(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 February 2024 (15.02.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/035706 A1

(51) International Patent Classification:
H04W 36/00 (2009.01)

(21) International Application Number:
PCT/US2023/029737

(22) International Filing Date:
08 August 2023 (08.08.2023)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/370,759 08 August 2022 (08.08.2022) US

(71) Applicant: **APPLE INC.** [US/US]; One Apple Park Way, Cupertino, California 95014 (US).

(72) Inventors: **PALLE VENKATA, Naveen Kumar R.**; One Apple Park Way, Cupertino, California 95014 (US). **SIROTKIN, Alexander**; One Apple Park Way, Cupertino, California 95014 (US). **XU, Fangli**; One Apple Park Way, Cupertino, California 95014 (US). **HU, Haijing**; One Apple Park Way, Cupertino, California 95014 (US). **CHENG, Peng**; One Apple Park Way, Cupertino, California 95014 (US). **KUO, Ping-Heng**; One Apple Park Way, Cupertino, California 95014 (US). **ROSSBACH, Ralf**; One Apple Park Way, Cupertino, California 95014 (US). **GURUMOORTHY, Sethuraman**; One Apple Park Way, Cupertino, California 95014 (US). **CHEN, Yuqin**; One Apple Park Way, Cupertino, California 95014 (US). **WU, Zhibin**; One Apple Park Way, Cupertino, California 95014 (US).

(74) Agent: **MARCIN, Michael J.** et al.; 150 Broadway, Suite 702, New York, New York 10038 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,

(54) Title: CONFIGURATION OF CONDITIONAL MULTI-DC AND PERSISTENCE OF CONFIGURATION

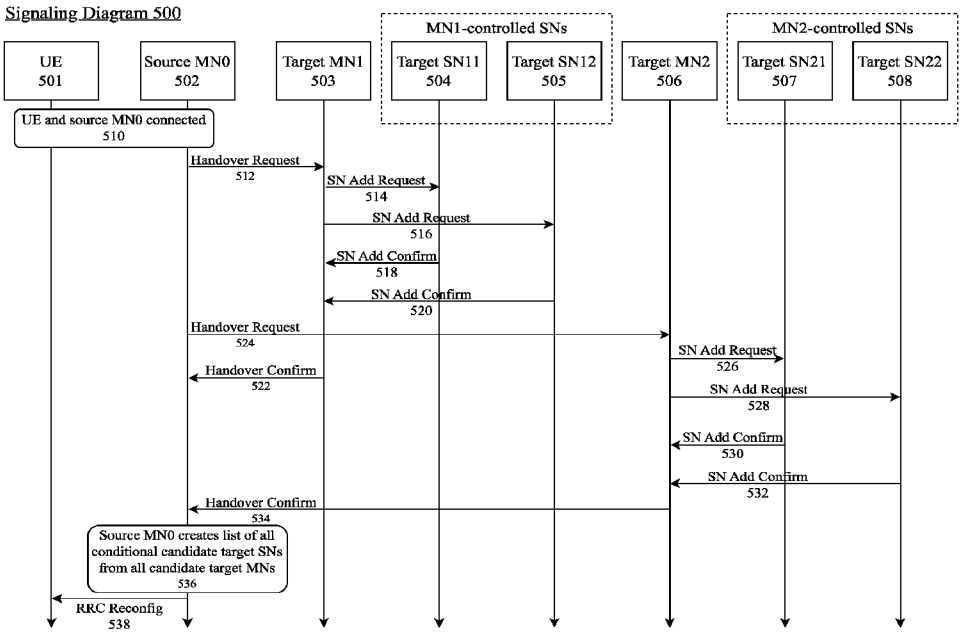

Fig. 5a

(57) **Abstract:** A base station configured as a source master node (MN) for a user equipment (UE) and configured to transmit a first handover request to a first candidate target master node (MN) including conditional handover (CHO) information for the UE, decode a first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective trigger condition and a respective secondary cell group (SCG) configuration for respective candidate target secondary nodes (SNs), generate a total list of conditional configurations and transmit a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

WO 2024/035706 A1

[Continued on next page]

CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

Configuration of Conditional Multi-DC and Persistence of Configuration

Inventors: Naveen Kumar R Palle Venkata, Alexander Sirotkin, Fangli Xu, Haijing Hu, Peng Cheng, Ping-Heng Kuo, Ralf Rossbach, Sethuraman Gurumoorthy, Yuqin Chen and Zhibin Wu

Priority/Incorporation By Reference

[0001] This application claims priority to U.S. Provisional Application Serial No. 63/370,759 filed on August 8, 2022, and entitled "Configuration of Conditional Multi-DC and Persistence of Configuration," the entirety of which is incorporated herein by reference.

Background

[0002] A user equipment (UE) may establish a connection to at least one of a plurality of different networks or types of networks, for example a 5G New Radio (NR) radio access technology (RAT) and a Long-Term Evolution (LTE) RAT. The UE may support standalone (SA) carrier aggregation (CA) on LTE, SA CA on NR (NR-CA), or a variety of non-standalone (NSA) and/or dual-connectivity (DC) functionalities in which a plurality of component carriers (CCs) are combined across LTE and/or NR. In NR-NR DC (NR-DC), the UE is connected to two cells or cell groups (CG) wherein one gNB acts as master node (MN) (or primary cell (PCell)) in a master CG (MCG) and another gNB acts as a secondary node (SN) (or primary secondary cell (PSCell)) in a secondary CG (SCG).

[0003] Conditional handover (CHO) relates to an operation in which the network provides the UE with a list of target cell(s) for CHO with a corresponding radio resource control (RRC) configuration, which are prepared for handover to the UE in advance of the actual handover. For each target cell, the

source gNB provides at least one condition for the UE to perform CHO. The condition(s) may relate to a radio quality for the target cell, as determined by the UE. The UE performs measurements on the target cells and, when the condition is satisfied for a target cell, the UE starts CHO and applies the preconfigured target cell configuration immediately. With CHO, the UE is able to perform handover without the involvement of the source cell, e.g., even when a radio quality of the connection with the source cell has degraded such that a source cell-initiated handover is not possible.

[0004] In 5G New Radio (NR), conditional configurations can be used for CHO and/or for changing a MCG or a SCG in DC operation. It may be desirable in Rel-18 to minimize the signaling needed for the UE to change CGs, e.g., to handover from a source SN of a first SCG to a target SN of a second SCG in NR-DC operation. Additionally, CHO can be specified in NR-DC in scenarios where one or more target MCGs and multiple candidate SCGs are available.

Summary

[0005] Some exemplary embodiments are related to an apparatus of a base station configured as a source master node (MN) for a user equipment (UE), the apparatus having processing circuitry configured to configure transceiver circuitry to transmit a first handover request to at least a first candidate target master node (MN) including conditional handover (CHO) information for the UE, decode, from signaling received from at least the first candidate target MN, a first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least

two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs, generate a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received and configure transceiver circuitry to transmit a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[0006] Other exemplary embodiments are related to a processor configured to configure transceiver circuitry to transmit a first handover request to at least a first candidate target master node (MN) including conditional handover (CHO) information for the UE, decode, from signaling received from at least the first candidate target MN, a first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG)

configuration for the respective candidate target SNs, generate a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received and configure transceiver circuitry to transmit a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[0007] Still further exemplary embodiments are related to an apparatus of a base station connected to a source master node (MN) for a user equipment (UE), the apparatus having processing circuitry configured to decode, from signaling received from the source MN, a handover request including conditional handover (CHO) information for the UE, configure transceiver circuitry to transmit a respective secondary node (SN) addition request to at least two candidate target SNs under control of the base station, decode, from signaling received from at least two candidate target SNs, a respective SN addition confirm that confirms the at least two candidate target SNs are available for CHO of the UE, determine a list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the at least two candidate target SNs available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell

group (SCG) configuration for the respective candidate target SNs and configure transceiver circuitry to transmit the list of conditional configurations to the source MN.

[0008] Additional exemplary embodiments are related to a processor configured to decode, from signaling received from the source MN, a handover request including conditional handover (CHO) information for the UE, configure transceiver circuitry to transmit a respective secondary node (SN) addition request to at least two candidate target SNs under control of the base station, decode, from signaling received from at least two candidate target SNs, a respective SN addition confirm that confirms the at least two candidate target SNs are available for CHO of the UE, determine a list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the at least two candidate target SNs available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and configure transceiver circuitry to transmit the list of conditional configurations to the source MN.

[0009] More exemplary embodiments are related to an apparatus of a user equipment (UE) connected to a source master node (MN), the apparatus having processing circuitry configured to decode, from signaling received from the source MN, a radio resource control (RRC) reconfiguration including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional

configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and when a given trigger condition of a given conditional configuration from the total list is satisfied, apply a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[0010] Further exemplary embodiments are related to a processor configured to decode, from signaling received from the source MN, a radio resource control (RRC) reconfiguration including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and when a given trigger condition of a

given conditional configuration from the total list is satisfied, apply a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

Brief Description of the Drawings

[0011] Fig. 1 shows a network arrangement according to various exemplary embodiments.

[0012] Fig. 2 shows an exemplary UE according to various exemplary embodiments.

[0013] Fig. 3 shows an exemplary network base station according to various exemplary embodiments.

[0014] Fig. 4a shows an exemplary RRC configuration including conditional reconfigurations for conditional handover (CHO) and/or CPC/CA according to various exemplary embodiments.

[0015] Fig. 4b shows an exemplary conditional handover (CHO) configuration including conditional reconfigurations for respective SCG configurations according to various exemplary embodiments.

[0016] Fig. 4c shows an exemplary network arrangement including a UE 452 performing mobility switches amongst a plurality of candidate SNs according to various exemplary embodiments.

[0017] Fig. 5a shows a signaling diagram for configuring conditional handover (CHO) in a network arrangement including

multiple target master nodes controlling multiple target secondary nodes according to various exemplary embodiments.

[0018] Fig. 5b shows an exemplary RRC configuration for conditional handover (CHO) in a network arrangement including multiple target master nodes (MNs) controlling multiple target secondary nodes (SNs) according to various exemplary embodiments.

[0019] Fig. 5c shows an exemplary signaling diagram for executing conditional handover (CHO) in a network arrangement including multiple target master nodes controlling multiple target secondary nodes according to various exemplary embodiments.

[0020] Fig. 5d shows an exemplary RRC reconfiguration for conditional handover (CHO) of a UE with embedded SN configurations according to various exemplary embodiments.

[0021] Fig. 5e shows an exemplary information element (IE) for a new conditional trigger according to various exemplary embodiments.

[0022] Fig. 6a shows an exemplary RRC configuration for conditional handover (CHO) comprising two conditional configuration lists that are one to one mapped according to various exemplary embodiments.

[0023] Fig. 6b shows an exemplary information element (IE) for a new Rel-18 conditional configuration according to various exemplary embodiments.

[0024] Fig. 6c shows an exemplary RRC configuration for conditional handover (CHO) comprising two conditional configuration lists that are mapped based on ID according to various exemplary embodiments.

[0025] Fig. 6d shows an exemplary information element (IE) for a new Rel-18 conditional configuration according to various exemplary embodiments.

[0026] Fig. 7 shows an exemplary information element (IE) for a new Rel-18 conditional configuration including a reference configuration according to various exemplary embodiments.

Detailed Description

[0027] The exemplary aspects may be further understood with reference to the following description and the related appended drawings, wherein like elements are provided with the same reference numerals. The exemplary aspects describe operations for configuring conditional reconfigurations for a user equipment (UE) in scenarios where multiple candidate combinations of a master cell group (MCG) and a secondary cell group (SCG) are available for handover or switching. In some embodiments, multiple candidate secondary nodes (SNs) are available and under the control of a single master node (MN). Operations are described for distinguishing among these multiple candidate SNs, including associating each candidate SN with an ID unique to a source MN and configuration operations for the UE and the various network nodes.

[0028] In other embodiments, configuration aspects are described that ensure the interoperability between the radio

resource control (RRC) message extensions described herein, e.g., for Rel-18 New Radio (NR), and existing RRC specifications for prior releases, e.g., Rel-16/17 NR. In one aspect, a separate Rel-18 list of conditional reconfigurations can be mapped to a list of Rel-16/17 conditional reconfigurations, e.g., one-to-one mapped, or by implementing an optional ID for the entries in the Rel-16/17 list that is referred to by entries in the Rel-18 list. In still other embodiments, the network can explicitly configure whether a configuration ID should be saved at the UE or released after a conditional reconfiguration is triggered. A delta configuration can be used to adjust a saved conditional configuration or a reference configuration, to be described in greater detail below.

[0029] The exemplary aspects are described with regard to a UE. However, the use of a UE is provided for illustrative purposes. The exemplary aspects may be utilized with any electronic component that may establish a connection with a network and is configured with the hardware, software, and/or firmware to exchange information and data with the network. Therefore, the UE as described herein is used to represent any electronic component that is capable of dual connectivity (DC) operations with one or more networks, e.g., the 5G radio access network (RAN).

[0030] The exemplary embodiments are also described with regard to a 5G New Radio (NR) radio access network (RAN). However, reference to a 5G NR RAN is merely provided for illustrative purposes. The exemplary embodiments may be utilized with any network implementing dual connectivity (DC) functionalities similar to those described herein. Therefore,

the 5G NR network as described herein may represent any type of network implementing DC functionalities as the 5G NR network.

[0031] The exemplary embodiments are also described with regard to dual connectivity (DC). Those skilled in the art will understand that DC generally refers to a scenario in which the UE is connected to a master node (MN) and a secondary node (SN). The MN may be one of multiple nodes that form a master cell group (MCG) and the SN may be one of multiple nodes that form a secondary cell group (SCG). The nodes of the cell groups may be further characterized by their roles within their respective cell group. In the examples provided below, reference is made to various different types of cells. Those skilled in the art will understand that each of these different types of cells are defined in third generation partnership program (3GPP) Specifications. For instance, the MCG may comprise a primary cell (PCell) and zero or more secondary cells (SCells). Throughout this description, the terms "MN" and "PCell" may be used interchangeably. The SCG may comprise a primary secondary cell (PSCell) and zero or more SCells. Throughout this description, the terms "SN" and "PSCell" may also be used interchangeably.

[0032] Fig. 1 shows an exemplary network arrangement 100 according to various exemplary embodiments. The exemplary network arrangement 100 includes a user equipment (UE) 110. Those skilled in the art will understand that the UE may be any type of electronic component that is configured to communicate via a network, e.g., mobile phones, tablet computers, smartphones, phablets, embedded devices, wearable devices, Cat-M devices, Cat-M1 devices, MTC devices, eMTC devices, other types of Internet of Things (IoT) devices, etc. It should also be

understood that an actual network arrangement may include any number of UEs being used by any number of users. Thus, the example of a single UE 110 is merely provided for illustrative purposes.

[0033] The UE 110 may communicate directly with one or more networks. In the example of the network configuration 100, the networks with which the UE 110 may wirelessly communicate are a 5G NR radio access network (5G NR-RAN) 120, an LTE radio access network (LTE-RAN) 122 and a wireless local access network (WLAN) 124. Therefore, the UE 110 may include a 5G NR chipset to communicate with the 5G NR-RAN 120, an LTE chipset to communicate with the LTE-RAN 122 and an ISM chipset to communicate with the WLAN 124. However, the UE 110 may also communicate with other types of networks (e.g., legacy cellular networks) and the UE 110 may also communicate with networks over a wired connection. With regard to the exemplary aspects, the UE 110 may establish a connection with the 5G NR-RAN 120 and the LTE-RAN 122 in a NSA or DC mode of operation.

[0034] The 5G NR-RAN 120 and the LTE-RAN 122 may be portions of cellular networks that may be deployed by cellular providers (e.g., Verizon, AT&T, T-Mobile, etc.). These networks 120, 122 may include, for example, cells or base stations (Node Bs, eNodeBs, HeNBs, eNBS, gNBs, gNodeBs, macrocells, microcells, small cells, femtocells, etc.) that are configured to send and receive traffic from UEs that are equipped with the appropriate cellular chip set. The WLAN 124 may include any type of wireless local area network (WiFi, Hot Spot, IEEE 802.11x networks, etc.).

[0035] The UE 110 may connect to the 5G NR-RAN 120 via at least one of the next generation nodeB (gNB) 120A and/or the gNB

120B. Reference to two gNBs 120A, 120B is merely for illustrative purposes. The exemplary aspects may apply to any appropriate number of gNBs. The UE 110 may additionally connect to the LTE-RAN 122 via at least one of the enhanced nodeB (eNB) 122A and/or the eNB 122B. Reference to two eNBs 122A, 122B is merely for illustrative purposes. The exemplary aspects may apply to any appropriate number of eNBs.

[0036] In addition to the networks 120, 122 and 124 the network arrangement 100 also includes a cellular core network 130, the Internet 140, an IP Multimedia Subsystem (IMS) 150, and a network services backbone 160. The cellular core network 130, e.g., the 5GC for the 5G NR network, may be considered to be the interconnected set of components that manages the operation and traffic of the cellular network. The cellular core network 130 also manages the traffic that flows between the cellular network and the Internet 140.

[0037] The IMS 150 may be generally described as an architecture for delivering multimedia services to the UE 110 using the IP protocol. The IMS 150 may communicate with the cellular core network 130 and the Internet 140 to provide the multimedia services to the UE 110. The network services backbone 160 is in communication either directly or indirectly with the Internet 140 and the cellular core network 130. The network services backbone 160 may be generally described as a set of components (e.g., servers, network storage arrangements, etc.) that implement a suite of services that may be used to extend the functionalities of the UE 110 in communication with the various networks.

[0038] Fig. 2 shows an exemplary UE 110 according to various exemplary embodiments. The UE 110 will be described with regard to the network arrangement 100 of Fig. 1. The UE 110 may represent any electronic device and may include a processor 205, a memory arrangement 210, a display device 215, an input/output (I/O) device 220, a transceiver 225, and other components 230. The other components 230 may include, for example, an audio input device, an audio output device, a battery that provides a limited power supply, a data acquisition device, ports to electrically connect the UE 110 to other electronic devices, sensors to detect conditions of the UE 110, etc. Additionally, the UE 110 may be configured to access an SNPN.

[0039] The processor 205 may be configured to execute a plurality of engines for the UE 110. For example, the engines may include a conditional reconfiguration engine 235 for performing operations related to receiving a configuration from the network for performing conditional handover (CHO) or a secondary cell group (SCG) switch. Multiple conditional target secondary nodes (SNs) can be configured and uniquely identified for completing the handover/switch. These and further operations will be described in greater detail below.

[0040] The above referenced engine being an application (e.g., a program) executed by the processor 205 is only exemplary. The functionality associated with the engines may also be represented as a separate incorporated component of the UE 110 or may be a modular component coupled to the UE 110, e.g., an integrated circuit with or without firmware. For example, the integrated circuit may include input circuitry to receive signals and processing circuitry to process the signals and other information. The engines may also be embodied as one

application or separate applications. In addition, in some UEs, the functionality described for the processor 205 is split among two or more processors such as a baseband processor and an applications processor. The exemplary aspects may be implemented in any of these or other configurations of a UE.

[0041] The memory 210 may be a hardware component configured to store data related to operations performed by the UE 110. The display device 215 may be a hardware component configured to show data to a user while the I/O device 220 may be a hardware component that enables the user to enter inputs. The display device 215 and the I/O device 220 may be separate components or integrated together such as a touchscreen.

[0042] The transceiver 225 may be a hardware component configured to establish a connection with the 5G-NR RAN 120, the LTE RAN 122 etc. Accordingly, the transceiver 225 may operate on a variety of different frequencies or channels (e.g., set of consecutive frequencies). The transceiver 225 may encompass an advanced receiver (e.g., E-MMSE-RC, R-ML, etc.) for MU-MIMO. The transceiver 225 includes circuitry configured to transmit and/or receive signals (e.g., control signals, data signals). Such signals may be encoded with information implementing any one of the methods described herein. The processor 205 may be operably coupled to the transceiver 225 and configured to receive from and/or transmit signals to the transceiver 225. The processor 205 may be configured to encode and/or decode signals (e.g., signaling from a base station of a network) for implementing any one of the methods described herein.

[0043] Fig. 3 shows an exemplary network base station, in this case gNB 120A, according to various exemplary embodiments.

As noted above with regard to the UE 110, the gNB 120A may represent a serving cell for the UE 110. The gNB 120A may represent any access node of the 5G NR network through which the UE 110 may establish a connection and manage network operations. The gNB 120A illustrated in Fig. 3 may also represent the gNB 120B.

[0044] The gNB 120A may include a processor 305, a memory arrangement 310, an input/output (I/O) device 320, a transceiver 325, and other components 330. The other components 330 may include, for example, an audio input device, an audio output device, a battery, a data acquisition device, ports to electrically connect the gNB 120A to other electronic devices, etc.

[0045] The processor 305 may be configured to execute a plurality of engines of the gNB 120A. For example, the engines may include a conditional reconfiguration engine 330 for performing operations including configuring a UE for performing conditional handover (CHO) or a secondary cell group (SCG) switch. The gNB 120A can receive configurations for candidate conditional secondary nodes (SNs) that are uniquely identified and provide these configurations to the UE for completing the handover/switch. These and further operations will be described in greater detail below.

[0046] The above noted engine 330 being an application (e.g., a program) executed by the processor 305 is only exemplary. The functionality associated with the engine 330 may also be represented as a separate incorporated component of the base station 300 or may be a modular component coupled to the base station 300, e.g., an integrated circuit with or without

firmware. For example, the integrated circuit may include input circuitry to receive signals and processing circuitry to process the signals and other information. In addition, in some base stations, the functionality described for the processor 305 is split among a plurality of processors (e.g., a baseband processor, an applications processor, etc.). The exemplary embodiments may be implemented in any of these or other configurations of a base station.

[0047] The memory 310 may be a hardware component configured to store data related to operations performed by the UEs 110, 112. The I/O device 320 may be a hardware component or ports that enable a user to interact with the gNB 120A.

[0048] The transceiver 325 may be a hardware component configured to exchange data with the UE 110 and any other UE in the system 100. The transceiver 325 may operate on a variety of different frequencies or channels (e.g., set of consecutive frequencies). Therefore, the transceiver 325 may include one or more components (e.g., radios) to enable the data exchange with the various networks and UEs. The transceiver 320 includes circuitry configured to transmit and/or receive signals (e.g., control signals, data signals). Such signals may be encoded with information implementing any one of the methods described herein. The processor 305 may be operably coupled to the transceiver 320 and configured to receive from and/or transmit signals to the transceiver 320. The processor 305 may be configured to encode and/or decode signals (e.g., signaling from a UE) for implementing any one of the methods described herein.

[0049] Conditional handover (CHO) relates to an operation in which a network provides a user equipment (UE) a list of target

cell(s) for CHO with a corresponding radio resource control (RRC) configuration, which are prepared for handover to the UE in advance of the actual handover. For each target cell, the source gNB provides at least one condition for the UE to perform CHO. The condition(s) may relate to a radio quality for the target cell, as determined by the UE. The UE performs measurements on the target cells and, when the condition is satisfied for a target cell, the UE starts CHO and applies the preconfigured target cell configuration immediately. With CHO, the UE is able to perform handover without the involvement of the source cell, e.g., even when a radio quality of the connection with the source cell has degraded such that a source cell-initiated handover is not possible.

[0050] Dual connectivity (DC) generally refers to a scenario in which the UE is connected to a master node (MN) and a secondary node (SN). The MN may be one of multiple nodes that form a master cell group (MCG) and the SN may be one of multiple nodes that form a secondary cell group (SCG). The nodes of the cell groups may be further characterized by their roles within their respective cell group. In the examples provided below, reference is made to various different types of cells. Those skilled in the art will understand that each of these different types of cells are defined in third generation partnership program (3GPP) Specifications. For instance, the MCG may comprise a primary cell (PCell) and zero or more secondary cells (SCells). Throughout this description, the terms “MN” and “PCell” may be used interchangeably. The SCG may comprise a primary secondary cell (PSCell) and zero or more SCells. Throughout this description, the terms “SN” and “PSCell” may also be used interchangeably. The PCell and the PSCell may be jointly referred to as a SpCell (special cell).

[0051] Conditional primary secondary cell (PSCell) addition/change (CPA/CPC) relates to an operation in DC where a list of target PSCell(s) is provided to the UE, along with corresponding condition(s) for handover, and the UE initiates handover when the condition is satisfied for one of the target PSCells. The CPA/CPC configuration contains the configuration of CPA/CPC candidate PSCell(s), execution condition(s) and may contain the MCG configuration, to be applied when CPA/CPC execution is triggered. An execution condition may comprise any number of conditions but typically includes one or two trigger condition(s) (CondEvents, as defined in TS 38.331 [4] or TS 36.331 [10]) regarding a measurement object. In some examples, a single RS type and two different trigger quantities (e.g., RSRP and RSRQ, RSRP and SINR, etc.) can be used for the evaluation of CPA/CPC execution condition of a single candidate PSCell. However, these are not requirements of the exemplary embodiments.

[0052] The RRC IE *ConditionalReconfiguration* is used to add, modify and release the configuration of conditional reconfigurations. The *ConditionalReconfiguration* IE includes a *condReconfigToAddModList* IE including a list of the configurations of candidate SpCells to be added or modified for CHO or CPA/CPC and a *condReconfigToRemoveList* IE including a list of configurations of candidate SpCells to be removed. The *condReconfigToAddModList* IE includes a list of conditional reconfigurations with an associated execution condition(s) and an *RRCReconfiguration* message to be applied when the condition(s) are fulfilled. The IE *CondReconfigID* is used to identify a CHO or CPC configuration.

[0053] As described above, an RRC message can include conditional reconfiguration IEs that include further RRC reconfigurations embedded within, which may include further conditional reconfigurations, and so on.

[0054] Fig. 4a shows an exemplary RRC configuration 400 including conditional reconfigurations for conditional handover (CHO) and/or CPC/CA according to various examples. A first RRC reconfiguration 402 comprises a MCG configuration, an SCG configuration, and three conditional reconfigurations (cond reconfig 1; cond reconfig 2; cond reconfig 3). Each of the three conditional reconfigurations is associated with a respective ID, trigger/execution condition and optional (additional) RRCReconfiguration.

[0055] In this example, the SCG configuration for the first RRC reconfiguration 402 is a Rel-16 CPC configuration that includes (e.g., points to) a second RRC reconfiguration 404. The second RRC reconfiguration 404 comprises a conditional reconfiguration (cond reconfig 4) (e.g., no MCG or SCG config). Thus, the UE begins evaluating the conditional reconfiguration trigger condition of the second RRC reconfiguration 404 when the first RRC reconfiguration 402 is decoded. The conditional reconfiguration of the second RRC reconfiguration 404 points to a third RRC reconfiguration 406, which comprises a SCG configuration. This type of arrangement may be referred to as a "nested" or embedded conditional configuration.

[0056] The first conditional reconfiguration IE (cond reconfig 1) of the first RRC configuration 402 is a Rel-16 CHO configuration and points to a fourth RRC reconfiguration 408 that comprises a MCG configuration. The second conditional

reconfiguration (cond reconfig 2) of the first RRC reconfiguration 402 is a Rel-17 CPC configuration and points to a fifth RRC reconfiguration 410 that comprises a SCG configuration. The third conditional reconfiguration (cond reconfig 3) of the first RRC reconfiguration 402 is a Rel-17 CHO+SN and points to a sixth RRC reconfiguration 412 that comprises a MCG configuration and a SCG configuration.

[0057] For Rel-18 mobility enhancements, it may be desirable to specify a mechanism and procedures for NR-DC with selective activation of the cell groups (CG) (at least for SCGs) via L3 (RRC) enhancements to allow a subsequent CG change after an initial CG change without reconfiguration and/or re-initiation of CPC/CPA (first objective). Further, it may be desirable to specify CHO including target MCG and multiple candidate SCGs for CPC/CPA in NR-DC (second objective). CHO including target MCG and target SCG can be used as the baseline.

[0058] To achieve the second objective above, the UE may be configured with multiple conditional MCG-SCG (DC) combinations, including the case of a conditional configuration where potential target MNs can have multiple candidate SNs with associated conditional reconfigurations. Current specifications allows the UE to be configured with up to 8 conditional reconfigurations. Each of these can be a CHO or a MN-I-CPC/CPA or SN-I-CPC (but provided by the MN). For the case of multiple candidate SNs, the conditional configurations can be embedded/nested as described above, or may not be embedded/nested.

[0059] Fig. 4b shows an exemplary conditional handover (CHO) configuration 420 including conditional reconfigurations for

respective SCG configurations according to one example. In this example, the MCG configuration corresponds to a target master node (MN) and the SCG configurations correspond to target secondary nodes (SN) under the control of the target MN.

[0060] A first RRC reconfiguration 422 comprises a MCG configuration (for a source MN), an SCG configuration (for a source SN), and three conditional reconfigurations (cond reconfig 1; cond reconfig 2; cond reconfig 3).

[0061] In this example, the first and second conditional reconfigurations (cond reconfig 1, 2) of the first RRC reconfiguration 422 may relate to Rel-16/17 mechanisms. The third conditional reconfiguration of the first RRC reconfiguration 422 points to a second RRC reconfiguration 424 that comprises a MCG configuration, no SCG configuration, and two additional conditional reconfigurations (cond reconfigs 4, 5). The first conditional reconfiguration (cond reconfig 4) of the second RRC configuration 424 points to a third RRC reconfiguration 426 that comprises a first SCG configuration. The second conditional reconfiguration (cond reconfig 5) of the second RRC configuration 424 points to a fourth RRC reconfiguration 428 that comprises a second SCG configuration.

[0062] As shown above, trigger conditions can be configured that point to multiple candidate SNs/SCGs that can be selected by the UE. In R17 CPC, when a conditional reconfiguration trigger condition is satisfied for a SCG configuration, the UE provides the condReconfig ID for the selected SN to the MN to complete the handover. However, current techniques do not consider that multiple candidate SNs can be conditionally configured for multiple candidate MNs. To achieve the second

objective above, the network should know which SN among multiple candidate SNs the UE has chosen based on the conditional trigger.

[0063] To achieve the first objective above, and allow multiple CG changes without requiring RRC reconfiguration, the UE may store (or not delete) the conditional configurations (of at least the candidate SNs) after each triggering of a conditional mobility action that causes a switch to a different SCG. The network can always reconfigure the UE with a L3 message (e.g., RRC) at/after every SCG change, however, the first objective aims to minimize any signaling for subsequent CG changes. If this L3 signaling is to be minimal or absent then the information from the network to the UE for the SCG change should be minimal.

[0064] Fig. 4c shows an exemplary network arrangement 450 including a UE 452 performing mobility switches among a plurality of candidate SNs 456-462 according to one example. The UE 452 is connected to a master node (MN) 454 that controls SNs 456-462, e.g., SN0 456, SN1 458, SN2 460, SN3 462. The UE 452 has conditional configurations for each of the SCGs corresponding to the SNs 456-462. According to the mobility pattern of the UE 452, first, the condition for SN0 456 is satisfied and the UE 452 applies the configuration of the SCG for SN0 456 (mobility switch 1). Next, the condition for SN2 460 is satisfied and the UE 452 applies the configuration of the SCG for SN2 460 (mobility switch 2). Next, the condition for SN0 456 is satisfied and the UE 452 applies the configuration of the SCG for SN0 456 (mobility switch 3). Next, the condition for SN1 458 is satisfied and the UE 452 applies the configuration of the SCG for SN1 458 (mobility switch 4).

[0065] There is no guarantee on the mobility pattern of the UE, and the conditional handover configurations have to be provided to each target cell after handover to allow the (new) MN to complete subsequent handovers to further cells. A delta configuration over the (previous) source cell configuration may use a centralized node that keeps track of the "resultant" configuration the UE is using.

[0066] According to various exemplary embodiments described herein, methods are proposed that address these objectives discussed above. In one aspect, techniques are described for distinguishing which SCG/SN among multiple candidate SCGs/SNs the UE has chosen based on the conditional trigger. In another aspect, techniques are described for ensuring the inter-operability between the present embodiments and previous techniques/releases. In still another embodiment, techniques are described for ensuring the persistence of the conditional SCG/SN configurations even after a conditional reconfiguration has been applied, e.g., ensuring that the UE and network are in sync with respect to the current conditional configurations of the UE even with mobility across different CGs.

[0067] According to one aspect of these exemplary embodiments, each candidate SN/SCG can be associated with a unique ID (e.g., conditional configuration ID) and a separate trigger condition. The network can configure the Rel-18 conditional configurations with candidate SNs where each candidate SN is listed outside of its MN. The candidate SNs may be uniquely identified by the UE/network and are not required to be associated with one particular MN.

[0068] As described above, in existing specifications, the UE is expected to be configured with up to 8 conditional configurations. In the present embodiments, each of the candidate SNs counts towards the total conditional configurations the UE supports. In some scenarios, a candidate SN is part of multiple different MNs and is counted per MN. Each of the conditional candidate SN can have a separate trigger condition, which provides the means for the network to provide separate SN triggers. Conditional executions (up to 2) can be distributed between the MN and a candidate SN for that MN.

[0069] A target MN can receive a handover request from a source MN including conditional handover information for the UE. The target MN can request the SNs under its control to be added to the conditional handover configuration for the UE. For SNs that confirm the request, the target MN populates a list including the candidate SNs with a separate list of conditional configurations. The target MN may also add a conditional configuration ID for each of the candidate SNs it adds for conditional SN addition. This list is provided to the source MN.

[0070] The source MN creates a list of total conditional candidates by combining the conditional candidates from all potential target MNs from which the source MN received conditional configurations. The conditional configuration IDs may be unique across all target MNs and candidate SNs of these MNs. In one option, the source MN can provide a different ID range/space to each of the respective target MNs so that the target MN can associate the SNs under the MN control with an ID from the ID space, thus ensuring that the SN IDs are unique to

the source MN. In another option, the source MN can perform ID re-negotiation with the target MNs, if necessary.

[0071] Once the conditional reconfiguration ID for a particular SN is received from the UE (when the triggering conditions happen), the source MN correctly routes the reconfiguration complete message back to the corresponding target MN, based on the UE-provided conditional reconfiguration ID. The target MN then uses this ID to correctly route the reconfiguration complete message from the UE to the corresponding SN within its candidate SN pool.

[0072] Fig. 5a shows a signaling diagram 500 for configuring conditional handover (CHO) in a network arrangement including multiple target master nodes controlling multiple target secondary nodes according to various exemplary embodiments. In this example, the signaling diagram 500 includes a UE 501 connected to a source master node (MN0) 502. The source MN0 502 is connected to a first target MN (MN1) 503 and a second target MN (MN2) 506. The first target MN1 503 controls a first target secondary node (SN11) 504 and a second target SN (SN12) 505, while the second target MN2 506 controls a third target SN (SN21) 507 and a fourth target SN (SN22) 508. It should be understood that the target MNs and SNs can represent MCGs and SCGs, respectively, and that additional cells can be under the control of the target MNs (PCells) and target SNs (PSCells).

[0073] In 510, the UE 501 and the source MN0 502 establish a connection. The source MN0 502 can determine to configure the UE 501 with conditional handover (CHO), e.g., based on measurement reports received from the UE 501. To determine the

availability of neighbor MNs/SNs, the source MN0 502 can submit handover requests to neighbor target MNs.

[0074] In 512, the source MN0 502 transmits a first handover request to the first target MN1 503 including conditional handover information for the UE 501. In some embodiments, the handover request can further include a first ID space to be used for identifying SNs controlled by the first target MN1 503, e.g., first target SN11 504 and second target SN12 505. For example, the first ID space for MN1-controlled SNs can include IDs 10-19. In 524, the source MN0 502 transmits a second handover request to the second target MN2 506 including conditional handover information for the UE 501 and, in some embodiments, a second ID space to be used for identifying SNs controlled by the second target MN2 506, e.g., third target SN21 507 and fourth target SN22 508. For example, the second ID space for MN2-controlled SNs can include IDs 20-29. Those skilled in the art will ascertain that additional candidate target MNs can be prepared for CHO and the exemplary embodiments are not limited to two candidate target MNs, e.g., MN1 503 and MN2 506.

[0075] Based on the received handover request, the candidate target MNs 503, 506 can request SNs under their control to be added as candidate target SNs.

[0076] In 514, the first target MN1 503 transmits a first SN addition request to the first target SN11 504 under MN1 control including conditional handover information for the UE 501. In 516, the first target MN1 503 transmits a second SN addition request to the second target SN12 504 under MN1 control including conditional handover information for the UE 501. Those skilled in the art will ascertain that additional

candidate target SNs can be prepared for CHO and the exemplary embodiments are not limited to two candidate target SNs, e.g., SN11 504 and SN12 505.

[0077] In 518, the first target MN1 503 receives a first SN addition confirm from the first target SN11 504 including an SN configuration. The SN configuration can, in some embodiments, further include a trigger condition for the first target SN11 504. In 520, the target MN1 503 receives a second SN addition confirm from the second target SN12 505 including an SN configuration and potential trigger condition for the second target SN12 505.

[0078] After receiving the SN addition confirmation from the requested target SNs, the first target MN1 503 can respond to the source MN0 502 with a handover confirmation including information for the target SNs under the control of the first target MN1 503.

[0079] In 522, the first target MN1 503 transmits a first handover confirmation to the source MN0 502 including a conditional configuration list of the target SNs 504, 505. The target SNs 504, 505 are each associated with a SN ID (SN11, SN12) (conditional configuration ID) that is unique to the target MN1 503. In some embodiments, when the handover request of 512 includes an ID space to be used for the SNs, the SN IDs can be unique to the source MN0 502 across all neighbor target MNs. The first handover confirmation can also include CHO trigger conditions for the respective target SNs 504, 505.

[0080] A process similar to that described for 514-522 can be performed for the second target MN2 506. In 526, the second target MN2 506 transmits a third SN addition request to the

third target SN21 507 under MN2 control including conditional handover information. In 528, the second target MN2 506 transmits a fourth SN addition request to the fourth target SN22 508 under MN2 control including conditional handover information. Those skilled in the art will ascertain that additional candidate target SNs can be prepared for CHO and the exemplary embodiments are not limited to two candidate target SNs, e.g., SN21 507 and SN22 508.

[0081] In 530, the second target MN2 506 receives a third SN addition confirm from the third target SN21 507 including an SN configuration that can, in some embodiments, further include a trigger condition for the third target SN21 507. In 532, the second target MN2 506 receives a fourth SN addition confirm from the fourth target SN22 508 including an SN configuration and potential trigger condition for the fourth target SN22 508.

[0082] After receiving the SN addition confirmation from the requested target SNs, the second target MN2 506 can respond to the source MN0 502 with a handover confirmation including information for the target SNs under the control of the second target MN2 506.

[0083] In 534, the second target MN2 506 transmits a second handover confirmation to the source MN0 502 including a conditional configuration list of the target SNs 507, 508. The target SNs 507, 508 are each associated with a SN ID (SN21, SN22) (conditional configuration ID) that is unique to the second target MN2 506. In some embodiments, when the handover request of 524 includes an ID space to be used for the SNs, the SN IDs can be unique to the source MN0 502 across all neighbor

target MNs. The first handover confirmation can also include CHO trigger conditions for the respective target SNs 504, 505.

[0084] In 536, the source MN0 502 creates a list of total conditional candidate by combining the conditional candidates received from all potential target MNs, e.g., first target MN1 503 and second target MN2 506, from which the source MN0 502 received a handover confirm.

[0085] In the example of Fig. 5a, the source MN0 502 provides, in the first handover request of 512, a first ID space or range including IDs 10-19 to be used for SNs controlled by the first target MN1 503. Thus, in the handover confirm from the first target MN1 503, the SN IDs for the target SNs 504, 505 are within the ID range 10-19, e.g., first target SN11 504 and second target SN12 505. The source MN0 502 further provides, in the second handover request, a second ID space or range including IDs 20-29 to be used for SNs controlled by the second target MN2 506. Thus, in the handover confirm from the second target MN2 506, the SN IDs for target SNs 507, 508 are within the ID range 20-29, e.g., first target SN21 507 and second target SN22 508.

[0086] By providing the ID range(s), the source MN0 502 ensures that the SN IDs received from the multiple target SNs are unique and do not conflict with one another.

[0087] In other exemplary embodiments, the source MN0 502 does not provide the ID space(s) to the target MNs. In this embodiment, it is possible that the SN configurations received from the first target MN1 503 and the second target MN2 506 overlap/conflict. If such a conflict exists, the source MN0 502 can reallocate SN IDs so that the SN IDs for all the target SNs

(SN11, SN12, SN21, SN22) are unique/non-overlapping and inform the target MNs of the renumbering with a SN modification request.

[0088] In 538, the source MN0 502 transmits an RRC reconfiguration to the UE 501 including the conditional handover information, e.g., a list of configurations for CHO to a target MN and target SNs, each conditional configuration being associated with a unique ID. As described above, each of the candidate SN can have a separate trigger condition. The trigger condition can point to an RRC reconfiguration including a target MN and a target SN.

[0089] Fig. 5b shows an exemplary RRC configuration 540 for conditional handover (CHO) in a network arrangement including multiple target master nodes (MNs) controlling multiple target secondary nodes (SNs) according to various exemplary embodiments. A first RRC reconfiguration 542 comprises three conditional reconfigurations (cond reconfig 1; cond reconfig 2; cond reconfig 3). Each of the three conditional reconfigurations is associated with a respective trigger/execution condition. In this example, the trigger condition for the each of the conditional reconfiguration points to a respective further RRC configuration comprising a different combined MCG configuration and a SCG configuration. Each SCG configuration can correspond to a different SN.

[0090] In this example, the first conditional reconfiguration points to a second RRC reconfiguration 544 that comprises a MCG configuration for MCG-A and a SCG configuration for SCG-x. The second conditional reconfiguration points to a third RRC reconfiguration 546 that comprises a MCG configuration for MCG-A

and a SCG configuration for SCG-y. The third conditional reconfiguration points to a fourth RRC reconfiguration 548 that comprises a MCG configuration for MCG-A and a SCG configuration for SCG-z.

[0091] As shown, each candidate SCG is separately configured with its MCG. Each of the candidate SN/SCG has a separate trigger condition that can be distributed between the MN and a candidate SN for that MN. Once configured with the CHO parameters, the UE may evaluate the conditional triggers on a periodic basis.

[0092] Fig. 5c shows an exemplary signaling diagram 550 for executing conditional handover (CHO) in a network arrangement including multiple target master nodes controlling multiple target secondary nodes according to various exemplary embodiments. The network arrangement for the signaling diagram 550 corresponds to that of the signaling diagram 500 of Fig. 5a and includes a UE 501 connected to a source master node (MN0) 502; the source MN0 502 connected to a first target MN (MN1) 503 and a second target MN (MN2) 506; the first target MN1 503 controls a first target secondary node (SN11) 504 and a second target SN (SN12) 505; the second target MN2 506 controls a third target SN (SN21) 507 and a fourth target SN (SN22) 508.

[0093] In 552, the UE evaluates the trigger conditions and determines that one of the conditions is met. In this example, the conditional configuration ID for the trigger condition is uniquely associated with (points to) target MN1 and target SN12.

[0094] In 554, the UE transmits an RRC Reconfiguration complete to the first target MN1 503 including the conditional reconfiguration ID pointing to target SN12 505. The first

target MN1 routes the message to target SN12 505 based on the ID.

[0095] In 556, the first target MN1 503 transmits a handover success to the source MN0 502. In 558, the source MN0 502 transmits a handover cancel request to the second target MN2 506.

[0096] In 560, the second target MN2 506 transmits a first SN release request to the third target SN21 507 under MN2 control including conditional handover information for the UE. In 562, the second target MN2 506 transmits a second SN release request to the fourth target SN22 508 under MN2 control including conditional handover information for the UE. In 564, the second target MN2 506 receives a first SN release confirm from the third target SN21 507. In 566, the second target MN2 506 receives a second SN release confirm from the fourth target SN22 508.

[0097] The techniques described above have the advantage that the UE does not have to parse the entire RRC configuration at configuration time. The conditional reconfiguration message is used to determine the presence of (and find the configuration of) the candidate SN associated with the trigger condition of the triggered reconfiguration. It is also simple to track the total number of conditional configurations with which the UE is provided.

[0098] For the triggered conditional reconfiguration, the conditional reconfig ID is provided to the target master node and informs the MN which SN is selected for handover of the UE. This is important in cases where the same SN is part of different MNs.

[0099] In other exemplary embodiments, the target MN can add a separate list of conditional reconfigurations for the candidate SNs under the control of the target MN. For each of the conditional candidate SNs, the target MN adds an ID that can be local to this MN. In other words, other target MNs can use the same ID for SNs under the control of the other target MNs. The target MN adds a conditional config ID for the entire configuration. Similar to the aspects described above, this conditional config ID can be selected based on an ID range/space provided by the source MN, or by ID negotiation. This conditional config ID, with the embedded conditional configurations for the respective target SNs for the target MN, is provided to the source MN.

[00100] Fig. 5d shows an exemplary RRC reconfiguration 570 for conditional handover (CHO) of a UE with embedded SN configurations according to various exemplary embodiments. The first RRC configuration 572 comprises three conditional reconfigurations (cond reconfig 1; cond reconfig 2; cond reconfig 3). Each of the three conditional reconfigurations is associated with a respective trigger condition. In this example, the third conditional reconfiguration is associated with an ID (ID 7) for a target MN/MCG and points to a second RRC configuration 574 comprising a MCG configuration and additional conditional reconfigurations.

[00101] In this example, the second RRC configuration 574 configures the MCG corresponding to ID 7. The second RRC reconfiguration 574 further includes a first conditional reconfiguration associated with an ID (ID 23) and a second conditional reconfiguration associated with an ID (ID 4). The

first conditional reconfiguration points to a third RRC reconfiguration 576 including a SCG configuration (corresponding to ID 23), and the second conditional reconfiguration points to a fourth RRC reconfiguration 578 including a SCG configuration (corresponding to ID 4).

[00102] In this embodiment, at UE reception of the message, the UE parses the entire message (including the internal configs of SN for each MN). The UE evaluates the triggering condition for each target MN and associated SNs. When satisfied, the UE applies the total configuration (of the specific SN of the triggered MN). The UE sends the ID for the MN and, among the IDs related to SN (within this MN), the UE sends the ID associated with the SN the UE conditionally added.

[00103] To accommodate the handling of multiple candidate SNs, a new conditional trigger is proposed that the UE uses for evaluation of candidate SNs. This can be used on top of existing conditional trigger from Rel-16. The new trigger may have a new trigger configuration ID and a trigger condition that is meant for each SN.

[00104] Fig. 5e shows an exemplary information element (IE) 580 for a new conditional trigger according to various exemplary embodiments. The new conditional trigger is shown in 582. Within the new conditional trigger 582, a list of new conditional reconfigurations can be added, each including a conditional reconfiguration ID 584 and an execution condition 586.

[00105] According to another aspect of these exemplary embodiments, techniques are described for ensuring that the RRC message extensions for Rel-18 for multiple candidate SNs (for

each potential target MN) are inter-operable between different nodes (of R17 and R18) and UEs of R17 and R18.

[00106] In some embodiments, the list of conditional configurations can be extended as a separate list (of R18 extension). In one option, the R18 list can be a one-to-one (1-1) mapping with the R-16/17 list so that the target MN information can be applied from the MN list to the R18 list (which then has the MN info as absent). These exemplary embodiments assume that only 8 conditional configurations are to be used for R18, similar to Rel-16/17.

[00107] Fig. 6a shows an exemplary RRC configuration 600 for conditional handover (CHO) comprising two conditional configuration lists that are one to one mapped according to various exemplary embodiments. The RRC configuration 600 includes an RRC reconfiguration 602 including a conditional reconfiguration list 604 that includes a Rel-16/17 list of conditional reconfigurations and a Rel-18 list of conditional reconfigurations. In this option, the entries in the two lists are 1-1 mapped.

[00108] In this example, the first entry in the Rel-16 list provides a configuration for MN1 and SN1 and the second entry in the Rel-16 list provides a configuration for MN2. The first entry in the Rel-18 list provides a configuration for SN3 and the second entry in the Rel-18 list provides a configuration for SN4. Therefore, the resultant configuration with 1-1 mapping is MN1 with SN1 and SN3; and MN2 with SN4.

[00109] Fig. 6b shows an exemplary information element (IE) 610 for a new Rel-18 conditional configuration according to various exemplary embodiments. The new conditional

configuration is limited to the same maximum number of conditional configurations as the legacy specifications, e.g., for Rel 16/17. Thus, the new Rel-18 conditional configuration uses a parameter 612 setting the maximum number of conditional configurations that is the same as that used for Rel-16/17.

[00110] In another option, the R18 list can have an optional ID which if present, can point to the ID of the R16/17 conditional configuration that the UE "combines" with the R18 list entry. Multiple entries of R18 list can point to one or more R17 entries. This option does not assume that only 8 conditional configurations are to be used for R18, and is extensible. Both options use R17 for the first CHO + MN/SN config, and only the subsequent candidate SNs use the R18 extension.

[00111] Fig. 6c shows an exemplary RRC configuration 620 for conditional handover (CHO) comprising two conditional configuration lists that are mapped based on ID according to various exemplary embodiments. The RRC reconfiguration 622 includes a conditional reconfiguration that includes a Rel-16 list of conditional reconfigurations, each associated with an ID, and a Rel-18 list of conditional reconfigurations referencing one of the Rel-16 IDs. In this option, the Rel-16 configuration is mapped to the Rel-18 configuration referencing the Rel-16 ID.

[00112] In this example, the first entry in the Rel-16 list with ID1 provides a configuration for MN1 and SN1 and the second entry in the Rel-16 list with ID2 provides a configuration for MN2. The first entry in the Rel-18 list includes an ID (ID x) that references ID1 and adds a configuration for SN3. The

second entry in the Rel-18 list includes an ID (ID y) that references ID1 and adds a configuration for SN4. The third entry in the Rel-18 list includes an ID (ID z) that references ID2 and adds a configuration for SN3. Therefore, the resultant configuration is MN1 with SN1, SN3; MN1 with SN1, SN4; and MN2 with SN3.

[00113] It is noted that, using this option, the number of resultant configurations could be more than 8 if, for example, the number of allowable configurations is extended.

[00114] Fig. 6d shows an exemplary information element (IE) 630 for a new Rel-18 conditional configuration according to various exemplary embodiments. The new conditional configuration is not limited to the same maximum number of conditional configurations as the legacy specifications, e.g., for Rel 16/17. Thus, the new Rel-18 conditional configuration uses a parameter 632 setting the maximum number of conditional configurations that is different from that used for Rel-16/17.

[00115] Referring to the first objective of these exemplary embodiments discussed above, it may be desirable to specify a mechanism and procedures for NR-DC with selective activation of the cell groups (CG) (at least for SCGs) via L3 (RRC) enhancements to allow a subsequent CG change after an initial CG change without reconfiguration and/or re-initiation of CPC/CPA.

[00116] In another aspect of these exemplary embodiments, the network can explicitly configure, for each of the conditional configurations, whether that corresponding configuration ID is to be saved at the UE (not released after a triggering of conditional config). This ensures that interoperability exists when a R18 network node has conditional configurations with

nodes that are R17 (or have not implemented the R18 mod enhancement).

[00117] At every conditional event triggering (that makes the UE apply conditional config), the UE can keep the conditional configs that the network has requested the UE to keep. In one option, a delta config is used for every RRC message from the network to the UE (at any time during the CONNECTED mode where the UE keeps applying conditional config). After the conditional triggering event, the source MN can provide the current UE configuration to a target MN (new source MN) and the new source MN can reconfigure the UE using delta signaling based on the current UE configuration. This option could, however, get complicated in keeping in sync with the UE config by every node that serves the UE.

[00118] In another option, the conditional configuration is provided as a delta to a "reference" configuration previously provided to the UE. All the network nodes that are part of the conditional configurations (i.e., the nodes that provide the conditional configuration to the UE), base their configuration from the reference configuration.

[00119] Referring to the signaling diagram 500 of Fig. 5a above, at the initial handover configuration time (handover request 512 to the first target MN and handover request 524 to the second target MN), the source MN can provide the reference configuration to all the candidate target MNs. When the target MNs transmit the SN addition request to the SNs (SN add requests 514, 516, 526, 528), the request can further include the SN part of the reference configuration. The candidate target SNs can

derive the conditional configuration based on the reference configuration.

[00120] The target nodes provide the conditional configurations (relative to the reference configuration) to the source MN in the handover confirm. Source MN then provides the "reference config" to the UE, along with the conditional configs. The UE (and the NW nodes) start with the "reference config" + delta for every conditional handover. This implies that after every conditional triggering both the NW and UE start with a known configuration. This reference configuration (along with other configurations) is released at failure events. The reference configuration can be the current UE config at the time the source MN starts conditional configuration initiation to the NW nodes. In such a case, the NW does not have to configure the "reference" configuration to the UE explicitly. The UE assumes that the reference configuration is the current configuration when the UE receives the conditional configuration. This may be, for example, a boolean in the RRC message.

[00121] Fig. 7 shows an exemplary information element (IE) 700 for a new Rel-18 conditional configuration including a reference configuration according to various exemplary embodiments. The new Rel-18 conditional configuration uses a parameter 702 setting the reference configuration from which all subsequent conditional configurations are derived.

Examples

[00122] In a first example a method performed by a base station configured as a source master node (MN) for a user equipment (UE), the method comprising transmitting a first handover request to at least a first candidate target master

node (MN) including conditional handover (CHO) information for the UE, receiving a first handover confirm from at least the first candidate target MN, the first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs, generating a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received, and transmitting a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[00123] In a second example, the method of the first example, wherein the base station additionally transmits a second handover request to a second candidate target MN and receives a second handover confirm from the second candidate target MN including a second list of conditional configurations, wherein the total list of conditional configurations comprises both the first list and the second list.

[00124] In a third example, the method of the second example, wherein the first handover request comprises a first range of ID values for the first candidate target MN to use as conditional configuration IDs for the conditional configurations in the first list and the second handover request comprises a second range of ID values for the second candidate target MN to use as conditional configuration IDs for the conditional configurations in the second list, wherein the first range and the second range are non-overlapping.

[00125] In a fourth example, the method of the third example, wherein, when the conditional configurations of the first list and the second list are combined into the total list, the conditional configuration IDs in the total list are unique and non-overlapping based on the first range of ID values and the second range of ID values being non-overlapping.

[00126] In a fifth example, the method of the second example, wherein, when the conditional configurations of the first list and the second list are combined into an initial total list and the conditional configuration IDs in the initial total list are not all unique and non-overlapping, the method further comprises transmitting a SN modification request to at least one of the first or second candidate target MNs including a reallocation of the conditional configuration IDs in the initial total list and generating the total list based on the reallocation of the conditional configuration IDs.

[00127] In a sixth example, the method of the second example further comprising receiving a RRC reconfiguration complete message from the UE when the given trigger condition of the

given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN and routing the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID.

[00128] In a seventh example, the method of the first example, wherein the first list of conditional configurations from the first candidate target MN includes a single conditional configuration on a first level that, when triggered, includes at least two additional conditional configurations on a second level, wherein the at least two additional conditional configurations further include the respective trigger condition and the respective secondary cell group (SCG) configuration for the respective candidate target SNs.

[00129] In an eighth example, the method of the seventh example, wherein the at least two additional conditional configurations have conditional configuration IDs local to the first candidate target MN.

[00130] In a ninth example, the method of the eighth example, wherein the conditional configuration IDs for the at least two additional conditional configurations local to the first candidate target MN are not unique or non-overlapping with respect to further conditional configuration IDs for further additional conditional configurations local to a second candidate target MN.

[00131] In a tenth example, the method of the first example, wherein the RRC reconfiguration message transmitted to the UE includes a new conditional configuration type that is associated with an evaluation of candidate target SCGs, the new conditional configuration including a new conditional configuration ID and an associated trigger condition for a SCG.

[00132] In an eleventh example, the method of the first example, wherein the RRC reconfiguration message includes a first sub-list of conditional configurations in accordance with Rel-16 or Rel-17 specifications and a second sub-list of conditional configurations in accordance with Rel-18 specifications, wherein entries in the first sub-list and entries in the second sub-list are combined into a resultant configuration.

[00133] In a twelfth example, the method of the eleventh example, wherein the entries in the first sub-list are one to one mapped with entries in the second sub-list, wherein a maximum of eight conditional configurations are configurable for the UE.

[00134] In a thirteenth example, the method of the eleventh example, wherein the entries in the first sub-list are associated with a respective list ID and the entries in the second sub-list refer to one of the list IDs, wherein more than eight conditional configurations are configurable for the UE.

[00135] In a fourteenth example, a processor configured to perform any of the methods of the first through thirteenth examples.

[00136] In fifteenth example, a base station comprising a transceiver configured to communicate with a user equipment (UE) and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the first through thirteenth examples.

[00137] In a sixteenth example, a method performed by a base station connected to a source master node (MN) for a user equipment (UE), the method comprising receiving a handover request from the source master node (MN) including conditional handover (CHO) information for the UE, transmitting a respective secondary node (SN) addition request to at least two candidate target SNs under control of the base station, receiving a respective SN addition confirm from the at least two candidate target SNs to confirm the at least two candidate target SNs are available for CHO of the UE, determining a list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the at least two candidate target SNs available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and transmitting the list of conditional configurations to the source MN.

[00138] In a seventeenth example, the method of the sixteenth example, wherein the handover request comprises a first range of ID values for the base station to use as conditional configuration IDs for the conditional configurations in first list, wherein the first range and any additional ranges of IDs transmitted from the source MN to further target MNs are non-overlapping.

[00139] In an eighteenth example, the method of the sixteenth example, further comprising receiving a SN modification request from the source MN including a reallocation of the conditional configuration IDs in the initial total list.

[00140] In a nineteenth example, the method of the sixteenth example, further comprising receiving a RRC reconfiguration complete message from the UE via the source MN when a given trigger condition of a given conditional configuration from the list is satisfied, the RRC reconfiguration complete message including a given conditional configuration ID of the given conditional configuration associated with a given candidate target SN and routing the RRC reconfiguration complete message to the given candidate target SN based on the given conditional configuration ID.

[00141] In a twentieth example, the method of the sixteenth example, wherein the list of conditional configurations includes a single conditional configuration on a first level that, when triggered, includes at least two additional conditional configurations on a second level, wherein the at least two additional conditional configurations further include the respective trigger condition and the respective secondary cell group (SCG) configuration for the respective candidate target SNs.

[00142] In a twenty first example, the method of the twentieth example, wherein the at least two additional conditional configurations have conditional configuration IDs local to the base station.

[00143] In a twenty second example, a processor configured to perform any of the methods of the sixteenth through twenty first examples.

[00144] In twenty third example, a base station comprising a transceiver configured to communicate with a user equipment (UE) and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the sixteenth through twenty first examples.

[00145] In a twenty fourth example, a method performed by a user equipment (UE) connected to a source master node (MN), the method comprising receiving a radio resource control (RRC) reconfiguration from the source MN including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and when a given trigger condition of a given conditional configuration from the total list is satisfied, applying a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[00146] In a twenty fifth example, the method of the twenty fourth example, wherein the source MN additionally receives a second handover confirm from a second candidate target MN including a second list of conditional configurations, wherein the total list of conditional configurations received by the UE comprises both the first list and a second list, wherein the conditional configuration IDs in the total list are unique and non-overlapping based on the first range of ID values and the second range of ID values being non-overlapping.

[00147] In a twenty sixth example, the method of the twenty fifth example further comprising transmitting a RRC reconfiguration complete message to the source MN when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN, wherein the source MN routes the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID.

[00148] In a twenty seventh example, the method of the twenty fourth example, wherein the total list of conditional configurations received from the source MN includes a single conditional configuration on a first level associated with the first candidate target MN that, when triggered, includes at least two additional conditional configurations on a second level, wherein the at least two additional conditional configurations further include the respective trigger condition and the respective secondary cell group (SCG) configuration for

the respective candidate target SNs under the first candidate target MN.

[00149] In a twenty eighth example, the method of the twenty seventh example, wherein the at least two additional conditional configurations have conditional configuration IDs local to the first candidate target MN.

[00150] In a twenty ninth example, the method of the twenty eighth example, wherein the conditional configuration IDs for the at least two additional conditional configurations local to the first candidate target MN are not unique or non-overlapping with respect to further conditional configuration IDs for further additional conditional configurations local to a second candidate target MN.

[00151] In a thirtieth example, the method of the twenty fourth example, wherein the RRC reconfiguration message received from the source MN includes a new conditional configuration type that is associated with an evaluation of candidate target SCGs, the new conditional configuration including a new conditional configuration ID and an associated trigger condition for a SCG.

[00152] In a thirty first example, the method of the twenty fourth example, wherein the RRC reconfiguration message includes a first sub-list of conditional configurations in accordance with Rel-16 or Rel-17 specifications and a second sub-list of conditional configurations in accordance with Rel-18 specifications, wherein entries in the first sub-list and entries in the second sub-list are combined into a resultant configuration.

[00153] In a thirty second example, the method of the thirty first example, wherein the entries in the first sub-list are one to one mapped with entries in the second sub-list, wherein a maximum of eight conditional configurations are configurable for the UE.

[00154] In a thirty third example, the method of the thirty first example, wherein the entries in the first sub-list are associated with a respective list ID and the entries in the second sub-list refer to one of the list IDs, wherein more than eight conditional configurations are configurable for the UE.

[00155] In a thirty fourth example, a processor configured to perform any of the methods of the twenty fourth through thirty third examples.

[00156] In a thirty fifth example, a user equipment (UE) comprising a transceiver configured to communicate with a network and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the twenty fourth through thirty third examples.

[00157] In a thirty sixth example, a method performed by a base station configured as a source master node (MN) for a user equipment (UE), the method comprising transmitting a first handover request to at least a first candidate target master node (MN) including conditional handover (CHO) information for the UE, receiving a first handover confirm from at least the first candidate target MN, the first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective candidate target

secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs, generating a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received, transmitting a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration, wherein the RRC reconfiguration further includes an indication of at least a first conditional configuration to be saved by the UE after the given SCG configuration is applied.

[00158] In a thirty seventh example, the method of the thirty sixth example, wherein the first conditional configuration is saved at the UE so that the UE can receive a delta configuration that modifies the first conditional configuration from a given candidate target MN.

[00159] In a thirty eighth example, the method of the thirty sixth example, further comprising receiving a RRC reconfiguration complete message from the UE when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete

message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN, routing the RRC reconfiguration complete message to the given candidate target MN controlling the given candidate target SN based on the given conditional configuration and transmitting at least the first conditional configuration to the given candidate target MN for the given candidate target MN to determine the delta configuration when reconfiguring the UE.

[00160] In a thirty ninth example, a processor configured to perform any of the methods of the thirty sixth through thirty eighth first examples.

[00161] In a fortieth example, a base station comprising a transceiver configured to communicate with a user equipment (UE) and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the thirty sixth through thirty eighth first examples.

[00162] In a forty first example, a method performed by a base station connected to a source master node (MN) for a user equipment (UE), the method comprising receiving a handover request from the source master node (MN) including conditional handover (CHO) information for the UE, transmitting a respective secondary node (SN) addition request to at least one candidate target SN under control of the base station, receiving a respective SN addition confirm from the at least one candidate target SN to confirm the at least one candidate target SN is available for CHO of the UE, determining a list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the candidate target SNs available for CHO of

the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs, transmitting the list of conditional configurations to the source MN, receiving a RRC reconfiguration complete message from the UE via the source MN when a given trigger condition of a given conditional configuration from the total list is satisfied for the UE, the RRC reconfiguration complete message including a given conditional configuration ID of the given conditional configuration associated with a given candidate target SN under the base station and receiving at least a first conditional configuration configured for the UE from the source MN for the base station to determine a delta configuration when reconfiguring the UE.

[00163] In a forty second example, the method of the forty first example, further comprising reconfiguring the UE with an updated RRC reconfiguration for CHO wherein an updated first conditional configuration is provided as a delta to the first conditional configuration.

[00164] In a forty third example, the method of the forty first example, further comprising routing the RRC reconfiguration complete message to the given candidate target SN based on the given conditional configuration ID.

[00165] In a forty fourth example, a processor configured to perform any of the methods of the forty first through forty third examples.

[00166] In a forty fifth example, a base station comprising a transceiver configured to communicate with a user equipment (UE)

and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the forty first through forty third examples.

[00167] In a forty sixth example, a method performed by a user equipment (UE) connected to a source master node (MN), the method comprising receiving a radio resource control (RRC) reconfiguration from the source MN including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective at least one candidate target secondary node (SN) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SN, wherein the RRC reconfiguration further includes an indication of at least a first conditional configuration to be saved by the UE after a given SCG configuration is applied and when a given trigger condition of a given conditional configuration from the total list is satisfied, applying the given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[00168] In a forty seventh example, the method of the forty sixth example, further comprising transmitting a RRC

reconfiguration complete message to the source MN when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN, wherein the source MN routes the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID, wherein the source MN transmits at least the first conditional configuration to the given candidate target MN for the given candidate target MN to determine a delta configuration when reconfiguring the UE.

[00169] In a forty eighth example, the method of the forty sixth example, further comprising receiving an updated RRC reconfiguration from the given candidate target MN now serving as a current source MN for CHO, wherein an updated first conditional configuration is provided as a delta to the first conditional configuration.

[00170] In a forty ninth example, a processor configured to perform any of the methods of the forty sixth through forty eighth examples.

[00171] In a fiftieth example, a user equipment (UE) comprising a transceiver configured to communicate with a network and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the forty sixth through forty eighth examples.

[00172] In a fifty first example, a method performed by a base station configured as a source master node (MN) for a user

equipment (UE), the method comprising transmitting a first handover request to at least a first candidate target master node (MN) including conditional handover (CHO) information for the UE and a reference configuration, receiving a first handover confirm from at least the first candidate target MN, the first handover confirm including a first list of conditional configurations provided as a delta to the reference configuration, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs, generating a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received, transmitting a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations provided as a delta to the reference configuration, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[00173] In a fifty second example, the method of the fifty first example, wherein the reference configuration is a current configuration for the UE at a time the first handover request

was transmitted, wherein the UE determines the reference configuration based on the current configuration.

[00174] In a fifty third example, the method of the fifty first example, wherein the RRC reconfiguration further includes the reference configuration.

[00175] In a fifty fourth example, the method of the fifty first example, further comprising receiving a RRC reconfiguration complete message from the UE when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN and routing the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID, wherein the given candidate target MN has knowledge of the reference configuration and uses the reference configuration when reconfiguring the UE after handover.

[00176] In a fifty fifth example, a processor configured to perform any of the methods of the fifty first through fifty fourth examples.

[00177] In a fifty sixth example, a base station comprising a transceiver configured to communicate with a user equipment (UE) and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the fifty first through fifty fourth examples.

[00178] In a fifty seventh example, a method performed by a base station connected to a source master node (MN) for a user equipment (UE), the method comprising receiving a handover request from the source master node (MN) including conditional handover (CHO) information for the UE and a reference configuration, transmitting a respective secondary node (SN) addition request including the reference configuration to at least one candidate target SN under control of the base station, receiving a respective SN addition confirm from the at least one candidate target SN to confirm the at least one candidate target SN is available for CHO of the UE, determining a list of conditional configurations provided as a delta to the reference configuration, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the candidate target SNs available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs and transmitting the list of conditional configurations to the source MN.

[00179] In a fifty eighth example, the method of the fifty seventh example, further comprising receiving a RRC reconfiguration complete message from the UE via the source MN when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN and routing the RRC reconfiguration complete message to the given candidate target SN based on the given conditional configuration ID.

[00180] In a fifty ninth example, the method of the fifty eighth example, further comprising reconfiguring the UE with an updated RRC reconfiguration for CHO provided as a delta to the reference configuration.

[00181] In a sixtieth example, a processor configured to perform any of the methods of the fifty seventh through fifty ninth examples.

[00182] In a sixty first example, a base station comprising a transceiver configured to communicate with a user equipment (UE) and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the fifty seventh through fifty ninth examples.

[00183] In a sixty second example, a method performed by a user equipment (UE) connected to a source master node (MN), the method comprising receiving a radio resource control (RRC) reconfiguration from the source MN including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein the conditional configurations are provided as a delta to a reference configuration, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective at least one candidate target secondary node (SN) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition

and a respective secondary cell group (SCG) configuration for the respective candidate target SN and when a given trigger condition of a given conditional configuration from the total list is satisfied, applying a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

[00184] In a sixty third example, the method of the sixty second example, wherein the reference configuration is a current configuration for the UE at a time the first handover request was transmitted, wherein the UE determines the reference configuration based on the current configuration.

[00185] In a sixty fourth example, the method of the sixty second example, wherein the RRC reconfiguration further includes the reference configuration.

[00186] In a sixty fifth example, the method of the sixty second example, further comprising transmitting a RRC reconfiguration complete message to the source MN when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN, wherein the source MN routes the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID, wherein the given candidate target MN has knowledge of the reference configuration and uses the reference configuration when reconfiguring the UE after handover.

[00187] In a sixty sixth example, the method of the sixty fifth example, further comprising receiving a reconfiguration from the given candidate target MN now serving as a current source MN for CHO provided as a delta to the reference configuration.

[00188] In a sixty seventh example, a processor configured to perform any of the methods of the sixty second through sixty sixth examples.

[00189] In a sixty eighth example, a user equipment (UE) comprising a transceiver configured to communicate with a network and a processor communicatively coupled to the transceiver and configured to perform any of the methods of the sixty second through sixty sixth examples.

[00190] Those skilled in the art will understand that the above-described exemplary aspects may be implemented in any suitable software or hardware configuration or combination thereof. An exemplary hardware platform for implementing the exemplary aspects may include, for example, an Intel x86 based platform with compatible operating system, a Windows OS, a Mac platform and MAC OS, a mobile device having an operating system such as iOS, Android, etc. In a further example, the exemplary aspects of the above described method may be embodied as a program containing lines of code stored on a non-transitory computer readable storage medium that, when compiled, may be executed on a processor or microprocessor.

[00191] It is well understood that the use of personally identifiable information should follow privacy policies

and practices that are generally recognized as meeting or exceeding industry or governmental requirements for maintaining the privacy of users. In particular, personally identifiable information data should be managed and handled so as to minimize risks of unintentional or unauthorized access or use, and the nature of authorized use should be clearly indicated to users.

[00192] Although this application described various aspects each having different features in various combinations, those skilled in the art will understand that any of the features of one aspect may be combined with the features of the other aspects in any manner not specifically disclaimed or which is not functionally or logically inconsistent with the operation of the device or the stated functions of the disclosed aspects.

[00193] It will be apparent to those skilled in the art that various modifications may be made in the present disclosure, without departing from the spirit or the scope of the disclosure. Thus, it is intended that the present disclosure cover modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalent.

What is Claimed:

1. An apparatus of a base station configured as a source master node (MN) for a user equipment (UE), the apparatus comprising processing circuitry configured to:

configure transceiver circuitry to transmit a first handover request to at least a first candidate target master node (MN) including conditional handover (CHO) information for the UE;

decode, from signaling received from at least the first candidate target MN, a first handover confirm including a first list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs;

generate a total list of conditional configurations by combining the first list of conditional configurations received from the first candidate target MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received; and

configure transceiver circuitry to transmit a radio resource control (RRC) reconfiguration to the UE including the total list of conditional configurations, wherein, when a given trigger condition of a given conditional configuration from the total list is satisfied, the UE applies a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

2. The apparatus of claim 1, wherein the base station additionally transmits a second handover request to a second candidate target MN and receives a second handover confirm from the second candidate target MN including a second list of conditional configurations, wherein the total list of conditional configurations comprises both the first list and the second list.

3. The apparatus of claim 2, wherein the first handover request comprises a first range of ID values for the first candidate target MN to use as conditional configuration IDs for the conditional configurations in the first list and the second handover request comprises a second range of ID values for the second candidate target MN to use as conditional configuration IDs for the conditional configurations in the second list, wherein the first range and the second range are non-overlapping.

4. The apparatus of claim 3, wherein, when the conditional configurations of the first list and the second list are combined into the total list, the conditional configuration IDs in the total list are unique and non-overlapping based on the first range of ID values and the second range of ID values being non-overlapping.

5. The apparatus of claim 2, wherein, when the conditional configurations of the first list and the second list are combined into an initial total list and the conditional configuration IDs in the initial total list are not all unique and non-overlapping, wherein the processing circuitry is further configured to:

configure transceiver circuitry to transmit a SN modification request to at least one of the first or second candidate target MNs including a reallocation of the conditional configuration IDs in the initial total list; and

generate the total list based on the reallocation of the conditional configuration IDs.

6. The apparatus of claim 2, wherein the processing circuitry is further configured to:

decode, from signaling received from the UE, a RRC reconfiguration complete message when the given trigger condition of the given conditional configuration from the total list is satisfied, the RRC reconfiguration complete message including the given conditional configuration ID of the given conditional configuration associated with the given candidate target SN; and

route the RRC reconfiguration complete message to a given candidate target MN controlling the given candidate target SN based on the given conditional configuration ID.

7. The apparatus of claim 1, wherein the first list of conditional configurations from the first candidate target MN includes a single conditional configuration on a first level that, when triggered, includes at least two additional conditional configurations on a second level, wherein the at least two additional conditional configurations further include the respective trigger condition and the respective secondary cell group (SCG) configuration for the respective candidate target SNs.

8. The apparatus of claim 7, wherein the at least two additional conditional configurations have conditional configuration IDs local to the first candidate target MN.

9. The apparatus of claim 8, wherein the conditional configuration IDs for the at least two additional conditional configurations local to the first candidate target MN are not unique or non-overlapping with respect to further conditional configuration IDs for further additional conditional configurations local to a second candidate target MN.

10. The apparatus of claim 1, wherein the RRC reconfiguration message transmitted to the UE includes a new conditional configuration type that is associated with an evaluation of candidate target SCGs, the new conditional configuration including a new conditional configuration ID and an associated trigger condition for a SCG.

11. The apparatus of claim 1, wherein the RRC reconfiguration message includes a first sub-list of conditional configurations in accordance with Rel-16 or Rel-17 specifications and a second sub-list of conditional configurations in accordance with Rel-18 specifications, wherein entries in the first sub-list and entries in the second sub-list are combined into a resultant configuration.

12. The apparatus of claim 11, wherein the entries in the first sub-list are one to one mapped with entries in the second sub-list, wherein a maximum of eight conditional configurations are configurable for the UE.

13. The apparatus of claim 11, wherein the entries in the first sub-list are associated with a respective list ID and the entries in the second sub-list refer to one of the list IDs, wherein more than eight conditional configurations are configurable for the UE.

14. An apparatus of a base station connected to a source master node (MN) for a user equipment (UE), the apparatus comprising processing circuitry configured to:

decode, from signaling received from the source MN, a handover request including conditional handover (CHO) information for the UE;

configure transceiver circuitry to transmit a respective secondary node (SN) addition request to at least two candidate target SNs under control of the base station;

decode, from signaling received from at least two candidate target SNs, a respective SN addition confirm that confirms the at least two candidate target SNs are available for CHO of the UE;

determine a list of conditional configurations, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of the at least two candidate target SNs available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs; and

configure transceiver circuitry to transmit the list of conditional configurations to the source MN.

15. The apparatus of claim 14, wherein the handover request comprises a first range of ID values for the base station to use

as conditional configuration IDs for the conditional configurations in first list, wherein the first range and any additional ranges of IDs transmitted from the source MN to further target MNs are non-overlapping.

16. The apparatus of claim 14, wherein the processing circuitry is further configured to:

decode, from signaling received from the source MN, a SN modification request including a reallocation of the conditional configuration IDs in the initial total list.

17. The apparatus of claim 14, wherein the processing circuitry is further configured to:

decode, from signaling received from the UE, a RRC reconfiguration complete message via the source MN when a given trigger condition of a given conditional configuration from the list is satisfied, the RRC reconfiguration complete message including a given conditional configuration ID of the given conditional configuration associated with a given candidate target SN; and

route the RRC reconfiguration complete message to the given candidate target SN based on the given conditional configuration ID.

18. The apparatus of claim 14, wherein the list of conditional configurations includes a single conditional configuration on a first level that, when triggered, includes at least two additional conditional configurations on a second level, wherein the at least two additional conditional configurations further include the respective trigger condition and the respective secondary cell group (SCG) configuration for the respective candidate target SNs.

19. The apparatus of claim 18, wherein the at least two additional conditional configurations have conditional configuration IDs local to the base station.

20. An apparatus of a user equipment (UE) connected to a source master node (MN), the apparatus comprising processing circuitry configured to:

decode, from signaling received from the source MN, a radio resource control (RRC) reconfiguration including a total list of conditional configurations comprising a combination of a first list of conditional configurations received from a first candidate target MN from which a handover confirm was received by the source MN with any further lists of conditional configurations received from any further candidate target MNs from which a further handover confirm was received by the source MN, wherein each conditional configuration includes a respective conditional configuration ID associated with a respective one of at least two candidate target secondary nodes (SNs) under the first candidate target MN and available for CHO of the UE, wherein each conditional configuration further includes a respective trigger condition and a respective secondary cell group (SCG) configuration for the respective candidate target SNs; and

when a given trigger condition of a given conditional configuration from the total list is satisfied, apply a given SCG configuration corresponding to a given candidate target SN associated with a given conditional configuration ID of the given conditional configuration.

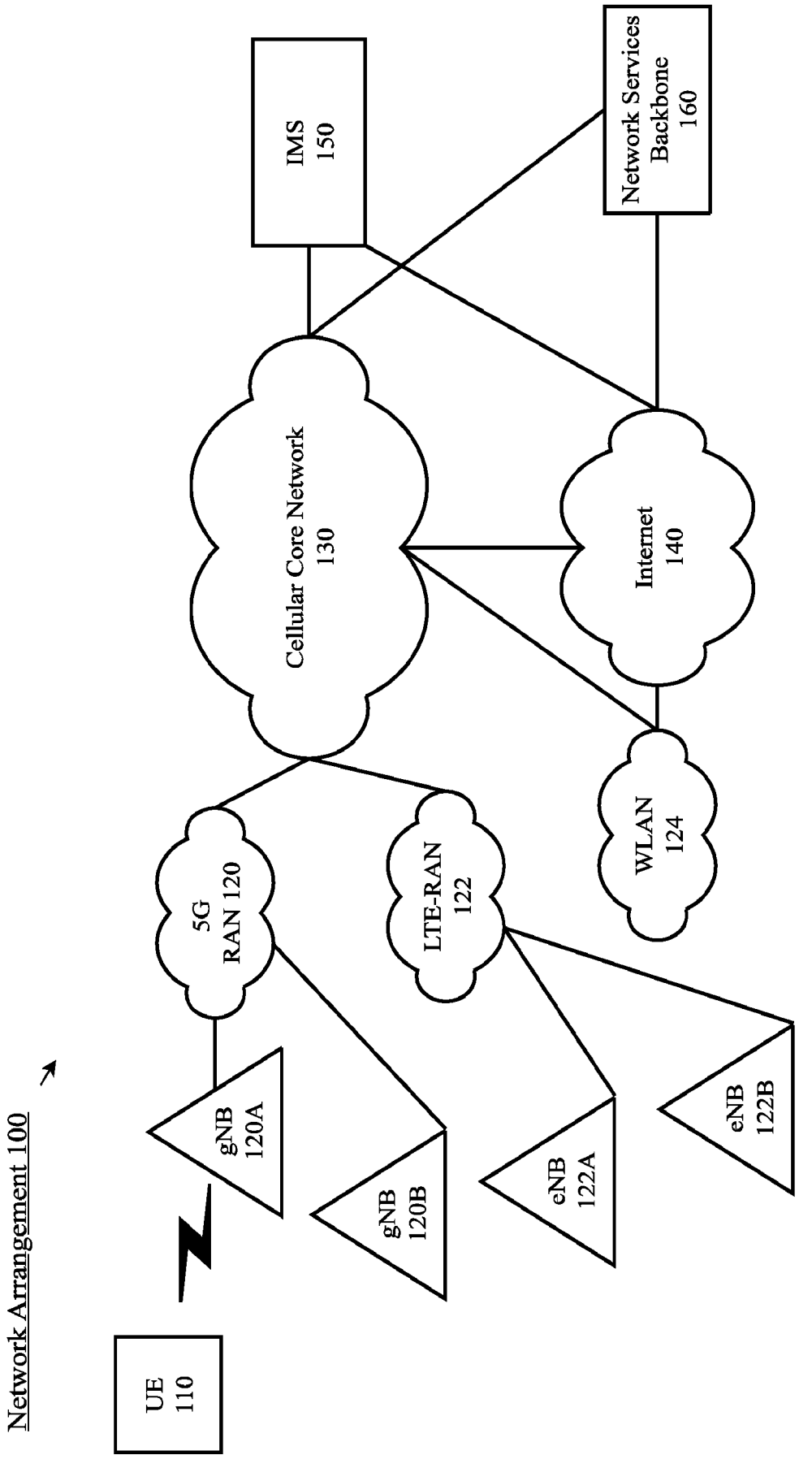
Network Arrangement 100
UE 110
gNB 120A
gNB 120B
5G RAN 120
LTE-RAN 122
eNB 122A
eNB 122B
WLAN 124
Cellular Core Network 130
Internet 140
IMS 150
Network Services Backbone 160

Fig. 1

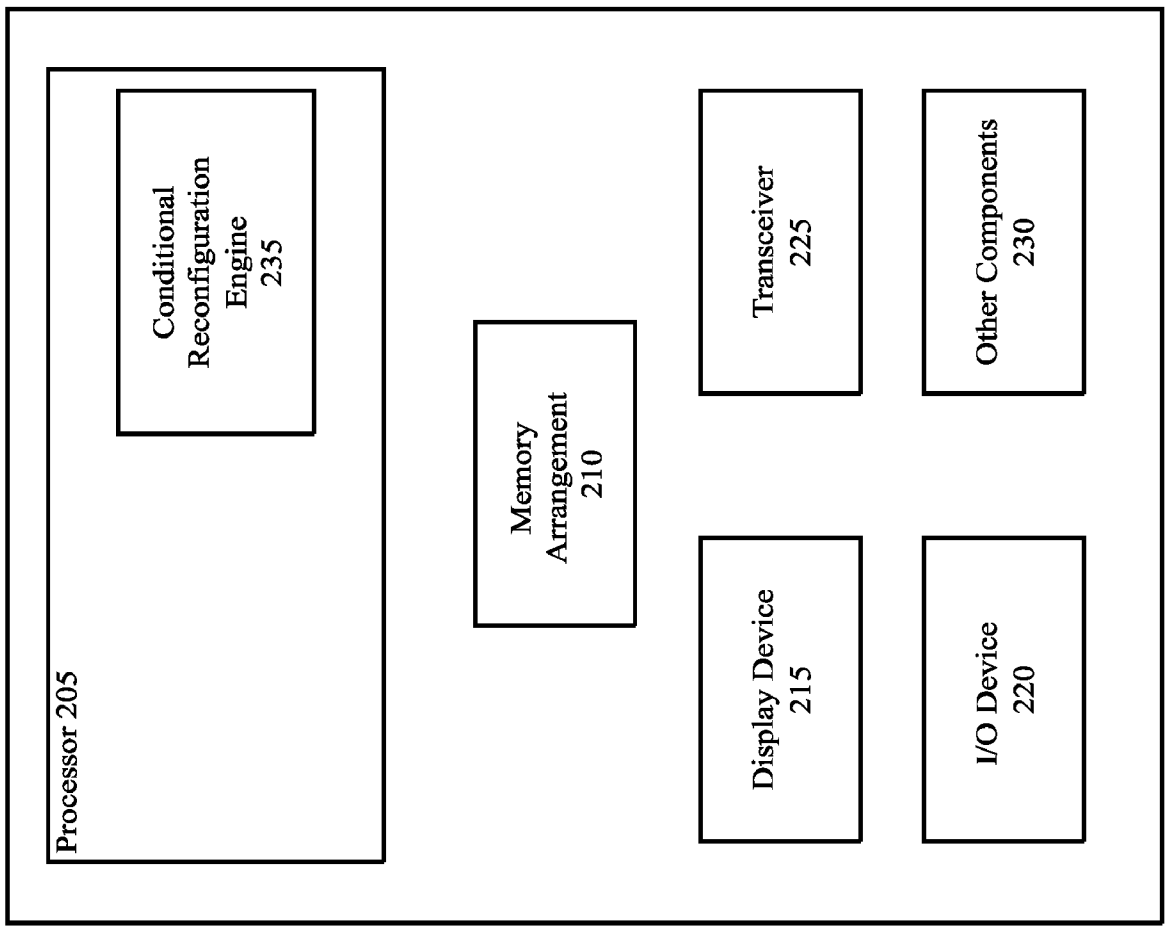
UE 110
Processor 205
Conditional Reconfiguration Engine 235
Memory Arrangement 210
Display Device 215
I/O Device 220
Transceiver 225
Other Components 230

Fig. 2

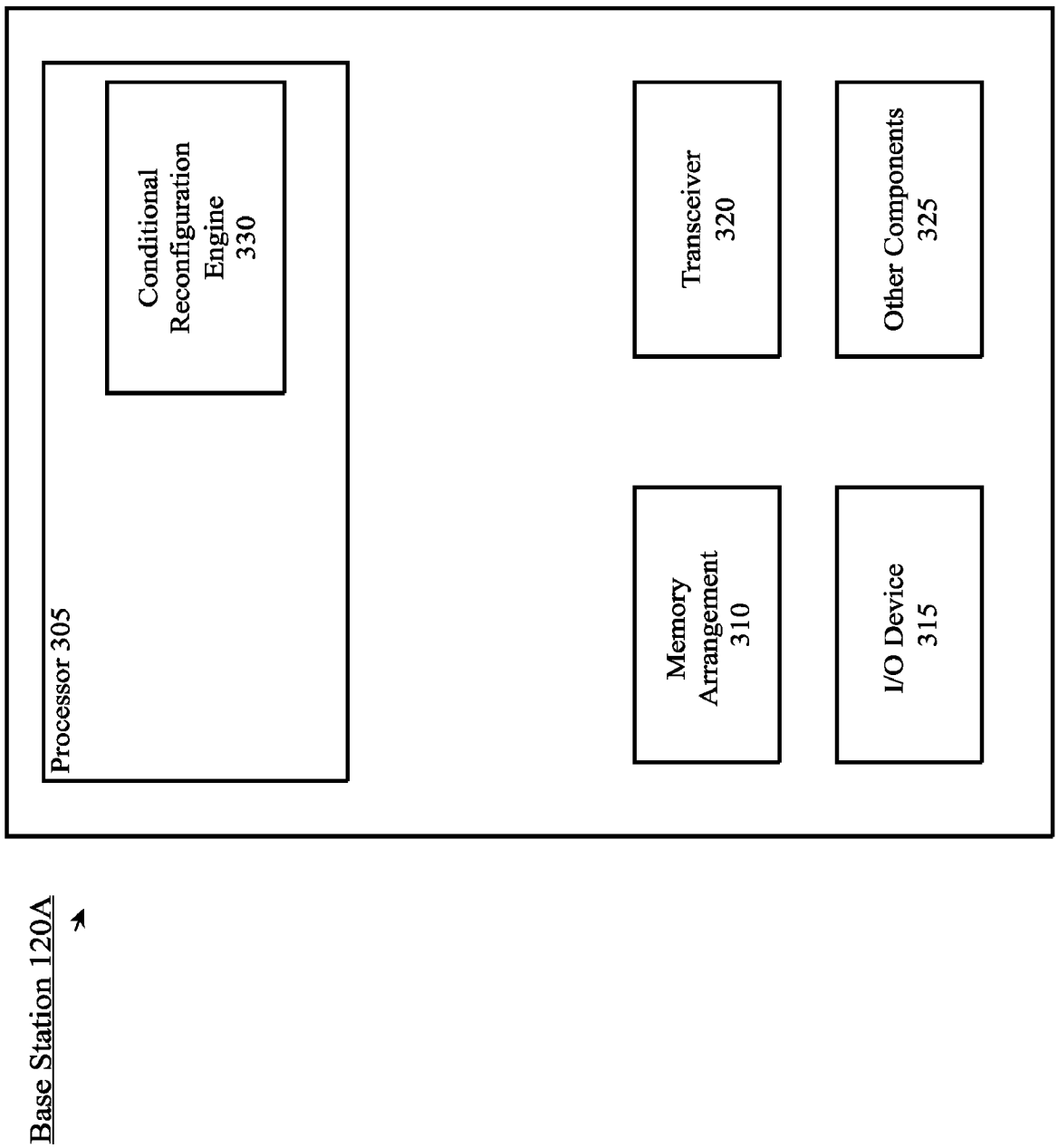
Base Station 120A
Processor 305
Conditional Reconfiguration Engine 330
Memory Arrangement 310
I/O Device 315
Transceiver 320
Other Components 325

Fig. 3

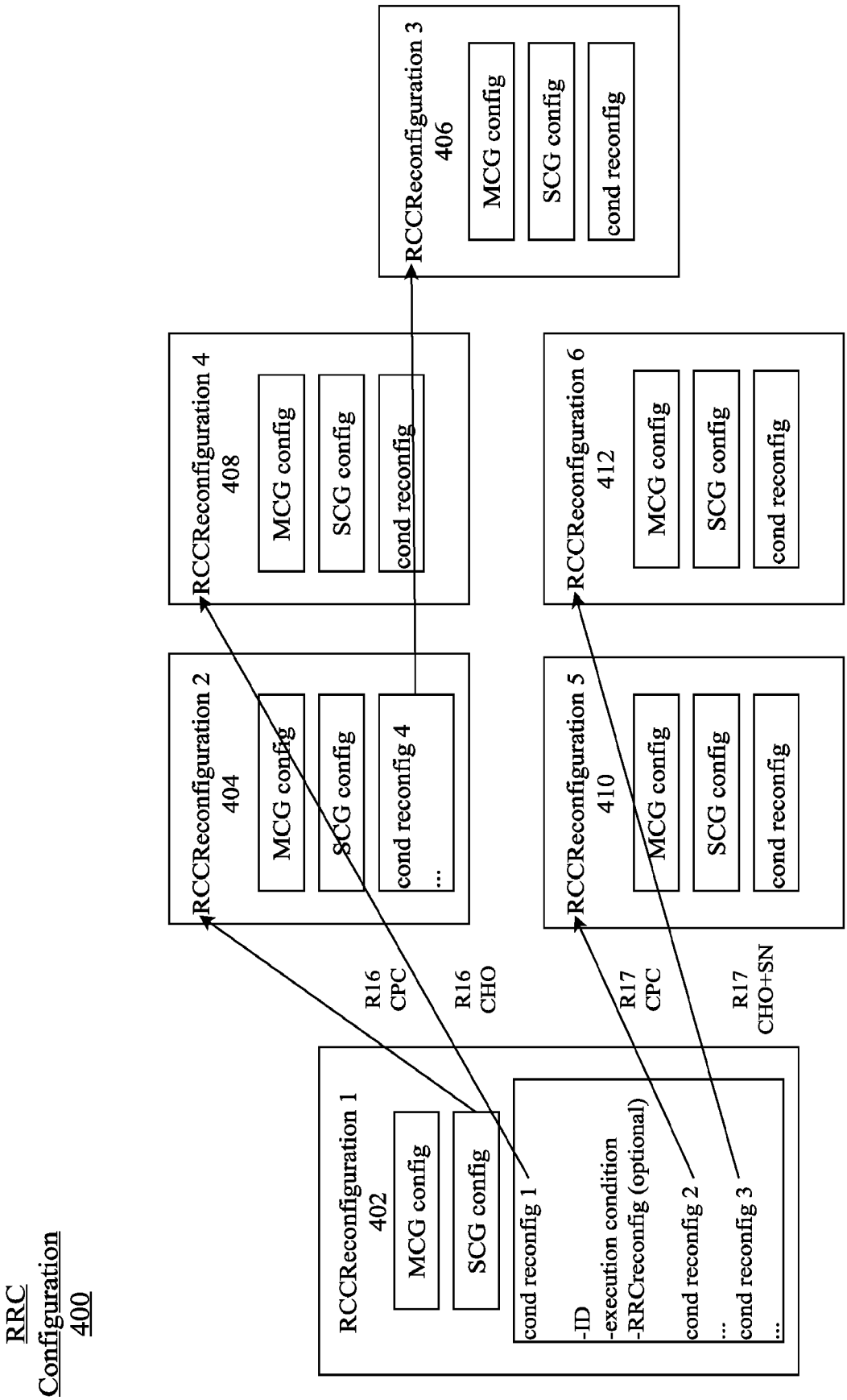
RRC Configuration 400
RCCReconfiguration 1 402
MCG config
SCG config
cond reconfig 1
-ID
-execution condition
-RRCreconfig (optional)
cond reconfig 2
...
cond reconfig 3
...
RCCReconfiguration 2 404
MCG config
SCG config
cond reconfig 4
...
RCCReconfiguration 3 406
MCG config
SCG config
cond reconfig
RCCReconfiguration 4 408
MCG config
SCG config
cond reconfig
RCCReconfiguration 5 410
MCG config
SCG config
cond reconfig
RCCReconfiguration 6 412
MCG config
SCG config
cond reconfig
R16 CPC
R16 CHO
R17 CPC
R17 CHO+SN

Fig. 4a

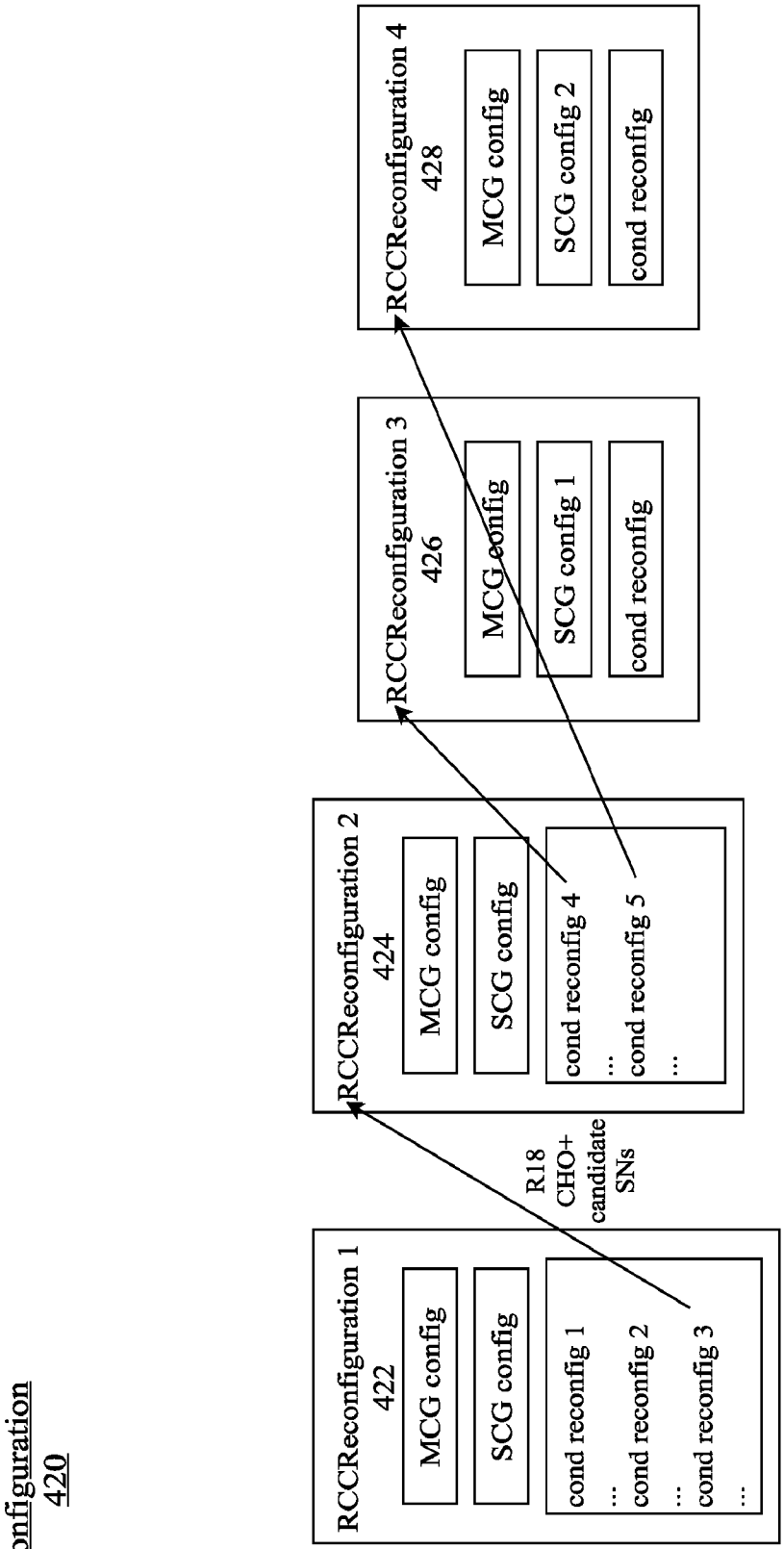
RRC Configuration 420
RCCReconfiguration 1 422
MCG config
SCG config
cond reconfig 1
...
cond reconfig 2
...
cond reconfig 3
...
R18 CHO+ candidate SNs
RCCReconfiguration 2 424
MCG config
SCG config
cond reconfig 4
...
cond reconfig 5
...
RCCReconfiguration 3 426
MCG config
SCG config 1
cond reconfig
RCCReconfiguration 4 428
MCG config
SCG config 2
cond reconfig

Fig. 4b

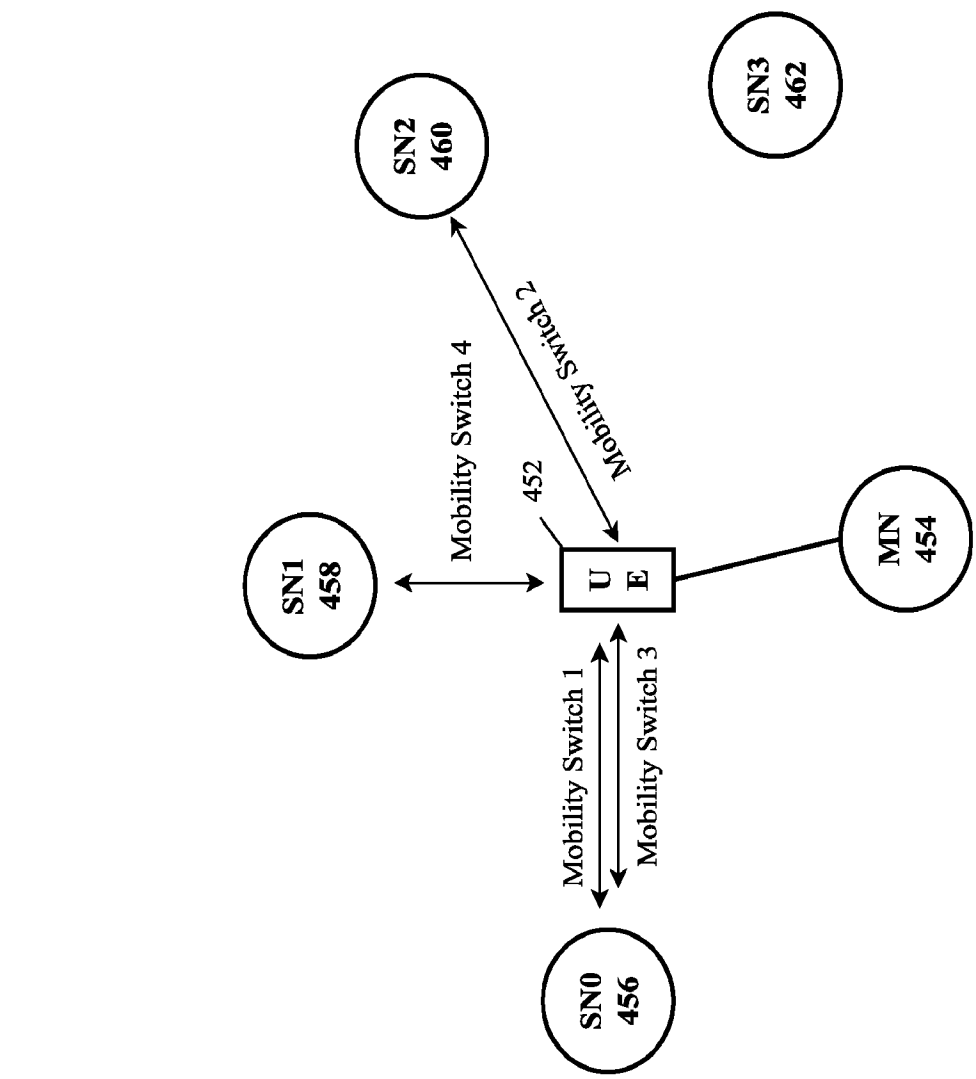
Network Arrangement 450
SN0 456
SN1 458
SN2 460
SN3 462
MN 454
UE
452
Mobility Switch 1
Mobility Switch 2
Mobility Switch 3
Mobility Switch 4

Fig. 4c

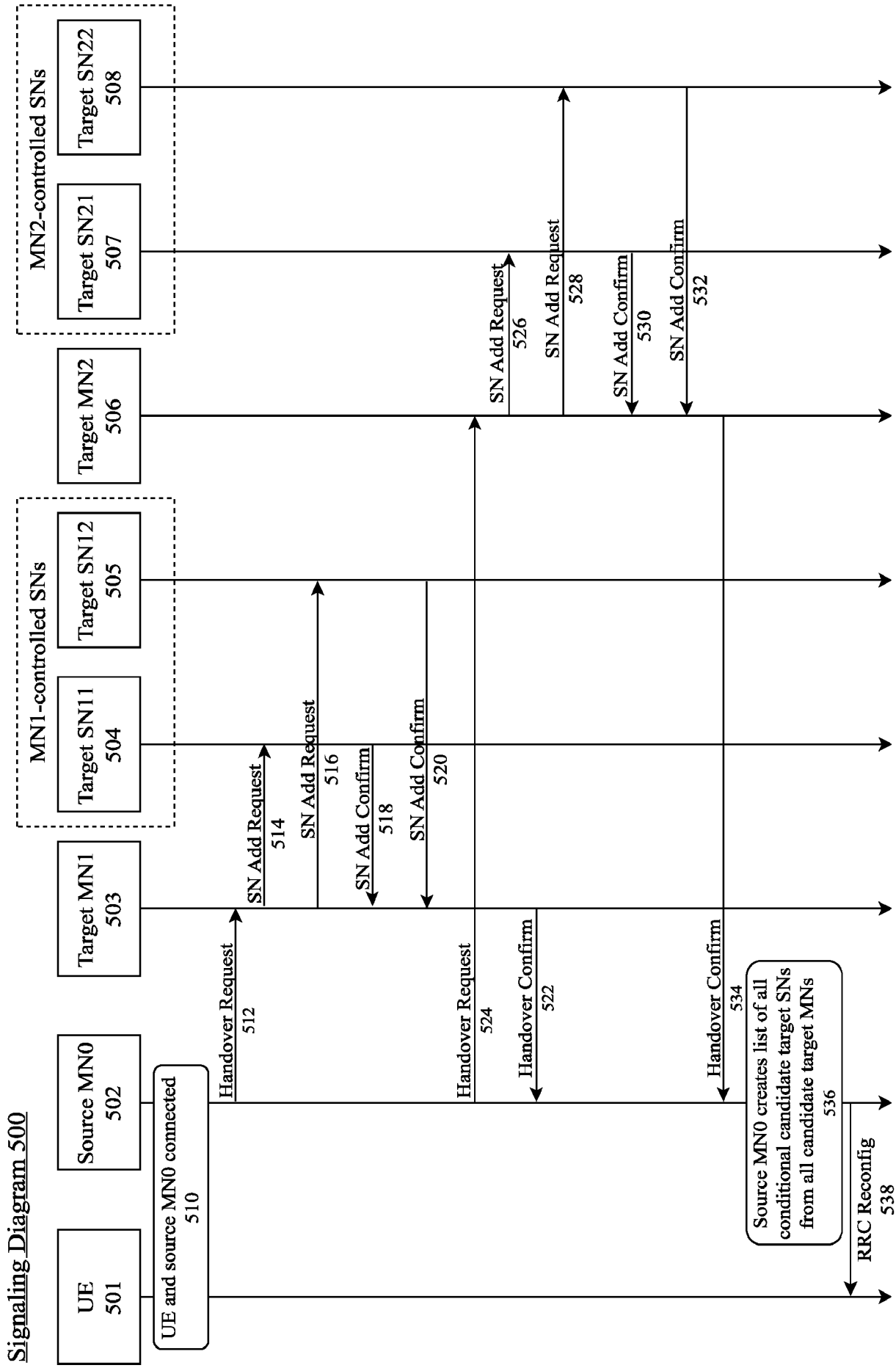
Signaling Diagram 500
UE 501
Source MN0 502
Target MN1 503
MN1-controlled SNs
Target SN11 504
Target SN12 505
Target MN2 506
MN2-controlled SNs
Target SN21 507
Target SN22 508
UE and source MN0 connected 510
Handover Request 512
SN Add Request 514
SN Add Request 516
SN Add Confirm 518
SN Add Confirm 520
Handover Request 524
Handover Confirm 522
SN Add Request 526
SN Add Request 528
SN Add Confirm 530
SN Add Confirm 532
Handover Confirm 534
Source MN0 creates list of all conditional candidate target SNs from all candidate target MNs 536
RRC Reconfig 538

Fig. 5a

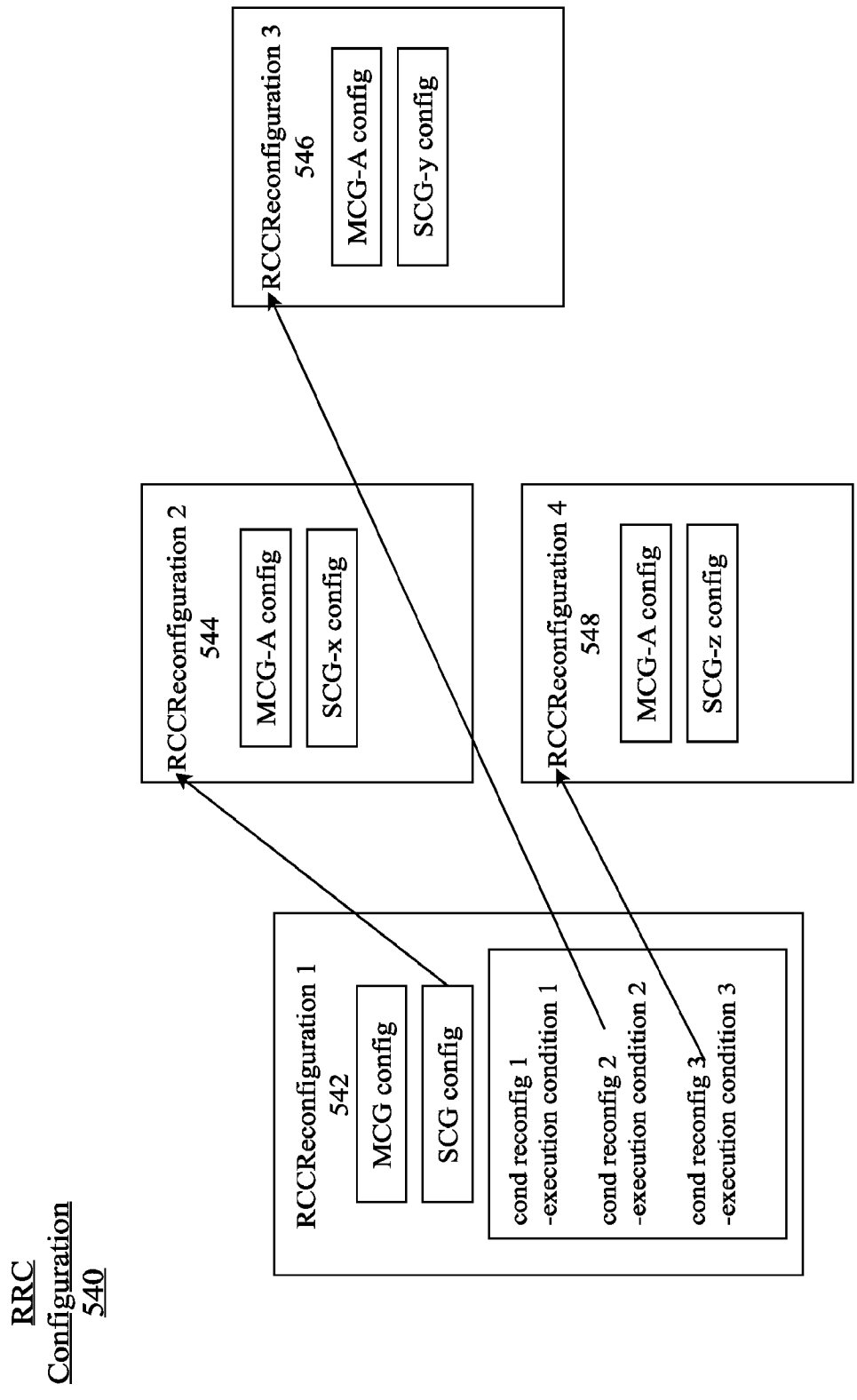
RRC Configuration 540
RCCReconfiguration 1 542
MCG config
SCG config
cond reconfig 1 -execution condition 1
cond reconfig 2 -execution condition 2
cond reconfig 3 -execution condition 3
RCCReconfiguration 2 544
MCG-A config
SCG-x config
RCCReconfiguration 3 546
MCG-A config
SCG-y config
RCCReconfiguration 4 548
MCG-A config
SCG-z config

Fig. 5b

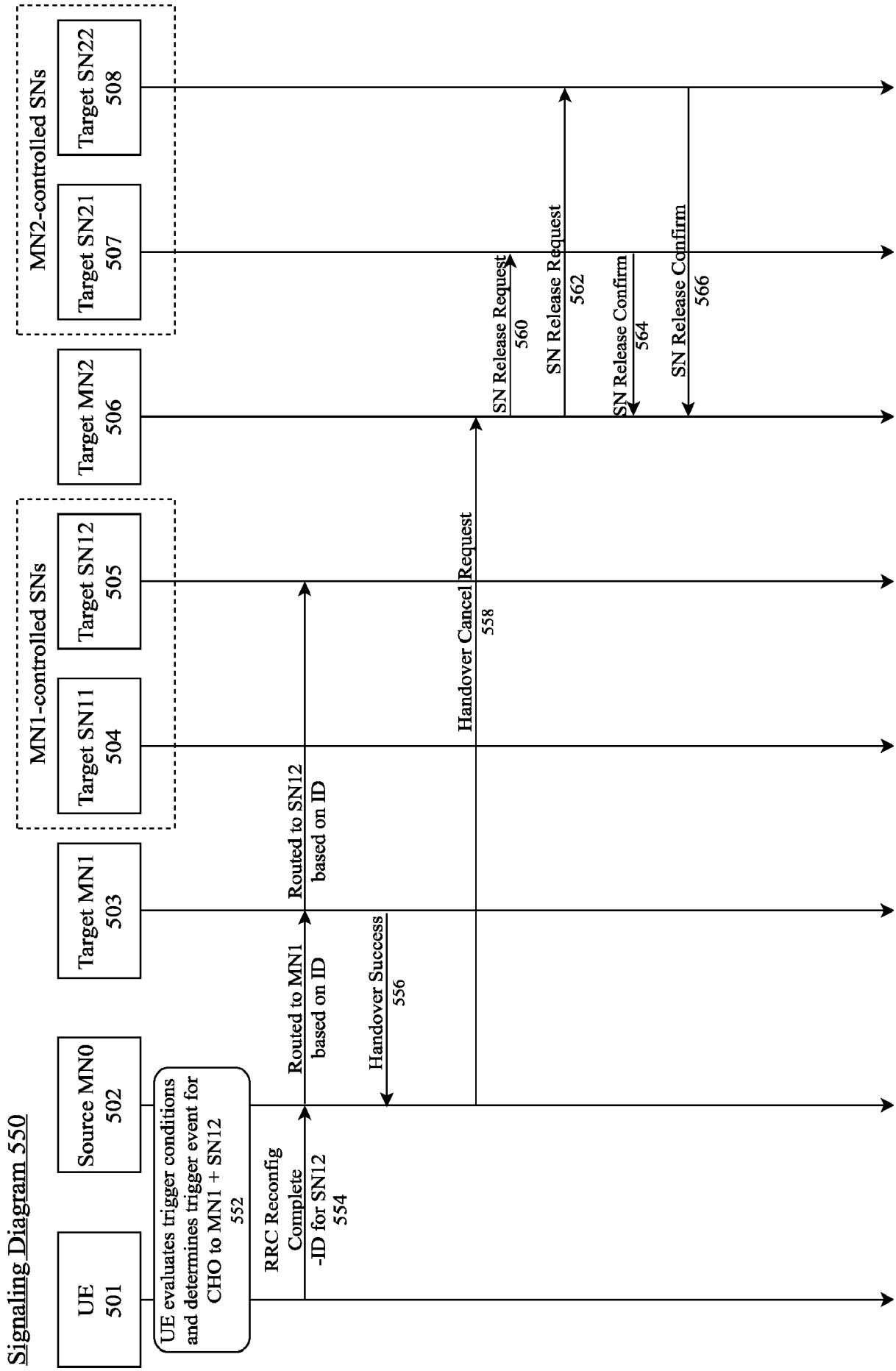
Signaling Diagram 550
UE 501
Source MN0 502
Target MN1 503
MN1-controlled SNs
Target SN11 504
Target SN12 505
Target MN2 506
MN2-controlled SNs
Target SN21 507
Target SN22 508
UE evaluates trigger conditions and determines trigger event for CHO to MN1 + SN12 552
RRC Reconfig Complete -ID for SN12 554
Routed to MN1 based on ID
Handover Success 556
Routed to SN12 based on ID
Handover Cancel Request 558
SN Release Request 560
SN Release Request 562
SN Release Confirm 564
SN Release Confirm 566

Fig. 5c

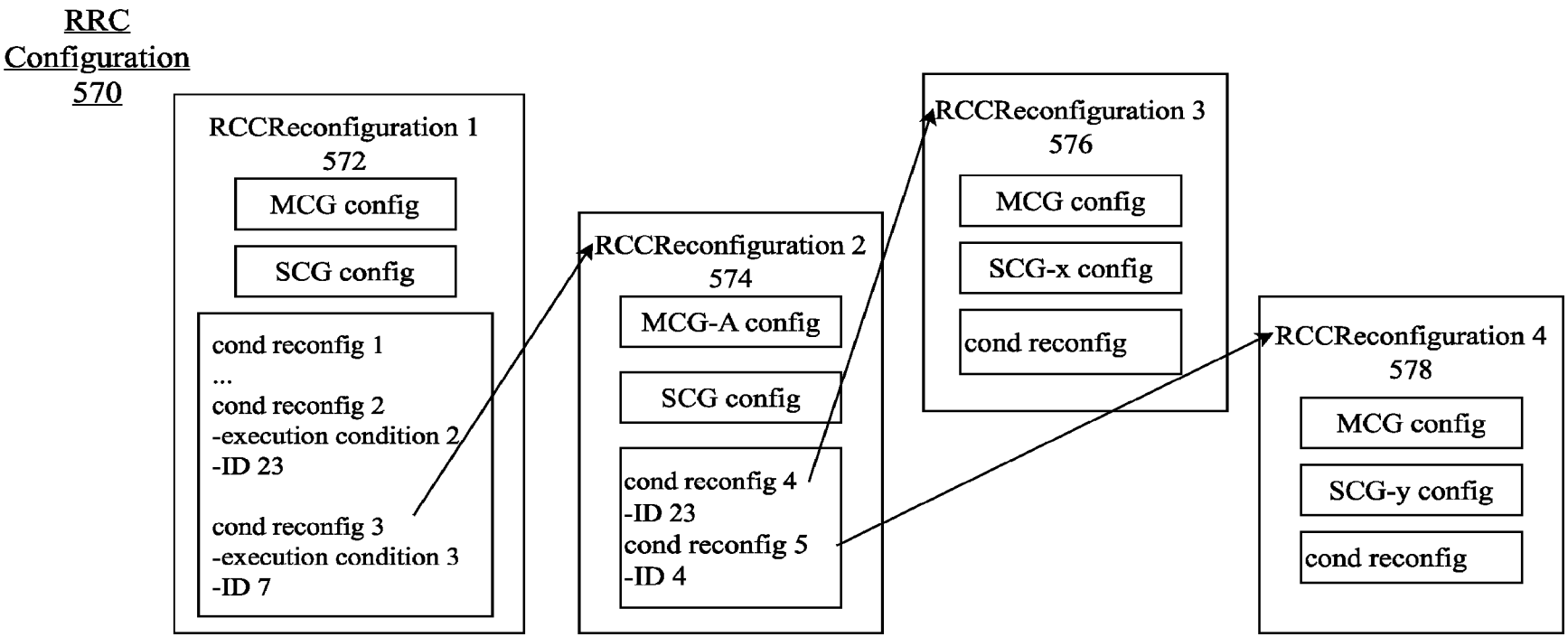

Fig. 5d

RRC Configuration 580

584 582

```
CondReconfigToAddModExtList-r18 : : = SEQUENCE  (SIZE (1..maxNrofCondCells-r18))  OF CondReconfigToAddMod-r18

CondReconfigToAddMod-r18 : : = SEQUENCE {
          condReconfigId-r18          CondReconfigId-r18
      condExecutionCond-r16  SEQUENCE (SIZE (1..2)) OF MeasId  OPTIONAL,          --  Cond condReconfigAdd
      condRRCReconfig-r18    OCTET STRING (CONTAINING RRCReconfiguration)   OPTIONAL,          --  Cond  condReconfigAdd
         conExecutionCondSCG-r18     SEQUENCE  (SIZE (1..X))  OF LinkedTriggers  OPTIONAL
          ...
}
```

586

Fig. 5e

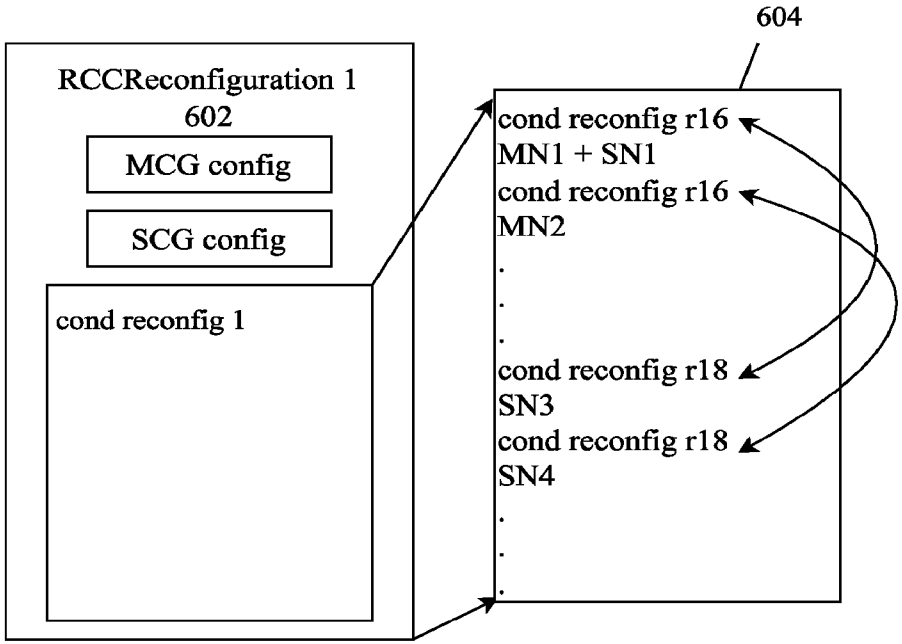

Fig. 6a

IE
610

612

```
CondReconfigToAddModExtList-r18 : : = SEQUENCE  (SIZE (1..maxNrofCondCells-r16))  OF CondReconfigToAddMod-r18

CondReconfigToAddMod-r18 : : = SEQUENCE {
    condReconfigId-r18        CondReconfigId-r18,
  condExecutionCond-r16  SEQUENCE (SIZE (1..2)) OF MeasId  OPTIONAL,          --  Cond condReconfigAdd
  condRRCReconfig-r18    OCTET STRING (CONTAINING RRCReconfiguration)   OPTIONAL,          --  Cond  condReconfigAdd
   conExecutionCondSCG-r18       OCTET STRING (CONTAINING CondReconfigExecCondSCG-r17)   OPTIONAL,    --  Need M
   ...
}
CondReconfiExecCondSGC-r17  ::=  SEQUENCE  (SIZE (1..2)) OF MeasId
```

Fig. 6b

RRC Configuration 620

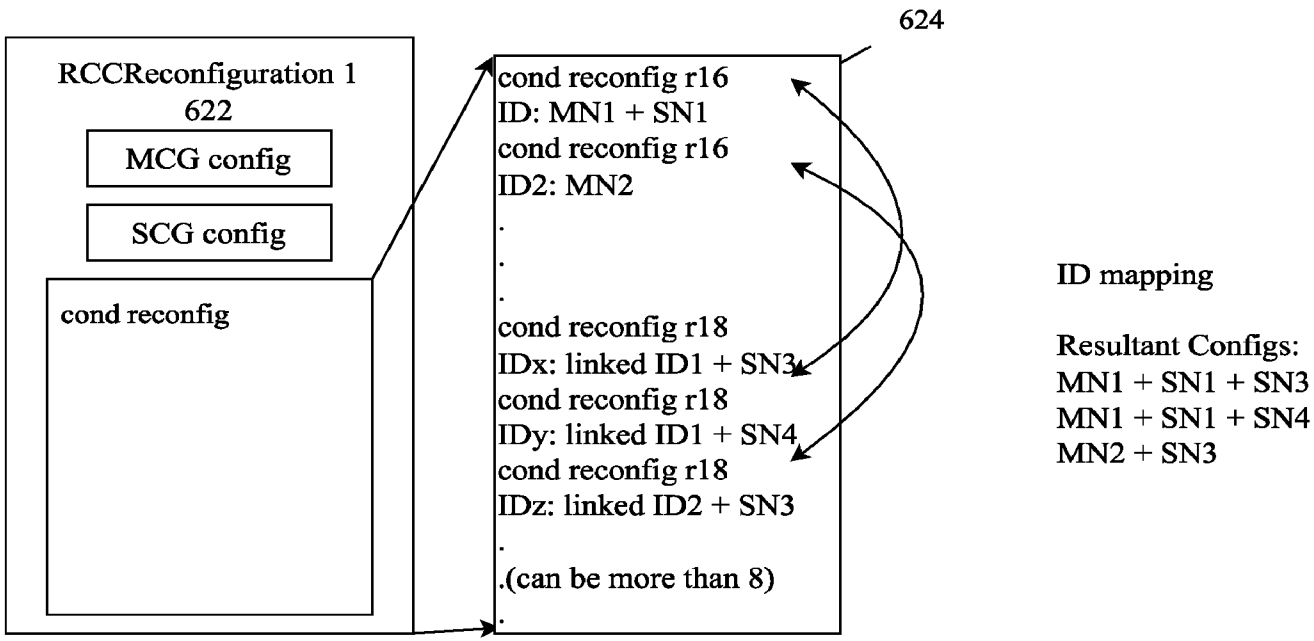

Fig. 6c

IE 630

632

```
CondReconfigToAddModExtList-r18 : := SEQUENCE  (SIZE (1.maxNrofCondCells-r18)) OF CondReconfigToAddMod-r18

CondReconfigToAddMod-r18 : : = SEQUENCE {
    condReconfigId-r18       CondReconfigId-r18,
  condExecutionCond-r16  SEQUENCE (SIZE (1..2)) OF MeasId  OPTIONAL,          --  Cond condReconfigAdd
  condRRCReconfig-r18    OCTET STRING (CONTAINING RRCReconfiguration)   OPTIONAL,          --  Cond  condReconfigAdd
   conExecutionCondSCG-r18      OCTET STRING (CONTAINING CondReconfigExecCondSCG-r17)   OPTIONAL,    --  Need M
   ...
}
CondReconfiExecCondSGC-r17  ::=  SEQUENCE  (SIZE (1..2)) OF MeasId
```

Fig. 6d

IE
700

```
ConditionalReconfiguration-r16 ::= SEQUENCE {
   attemptCondReconfig-r16      ENUMERATED {true}  OPTIONAL,   -- Cond CHO
   condReconfigToRemoveList-r16 CondReconfigToRemoveList-r16 OPTIONAL,   -- Need N
   condReconfigToAddModList-r16 CondReconfigToAddModList-r16 OPTIONAL,   -- Need N
     ...
  [[
   condReconfigToRemoveList-r18 CondReconfigToRemoveList-r18 OPTIONAL,   -- Need N
   condReconfigToAddModList-r18 CondReconfigToAddModList-r18 OPTIONAL,   -- Need N
   ReferenceConditinalConfig    OCTET STRING (CONTAINING RRCReconfiguration)  OPTIONAL,
  ]]
}


CondReconfigToAddModExtList-r18 ::= SEQUENCE (SIZE(1..maxNofCondCells-r16)) OF CondReconfigToAddMod-r18

CondReconfigToAddMod-r18 ::= SEQUENCE {
     condReconfigId-r18    CondReconfigId-r18,
   condExecutionCond-r16  SEQUENCE (SIZE(1..2)) OF MeasId OPTIONAL,     -- Cond condReconfigAdd
   conRRCReconfig-r18     OCTET STRING (CONTAINING RRCReconfiguration) OPTIONAL,        -- Cond conReconfigAdd

     conExecutionCondSCG-r18     OCTET STRING (CONTAINING CondReconfigExecCondSCG-r17) OPTIONAL,          -- Need M
     ...,
  [[
     KeepConfigAfterExecution-r18  ENUMERATED {true}  OPTIONAL,
  ]]
}
CondReconfigExecCondSCG-r17 ;; SEQUENCE (SIZE(1..2))  OF MeasId
```

702

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2023/029737

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00
ADD.

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

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2022/141470 A1 (LENOVO BEIJING LTD [CN]) 7 July 2022 (2022-07-07) paragraph [0076] - paragraph [0116]	1-20
Y	WO 2021/109394 A1 (ZTE CORP [CN]) 10 June 2021 (2021-06-10) page 27, last line - page 31, line 11; figures 6-7	1-20
Y	CN 110 545 567 A (SPREADTRUM COMMUNICATIONS SHANGHAI INC) 6 December 2019 (2019-12-06) paragraph [0084]	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2023	09/11/2023

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Baas, Gert-Jan

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2023/029737

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2022141470 A1	07-07-2022	AU 2020483580 A1	06-07-2023
		CA 3200751 A1	07-07-2022
		CN 116671173 A	29-08-2023
		EP 4272486 A1	08-11-2023
		WO 2022141470 A1	07-07-2022
WO 2021109394 A1	10-06-2021	CN 115398968 A	25-11-2022
		EP 4118874 A1	18-01-2023
		US 2023097891 A1	30-03-2023
		WO 2021109394 A1	10-06-2021
CN 110545567 A	06-12-2019	CN 110545567 A	06-12-2019
		CN 114222336 A	22-03-2022
		CN 114679754 A	28-06-2022
		CN 114828123 A	29-07-2022
		EP 4044669 A1	17-08-2022
		JP 2022550134 A	30-11-2022
		US 2022369173 A1	17-11-2022
		WO 2021057235 A1	01-04-2021