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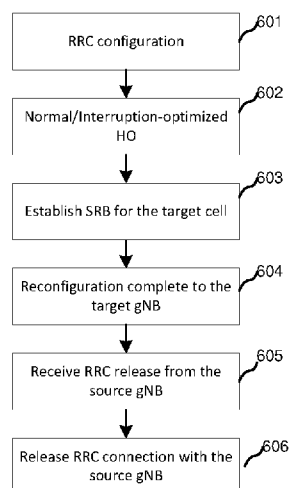


Fig 6

(57) Abstract: These disclosed embodiments describe a method for a UE and network to perform interruption-optimized HO. One type of HO command is transmitted by the source gNB. In novel aspect, UE is in the tentative dual RRC upon reception of the interruption-optimized HO command. In the tentative dual RRC, UE may have two RRC entity, one for the source gNB and the other is for the target gNB. In one embodiment, two SRBs are established. One is used for RRC message transmission/reception to/from the source gNB and the other is used for the target gNB. Furthermore, RLM is performed for the source cell even when UE is in tentative dual RRC. UE transfers to single RRC state when the connection with the source is released.

APPARATUS AND MECHANISM TO REDUCE MOBILITY INTERRUPTION THROUGH DUAL RRC IN WIRELESS NETWORK

TECHNICAL FIELD

This disclosure relates generally to wireless communications and, more particularly, to
5 handover.

BACKGROUND

In current wireless communication network, handover procedure is performed to support mobility when UE moves among different cells. For example, in current NR system, only basic handover is introduced. The basic handover is mainly based on LTE handover mechanism in which
10 network controls UE mobility based on UE measurement reporting. In the basic handover, similar to LTE, source gNB triggers handover by sending HO request to target gNB and after receiving ACK from the target gNB, the source gNB initiates handover by sending HO command with target cell configuration. The UE sends PRACH to the target cell after RRC reconfiguration is applied with target cell configuration.

15 Interruption during Handover is defined as the shortest time duration supported by the system during which a user terminal cannot exchange user plane packets with any base station during mobility transitions. In NR, 0ms interruption is one of the requirement to provide seamless handover UE experience. Mobility performance is one of the most important performance metric for NR. Therefore, it is important to identify handover solution to achieve high handover performance with
20 0ms interruption, low latency and high reliability. In Rel-15 NR, 0ms interruption time can be achievable by using intra-cell using beam mobility and addition/release of SCell for CA operation. However, there is demand to achieve 0ms interruption time in more scenarios especially in URLLC type of service which requires 1ms of end-to-end delay in some scenarios. Therefore, to reduce HO/ SCG change interruption time should be the use cases and requirements in Release 16. The mobility
25 enhancements should be applied to both inter-/intra-frequency HO/SCG change. The mobility enhancements should not be limited to the high frequency range although challenges/channel characteristic in high/med frequency should be considered. Solutions to reduce HO/ SCG change interruption time is also beneficial to high speed trains and aerial use case where channel situation becomes challenging in terms of HO performance.

In order to reduce the mobility interruption, apparatus and mechanisms for control plane handling over Uu interface are provided.

SUMMARY

Other embodiments and advantages are described in the detailed description below. This
5 summary does not purport to define the invention. The invention is defined by the claims.

The interruption-optimized HO command is transmitted by the source gNB through *RRCReconfiguration* message. After reception of *RRCReconfiguration* message, UE responds the *RRCReconfigurationComplete* message towards the target gNB.

10 In one embodiment, UE responds the *RRCReconfigurationComplete* to both the source gNB and the target gNB. UE is in the tentative state of two RRC, one for the source gNB and the other is for the target gNB. In one embodiment, two SRB1s are established. One is used for RRC message transmission/reception to/from the source gNB and the other is used for the target gNB. There are two RRC entities at the UE side to differentiate the two SRB1s.

15 In one embodiment, RLM is performed for the source cell even when UE is in the tentative state of two RRC. In one embodiment, UE release RRC connection with the source gNB when RLF on the source cell occurs. In another embodiment, UE release RRC connection with the source gNB when *DataInactivityTimer* configured by the source gNB expires. In one embodiment, when RRC connection release message is received from the source gNB, UE release the RRC connection with the source cell and release the corresponding RRC entity and configurations.

20 In one embodiment, the source connection release is coordinated between the source gNB and the target gNB. It is used to initiate the release of the UE context and UE connection at the source gNB. The procedure may be initiated either by the source gNB or by the target gNB. In one embodiment, the source connection release is initiated by the source cell. The source gNB sends source connection release required message and the target gNB responds source connection release
25 confirm message. In one embodiment, the source connection release is initiated by the target cell. The target gNB sends source connection release request message and the source gNB responds source connection release acknowledge message. In one embodiment, the source gNB can reject the request.

BRIEF DESCRIPTION OF DRAWINGS

30 The accompanying drawings, where like numerals indicate like components, illustrate

embodiments of the invention.

Figure 1 is a schematic system diagram illustrating an exemplary wireless network in accordance with embodiments of the current invention.

5 Figure 2 is an exemplary block diagrams illustrating the control plane architecture when interruption-optimized HO is performed in accordance with embodiments of the current invention.

Figure 3 is an exemplary block diagrams illustrating the control plane architecture when interruption-optimized HO is performed in accordance with embodiments of the current invention.

Figure 4 illustrates exemplary flow chart and diagram of interruption-optimized HO procedure in accordance with embodiments of the current invention.

10 Figure 5 is an exemplary block diagrams and flow chart illustrating the control plane procedure over Uu interface when interruption-optimized HO is performed in accordance with embodiments of the current invention.

Figure 6 illustrates exemplary flow chart of interruption-optimized handover procedure at the UE side in accordance with embodiments of the current invention.

15 DETAILED DESCRIPTION

Reference will now be made in detail to some embodiments of the invention, examples of which are illustrated in the accompanying drawings.

Figure 1 is a schematic system diagram illustrating an exemplary wireless network 100 in accordance with embodiments of the current invention. Wireless system 100 includes one or more
20 fixed base infrastructure units forming a network distributed over a geographical region. The base unit may also be referred to as an access point, an access terminal, a base station, a Node-B, an eNode-B, a gNB, or by other terminology used in the art. The network can be homogeneous network or heterogeneous network, which can be deployed with the same frequency or different frequency. The frequency used to provide coverage can be on low frequency e.g. sub-6GHz or on high
25 frequency e.g. above-6GHz. As an example, base stations (BSs) 101, 102, 103, 191 and 192 serve a number of mobile stations (MSs, or referred to as UEs) 104, 105, 106 and 107 within a serving area, for example, a cell, or within a cell sector. In some systems, one or more base stations are coupled to a controller forming an access network that is coupled to one or more core networks. All the base
30 stations can be adjusted as synchronous network, which means that that the transmission at the base stations are synchronized in time. On the other hand, asynchronous transmission between different base stations is also supported. The base station 101, 191, 192 are a macro base station, which provides large coverage. It is either a gNB or an ng-eNB, which providing NR user plane/E-UTRA

and control plane protocol terminations towards the UE. The gNBs and ng-eNBs are interconnected with each other by means of the Xn interface, e.g. 175, 176 and 176. The gNBs and ng-eNBs are also connected by means of the NG interfaces, e.g. 172, 173 and 174 to the 5GC, more specifically to the AMF (Access and Mobility Management Function) by means of the NG-C interface and to the UPF (User Plane Function) by means of the NG-U interface. UE 104 is moving, which is originally served by gNB 101 through the radio link 111. The cell served by gNB 101 is considered as the serving cell. When UE 104 moves among different cells, the serving cell needs to be changed through handover (HO) and the radio link between the UE and the network changes. All other cells instead of the serving cell is considered as neighboring cells, which can either be detected by UE or configured by the network. Among those neighboring cells, one or multiple cells are selected by the network as candidate cells, which are potentially used as the target cell. The target cell is the cell towards which HO is performed. For example, if the cell of gNB 191 is considered as the target cell. After HO, the connection between UE and the network is changed from gNB 101 to gNB 191. The original serving cell is considered as source cell. In order to reduce the mobility interruption during HO, it is possible that UE can be connected to both gNB 101 and gNB 191 simultaneously for a while and keeps data transmission with the source cell even if the connection with the target cell has been established.

The gNB 102 and gNB 103 are base station, providing coverage of small cells. They may have a serving area overlapped with a serving area of gNB 101, as well as a serving area overlapped with each other at the edge. They can provide coverage through single beam operation or multiple beam operation. In multiple beam operation, the gNBs 102 and 103 may have multiple sectors each of which corresponds to multiple beam to cover a directional area. As shown in figure 1, Beams 121, 122, 123 and 124 are exemplary beams of gNB 102, while Beams 125, 126, 127 and 128 are exemplary beams of gNB 103. The coverage of the gNBs 102 and 103 can be scalable based on the number of TRPs radiate the different beams. For example, UE or mobile station 104 is only in the service area of gNB 101 and connected with gNB 101 via a link 111. UE 106 is connected with the HF network only, which is covered by beam 124 of gNB 102 and is connected with gNB 102 via a link 114. UE 105 is in the overlapping service area of gNB 101 and gNB 102. In one embodiment, UE 105 is configured with dual connectivity and can be connected with gNB 101 via a link 113 and gNB 102 via a link 115 simultaneously. UE 107 is in the service areas of gNB 101, gNB 102, and gNB 103. In embodiment, UE 107 is configured with dual connectivity and can be connected with gNB 101 with a link 112 and gNB 103 with a link 117. In embodiment, UE 107 can switch to a link 116 connecting to gNB 102 upon connection failure with gNB 103. Furthermore, all of the base stations can be interconnected with each other by means of the Xn interface. They can be also connected by means of the NG interfaces to the 5GC, more specifically to the AMF by means of the

NG-C interface and to the UPF by means of the NG-U interface.

Figure 1 further illustrates simplified block diagrams 130 and 150 for UE 107 and gNB/eNB 101, respectively. Mobile station 107 has an antenna 135, which transmits and receives radio signals. A RF transceiver module 133, coupled with the antenna, receives RF signals from antenna 135, and converts them into baseband signals which are sent to processor 132. Please be noted that RF transceiver module 133 as shown in figure 1 is an example. In another embodiment, the RF transceiver module may comprise at least two RF modules (not shown), one RF module is used for transmitting and receiving on one band, and another RF module is used for signal transceiving on another frequency bands. RF transceiver 133 also receives baseband signals from processor 132, and converts them into RF signals which are to be sent out via antenna 135. Processor 132 processes the received baseband signals and invokes different functional modules to perform features in mobile station 107. Memory 131 stores program instructions and data 134 to control the operations of mobile station 107. Mobile station 107 also includes multiple function modules that carry out different tasks in accordance with embodiments of the current invention.

A HO controller 137 controls whether to perform normal HO and interruption-optimized HO according to the RRC reconfiguration message received from the source cell. A normal HO controller 140 controls the normal HO procedure and perform transmission/reception of the signaling and RRC messages required for the normal HO procedure. In one embodiment for normal handover, the source gNB initiates handover and issues a Handover Request over the Xn interface. The target gNB performs admission control and provides the RRC configuration as part of the Handover Acknowledgement. The source gNB provides the RRC configuration to the UE in the Handover Command. The Handover Command message includes at least cell ID and all information required to access the target cell so that the UE can access the target cell without reading system information. For some cases, the information required for contention-based and contention-free random access can be included in the Handover Command message. The access information to the target cell may include beam specific information, if any. Finally, the UE moves the RRC connection to the target gNB and replies the Handover Complete.

An interruption-optimized HO controller 141 controls the interruption-optimized HO procedure and perform transmission/reception of the signaling and RRC messages required for the interruption-optimized HO procedure. In one embodiment, interruption-optimized HO procedure is triggered by one type of HO command. In one embodiment, there are different types of HO command, which can be used to trigger different types of HO procedure. In one embodiment, UE receives the interruption-optimized HO command, which indicates that UE should maintain the connection with the source cell when performing HO towards the target cell. So UE keeps the configuration of source

cell and continues data transmission with the source cell when UE perform random access towards the target cell and even after the connection with the target cell is established. For interruption-optimized HO, UE tentatively maintains the radio link or connection simultaneously with both the source gNB and the target gNB. It can be considered as a tentative state with dual RRC. The tentative state ends when either connection with the source gNB or the target gNB is released.

A RRC Configuration storage 142 and 145 store the RRC configuration for source cell and target cell respectively. The RRC configuration includes radio bearer configuration, cell group configuration, measurement configuration, security information, full configuration, etc, which are required for UE to perform signaling/data transmission and reception.

A connection controller 143 and 146 control the RRC connection with the source cell and the target cell respectively. In one embodiment, the connection controller controls RRC reconfiguration procedure, RRC connection release procedure, RRC connection resume and RRC connection re-establishment procedure. In one embodiment, the connection controller of the source cell only controls RRC reconfiguration and the RRC connection release when UE performs HO towards the target cell and after connection with the target cell is established.

A RRC PDU encoder/decoder 144 and 147 encode/decode the RRC messages, which are transmitted/received to/from the source cell and target cell respectively.

In one embodiment, all the above mentioned functions can be contained in one RRC entity 136. In another embodiment, there are two RRC entities, one is for source cell and the other is for target cell.

Similarly, gNB 101 has an antenna 155, which transmits and receives radio signals. A RF transceiver module 153, coupled with the antenna, receives RF signals from antenna 155, and converts them into baseband signals which are sent to processor 152. RF transceiver 153 also receives baseband signals from processor 152, and converts them to RF signals which are to be sent out via antenna 155. Processor 152 processes the received baseband signals and invokes different functional modules to perform features in gNB 101. Memory 151 stores program instructions and data 154 to control the operations of gNB 103. gNB 101 also includes multiple function modules over Uu interface that carry out different tasks in accordance with embodiments of the current invention.

A RRC configuration provider 161 provides RRC configurations for normal HO, interruption-optimized HO and regular RRC configuration through RRC configuration message. The RRC configuration includes radio bearer configuration, cell group configuration, measurement configuration, security information, full configuration, etc, which are required for UE to perform signaling/data transmission and reception. Either full configuration or delta configuration can be

performed. In case of interruption-optimized HO, it indicates that UE should maintain the connection with the source cell when performing HO towards the target cell.

A connection controller 162 controls the RRC connection establishment, RRC connection resume, RRC connection re-establishment, RRC connection release, RRC reconfiguration and execution of the interruption-optimized HO and normal HO for the UE. The connection controller for source cell only controls RRC reconfiguration and RRC release when UE performs random access towards the target cell and after the connection with the target cell is established.

A normal HO controller 163 controls the normal HO procedure and transmits/receives the related signaling and RRC messages. It also controls the HO preparation modular 165 for the coordination with the neighboring cells.

An interruption-optimized HO controller 164 controls the interruption-optimized HO procedure and transmits/receives the related signaling and RRC messages. It also controls the HO preparation modular 165 for the coordination with the neighboring cells.

A RRC PDU encoder/decoder 165 encode/decode the RRC messages, which are transmitted/received to/from the UE.

gNB 101 also includes multiple function modules over Xn interface that carry out different tasks in accordance with embodiments of the current invention.

A HO Preparation modular 167 performs HO preparation procedure towards one or multiple candidate cells for normal HO and interruption-optimized HO. The Handover preparation procedure is initiated by the source gNB if it determines the necessity to initiate the handover via the Xn interface. In one embodiment for normal HO, the source gNB sends a HANDOVER REQUEST to the target gNB including the bearers to be setup by the target gNB. In one embodiment for interruption-optimized HO, the source gNB sends the HANDOVER REQUEST to the target gNBs including interruption-optimized HO indication and the bearers to be setup by the target gNB. In one embodiment, the bears contains signaling radio bearers, e.g. SRB1 and SRB2. The handover preparation phase is finished upon the reception of the HANDOVER REQUEST ACKNOWLEDGE message in the source gNB, which includes at least radio interface related information, successfully established and failed established RBs. In case the handover resource allocation is not successful (e.g. no resources are available on the target side) the target gNB responds with the HANDOVER PREPARATION FAILURE message instead of the HANDOVER REQUEST ACKNOWLEDGE message.

A UE context release modular 168 determines when to release UE context. At handover, the UE Context Release procedure can be initiated by the target gNB to signal to the source gNB that resources for the handed over UE context can be released. At handover, by sending UE CONTEXT

RELEASE the target eNB informs the source eNB of Handover success and triggers the release of resources. In one embodiment, UE context can be released by the source gNB itself if it determines to release the connection with the UE or it detects that RLF has occurred to the UE.

5 A SN STATUS TRANSFER modular 169 transfers the uplink PDCP SN and HFN receiver status and the downlink PDCP SN and HFN transmitter status from the source to the target gNB during an Xn handover for each respective RBs for which PDCP SN and HFN status preservation applies. In one embodiment of interruption-optimized HO, the SN status transfer performed just after HANDOVER REQUEST ACKNOWLEDGE message is received. In another embodiment of interruption-optimized HO, the SN status transfer procedure is performed once again upon the source
10 sends the RRC connection release message towards the UE.

A mobility and path switching modular 170 controls Xn initiated HO and path switching procedure over the NG-C interface. The handover completion phase for Xn initiated handovers comprises the following steps: the PATH SWITCH message is sent by the target gNB to the AMF when the UE has successfully been transferred to the target cell. The PATH SWITCH message
15 includes the outcome of the resource allocation. The AMF responds with the PATH SWITCH ACK message which is sent to the gNB. The MME responds with the PATH SWITCH FAILURE message in case a failure occurs in the 5GCN.

Figure 2 is an exemplary block diagrams illustrating the control plane architecture when interruption-optimized HO is performed in accordance with embodiments of the current invention.

20 The NAS control protocol 201 terminated in AMF or MME (depending on different types of CN) at the network side. It performs the functions of authentication, mobility management, security control, etc. At the UE side, NAS control protocol 206 is the peer entity, communicates with the NAS entity 201 at the network side. The RRC layer 202 and 203 terminated in each gNB on the network side performs the functions of broadcast of System Information related to AS and NAS,
25 paging initiated by 5GC or NG-RAN, establishment, maintenance and release of an RRC connection, security, establishment, configuration, maintenance and release of signalling Radio Bearers (SRBs) and data Radio Bearers (DRBs), mobility functions, QoS management, UE measurement reporting and control of the reporting, detection of and recovery from radio link failure and NAS message transfer to/from NAS from/to UE. At the UE side, one or two RRC entities are used as the peer
30 entity of RRC entity 202 and 203 for the RRC messages transmission/reception with the different base stations. In one embodiment for the interruption-optimized HO, UE has one RRC entity, which transmits/receives the SRBs from both the source gNB and the target gNB. In another embodiment for the interruption-optimized HO, UE has two RRC entities, which correspond to the source gNB and the target gNB respectively. One RRC entity 204 is used for SRBs transmission/reception with

the source gNB and the other RRC entity 205 is used for SRBs transmission/reception with the target gNB.

Figure 3 is an exemplary block diagrams illustrating the control plane architecture when interruption-optimized HO is performed in accordance with embodiments of the current invention.

5 The NAS control protocol 301 terminated in AMF or MME (depending on different types of CN) at the network side. It performs the functions of authentication, mobility management, security control, etc. At the UE side, NAS control protocol 306 is the peer entity, communicates with the NAS entity 301 at the network side. Different from the embodiment of Figure 2, UE can communicate with the NAS protocol of the network either through the source gNB or the target gNB, or both of them. The RRC layer 302 and 303 terminated in each gNB on the network side performs the functions of broadcast of System Information related to AS and NAS, paging initiated by 5GC or NG-RAN, establishment, maintenance and release of an RRC connection, security, establishment, configuration, maintenance and release of signalling Radio Bearers (SRBs) and data Radio Bearers (DRBs), mobility functions, QoS management, UE measurement reporting and control of the reporting, detection of and recovery from radio link failure and NAS message transfer to/from NAS from/to UE. At the UE side, one or two RRC entities are used as the peer entity of RRC entity 302 and 303 for the RRC messages transmission/reception with the different base stations. In one embodiment for the interruption-optimized HO, UE has one RRC entity, which transmits/receives the SRBs from both the source gNB and the target gNB. In another embodiment for the interruption-optimized HO, UE has two RRC entities, which correspond to the source gNB and the target gNB respectively. One RRC entity 304 is used for SRBs transmission/reception with the source gNB and the other RRC entity 305 is used for SRBs transmission/reception with the target gNB.

Figure 4 illustrates exemplary flow chart and diagram of interruption-optimized HO procedure in accordance with embodiments of the current invention.

0. The UE context within the source gNB contains information regarding roaming and access restrictions which were provided either at connection establishment or at the last TA update.

1. The source gNB configures the UE measurement procedures and the UE reports according to the measurement configuration.

30 2. The source gNB decides to perform interruption-optimized HO or normal HO for the UE, based on *MeasurementReport* and RRM information.

3. If interruption-optimized HO is initiated, the source gNB issues the Handover Request messages to the target gNBs.

- In one embodiment, the source gNB passes one or multiple transparent RRC containers with

necessary information to prepare the handover at the target sides. In other embodiment, the source gNB includes the necessary information to prepare the handover as information elements in XnAP messages.

• In one embodiment, the Handover Request messages sent to the target gNB includes the interruption-optimized HO indication, which informs the target gNBs to perform interruption-optimized HO. In one embodiment, a transparent RRC container is transmitted to the target gNB.

• In one embodiment, the information includes at least the target cell ID, KgNB*, the C-RNTI of the UE in the source gNB, RRM-configuration, the current QoS flow to DRB mapping rules applied to the UE, the minimum system information from source gNB, the UE capabilities for different RATs, PDU session related information, and can include the UE reported measurement information including beam-related information if available. The PDU session related information includes the slice information (if supported) and QoS flow level QoS profile(s).

4. Admission Control may be performed by the target gNB.

5. Each target gNB prepares the handover with L1/L2 and sends the HANDOVER REQUEST ACKNOWLEDGE to the source gNB.

• In one embodiment, HANDOVER REQUEST ACKNOWLEDGE includes a transparent container to be sent to the UE as an RRC message to perform the handover.

• In one embodiment, HANDOVER REQUEST ACKNOWLEDGE includes necessary information as information element of XnAP message to be sent to the UE to perform the handover.

• In one embodiment, the HANDOVER REQUEST ACKNOWLEDGE includes the security algorithm and security key used in the target gNB.

6. The source gNB sends the SN STATUS TRANSFER message to the target gNB and performs data forwarding immediately to the target gNB. So that there will be data available for transmission at the target gNB when the connection with the target gNB is established for the UE.

7. The source gNB triggers the Uu handover by sending an *RRCReconfiguration* message to the UE, containing the information required to access the target cell: at least the target cell ID, the new C-RNTI, the target gNB security algorithm identifiers for the selected security algorithms. It can also include a set of dedicated RACH resources, the association between RACH resources and SSB(s), the association between RACH resources and UE-specific CSI-RS configuration(s), common RACH resources, and target cell SIBs, etc.

• In one embodiment, the *RRCReconfiguration* message indicates that interruption-optimized HO is performed. So UE should maintain the connection with the source cell when perform HO with the target cell. In order to keep data transmission with the source cell, part or all RRC configuration

provided by the source gNB is kept. In one embodiment, the lower-layer configuration at least for the MCG are kept. In one embodiment, at least one DRB and the corresponding DRB configuration is kept. For SRBs and SRB related configuration, in one embodiment, SRBs and the configuration for SRBs including SRB1 and SRB2 are kept at the UE side; in one embodiment, only SRB1 and the configuration for SRB1 are kept at the UE side.

8. The UE maintains the connection with the source cell and synchronises to the target cell. It completes the RRC handover procedure by sending *RRCReconfigurationCompletemessage* to the network.

- In one embodiment, the message as the response to the HO command is the *RRCReconfigurationCompletemessage*. In one embodiment, the response message is sent to the target gNB.

- In one embodiment, the response message is sent to both the source gNB and the target gNB.
- In one embodiment, another UL RRC message is used as the response to the HO command. The UL RRC message is transmitted towards the source gNB indicating that the connection with the target gNB is established.

9. The source connection release is coordinated between the source gNB and the target gNB. It is used to initiate the release of the UE context and UE connection at the source gNB. The procedure may be initiated either by the source gNB or by the target gNB.

- In one embodiment, the source connection release is initiated by the source cell. The source gNB sends source connection release required message and the target gNB responds source connection release confirm message.

- In one embodiment, the source connection release is initiated by the target cell. The target gNB sends source connection release request message and the source gNB responds source connection release acknowledge message. In one embodiment, the source gNB can reject the request.

10. The source gNB sends the RRC connection release message to the UE and release UE context.

- In one embodiment, it does not necessarily need to involve signalling towards the UE, e.g. in case of Radio Link Failure towards the source gNB, or in case of *DataInactivityTimer* at the network side expires.

11. The source gNB sends the SN STATUS TRANSFER message to the target gNB and performs data forwarding to the target gNB.

12. The target gNB sends a PATH SWITCH REQUEST message to AMF to trigger 5GC to

switch the DL data path towards the target gNB and to establish an NG-C interface instance towards the target gNB.

13.5GC switches the DL data path towards the target gNB. The UPF sends one or more "end marker" packets on the old path to the source gNB per PDU session/tunnel and then can release any U-plane/TNL resources towards the source gNB.

14.The AMF confirms the PATH SWITCH REQUEST message with the PATH SWITCH REQUEST ACKNOWLEDGE message.

- Figure 5 is an exemplary block diagrams and flow chart illustrating the control plane procedure over Uu interface when interruption-optimized HO is performed in accordance with embodiments of the current invention. The interruption-optimized HO command is transmitted by the source gNB through *RRCReconfiguration* message in 501. After reception of *RRCReconfiguration* message, UE responds the *RRCReconfigurationComplete* message 502 towards the target gNB. In one embodiment, UE responds the *RRCReconfigurationComplete* to both the source gNB and the target gNB. UE is in the tentative state of two RRC, one for the source gNB and the other is for the target gNB. In one embodiment, two SRB1s are established. One is used for RRC message transmission/reception to/from the source gNB and the other is used for the target gNB. There are two RRC entities at the UE side to differentiate the two SRB1s. In one embodiment, there is only one RRC entity and the original SRB1 for RRC message transmission with the source gNB is changed to another SRB type, e.g. SRB4. In one embodiment, RLM is performed for the source cell even when UE is in the tentative state of two RRC. In one embodiment, UE release RRC connection with the source gNB when RLF on the source cell occurs. In another embodiment, UE release RRC connection with the source gNB when *DataInactivityTimer* configured by the source gNB expires. In one embodiment, when RRC connection release message is received from the source gNB, UE release the RRC connection with the source cell and release the corresponding RRC entity and configurations.

Figure 6 illustrates exemplary flow chart of interruption-optimized handover procedure at the UE side in accordance with embodiments of the current invention. In step 601, UE receives RRC Reconfiguration messages, which indicates whether normal HO, or interruption-optimized HO, or other types of HO is performed. In step 603, UE performs normal HO or interruption-optimized HO based on the reconfiguration message. Upon reception of the HO command, UE is transferred to a tentative of state of dual RRC. In step 603, UE establishes SRB for the target gNB. In one embodiment, UE establishes a RRC entity for the target gNB. Meanwhile, UE keeps the SRB of the source gNB, the configuration of which can be modified by the source gNB. In step 604, UE sends *RRCReconfigurationComplete* message to the target gNB. In step 605, UE receives RRC connection

release message from the source gNB. Upon reception of the connection release message, UE ends the tentative state of dual RRC. In step 606, UE releases RRC connection with the source gNB.

5 While the present disclosure and the best modes thereof have been described in a manner establishing possession and enabling those of ordinary skill to make and use the same, it will be understood and appreciated that there are equivalents to the exemplary embodiments disclosed herein and that modifications and variations may be made thereto without departing from the scope and spirit of the inventions, which are to be limited not by the exemplary embodiments but by the appended claims.

CLAIMS

1. A method for a UE to perform interruption-optimized handover comprising:

Receiving one type of HO command from the source gNB, wherein the type of HO command indicating to perform interruption-optimized HO;

5 Transferring to a tentative dual RRC, wherein one set of SRB is used for the RRC procedure and signaling towards the source cell and the other set of SRB is for the target cell; and

Transferring to single RRC and releasing the connection with the source gNB.

2. The method of claim 1, wherein the tentative dual RRC contains two sets of RRC configurations and controls two sets of RRC procedures, one is for the source cell and the other is for
10 the target cell.

3. The method of claim 2, wherein the RRC configuration contains the lower-layer configuration, DRB configuration for at least one DRB and SRB configuration for at least one SRB.

4. The method of claim 3, wherein the SRB is SRB1.

5. The method of claim 2, further comprising UE keeps two RRC entities, one RRC entity for
15 the source gNB and the other is established for the target gNB.

6. The method of claim 1, further comprising UE responds the RRC connection complete message to the target gNB, or to both the source gNB and the target gNB.

7. The method of claim 1, transferring to single RRC further comprising receiving RRC connection release message from the source gNB.

20 8. The method of claim 1, transferring to single RRC further comprising releasing RRC connection with the source gNB when DataInactiveTimer of the source gNB expires.

9. The method of claim 1, further comprising performing RLM on the source cell when UE is in dual RRC.

25 10. The method of claim 9, further comprising releasing RRC connection with the source cell when RLF occurs in the source cell.

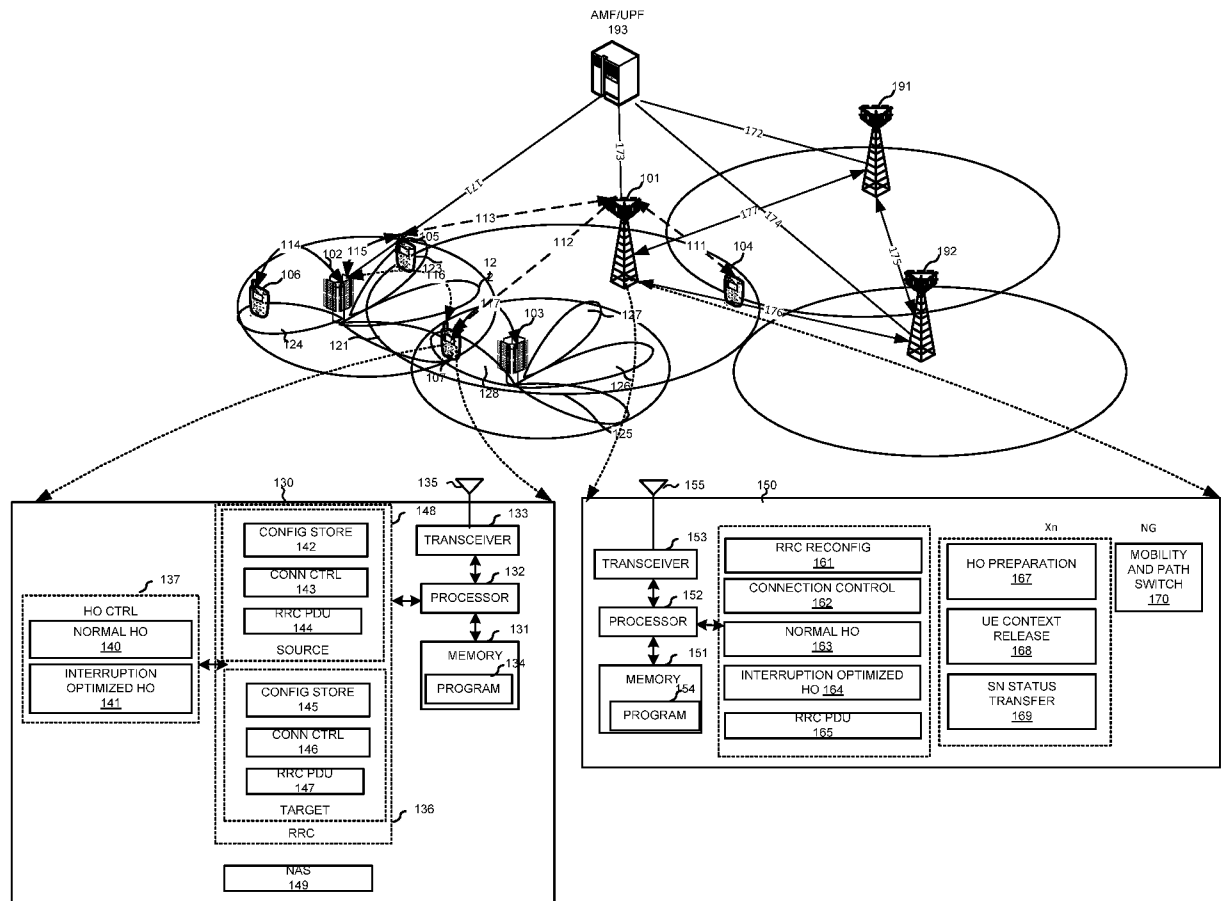


FIG. 1

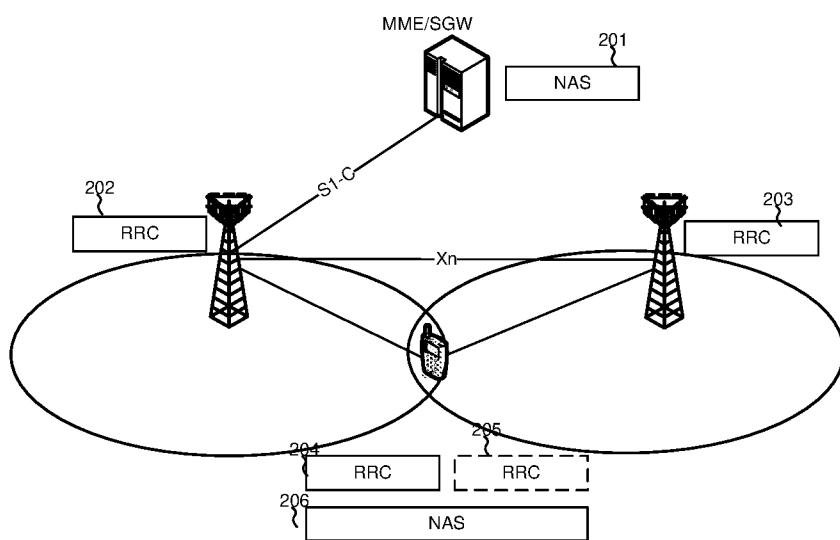


Fig. 2

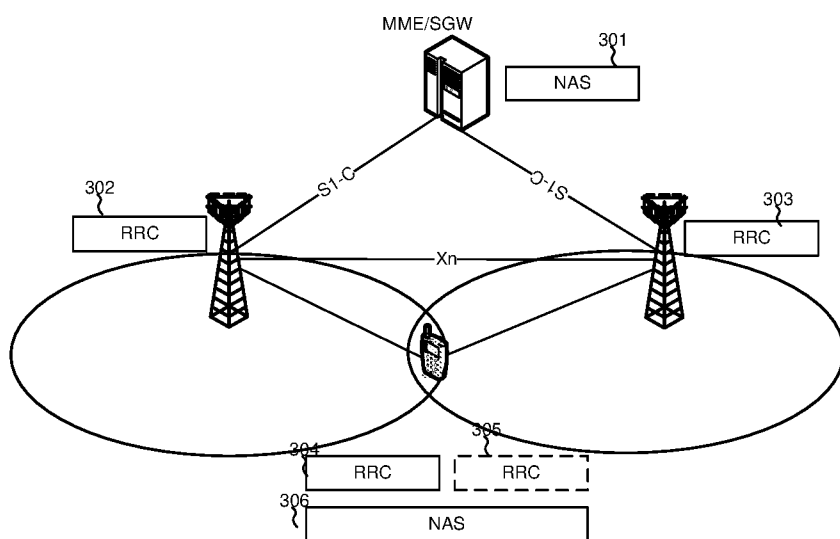
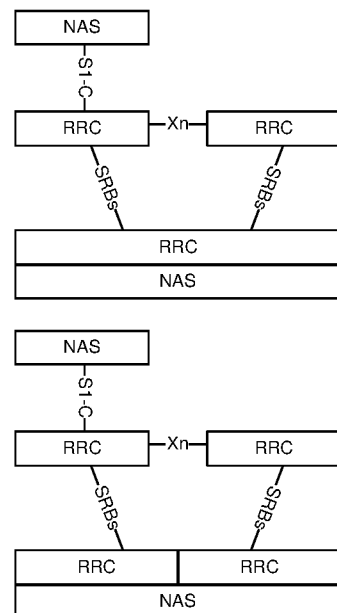
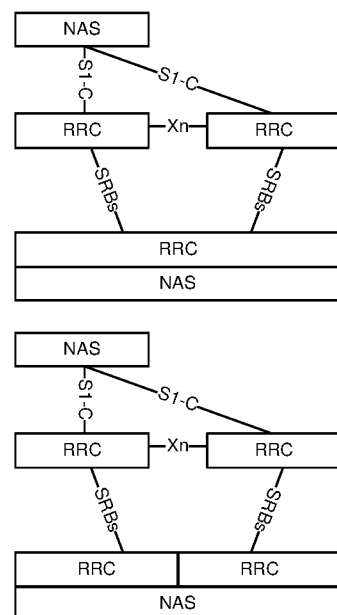


Fig 3



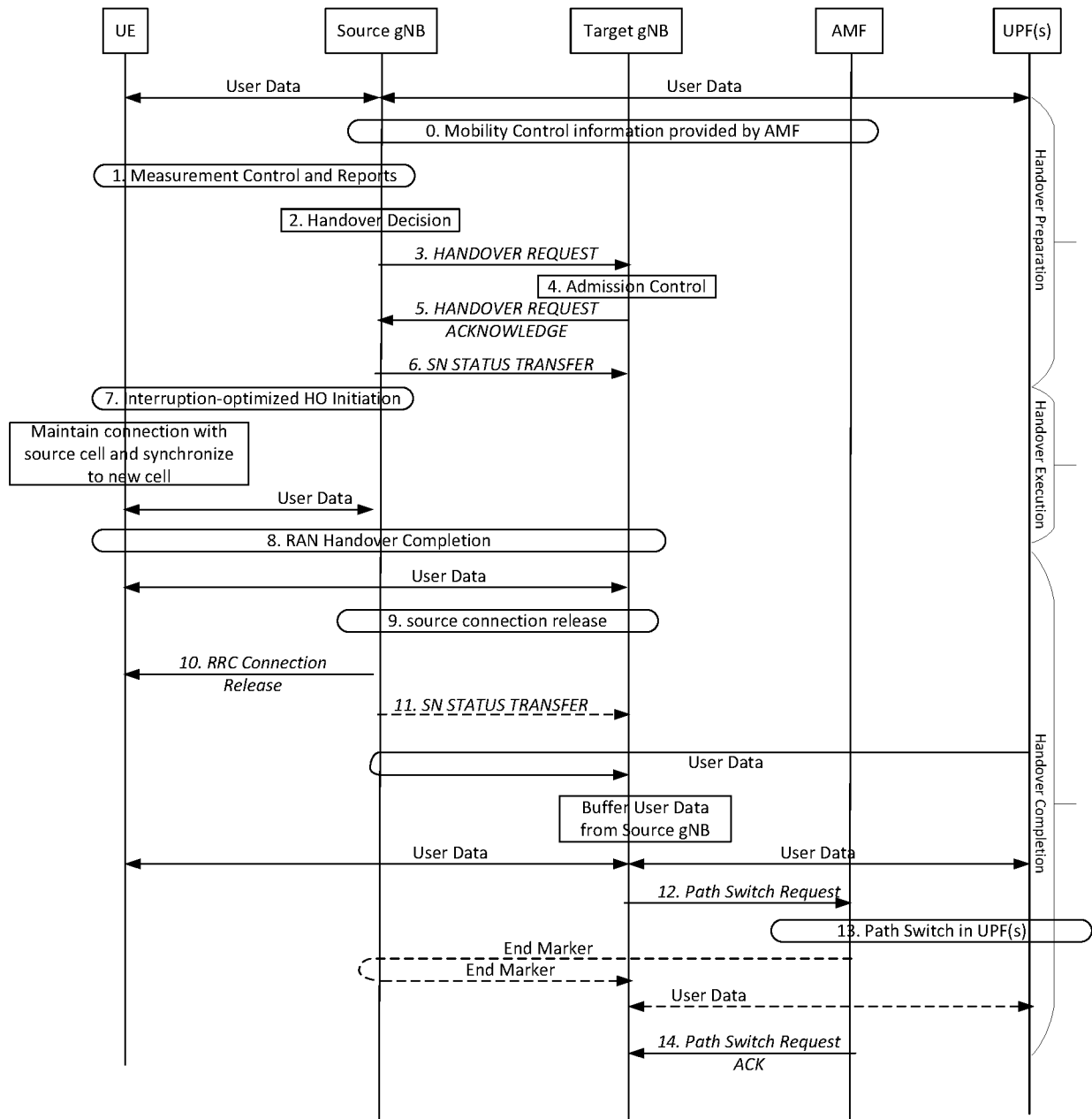
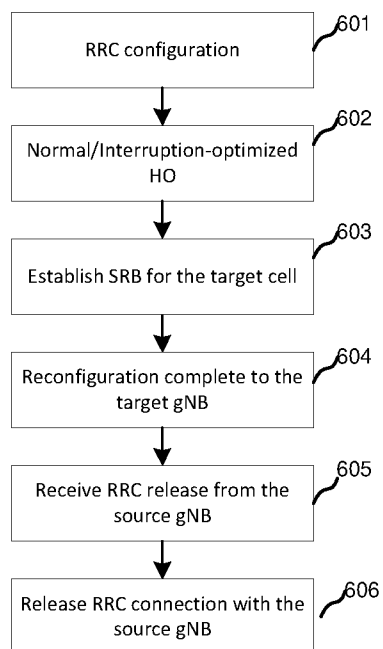
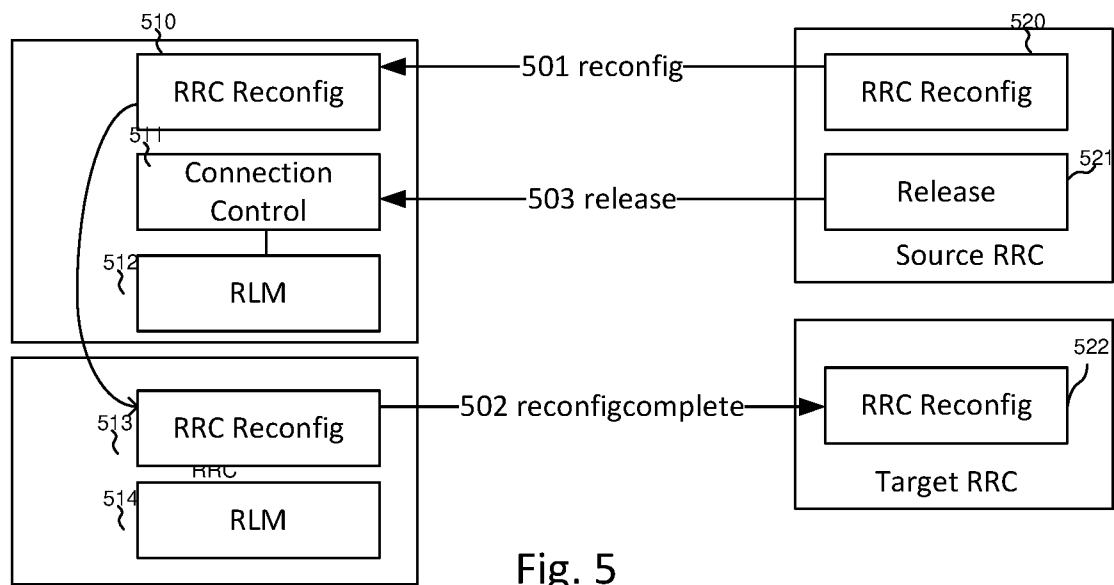


Fig. 4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/113096**A. CLASSIFICATION OF SUBJECT MATTER**

H04W 36/00(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04Q

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

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

CNPAT,CNKI,WPI,EPODOC: handover, handoff, HO, gNB, source, target, RRC, DC, cell, DRB, SRB, connection, release, message

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 1350763 A (NORTEL NETWORKS LTD.) 22 May 2002 (2002-05-22) description, page 1 lines 8-21	1-10
A	CN 1997204 A (HUAWEI TECHNOLOGIES CO., LTD.) 11 July 2007 (2007-07-11) the whole document	1-10
A	CN 106714259 A (NUBIA TECHNOLOGY CO., LTD.) 24 May 2017 (2017-05-24) the whole document	1-10
A	US 2010272268 A1 (QUALCOMM INC.) 28 October 2010 (2010-10-28) the whole document	1-10

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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“&” document member of the same patent family

Date of the actual completion of the international search

18 June 2019

Date of mailing of the international search report

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Telephone No. 86-(10)-53961605

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/113096

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