layer, layer-2, RRC, and NAS functionality, in order to wirelessly connect to the DeNB.

[0044] The RN 100 may terminate the S1, X2 and Un interfaces. The DeNB 110 may provide S1 and X2 proxy functionality between the RN 100 and other network nodes (other eNBs, MMEs and S-GWs). The S1 and X2 proxy functionality may include passing UE-dedicated S1 and X2 signaling messages as well as GTP data packets between the S1 and X2 interfaces associated with the RN 100 and the S1 and X2 interfaces associated with other network nodes. Due to the proxy functionality, the DeNB 110 appears as an MME (for S1) and an eNB (for X2) to the RN.

[0045] The DeNB 110 may also embed and provides the S-GW/P-GW-like functions needed for the RN operation. This includes creating a session for the RN 100 and managing EPS bearers for the RN 100, as well as terminating the S11 interface towards the MME serving the RN 100.

[0046] The RN and the DeNB may also perform mapping of signaling and data packets onto EPS bearers that are setup for the RN. The mapping may be based on existing QoS mechanisms defined for the UE and the P-GW.

[0047] The relay node may be classified to a fixed relay node and a mobile relay node. One of the possible deployment scenarios of mobile relay node is high speed public transportation, e.g, a high speed railway. Hence, it is easily expected that the provision of various good quality services towards the users on a high speed public transportation will be important. Meanwhile, the service requirements offered by the fixed relay node seem to be different from those offered by the mobile relay node. So, there might be a few of considerations that should be resolved in the mobile relay node. The solutions to resolve these considerations for mobile relay node may have impacts on radio a radio access network (RAN).

[0048] A handover procedure may be supported in 3GPP LTE-A. Currently, in RRC_CONNECTED state, the network controls the handover procedure per UE basis. That is, the network decides the movement of each UE toward a new cell. The network triggers the handover procedure based on the radio conditions and load. When the mobile relay node is deployed, it is expected that the excessive signaling overhead will be incurred from per UE based handover. For example, massive UEs served by the

mobile relay node may perform the handover procedure at the same time toward the same target eNB (or DeNB) when a high speed train having the mobile relay node stops at the station in the high speed railway scenario. Accordingly, the handover success rate will be reduced due to the excessive signaling overhead in a short period of time, and the UEs on the mobile relay node attached to the high speed public transportation will suffer from the reduced handover success rate. The problem stated above can also occur in the typical handover scenario (e.g., S1 handover) between macro cells without considering the mobile relay node when massive UEs perform the handover procedure almost at the same time.

[0049] For another example, massive UEs served by the mobile relay node may perform the handover procedure almost at the same time toward the same target eNB (or DeNB) when a high speed train having the mobile relay node moves fast in the high speed railway scenario. The handover success rate can be reduced due to the excessive signaling overhead in a short period of time, and the UEs on the mobile relay node attached to the high speed public transportation will suffer from the reduced handover success rate. In addition, the signaling storm incurred from the handover requests of large number of UEs will cause an overload to the network. This problem can also occur in the typical handover situation (e.g., S1 handover) between macro cells without considering the mobile relay node when massive UEs perform handover almost at the same time.

[0050] Therefore, optimization is needed to resolve the problems.

Summary of Invention

Technical Problem

[0051] The present invention provides a method and apparatus for performing a handover procedure in a wireless communication system including a mobile relay node. The present invention provides a method of performing a group handover procedure by utilizing a list of UEs on a mobile relay node when massive UEs perform the handover procedure at the same time.

Solution to Problem

[0052] In an aspect, a method for performing a handover procedure, by a target evolved NodeB (eNB), in a wireless communication system including a mobile relay node is provided. The method includes receiving a handover request message containing a list of a plurality of user equipments (UEs) on the mobile relay node, performing an admission control for the plurality of UEs, and transmitting a handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

[0053] The handover request message may be received from the mobile relay node, and the

handover request acknowledge message may be transmitted to the mobile relay node.

[0054] The handover request message may be received after the mobile relay node receives measurement reports from the plurality of UEs.

[0055] The mobile relay node may not move.

[0056] The handover request message may contain information on the plurality of UEs.

[0057] The plurality of UEs may be grouped based on a predefined time period among multiple UEs.

[0058] The handover request message may be received from a serving donor eNB (DeNB), and the handover request acknowledge message may be transmitted to the serving DeNB.

[0059] The handover request message may be received after the serving DeNB receives measurement report from the mobile relay node.

[0060] The handover request message may be received from a target mobile management entity (MME), and the handover request acknowledge message may be transmitted to the target MME.

[0061] The handover request message may be received after a serving DeNB transmits a handover required message containing the list of a plurality of UEs to a source MME.

[0062] In another aspect, a method for performing a handover procedure, by a mobile relay node, in a wireless communication system including the mobile relay node is provided. The method includes receiving measurement reports from a plurality of user equipments (UEs) on the mobile relay node, transmitting a handover request message to a target evolved NodeB (eNB), the handover request message containing a list of the plurality of UEs, and receiving a handover request acknowledge message from the target eNB, the handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

[0063] In another aspect, a method for performing a handover procedure, by a target evolved NodeB (eNB), in a wireless communication system including a mobile relay node is provided. The method includes receiving a handover request message containing a group handover indication, performing an admission control for a plurality of user equipments (UEs) on the mobile relay node, and transmitting a handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

Advantageous Effects of Invention

[0064] A signaling overhead may be reduced when massive UEs attached to the mobile relay node perform the handover procedure at the same time.

Brief Description of Drawings

[0065] FIG. 1 shows network structure of an evolved universal mobile telecommunication

system (E-UMTS).

[0066] FIG. 2 shows architecture of a typical E-UTRAN and a typical EPC.

[0067] FIG. 3 shows a user-plane protocol and a control-plane protocol stack for the E-UMTS.

[0068] FIG. 4 shows an example of structure of a physical channel.

[0069] FIG. 5 shows a block diagram illustrating network structure of an LTE-A system introducing a relay system.

[0070] FIG. 6 shows a basic intra-mobile management entity (MME)/serving gateway (S-GW) handover procedure.

[0071] FIG. 7 shows an overall procedure of connected mode mobility management according to an embodiment of the present invention.

[0072] FIG. 8 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention.

[0073] FIG. 9 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention.

[0074] FIG. 10 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention.

[0075] FIG. 11 is a block diagram showing wireless communication system to implement an embodiment of the present invention.

Mode for the Invention

[0076] The technology described below can be used in various wireless communication systems such as code division multiple access (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), single carrier frequency division multiple access (SC-FDMA), etc. The CDMA can be implemented with a radio technology such as universal terrestrial radio access (UTRA) or CDMA-2000. The TDMA can be implemented with a radio technology such as global system for mobile communications (GSM)/general packet ratio service (GPRS)/enhanced data rate for GSM evolution (EDGE). The OFDMA can be implemented with a radio technology such as institute of electrical and electronics engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802-20, evolved UTRA (E-UTRA), etc. IEEE 802.16m is an evolution of IEEE 802.16e, and provides backward compatibility with an IEEE 802.16-based system. The UTRA is a part of a universal mobile telecommunication system (UMTS). 3rd generation partnership project (3GPP) long term evolution (LTE) is a part of an evolved UMTS (E-UMTS) using the E-UTRA. The 3GPP LTE uses the OFDMA in downlink and uses the SC-FDMA in uplink. LTE-advance (LTE-A) is an evolution of the 3GPP LTE.

[0077] For clarity, the following description will focus on the LTE-A. However, technical features of the present invention are not limited thereto.

[0078] FIG. 6 shows a basic intra-mobile management entity (MME)/serving gateway (S-GW) handover procedure.

[0079] In E-UTRAN, network-controlled UE-assisted handovers may be performed in RRC-CONNECTED state. Part of the handover command comes from the target eNB and is transparently forwarded to the UE by the source eNB. To prepare the handover procedure, the source eNB passes all necessary information to the target eNB (e.g. E-RAB attributes and RRC context). When a carrier aggregation (CA) is configured and to enable seconday cell (SCell) selection in the target eNB, the source eNB can provide in decreasing order of radio quality a list of the best cells. Both the source eNB and the UE keep some context (e.g. C-RNTI) to enable the return of the UE in case of handover procedure failure. The UE accesses the target cell via a random access channel (RACH) following a contention-free procedure using a dedicated RACH preamble or following a contention-based procedure if dedicated RACH preambles are not available. If the RACH procedure towards the target cell is not successful within a certain time, the UE initiates radio link failure recovery using the best cell.

[0080] The preparation and execution phase of the handover procedure is performed without evolved packet core (EPC) involvement. It means that preparation messages are directly exchanged between the eNBs. The release of the resources at the source side during the handover completion phase is triggered by the eNB. In case an RN is involved, its DeNB relays the appropriate S1 messages between the RN and the MME (S1-based handover) and X2 messages between the RN and target eNB (X2-based handover). The DeNB is explicitly aware of a UE attached to the RN due to the S1 proxy and X2 proxy functionality.

[0081] First, the handover preparation procedure is described.

[0082] 0. Area restriction information is provided. The UE context within the source eNB contains information regarding roaming restrictions which where provided either at connection establishment or at the last timing advance (TA) update.

[0083] 1. The source eNB configures the UE measurement procedures according to the area restriction information, and transmits a measurement control message to the UE through L3 signaling. Measurements provided by the source eNB may assist the function controlling the UE's connection mobility. Meanwhile, the packet data is exchanged between the UE and the source eNB, or between the source eNB and the serving gateway.

[0084] 2. The UE transmits measurement reports by the rules set by i.e. system information, specification etc to the source eNB through L3 signaling.

[0085] 3. The source eNB makes handover decision based on the measurement reports and

radio resource management (RRM) information.

[0086] 4. The source eNB transmits a handover request message through L3 signaling to the target eNB passing necessary information to prepare the handover procedure at the target side. UE X2 / UE S1 signaling references enable the target eNB to address the source eNB and the EPC. The evolved radio access bearer (E-RAB) context includes necessary radio network layer (RNL) and transport network layer (TNL) addressing information, and quality of service (QoS) profiles of the E-RABs.

[0087] In the case of a UE under an RN performing handover procedure, the handover request message is received by the DeNB, which reads the target cell ID from the message, finds the target eNB corresponding to the target cell ID, and forwards the X2 message toward the target eNB.

[0088] In the case of a UE performing handover procedure toward an RN, the handover request is received by the DeNB, which reads the target cell ID from the message, finds the target RN corresponding to the target cell ID, and forwards the X2 message toward the target RN.

[0089] 5. The target eNB performs admission control. The admission control may be performed dependent on the received E-RAB QoS information to increase the likelihood of a successful handover, if the resources can be granted by target eNB. The target eNB configures the required resources according to the received E-RAB QoS information and reserves a C-RNTI and optionally a RACH preamble. The AS-configuration to be used in the target cell can either be specified independently (i.e. an "establishment") or as a delta compared to the AS-configuration used in the source cell (i.e. a "reconfiguration").

[0090] 6. The target eNB transmits a handover request acknowledge message to the source eNB through L3 signaling, and prepares the handover. The handover request acknowledge message may include a transparent container to be sent to the UE as an RRC message to perform the handover. The transparent container may include a new C-RNTI, target eNB security algorithm identifiers for the selected security algorithms, a dedicated RACH preamble, and possibly some other parameters i.e. access parameters, SIBs, etc. The handover request acknowledge message may also include RNL/TNL information for the forwarding tunnels, if necessary. Meanwhile, as soon as the source eNB receives the handover request acknowledge message, or as soon as the transmission of the handover command is initiated in the downlink, data forwarding may be initiated.

[0091] 7. The target eNB transmits an RRC connection reconfiguration message including mobility control information to perform the handover, to be sent by the source eNB to the UE. The source eNB performs the necessary integrity protection and ciphering of the message. The UE receives the RRC connection reconfiguration message with

necessary parameters. The UE is commanded by the source eNB to perform the handover procedure. The UE does not need to delay the handover execution for delivering the hybrid automatic repeat request (HARQ)/automatic repeat request (ARQ) responses to the source eNB.

[0092] Hereafter, the handover execution procedure will be described.

[0093] The UE detaches from old cell and synchronizes to new cell. In addition, the source eNB delivers buffered and in-transit packets to the target eNB.

[0094] 8. The source eNB transmits a serial number (SN) status transfer message to the target eNB to convey the uplink packet data convergence protocol (PDCP) SN receiver status and the downlink PDCP SN transmitter status of E-RABs for which PDCP status preservation applies. The uplink PDCP SN receiver status may include at least the PDCP SN of the first missing UL SDU and a bit map of the receive status of the out of sequence UL SDUs that the UE needs to retransmit in the target cell, if there are any such SDUs. The downlink PDCP SN transmitter status indicates the next PDCP SN that the target eNB shall assign to new SDUs, not having a PDCP SN yet. The source eNB may omit sending this message if none of the E-RABs of the UE shall be treated with PDCP status preservation.

[0095] 9. After receiving the RRC connection reconfiguration message including the mobility control information, the UE performs synchronization to the target eNB and access the target cell via RACH. The access to the target cell via the RACH may be a contention-free procedure if a dedicated RACH preamble was indicated in the mobility control information. Or, the access to the target cell via RACH may be a contention-based procedure if no dedicated preamble was indicated. The UE derives target eNB specific keys and configures the selected security algorithms to be used in the target cell.

[0096] 10. The target eNB responds to the synchronization of the UE with UL allocation and timing advance.

[0097] 11. When the UE has successfully accessed the target cell, the UE transmits an RRC connection reconfiguration complete message (C-RNTI) to confirm the handover procedure, along with an uplink buffer status report, whenever possible, to the target eNB to indicate that the handover procedure is completed for the UE. The target eNB verifies the C-RNTI sent in the RRC connection reconfiguration complete message. The target eNB can now begin transmitting data to the UE. The packet data is exchanged between the UE and the target eNB.

[0098] Hereafter, the handover completion procedure will be described.

[0099] 12. The target eNB transmits a path switch request message to MME to inform that the UE has changed cell.

[0100] 13. The MME transmits a user plane update request message to a serving gateway

(S-GW).

[0101] 14. The S-GW switches the downlink data path to the target side. The S-GW transmits one or more end marker packets on the old path to the source eNB and then can release any U-plane/TNL resources towards the source eNB.

[0102] 15. The S-GW transmits a user plane update response message to MME.

[0103] 16. The MME transmits a path switch acknowledge message to the target eNB to confirm the path switch request message.

[0104] 17. The target eNB transmits a UE context release message to the source eNB to inform success of the handover procedure and trigger the release of resources by the source eNB.

[0105] 18. When the UE context release message is received, the source eNB can release radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue.

[0106] For an efficient handover procedure and reducing a signaling overhead, a method for performing a handover procedure by using a list of UEs and/or a group handover indication is described below.

[0107] First, a method for performing a handover procedure by using a list of UEs is proposed. This method can be seen as an implicit notification for group mobility.

[0108] FIG. 7 shows an overall procedure of connected mode mobility management according to an embodiment of the present invention.

[0109] The method described in FIG. 7 may be applied when a high speed train stops at a station in a high speed public transportation scenario. The UEs try to handover to the target eNB. The mobile relay forwards a handover request message containing the list of UEs toward the target eNB when it receives the measurement reports from a group of corresponding UEs. That is, during each predefined (subsequent) time period, the handover requests from multiple UEs are grouped into a single handover request for the same target eNB and the grouped handover requests are sent to the respective target eNBs on the time period basis. The number of the grouped handover request may be at least one. That is, a plurality of UEs may be grouped into a single group or a plurality of groups. When a target eNB receives the handover request message, it performs the admission control for the UEs. The target eNB then returns a handover request acknowledge message containing the list of admitted UEs for handover. If the plurality of UEs is grouped into the plurality of groups, the handover request acknowledge message may contain the list of admitted UEs for each group.

[0110] Referring to FIG. 7, step S200 in FIG. 7 corresponds to 0 in FIG. 6.

[0111] In step S201, the mobile relay node configures the UE measurement procedures, and transmits a measurement control message to the UEs through L3 signaling. Measurements provided by the mobile relay node may assist the function controlling the

UE's connection mobility.

[0112] In step S202, the UEs transmit measurement reports to the mobile relay node through L3 signaling.

[0113] In step S203, the mobile relay node makes handover decision based on RRM information.

[0114] In step S204, the mobile relay node transmits a handover request message to the target eNB through L3 signaling to prepare the handover procedure at the target eNB.

[0115] When the mobile relay node receives multiple measurements reports from the UEs, the mobile relay node transmits the handover request message containing information on a list of UEs toward the target eNB. As explained before, the handover request message contains the information for multiple UEs for the same target eNB. Also, the grouping of handover requests (e.g., via measurement reports) from multiple UEs into a single handover request message may be done in a predefined time period basis. That is, during each predefined time period, the handover requests from multiple UEs may be grouped into the single handover request message which contains the information on the corresponding UEs. So, the grouped handover request message is transmitted to the same target eNB on a predefined time period basis. The handover request message may contain the followings for the corresponding UEs.

[0116] - MME UE S1AP ID

[0117] - UE Security Capabilities

[0118] - AS Security Information

[0119] - Subscriber Profile ID for RAN/Frequency Priority

[0120] - E-RAB related information

[0121] - RRC Context

[0122] - Handover Restriction List

[0123] - Location Reporting Information

[0124] - UE History Information

[0125] - Trace Activation

[0126] - SRVCC Operation Possible

[0127] - CSG Membership Status

[0128] The information described above may be defined in a UE Context Information IE, a UE History Information IE, a Trace Activation IE, an SRVCC Operation Possible IE and a CSG Membership Status IE. Also, the UE Context Information IE may contain the information on an MME UE S1AP ID, a UE Security Capabilities, AS Security Information, a Subscriber Profile ID for RAN/Frequency Priority, E-RAB related information, an RRC Context, a Handover Restriction List and Location Reporting Information. The IEs above may be defined in 3GPP TS 36.423.

[0129] In step S205, after receiving the handover request message from the mobile relay

node, the target eNB performs admission control for the UEs contained in the list of UEs in the handover request message.

[0130] The admission control may be performed dependent on the received E-RAB QoS information to increase the likelihood of a successful handover, if the resources can be granted by target eNB. The target eNB configures the required resources according to the received E-RAB QoS information and reserves a C-RNTI and optionally a RACH preamble.

[0131] In step S206, the target eNB returns a handover request acknowledge message as a response to the handover request message towards the mobile relay node through L3 signaling, and prepares the handover.

[0132] The handover request acknowledge message may contain the following for the admitted UEs for handover.

[0133] - E-RAB related information (Admitted E-RABs, Not Admitted E-RABs)

[0134] The handover request acknowledge message may also include a transparent container to be sent to the UE as an RRC message to perform the handover. The transparent container may include a new C-RNTI, target eNB security algorithm identifiers for the selected security algorithms, a dedicated RACH preamble, and possibly some other parameters i.e. access parameters, SIBs, etc.

[0135] Step S207 to step S218 in FIG. 7 are identical to 7 to 18 in FIG. 6.

[0136] Clearly, the handover procedure utilizing the list of UEs can also be adopted in the legacy handover scenario (S1 handover) between macro cells. In this case, the mobile relay node can be substituted into the source eNB for the above explanations of group handover procedure via UE list management.

[0137] FIG. 8 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention.

[0138] The method described in FIG. 8 may be applied when the mobile relay node attached to a high speed train moves fast between stations and performs an X2-based handover between DeNBs in a high speed public transportation scenario. The motivation of using a list of UEs under mobile relay node is to differentiate the handover of individual legacy UEs and the handover of mobile relay node. Since the mobile relay node should offer services to a lot of UEs, the E-RABs assigned to the mobile relay node may not be released during handover. That is, when a target eNB receives the handover request message, it performs admission control for the mobile relay node instead of the UEs under mobile relay node. Since the services offered to the UEs under mobile relay node should not be interrupted during handover, the target eNB will nearly accept the E-RABs associated with the mobile relay node.

[0139] Referring to FIG. 8, step S300 in FIG. 8 corresponds to 0 in FIG. 6.

[0140] In step S301, the serving DeNB configures the UE measurement procedures, and

transmits a measurement control message to the mobile relay node through L3 signaling. Measurements provided by the serving DeNB may assist the function controlling the RN's connection mobility.

[0141] In step S302, the mobile relay node transmits measurement report to the serving DeNB through L3 signaling.

[0142] In step S303, the serving DeNB makes handover decision based on RRM information.

[0143] In step S304, the serving DeNB transmits a handover request message to the target DeNB through L3 signaling to prepare the handover procedure at the target DeNB.

[0144] After receiving measurement report from the mobile relay node, the serving DeNB transmits the handover request message containing a list of UEs to the target DeNB. This can be done because the serving DeNB knows the UEs attached to the mobile relay node. The handover request message may contain the followings for the corresponding UEs.

[0145] - Old eNB UE X2AP ID

[0146] - Cause

[0147] - Target Cell ID

[0148] - GUMMEI

[0149] - UE Context Information: MME UE S1AP ID, UE Security Capabilities, AS Security Information, Subscriber Profile ID for RAN/Frequency Priority, E-RAB related information, RRC Context, Handover Restriction List, Location Reporting Information

[0150] - UE History Information

[0151] - Trace Activation

[0152] - SRVCC Operation Possible

[0153] - CSG Membership Status

[0154] In step S305, after receiving the handover request message from the serving DeNB, the target DeNB performs admission control for the UEs contained in the list of UEs in the handover request message.

[0155] The admission control may be performed dependent on the received E-RAB QoS information to increase the likelihood of a successful handover, if the resources can be granted by target eNB. The target eNB configures the required resources according to the received E-RAB QoS information and reserves a C-RNTI and optionally a RACH preamble.

[0156] In step S306, the target DeNB returns a handover request acknowledge message as a response to the handover request message towards the serving DeNB through L3 signaling, and prepares the handover.

[0157] The handover request acknowledge message may contain the following for the

admitted UEs for handover.

[0158] - E-RAB related information (Admitted E-RABs, Not Admitted E-RABs)

[0159] The handover request acknowledge message may also include a transparent container to be sent to the UE as an RRC message to perform the handover. The transparent container may include a new C-RNTI, target eNB security algorithm identifiers for the selected security algorithms, a dedicated RACH preamble, and possibly some other parameters i.e. access parameters, SIBs, etc.

[0160] Step S307 to step S318 in FIG. 8 are identical to 7 to 18 in FIG. 6.

[0161] FIG. 9 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention. The method described in FIG. 9 may be applied when the mobile relay node attached to a high speed train moves fast between stations and performs an S1-based handover between DeNBs in a high speed public transportation scenario.

[0162] Referring to FIG. 9, in step S400, the serving DeNB configures the UE measurement procedures, and transmits a measurement control message to the mobile relay node. Measurements provided by the serving DeNB may assist the function controlling the RN's connection mobility.

[0163] In step S401, the mobile relay node transmits measurement report to the serving DeNB.

[0164] In step S402, after receiving the measurement report from the mobile relay node, the serving DeNB transmits a handover required message containing a list of UEs to the source MME. The list of UEs comprises UEs on the mobile relay node. In step S403, the source MME forwards the list of UEs to the target MME through a forward relocation request message.

[0165] In step S404, the target MME transmits a handover request message containing the list of UEs to the target eNB. The target MME knows the UEs attached to the mobile relay node. The handover request messages may contain the followings for the corresponding UEs.

[0166] - MME UE S1AP ID

[0167] - Handover Type

[0168] - Cause

[0169] - UE Aggregate Maximum Bit Rate

[0170] - E-RAB related information

[0171] - Source to Target Transparent Container

[0172] - UE Security Capabilities

[0173] - Handover Restriction List

[0174] - Trace Activation

[0175] - Request Type

[0176] - SRVCC Operation Possible

[0177] - Security Context

[0178] - NAS Security Parameters to E-UTRAN

[0179] - CSG Id

[0180] - CSG Status

[0181] - GUMMEI

[0182] - MME UE S1AP ID 2

[0183] After receiving the handover request message from the target MME, the target eNB performs an admission control for the UEs contained in the handover request message.

[0184] In step S405, the target eNB returns a handover request acknowledge message as a response to the handover request message to the target MME. The handover request acknowledge message may contain the following information for the list of admitted UEs for handover.

[0185] - E-RAB related information (Admitted E-RABs, Failed to Setup E-RABs)

[0186] In step S406, the target MME forwards the handover request acknowledge message to the source MME through a forward relocation response message. In step S407, the source MME transmits a handover command message to the source eNB, and the source eNB forwards the handover command message to the mobile relay node. In step S408, the mobile relay node transmits a handover confirm message to the target eNB, and the target eNB transmits a handover notify message to the target MME.

[0187] In step S409, the source MME and the target MME exchanges a forward relocation complete notification message and a forward relocation complete acknowledge message. In step S410, the source MME and the source eNB exchanges the forward relocation complete notification message and the forward relocation complete acknowledge message.

[0188] The handover procedure using a group handover indication is secondly proposed. This can be seen as an explicit notification for group mobility.

[0189] FIG. 10 shows an overall procedure of connected mode mobility management according to another embodiment of the present invention.

[0190] The method described in FIG. 10 may be applied when the mobile relay node attached to a high speed train moves fast between stations and performs an S1-based handover between DeNBs in a high speed public transportation scenario. The motivation of using a group handover indication under mobile relay node is to differentiate the handover of individual legacy UEs and the handover of mobile relay node. Since the mobile relay node should offer services to a lot of UEs, the E-RABs assigned to the mobile relay node may not be released during handover. That is, when a target eNB receives the handover request message, it performs admission control for the mobile relay node instead of the UEs under mobile relay node. Since the services

offered to the UEs under mobile relay node should not be interrupted during handover, the target eNB will nearly accept the E-RABs associated with the mobile relay node.

[0191] Referring to FIG. 10, in step S500, the serving DeNB configures the UE measurement procedures, and transmits a measurement control message to the mobile relay node. Measurements provided by the serving DeNB may assist the function controlling the RN's connection mobility.

[0192] In step S501, the mobile relay node transmits measurement report to the serving DeNB. This is done instead of the measurement reports from individual UEs under mobile relay node. This is because the mobile relay node offers the best quality services to the UEs under itself and thus the UEs under mobile relay node do not need to perform handover procedure.

[0193] In step S502, after receiving the measurement report from the mobile relay node, the serving DeNB transmits a handover required message containing a group handover indication to the source MME. The group handover indication may contain information on the target eNB, the target MME, etc. In step S503, the source MME forwards the group handover indication to the target MME through a forward relocation request message.

[0194] In step S504, the target MME transmits a handover request message containing the group handover indication to the target eNB. The target MME knows the UEs attached to the mobile relay node. Together with the group handover indication, the followings for the corresponding UEs can also be transported via the handover request message. This is to let the target eNB know about the UEs handed over to itself under the mobile relay node.

[0195] - MME UE S1AP ID

[0196] - Handover Type

[0197] - Cause

[0198] - UE Aggregate Maximum Bit Rate

[0199] - E-RAB related information

[0200] - Source to Target Transparent Container

[0201] - UE Security Capabilities

[0202] - Handover Restriction List

[0203] - Trace Activation

[0204] - Request Type

[0205] - SRVCC Operation Possible

[0206] - Security Context

[0207] - NAS Security Parameters to E-UTRAN

[0208] - CSG Id

[0209] - CSG Status

[0210] - GUMMEI

[0211] - MME UE S1AP ID 2

[0212] After receiving the handover request message from the target MME, the target eNB performs an admission control for the UEs contained in the handover request message.

[0213] In step S505, the target eNB returns a handover request acknowledge message as a response to the handover request message to the target MME. The handover request acknowledge message may contain the following information for the list of admitted UEs for handover.

[0214] - E-RAB related information (Admitted E-RABs, Failed to Setup E-RABs)

[0215] In step S506, the target MME forwards the handover request acknowledge message to the source MME. In step S507, the source MME transmits a handover command message to the source eNB, and the source eNB forwards the handover command message to the mobile relay node. In step S508, the mobile relay node transmits a handover confirm message to the target eNB, and the target eNB transmits a handover notify message to the target MME.

[0216] In step S509, the source MME and the target MME exchanges a forward relocation complete notification message and a forward relocation complete acknowledge message. In step S510, the source MME and the source eNB exchanges the forward relocation complete notification message and the forward relocation complete acknowledge message.

[0217] Meanwhile, in step S520, the mobile relay node may transmit the group handover indication to the UE through RRC signaling. The group handover indication may contain information on the target eNB, the target MME, etc.

[0218] The handover procedure utilizing the group handover indication can be adopted in the legacy handover scenario (S1 handover) between macro cells. In such case, the mobile relay node can be substituted into the source eNB for the above explanations of group handover procedure.

[0219] Also, the two methods, which are the handover procedure using the list of UEs and the handover procedure using the group handover indication, may be used separately. But, they can be used in combination at the same time.

[0220] FIG. 11 is a block diagram showing wireless communication system to implement an embodiment of the present invention.

[0221] An target eNB 800 includes a processor 810, a memory 820, and an RF (radio frequency) unit 830. The processor 810 may be configured to implement proposed functions, procedures, and/or methods in this description. Layers of the radio interface protocol may be implemented in the processor 810. The memory 820 is operatively coupled with the processor 810 and stores a variety of information to operate the processor 810. The RF unit 830 is operatively coupled with the processor 810, and

transmits and/or receives a radio signal.

[0222] A mobile relay node or a serving DeNB 900 may include a processor 910, a memory 920 and a RF unit 930. The processor 910 may be configured to implement proposed functions, procedures and/or methods described in this description. Layers of the radio interface protocol may be implemented in the processor 910. The memory 920 is operatively coupled with the processor 910 and stores a variety of information to operate the processor 910. The RF unit 930 is operatively coupled with the processor 910, and transmits and/or receives a radio signal.

[0223] The processor 910 may include an application-specific integrated circuit (ASIC), another chip set, a logical circuit, and/or a data processing unit. The RF unit 920 may include a baseband circuit for processing radio signals. In software implemented, the aforementioned methods can be implemented with a module (i.e., process, function, etc.) for performing the aforementioned functions. The module may be performed by the processor 910.

[0224] In view of the exemplary systems described herein, methodologies that may be implemented in accordance with the disclosed subject matter have been described with reference to several flow diagrams. While for purposed of simplicity, the methodologies are shown and described as a series of steps or blocks, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the steps or blocks, as some steps may occur in different orders or concurrently with other steps from what is depicted and described herein. Moreover, one skilled in the art would understand that the steps illustrated in the flow diagram are not exclusive and other steps may be included or one or more of the steps in the example flow diagram may be deleted without affecting the scope and spirit of the present disclosure.

[0225] What has been described above includes examples of the various aspects. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the various aspects, but one of ordinary skill in the art may recognize that many further combinations and permutations are possible. Accordingly, the subject specification is intended to embrace all such alternations, modifications and variations that fall within the spirit and scope of the appended claims.

Claims

[Claim 1] A method for performing a handover procedure, by a target evolved NodeB (eNB), in a wireless communication system including a mobile relay node, the method comprising:
receiving a handover request message containing a list of a plurality of user equipments (UEs) on the mobile relay node;
performing an admission control for the plurality of UEs; and
transmitting a handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

[Claim 2] The method of claim 1, wherein:
the handover request message is received from the mobile relay node, and
the handover request acknowledge message is transmitted to the mobile relay node.

[Claim 3] The method of claim 2, wherein the handover request message is received after the mobile relay node receives measurement reports from the plurality of UEs.

[Claim 4] The method of claim 2, wherein the mobile relay node does not move.

[Claim 5] The method of claim 1, wherein the handover request message contains information on the plurality of UEs.

[Claim 6] The method of claim 1, wherein the plurality of UEs is grouped based on a predefined time period among multiple UEs.

[Claim 7] The method of claim 1, wherein:
the handover request message is received from a serving donor eNB (DeNB), and
the handover request acknowledge message is transmitted to the serving DeNB.

[Claim 8] The method of claim 7, wherein the handover request message is received after the serving DeNB receives measurement report from the mobile relay node.

[Claim 9] The method of claim 1, wherein:
the handover request message is received from a target mobile management entity (MME), and
the handover request acknowledge message is transmitted to the target MME.

[Claim 10] The method of claim 9, wherein the handover request message is received after a serving DeNB transmits a handover required message

containing the list of a plurality of UEs to a source MME.

[Claim 11] A method for performing a handover procedure, by a mobile relay node, in a wireless communication system including the mobile relay node, the method comprising:
receiving measurement reports from a plurality of user equipments (UEs) on the mobile relay node;
transmitting a handover request message to a target evolved NodeB (eNB), the handover request message containing a list of the plurality of UEs; and
receiving a handover request acknowledge message from the target eNB, the handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

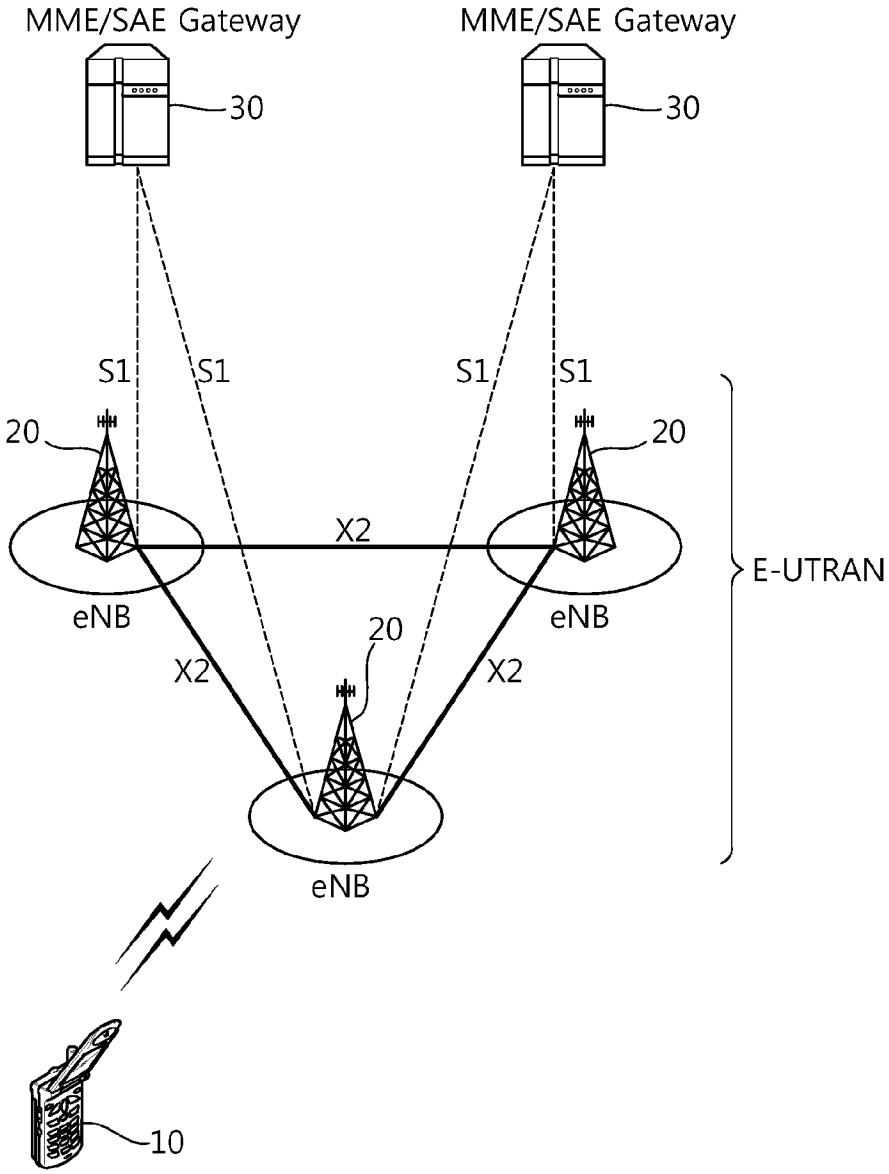
[Claim 12] The method of claim 11, wherein the mobile relay node does not move.

[Claim 13] The method of claim 11, wherein the handover request message contains information on the plurality of UEs.

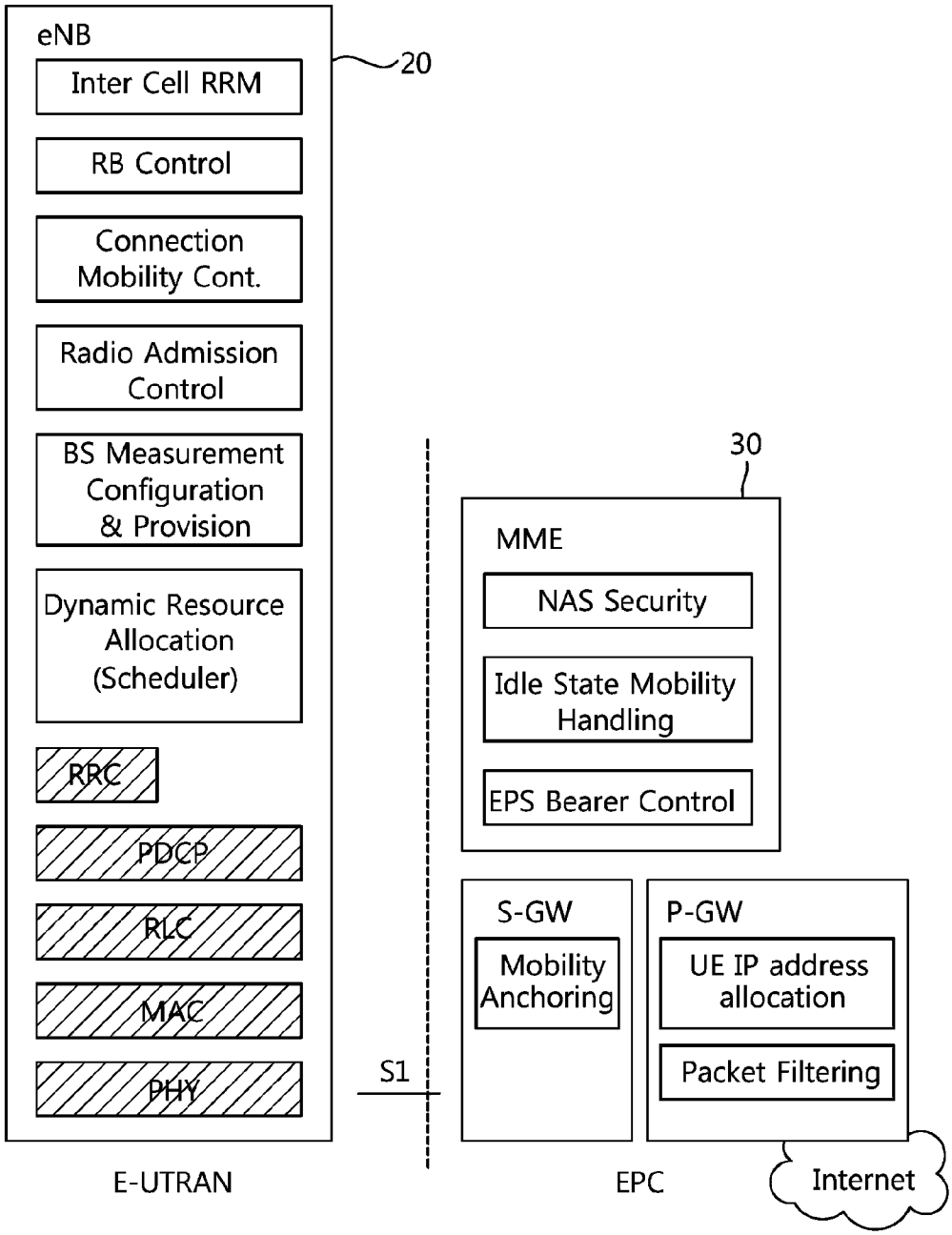
[Claim 14] The method of claim 11, wherein the plurality of UEs is grouped based on a predefined time period among multiple UEs.

[Claim 15] A method for performing a handover procedure, by a target evolved NodeB (eNB), in a wireless communication system including a mobile relay node, the method comprising:
receiving a handover request message containing a group handover indication;
performing an admission control for a plurality of user equipments (UEs) on the mobile relay node; and
transmitting a handover request acknowledge message containing a list of admitted UEs for handover among the plurality of UEs.

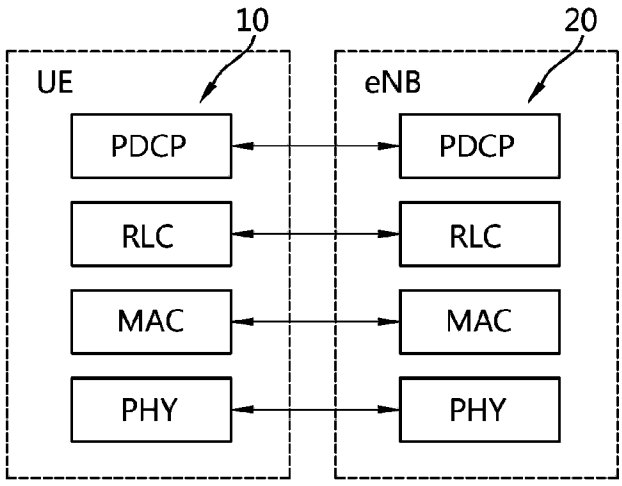
[Fig. 1]


MME/SAE Gateway
MME/SAE Gateway
30
30
S1
S1
S1
S1
20
20
X2
E-UTRAN
eNB
eNB
20
X2
X2
eNB
10

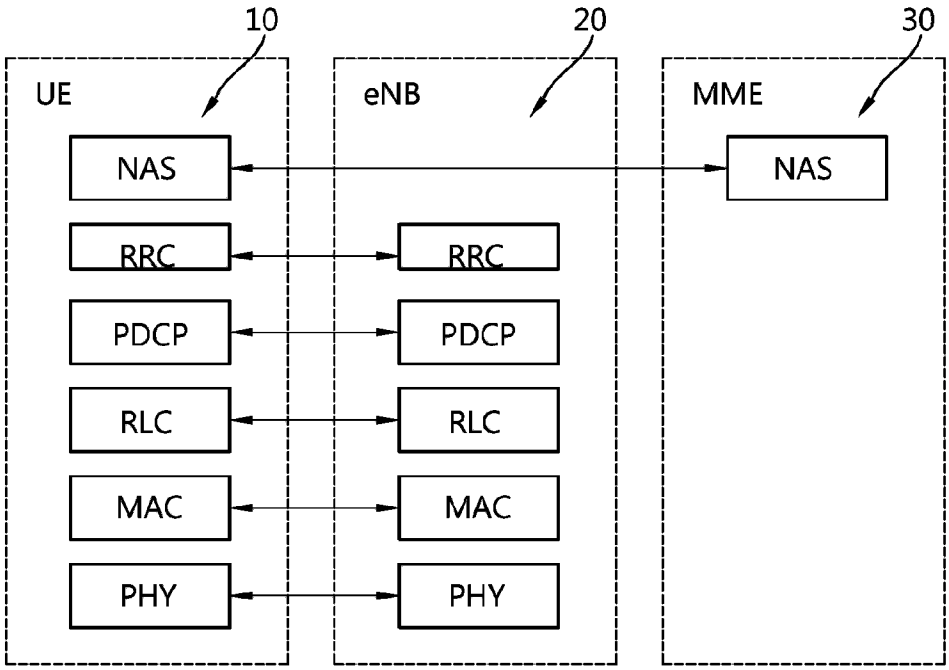
[Fig. 2]


eNB
20
Inter Cell RRM
RB Control
Connection Mobility Cont.
Radio Admission Control
BS Measurement Configuration & Provision
Dynamic Resource Allocation (Scheduler)
RRC
PDCP
RLC
MAC
PHY
E-UTRAN
S1
30
MME
NAS Security
Idle State Mobility Handling
EPS Bearer Control
S-GW
Mobility Anchoring
P-GW
UE IP address allocation
Packet Filtering
EPC
Internet

[Fig. 3]

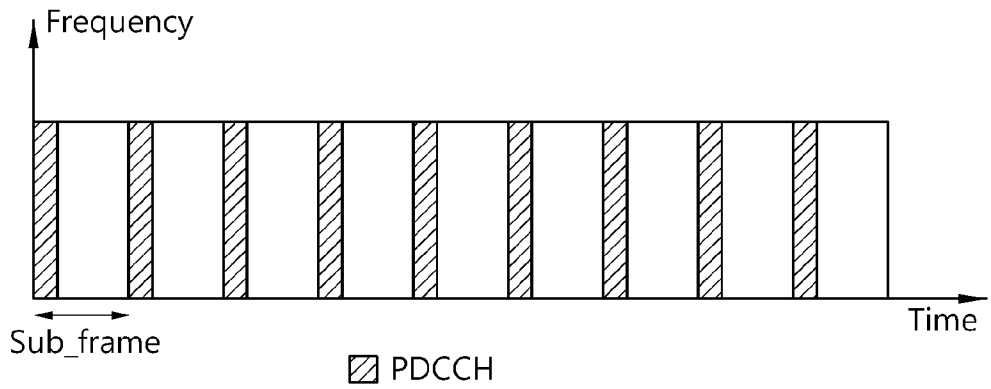

10
20
UE
eNB
PDCP
PDCP
RLC
RLC
MAC
MAC
PHY
PHY

(a)

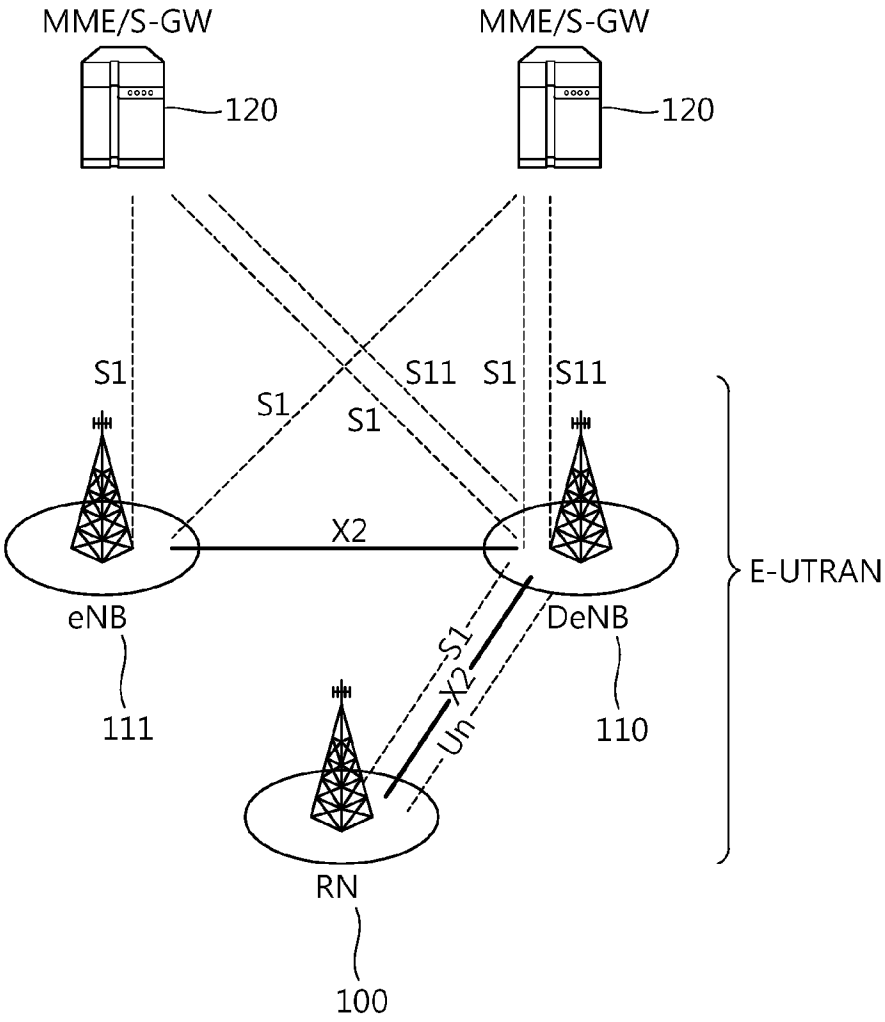

10
20
30
UE
eNB
MME
NAS
NAS
RRC
RRC
PDCP
PDCP
RLC
RLC
MAC
MAC
PHY
PHY

(b)

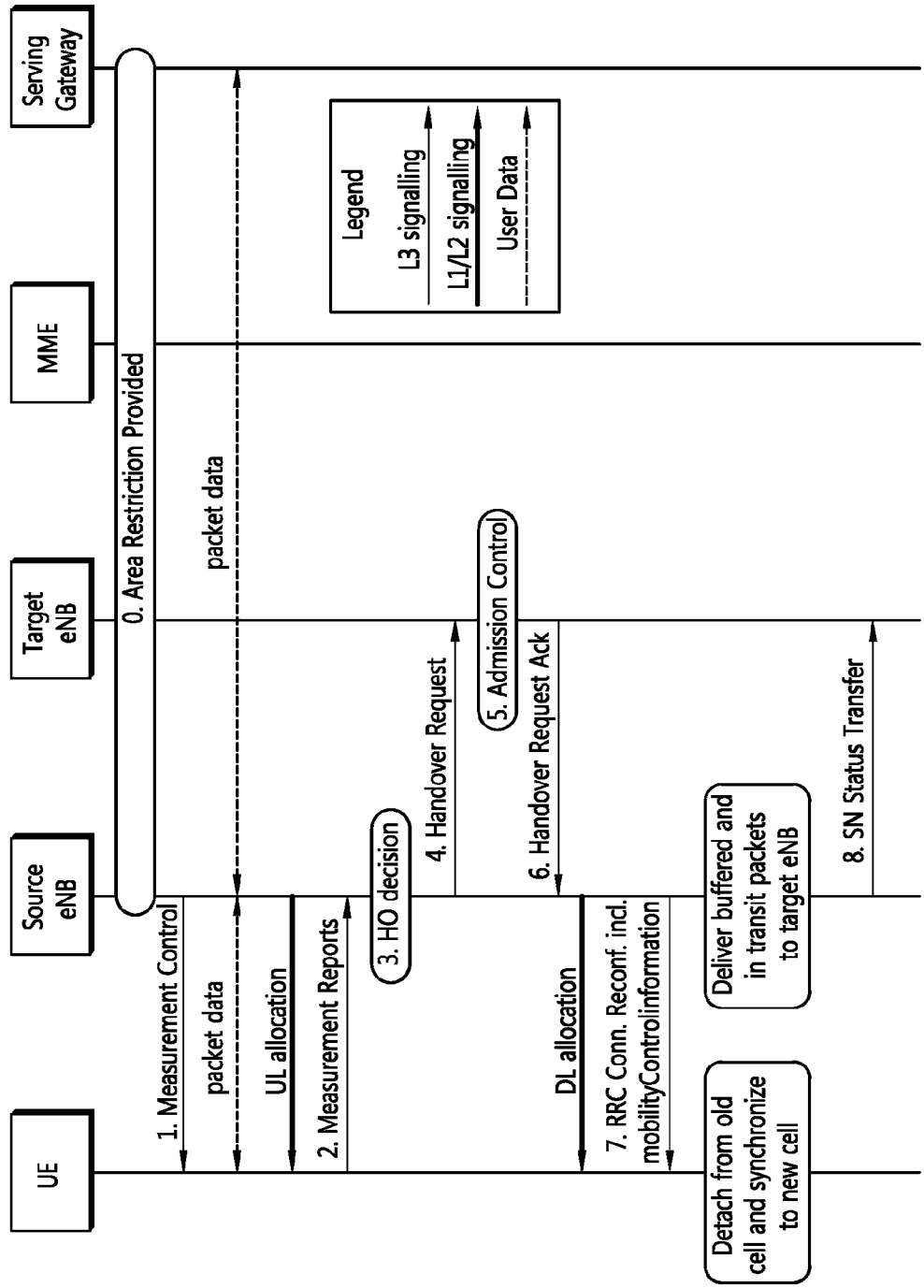
[Fig. 4]


Frequency
Time
Sub_frame
PDCCH

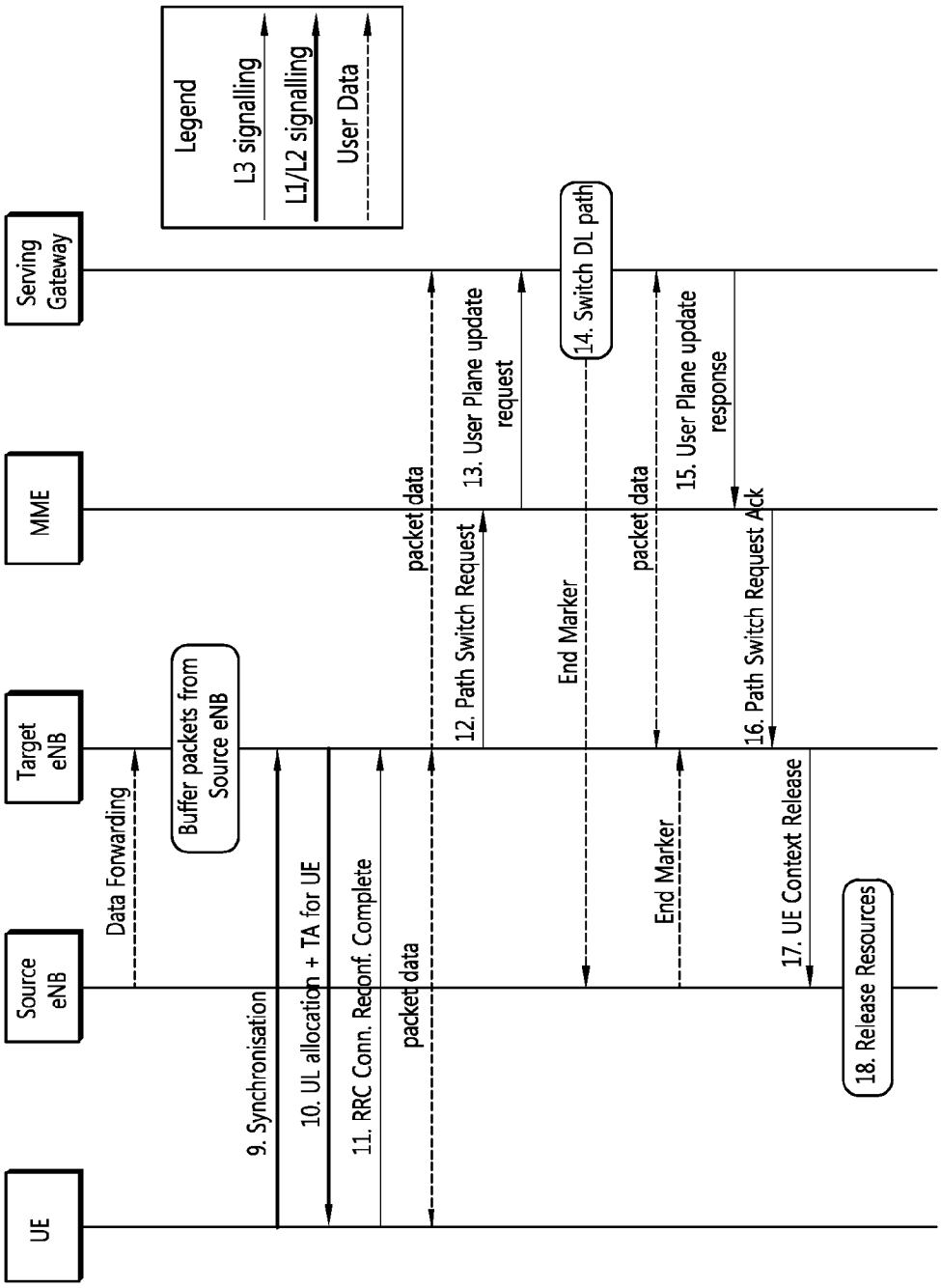
[Fig. 5]


MME/S-GW
MME/S-GW
120
120
S1
S1
S1
S11
S1
S11
X2
E-UTRAN
eNB
DeNB
111
110
S1
X2
Un
RN
100

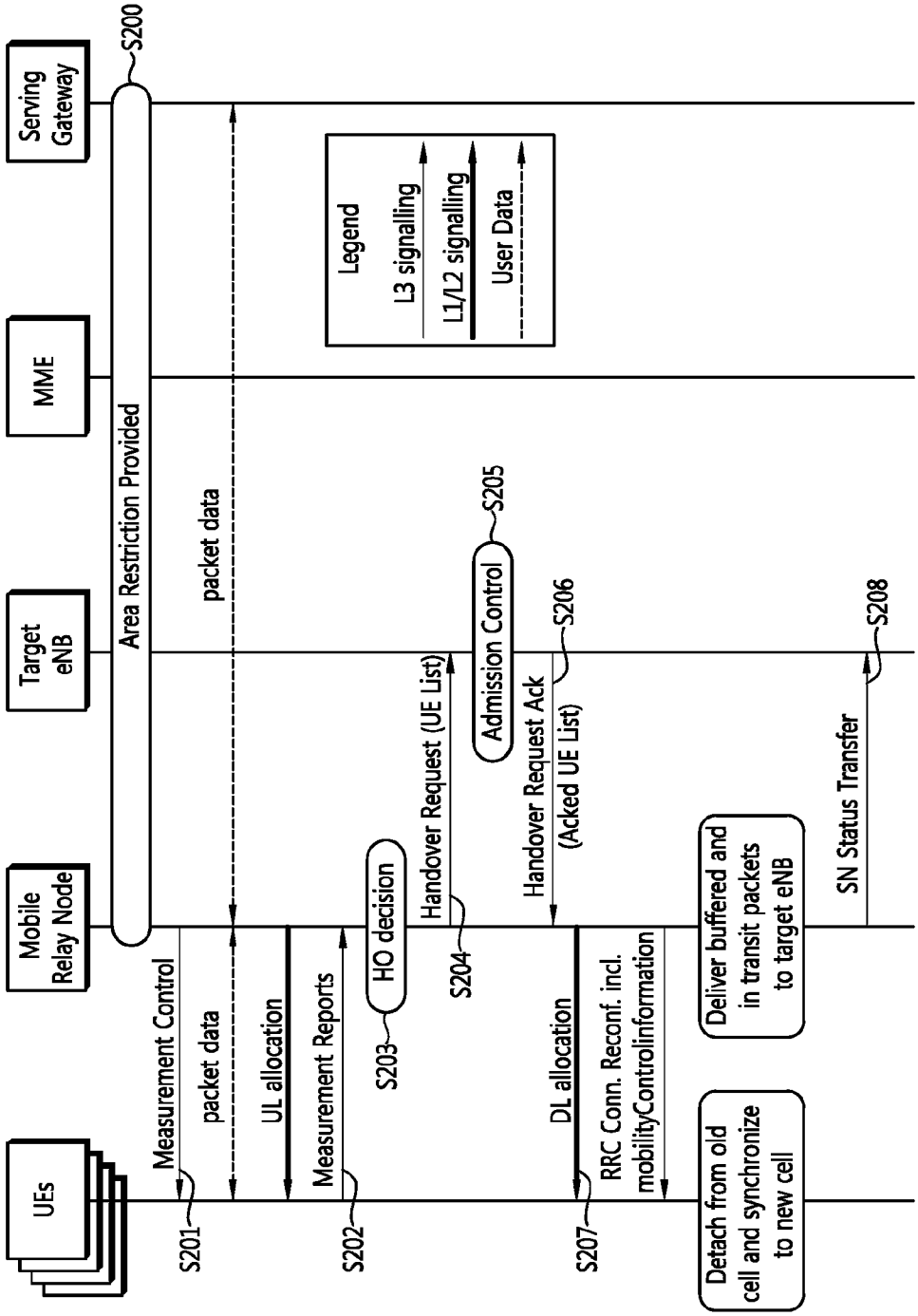
[Fig. 6a]


UE
Source eNB
Target eNB
MME
Serving Gateway
0. Area Restriction Provided
packet data
Legend
L3 signalling
L1/L2 signalling
User Data
1. Measurement Control
packet data
UL allocation
2. Measurement Reports
3. HO decision
4. Handover Request
5. Admission Control
6. Handover Request Ack
DL allocation
7. RRC Conn. Reconf. incl. mobilityControlInformation
Detach from old cell and synchronize to new cell
Deliver buffered and in transit packets to target eNB
8. SN Status Transfer

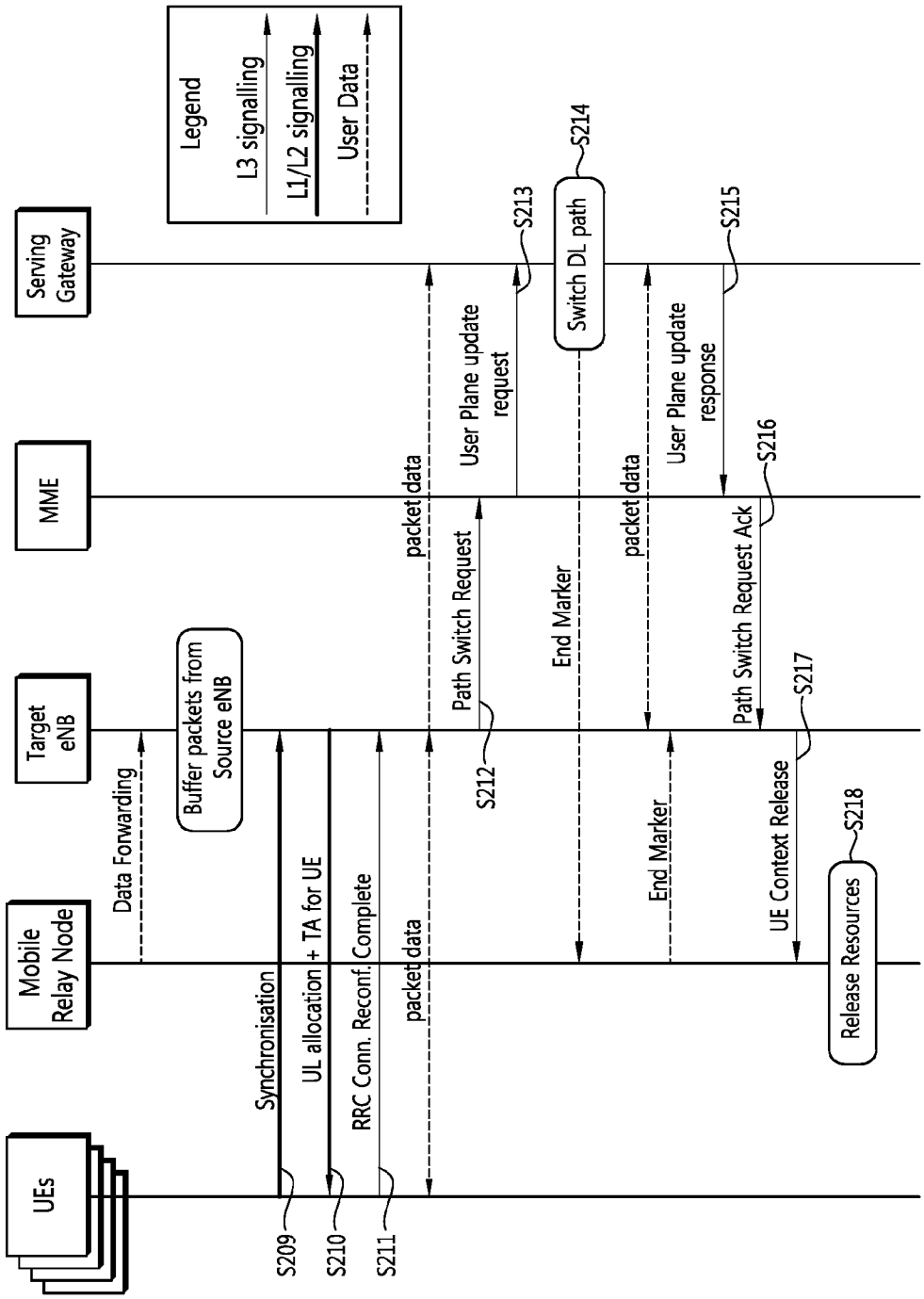
[Fig. 6b]


Legend
L3 signalling
L1/L2 signalling
User Data
Serving Gateway
MME
Target eNB
Source eNB
UE
Data Forwarding
Buffer packets from Source eNB
9. Synchronisation
10. UL allocation + TA for UE
11. RRC Conn. Reconf. Complete
packet data
12. Path Switch Request
13. User Plane update request
14. Switch DL path
End Marker
packet data
15. User Plane update response
16. Path Switch Request Ack
End Marker
17. UE Context Release
18. Release Resources

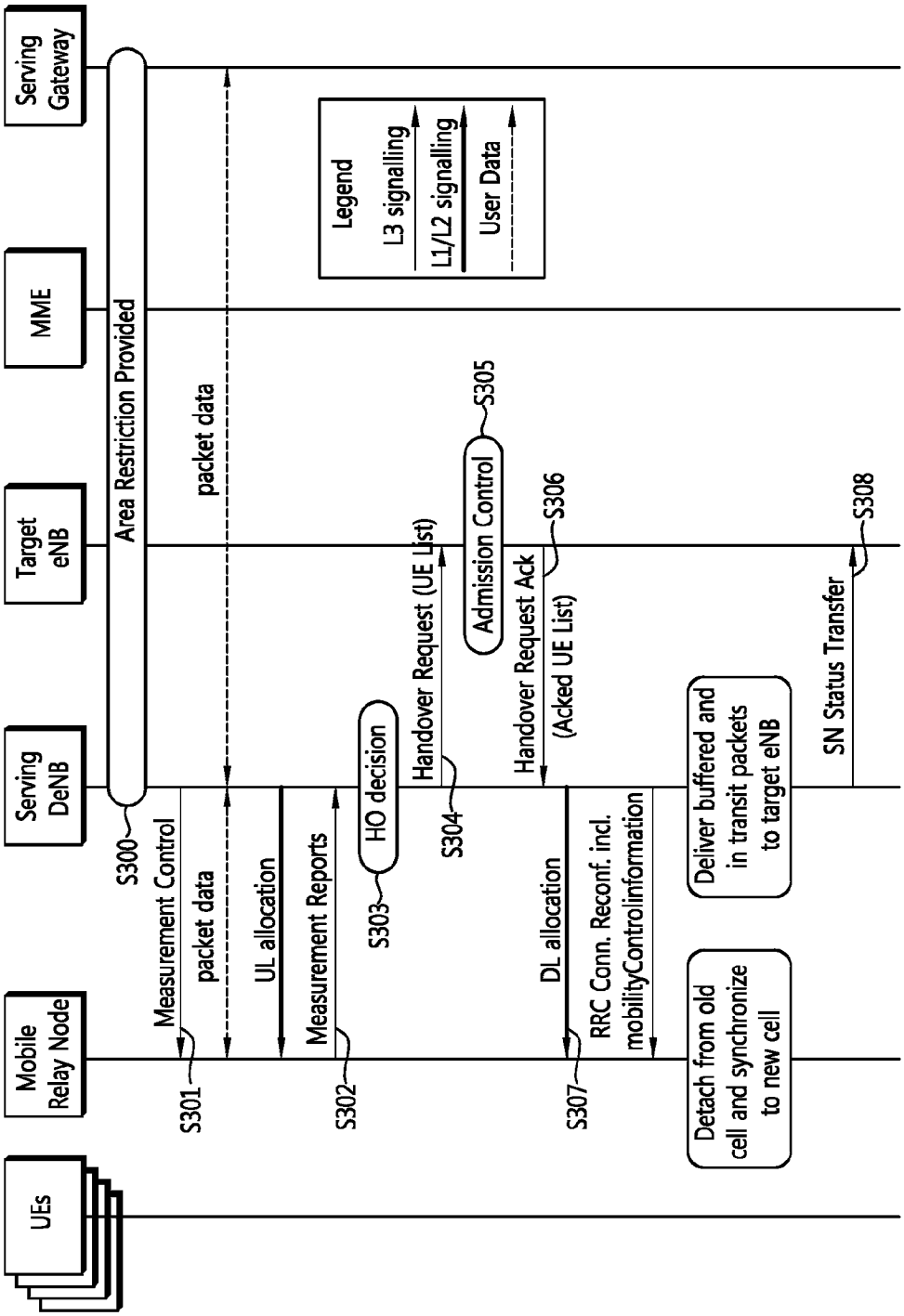
[Fig. 7a]


Serving Gateway
MME
Target eNB
Mobile Relay Node
UEs
S200
Area Restriction Provided
packet data
Legend
L3 signalling
L1/L2 signalling
User Data
Measurement Control
packet data
UL allocation
Measurement Reports
HO decision
Handover Request (UE List)
Admission Control
Handover Request Ack
(Acked UE List)
DL allocation
RRC Conn. Reconf. incl. mobilityControlInformation
Deliver buffered and in transit packets to target eNB
SN Status Transfer
Detach from old cell and synchronize to new cell
S201
S202
S203
S204
S205
S206
S207
S208

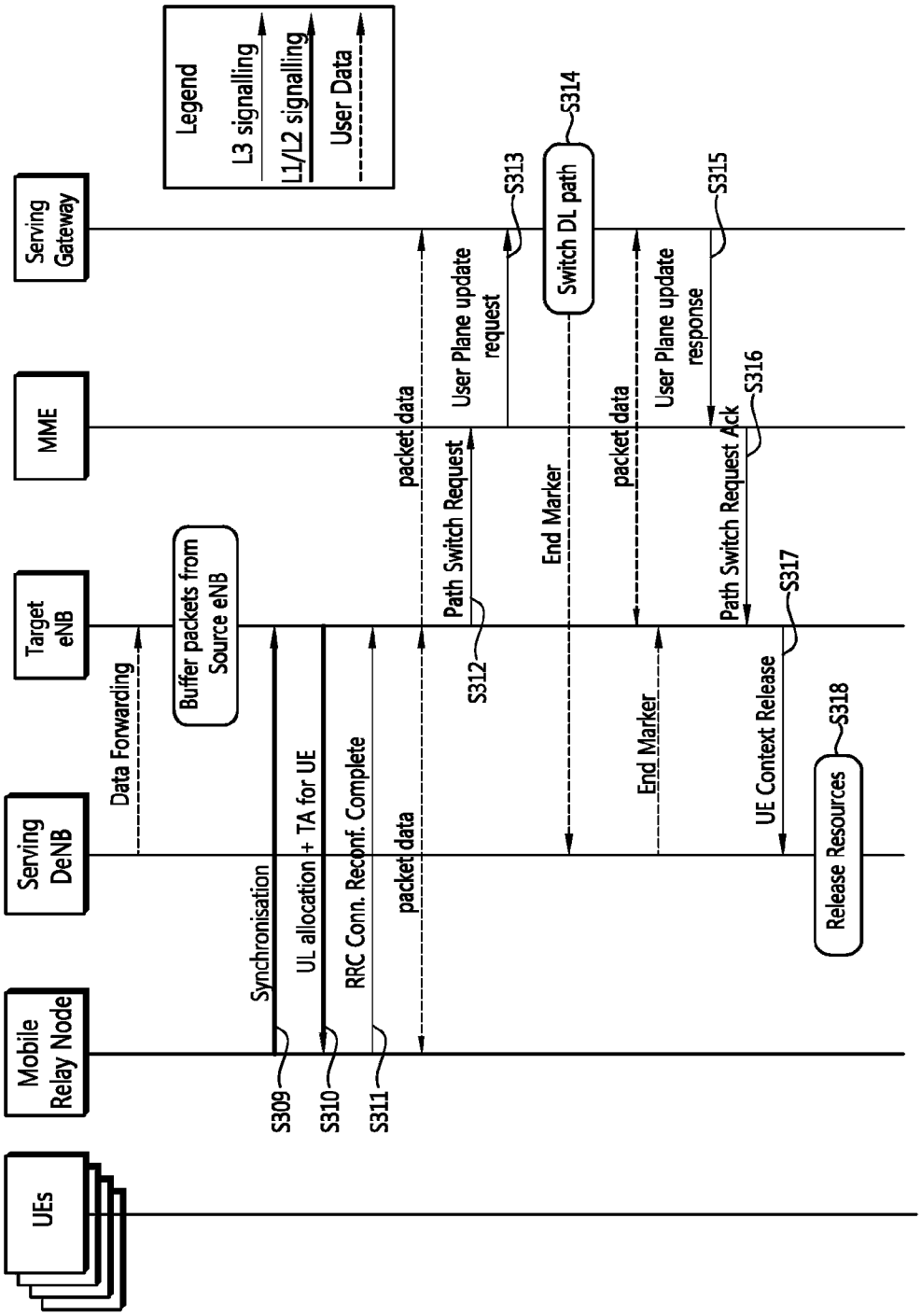
[Fig. 7b]


Legend
L3 signalling
L1/L2 signalling
User Data
Serving Gateway
MME
Target eNB
Mobile Relay Node
UEs
Data Forwarding
Buffer packets from Source eNB
Synchronisation
UL allocation + TA for UE
RRC Conn. Reconf. Complete
packet data
Path Switch Request
S212
User Plane update request
S213
Switch DL path
S214
End Marker
packet data
User Plane update response
S215
Path Switch Request Ack
S216
End Marker
UE Context Release
S217
Release Resources
S218
S209
S210
S211

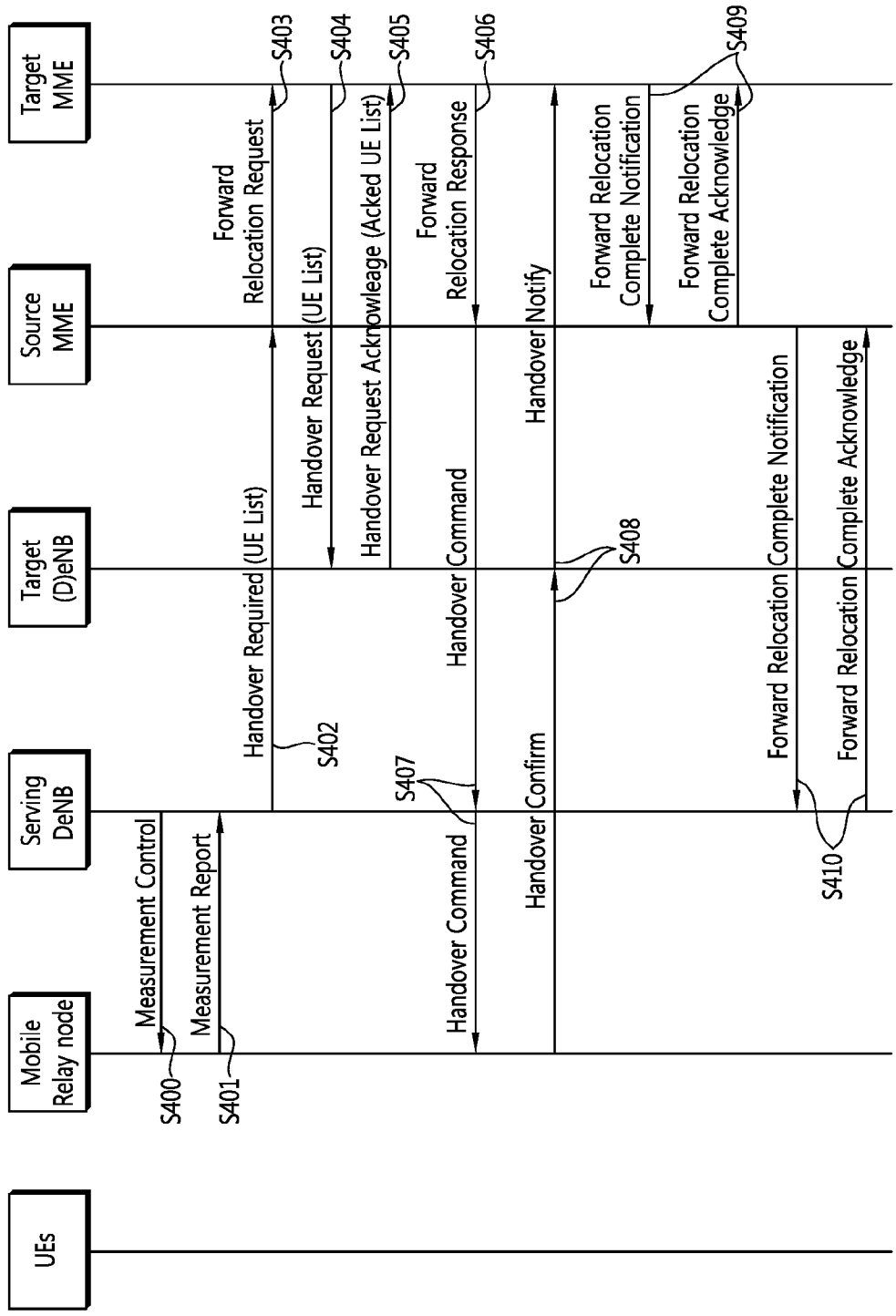
[Fig. 8a]


Serving Gateway
MME
Target eNB
Serving DeNB
Mobile Relay Node
UEs
Legend
L3 signalling
L1/L2 signalling
User Data
Area Restriction Provided
packet data
S300
Measurement Control
S301
packet data
UL allocation
Measurement Reports
S302
HO decision
S303
Handover Request (UE List)
S304
Admission Control
S305
Handover Request Ack
(Acked UE List)
S306
DL allocation
RRC Conn. Reconf. incl.
mobilityControlInformation
S307
Deliver buffered and
in transit packets
to target eNB
Detach from old
cell and synchronize
to new cell
SN Status Transfer
S308

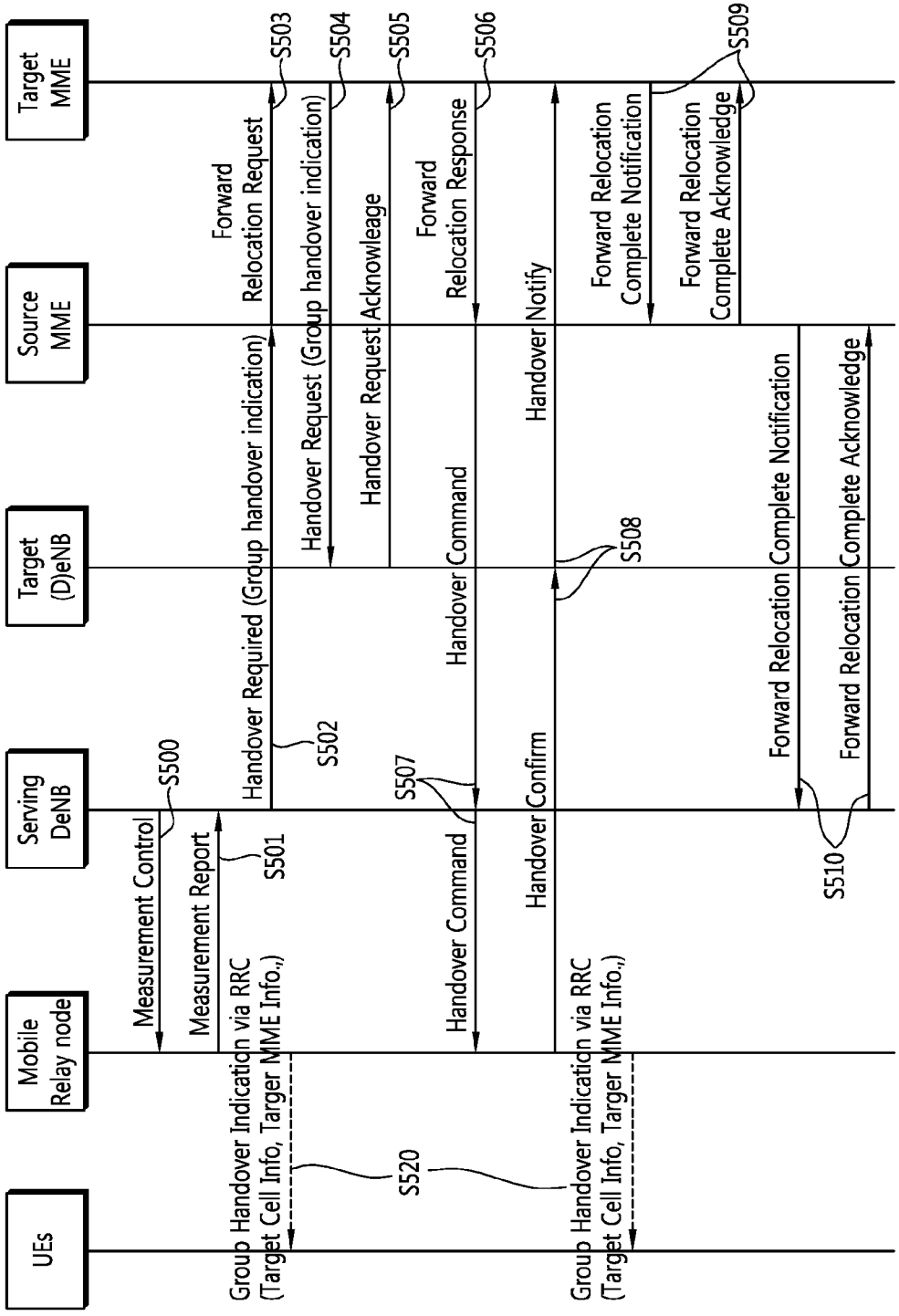
[Fig. 8b]


Legend
L3 signalling
L1/L2 signalling
User Data
UEs
Mobile Relay Node
Serving DeNB
Target eNB
MME
Serving Gateway
Synchronisation
UL allocation + TA for UE
RRC Conn. Reconf. Complete
packet data
Data Forwarding
Buffer packets from Source eNB
Path Switch Request
User Plane update request
Switch DL path
End Marker
packet data
User Plane update response
Path Switch Request Ack
End Marker
UE Context Release
Release Resources
S309
S310
S311
S312
S313
S314
S315
S316
S317
S318

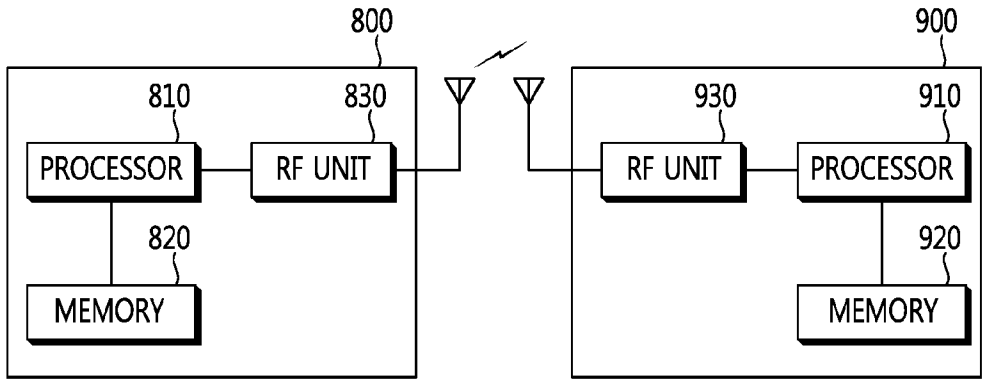
[Fig. 9]


UEs
Mobile Relay node
Serving DeNB
Target (D)eNB
Source MME
Target MME
Measurement Control
Measurement Report
Handover Required (UE List)
Handover Request (UE List)
Handover Request Acknowleage (Acked UE List)
Forward Relocation Request
Forward Relocation Response
Forward Relocation Complete Notification
Forward Relocation Complete Acknowledge
Handover Command
Handover Confirm
Handover Notify
Forward Relocation Complete Notification
Forward Relocation Complete Acknowledge
S400
S401
S402
S403
S404
S405
S406
S407
S408
S409
S410

[Fig. 10]


Target MME
Source MME
Target (D)eNB
Serving DeNB
Mobile Relay node
UEs
S500
S501
S502
S503
S504
S505
S506
S507
S508
S509
S510
S520
Measurement Control
Measurement Report
Handover Required (Group handover indication)
Forward Relocation Request
Handover Request (Group handover indication)
Handover Request Acknowleage
Forward Relocation Response
Handover Command
Handover Notify
Handover Confirm
Handover Command
Forward Relocation Complete Notification
Forward Relocation Complete Acknowledge
Forward Relocation Complete Notification
Forward Relocation Complete Acknowledge
Group Handover Indication via RRC (Target Cell Info, Targer MME Info.,)
Group Handover Indication via RRC (Target Cell Info, Targer MME Info.,)

[Fig. 11]


800
810
830
PROCESSOR
RF UNIT
820
MEMORY
900
930
910
RF UNIT
PROCESSOR
920
MEMORY