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(54) Title: EVALUATION OF WHETHER TO KEEP OR RELEASE SERVING PSCell

Evaluate a first CHO configuration to determine whether to keep or release the serving PSCell

601

Fig. 6

(57) Abstract: There is provided a method performed by a user equipment, UE, operating with multi-radio dual connectivity, MR-DC, with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, the MCG comprising a serving Primary Cell, PCell, and the SCG comprising a serving primary SCG cell, PSCell The method comprises evaluating (601) a first Conditional Handover, CHO, configuration to determine whether to keep or release the serving PSCell, wherein the at least one conditional first CHO reconfiguration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, wherein the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

Evaluation of whether to keep or release serving PSCell

Technical Field

This disclosure relates to mobility for a User Equipment (UE) that is operating with Multi-
5 Radio Dual Connectivity (MR-DC).

Background

3GPP Dual Connectivity

10 In 3rd Generation Partnership Project (3GPP) Release 12 (Rel-12), the Long Term Evolution (LTE) feature Dual Connectivity (DC) was introduced, to enable the User Equipment (UE) to be connected in two cell groups, each controlled by an LTE access node, eNBs, labelled as the Master eNB (MeNB) and the Secondary eNB (SeNB). The UE still only has one Radio Resource Control (RRC) connection with the network. In 3GPP, the Dual
15 Connectivity (DC) solution has since then been evolved and is now also specified for New Radio (NR) as well as between LTE and NR. With the introduction of 5th Generation (5G), the term Multi-Radio Dual Connectivity (MR-DC) was defined as a generic term for all dual connectivity options which includes at least one NR access node. This is described further in 3GPP Technical Standard (TS) 37.340 v17.4.0. Using the MR-DC generalised terminology,
20 the UE is connected in a Master Cell Group (MCG), controlled by the Master Node (MN), and in a Secondary Cell Group (SCG) controlled by a Secondary Node (SN).

Further, in MR-DC, when dual connectivity is configured for the UE, within each of the two cell groups, MCG and SCG, carrier aggregation may be used as well. In this case, within the Master Cell Group (MCG) controlled by the master node (MN), the UE may use one
25 Primary Cell (PCell) and one or more Secondary Cells (SCell(s)). Within the Secondary Cell Group (SCG) controlled by the secondary node (SN), the UE may use one Primary SCell (PSCell, also known as the Primary SCG cell in NR) and one or more SCell(s). This combined case is illustrated in Fig. 1.

In NR, the primary cell of a master or secondary cell group is sometimes also referred
30 to as the Special Cell (SpCell). Hence, the SpCell in the MCG is the PCell and the SpCell in the SCG is the PSCell.

There are different ways to deploy a 5G network with or without interworking with LTE (also referred to as Evolved Universal Terrestrial Radio Access (E-UTRA)) and Evolved Packet Core (EPC). These different ways to deploy 5G are also known as architecture
35 options. In principle, NR and LTE can be deployed without any interworking, denoted by NR stand-alone (SA) operation, also known as architecture option 2, that is gNB in NR can be connected to 5G core network (5GC) and eNB in LTE can be connected to EPC with no

interconnection between the two, also known as architecture option 1.

On the other hand, the first supported version of NR uses dual connectivity, denoted as EN-DC (E-UTRA Network-NR Dual Connectivity), also known as architecture option 3, as depicted in Fig. 2. In such a deployment, dual connectivity between NR and LTE is applied, where the UE is connected with both the LTE radio interface (LTE Uu in Fig. 2) to an LTE access node and the NR radio interface (NR Uu in Fig. 2) to an NR access node. Further, in EN-DC, the LTE access node acts as the master node (in this case known as the Master eNB (MeNB)), controlling the master cell group (MCG), and the NR access node acts as the secondary node (in this case sometimes also known as the Secondary gNB (SgNB)), controlling the secondary cell group (SCG). The SgNB has a user plane (UP) connection S1-U to the core network (EPC). The control plane (CP) connection S1-C to the core network (EPC) is instead provided by the MeNB. This is also called “Non-standalone NR” (NSA NR). It should be noted that in this case the functionality of an NR cell is limited and would be used for connected mode UEs as a booster and/or diversity leg, but an RRC_IDLE UE cannot camp on these NR cells. In EN-DC, there is no connection to the 5G core network (5GC).

With the introduction of 5GC, other options may be also valid. As mentioned above, option 2 supports stand-alone NR deployment where the gNB is connected to 5GC. Similarly, LTE can also be connected to 5GC using option 5 (also known as eLTE, E-UTRA/5GC, or LTE/5GC and the node can be referred to as a Next Generation-eNB (ng-eNB)). In these cases, both NR and LTE are seen as part of the Next Generation-Radio Access Network (NG-RAN), and both the ng-eNB and the gNB can be referred to as NG-RAN nodes.

It is worth noting that there are also other variants of dual connectivity between LTE and NR which have been standardised as part of NG-RAN connected to 5GC. Under the MR-DC umbrella there is:

- EN-DC (also known as architecture option 3): LTE is the master node and NR is the secondary node (EPC Core Network (CN) employed, as depicted in Fig. 2);
- NR-E-UTRA Dual Connectivity (NE-DC) (also known as architecture option 4): NR is the master node and LTE is the secondary (5GC employed);
- NG-RAN – E-UTRA Dual Connectivity (NGEN-DC) (also known as architecture option 7): LTE is the master node and NR is the secondary (5GC employed);
- New Radio-Dual Connectivity (NR-DC) (variant of architecture option 2): Dual connectivity where both the master node (MN) controlling the MCG and the secondary node (SN) controlling the SCG are NR (5GC employed, as depicted in Fig. 3).

Conditional Handover (CHO)

In 3GPP Release 16 (Rel-16), the conditional handover was standardised as a solution to increase the robustness at handover. In order to avoid the undesired dependence on the

serving radio link upon the time (and radio conditions) where the UE should execute the handover, the possibility to provide RRC signalling for the handover to the UE earlier was standardized. It is possible to associate the HO command with a condition e.g. based on radio conditions. For example, the condition may be similar to the radio conditions associated to an A3 event, where a given neighbour becomes X dB better than target. As soon as the condition is fulfilled, the UE executes the handover in accordance with the provided handover command.

Such a condition could e.g. be that the quality of the target cell or beam becomes X dB stronger than the serving cell. The threshold Y used in a preceding measurement reporting event should then be chosen lower than the one in the handover execution condition. This allows the serving cell to prepare the handover upon reception of an early measurement report and to provide the *RRCConnectionReconfiguration* with *mobilityControlInfo* (or the *RRCReconfiguration* with *reconfigurationWithSync*) at a time when the radio link between the source cell and the UE is still stable. The execution of the handover is done at a later point in time (and threshold), which is considered optimal for the handover execution.

Fig. 4 depicts an example of signalling in a conditional handover execution with a serving and a target cell. In practice there may often be many cells or beams that the UE has reported as possible candidates based on its preceding RRM measurements. The network should then have the freedom to issue conditional handover commands for several of those candidates. The *RRCConnectionReconfiguration* (*RRCReconfiguration*) message for each of those candidates may differ not just concerning the target cell but also e.g. in terms of the HO execution condition (RS to measure and threshold to exceed) as well as in terms of the RA preamble to be sent when a condition is met.

While the UE evaluates the condition, it continues operating per its current RRC configuration, i.e., without applying the conditional HO command. When the UE determines that the condition is fulfilled, it disconnects from the serving cell, applies the conditional HO command and connects to the target cell. These steps are equivalent to the legacy handover execution.

When the UE has successfully performed the random access procedure towards the target cell during a conditional handover or a normal handover, it then releases all the conditional reconfigurations that it has stored. The target cell may then configure new conditional reconfigurations to the UE if it is considered useful.

In 3GPP Release 17 (Rel-17), support for inclusion of a target SCG configuration in the CHO target configuration (to be applied at fulfilment of the CHO execution condition) was added. This means that when the CHO execution conditions are fulfilled, the UE applies the CHO target configuration with the included PSCell/SCG configuration and executes the corresponding procedures. The evaluation of the CHO execution conditions do not, however, include any evaluation of the radio conditions for the PSCell that is part of the CHO target

configuration.

Conditional PSCell Addition/Change

In 3GPP Rel-16, a solution for Conditional PSCell Change (CPC) procedure was also standardised. Therein a UE operating in Multi-Radio Dual Connectivity (MR-DC) receives in a conditional reconfiguration one or multiple RRC Reconfiguration(s) (e.g. an *RRCReconfiguration* message) containing an SCG configuration (e.g. an *secondaryCellGroup* of IE *CellGroupConfig*) with a *reconfigurationWithSync* that is stored and associated to an execution condition (e.g. a condition like an A3/A5 event configuration), so that one of the stored messages is only applied upon the fulfilment of the execution condition e.g. associated with the serving PSCell, upon which the UE would perform PSCell change (in case it finds a neighbour cell that is better than the current SpCell of the SCG). Only intra-SN CPC without MN involvement is standardised in 3GPP Rel-16, i.e. for cases where the (candidate) target PSCells are located in the current serving SN.

In 3GPP Rel-17 solutions for Conditional PSCell Addition (CPA) and inter-SN CPC were introduced. The CPA procedure is used for adding a PSCell/SCG to the configuration for a UE that is currently only configured with an MCG, when associated execution conditions are fulfilled. CPA is initiated by the MN by requesting an SCG configuration, which is to be provided as part of a conditional reconfiguration to the UE, from a (candidate) target SN (T-SN), and then sending it in a conditional reconfiguration to the UE together with the associated execution conditions.

The inter-SN CPC can be initiated either by the MN or by the source SN (S-SN), where the signalling towards the source SN and the (candidate) target SNs, as well as towards the UE, in both cases is handled by the MN. One of the possible signalling sequences for configuration of an inter-SN CPC, which is initiated by the source SN, can be seen in the signalling flow in Fig. 5.

For CPA in NR-DC, the execution conditions are configured using conditional event A4, i.e. where the condition is fulfilled when the corresponding neighbouring cell, i.e. the candidate target PSCell of the CPA configuration, becomes better than a configured threshold.

For SN-initiated CPC, the execution conditions are configured using conditional events A3 or A5, i.e. where the condition is fulfilled when the corresponding neighbouring cell, i.e. the candidate target PSCell of the CPC configuration, becomes offset better than the current serving PSCell or when the candidate target PSCell becomes better than a configured threshold and the current serving PSCell becomes worse than another configured threshold, respectively.

For MN-initiated CPC in Rel-17, the execution conditions are configured using conditional event A4, i.e. where the condition is fulfilled when the candidate target PSCell of

the CPC configuration becomes better than a configured threshold. This means that the corresponding PSCell change is triggered when the target candidate PSCell becomes good enough, i.e. there is then no check of the serving PSCell. It is then not so useful in most mobility scenarios since the serving PSCell may still be in good coverage when the condition is considered fulfilled, the serving PSCell can then even be in better coverage than the candidate target PSCell.

Conditional Handover with candidate SCGs

One objective in 3GPP Release 18 (Rel-18) is to specify Conditional Handover (CHO) including target MCG and candidate SCGs for CPC/CPA in NR-DC. That way the radio link quality of different PSCell candidates can be taken into account when determining what PSCell/SCG to access as part of the CHO execution.

It has been agreed in 3GPP RAN2 that simultaneous evaluation of CHO (the candidate target PCell) and of the associated CPC (i.e. the associated candidate target PSCells) is to be supported. It might be that the same is applicable for CHO associated with one or more CPA configurations. Thus, when the conditions for both CHO and an associated CPC/CPA are fulfilled, the UE may then apply the corresponding target configurations for both the candidate target PCell and the candidate target PSCell.

Summary

There currently exist certain challenge(s). When a UE is configured with MR-DC, e.g. a PSCell/SCG configuration in addition to the MCG configuration, and is configured with CHO and associated CPC configurations (i.e. the Rel-18 CHO with candidate SCGs), the UE will perform simultaneous evaluation of the candidate PCell (CHO) and one or more associated candidate SCGs/PSCells (CPC).

At the time when the execution conditions for CHO are fulfilled, the execution conditions for the candidate SCGs/PSCells (CPC) may or may not be fulfilled, e.g. depending on whether the UE is actually in coverage of the corresponding PSCells. This is however also true for the current serving PSCell at that point in time, i.e. the UE might at that time be either in good or bad coverage of that PSCell. In case the UE is in good coverage of the serving PSCell, that PSCell should be kept as part of the CHO execution, whereas if the UE only has poor coverage for the serving PSCell, it should instead be released as part of the CHO execution. However, there is no provision for determining whether the current serving PSCell should be released or kept. The existing conditional reconfigurations for candidate PSCell (CPC and CPA) and the existing conditional events (or conditions) cannot be used to evaluate whether to release or keep the current PSCell (or SCG configuration).

As an example, in order to consider the PSCell as applicable cell for conditional

reconfiguration evaluation, it needs to be included in *reconfigurationWithSync* within the *secondaryCellGroup* within the received *condRRCReconfig* (i.e. within the target configuration for the conditional reconfiguration). However, in case the serving PSCell is to be released (or even kept) as a result of the conditions being fulfilled, it will not be included in *reconfigurationWithSync* of a target configuration to be executed.

A further problem is that if the current serving PSCell is changed while the UE is configured with a Rel-18 CHO configuration with candidate SCGs, there would typically be a need to change the corresponding CHO configuration(s) with associated CPC configurations. For example, the PSCell that was earlier the serving PSCell may be changed to become a candidate target PSCell of a CPC configuration (associated to CHO) and one of the candidate target PSCell of a CPC configuration may have become the new serving PSCell.

Certain aspects of the disclosure and their embodiments may provide solutions to these or other challenges. The present disclosure relates to techniques for determining whether a current serving PSCell for a UE should be released or kept.

In some embodiments, the present disclosure relates to evaluating whether the serving PSCell should be kept or released at execution of CHO. The evaluating may be performed based on radio signal strength/quality. Different target configurations (e.g., with or without the current serving PSCell or SCG) can be applied depending on the result of the evaluation. Thus, conditional events for considering whether the serving PSCell should be kept or released may be introduced.

In some embodiments, conditional reconfigurations (e.g. corresponding to event A4 or A1), associated to the CHO for the same candidate target PCell, are configured to the UE for both the serving PSCell and for other candidate target PSCells and the UE evaluates these and selects the conditional configuration (for PSCell) for which execution conditions are fulfilled, at execution of the associated CHO.

In some embodiments, the UE is configured with conditional reconfigurations associated to the CHO for the same candidate target PCell, for both the serving PSCell and for other candidate target PSCells, but the UE does not perform measurements or evaluate the conditional reconfiguration for the current serving PSCell. An advantage of these embodiments is that, in case of a PSCell change before the CHO execution, the corresponding reconfiguration of the associated CPC configurations can then be avoided. Instead, the UE changes which conditional reconfigurations (CPC) it measures/evaluates and which it does not measure/evaluate based on which cell is the current serving PSCell.

In some embodiments, the present disclosure provides methods in which a UE can be configured with a conditional reconfiguration for release of a current PSCell/SCG. In some of these embodiments, the configuration is not associated to a CHO configuration.

Related network methods are also provided herein.

According to a first aspect, there is provided a method performed by a UE operating with MR-DC with at least a Master Cell Group (MCG), and a Secondary Cell Group (SCG). The MCG comprises a serving Primary Cell (PCell), and the SCG comprises a serving primary SCG cell (PSCell). The method comprises evaluating a first Conditional Handover (CHO) configuration to determine whether to keep or release the serving PSCell. The first CHO reconfiguration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, and the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

According to a second aspect, there is provided a method performed by a master node (MN). The MN is associated with a MCG for a UE that is operating with MR-DC with the MCG and a SCG. The MCG comprises a serving PCell, and the SCG comprises a serving PSCell. The method comprises: transmitting, to the UE, a first message comprising a first CHO configuration. The first CHO configuration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, and the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

According to a third aspect, there is provided a method performed by a secondary node (SN). The SN is associated with a SCG for a UE that is operating with MR-DC with at least a MCG and a SCG. The MCG comprises a serving PCell and the SCG comprises a serving PSCell. The method comprises: transmitting information related to a first CHO configuration. The first CHO configuration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

According to a fourth aspect, there is provided a method performed by a target MN (T-MN) for a UE that is operating with at least a MCG and a SCG. The MCG comprises a serving PCell and the SCG comprises a serving PSCell. The method comprises: transmitting, to a MN associated with the MCG, a second message comprising information related to a first CHO configuration. The first CHO configuration comprises one or more CHO execution conditions relating to a PCell, and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

According to a fifth aspect, there is provided a computer program product comprising a computer readable medium having computer readable code embodied therein, the computer readable code being configured such that, on execution by a suitable computer or processor, the computer or processor is caused to perform the method according to the first aspect, the

second aspect, the third aspect, the fourth aspect, or any embodiments thereof.

According to a sixth aspect, there is provided a UE configured to perform the method according to the first aspect or any embodiment thereof.

5 According to a seventh aspect, there is provided a UE comprising a processor and a memory, said memory containing instructions executable by said processor whereby said UE is operative to perform the method according to the first aspect or any embodiment thereof.

According to an eighth aspect, there is provided a first radio access network (RAN) node configured to perform the method according to the second aspect, the third aspect, the fourth aspect, or any embodiments thereof.

10 According to a ninth aspect, there is provided a first RAN node comprising a processor and a memory, said memory containing instructions executable by said processor whereby said first RAN node is operative to perform the method according to the second aspect, the third aspect, the fourth aspect, or any embodiments thereof.

Certain embodiments may provide one or more of the following technical advantage(s).
15 The techniques disclosed herein can provide a solution for configuration of conditions (e.g. events) related to whether the serving PSCell should be kept or released, e.g., at execution of a CHO with candidate SCGs/PSCells.

An advantage of the disclosed techniques is that the status of the serving PSCell may be taken into account when the CHO is to be executed in order to determine whether the
20 PSCell is to be kept or released at the execution of the CHO. This allows that the PSCell to be released at the CHO if the coverage is starting to become poor. In some cases, there is a need to perform a random access towards the PSCell if it is to be kept at the CHO execution, which can be avoided in case the PSCell coverage is anyway poor. Thus, the efficiency of the CHO may be improved.

25 Another advantage of the disclosed techniques is that the current serving PSCell may be configured as a target candidate PSCell in a CHO with associated CPC configuration. The UE then knows when to keep and when to release the PSCell at CHO with associated CPC execution without the network having to update the conditional reconfiguration when the PSCell changes or the radio conditions of the PSCell changes while the UE monitors the
30 conditions for the conditional reconfiguration. Thus, the present techniques reduce signalling between the network and the UE. This also enables the serving PSCell to be handled as a candidate PSCell, together with other candidate target PSCells, so that the best PSCell can be accessed by the UE at the CHO execution.

35 **Brief Description of the Drawings**

Some of the embodiments contemplated herein will now be described more fully with reference to the accompanying drawings, in which:

Fig. 1 is an illustration of dual connectivity combined with carrier aggregation in MR-DC;

Fig. 2 illustrates an EN-DC architecture;

Fig. 3 illustrates a NR-DC architecture;

Fig. 4 is a signalling diagram illustrating conditional handover execution;

5 Fig. 5 is a signalling diagram illustrating inter-3GPP CPC in 3GPP Rel-17;

Fig. 6 is a flow chart illustrating an exemplary method in a UE;

Fig. 7 is a flow chart illustrating an exemplary method in a Master Node;

Fig. 8 is a flow chart illustrating an exemplary method in a Secondary Node;

Fig. 9 is a flow chart illustrating an exemplary method in a target Master Node;

10 Fig. 10 is a flow chart illustrating another exemplary method in a UE;

Fig. 11 is a flow chart illustrating another exemplary method in a Master Node;

Fig. 12 is a flow chart illustrating another exemplary method in a Secondary Node;

Fig. 13 is a flow chart illustrating another exemplary method in a target Master Node;

15 Fig. 14 shows an example of a communication system in accordance with some embodiments;

Fig. 15 shows a UE in accordance with some embodiments;

Fig. 16 shows a network node in accordance with some embodiments; and

Fig. 17 is a block diagram illustrating a virtualization environment in which functions implemented by some embodiments may be virtualized.

20

Detailed Description

Some of the embodiments contemplated herein will now be described more fully with reference to the accompanying drawings. Embodiments are provided by way of example to convey the scope of the subject matter to those skilled in the art.

25 The present disclosure refers to a first network node operating as a Master Node (MN), e.g. having a Master Cell Group (MCG) configured to the UE. The MN can be a gNodeB, or a Central Unit gNodeB (CU-gNB) or an eNodeB, or a Central Unit eNodeB (CU-eNB), or any network node and/or network function.

30 The present disclosure also refers to a second network node operating as a Secondary Node (SN), or Source Secondary Node (S-SN) e.g. having a Secondary Cell Group (SCG) pre-configured (i.e. not connected to) to the UE. The SN can be a gNodeB, or a Central Unit gNodeB (CU-gNB) or an eNodeB, or a Central Unit eNodeB (CU-eNB), or any network node and/or network function. It should be noted that MN, S-SN and T-SN may be from the same or different Radio Access Technologies (RATs), and possibly be associated to different Core
35 Network nodes.

As used herein, an SN that is a “target secondary node” is equivalent to a target candidate SN, or a network node associated to a target candidate PSCell that is being

configured. If a UE were to connect to that cell, transmissions and receptions with the UE would be handled by that node if the cell is associated to that node.

As used herein, a MN that is a “target MN” or a “candidate target MN” or a “target candidate MN”, which corresponds to a network node associated to a target candidate PCell that is being configured. If the UE would connect to that cell, transmissions and receptions with the UE would be handled by that node if the cell is associated to that node. This disclosure often refers to a “source MN” which may correspond to a network node that is associated to a PCell that the UE is configured with before execution (and/or configuration) of a Handover or Conditional Handover procedure.

This disclosure indicates that a cell resides in a node, e.g. a target candidate cell resides in the S-SN or the t-SN. That is equivalent to saying that a cell is managed by the node, or is associated to the node, or associated with the node, or that the cell belongs to the node, or that the cell is of the node.

“SN-initiated CPC” corresponds to a procedure wherein the Source SN for a UE configured with MR-DC determines to configure CPC. After determining, the Source SN selects e.g. based on reported measurements, one or more target candidate cells (target candidate PCell(s)) where at least one cell is associated to the Source SN, and at least another cell is associated to a neighbour SN. It can be said that if all target candidate cells are associated to the Source SN that is an “SN-initiated intra-SN CPC”, which may be referred as the Release 16 solution. It can be said that if at least one target candidate cell is associated to a neighbour SN that is an “SN-initiated inter-SN CPC”, which may be referred as a Release 17 solution.

This disclosure refers to a candidate SN, or SN candidate, or an SN, as the network node (e.g. gNodeB) that is prepared during the CPA procedure and that can create an RRC Reconfiguration message with an SCG configuration (e.g. *RRCReconfiguration***) to be provided to the UE and stored, with an execution condition, wherein the UE only applies the message (the target configuration or candidate target configuration) upon the fulfilment of the execution condition. That candidate SN is associated to one or multiple PCell candidate cell(s) that the UE can be configured with. The UE then can execute the target configuration and accesses one of these candidate cells, associated to a candidate SN that becomes the SN or simply the SN after execution (i.e. upon fulfilment of the execution condition).

This disclosure refers to a Conditional PCell Change (CPC) configuration and procedures (like CPC execution), which most of the time refer to the procedure from the UE perspective. Other terms may be considered as synonyms such as conditional reconfiguration, or Conditional Configuration (since the message that is stored and applied upon fulfilment of a condition is an *RRCReconfiguration* or *RRCConnectionReconfiguration*). Terminology wise, conditional handover (CHO) could be interpreted in a broader sense, also

covering CPA (Conditional PSCell Change) procedures. This disclosure refers to a Conditional SN Change most of the time to refer to the procedure from the UE perspective, to refer to procedures between network nodes in which a node requests a target candidate SN (which may be the same as the Source SN or a neighbour SN) to configure a conditional PSCell Change (CPC) for at least one of its associated cells (cell associated to the target candidate SN).

This disclosure refers to CPAC as a way to refer to either a Conditional PSCell Addition (CPA) or a Conditional PSCell Change (CPC).

This disclosure refers to a neighbour SN and a Source SN as different entities, though both could be a target candidate SN for CPC.

The configuration of CPC can be done using the same Information Elements (IEs) as conditional handover, which is referred to herein as “conditional configuration” or “conditional reconfiguration”. The principle for the configuration is the same with configuring triggering/execution condition(s) and a reconfiguration message to be applied when the triggering condition(s) are fulfilled. The configuration IEs from TS 38.331:

– *ConditionalReconfiguration*

The IE *ConditionalReconfiguration* is used to add, modify and release the configuration of conditional configuration.

***ConditionalReconfiguration* information element**

```
-- ASN1START
-- TAG-CONDITIONALRECONFIGURATION-START

ConditionalReconfiguration-r16 ::=                               SEQUENCE {
    attemptCcondReconfig-r16                                     ENUMERATED {true}
OPTIONAL, -- Need N
    condConfigToRemoveList-r16                                   CondConfigToRemoveList-r16
OPTIONAL, -- Need N
    condConfigToAddModList-r16                                   CondConfigToAddModList-r16
OPTIONAL, -- Need N
    ...
}

CondConfigToRemoveList-r16 ::= SEQUENCE (SIZE (1..
maxNrofCondCells)) OF CondConfigId-r16
```

-- TAG-CONDITIONALRECONFIGURATION-STOP

ConditionalReconfiguration field descriptions
condConfigToAddModList List of the configuration of candidate SpCells to be added or modified for CHO or CPC.
condConfigToRemoveList List of the configuration of candidate SpCells to be removed. When the network removes the stored conditional configuration for a candidate cell, the network releases the measIDs associated to the condExecutionCond if it is not used by the condExecutionCond of other candidate cells.

- 5
- CondConfigId

The IE CondConfigId is used to identify a CHO or CPC configuration.

CondConfigId information element

10

-- ASN1START

-- TAG-CONDCONFIGID-START

CondConfigId-r16 ::= INTEGER (1.. maxNrofCond-Cells)

-- TAG-CONDCONFIGID-STOP

15

-- ASN1STOP

-
- CondConfigToAddModList
- The IE CHO-ConfigToAddModList concerns a list of conditional configurations to add or modify, with for each entry the cho-ConfigId and the associated condExecutionCond and condRRCReconfig.
- 20

CondConfigToAddModList information element

25

-- ASN1START

-- TAG-CONDCONFIGTOADDMODLIST-START

	CondConfigToAddModList-r16 ::=	SEQUENCE (SIZE (1..
	maxNrofCondCells)) OF CondConfigToAddMod-r16	
	CondConfigToAddMod-r16 ::=	SEQUENCE {
5	condConfigId-r16	CondConfigId-r16,
	condExecutionCond-r16	SEQUENCE (SIZE
	(1..2)) OF MeasId OPTIONAL, -- Need S	
	condRRCReconfig-r16	OCTET STRING
	(CONTAINING RRCReconfiguration) OPTIONAL, -- Need S	
10	...	
	}	
	-- TAG-CONDCONFIGTOADDMODLIST-STOP	
15	-- ASN1STOP	

CondConfigToAddMod field descriptions

condExecutionCond

The execution condition that needs to be fulfilled in order to trigger the execution of a conditional configuration. The field is mandatory present when a *condConfigId* is being added. Otherwise, when the *condRRCReconfig* associated to a *condConfigId* is being modified it is optionally present and the UE uses the stored value if the field is absent.

condRRCReconfig

The *RRCReconfiguration* message to be applied when the condition(s) are fulfilled. The field is mandatory present when a *condConfigId* is being added. Otherwise, when the *condExecutionCond* associated to a *condConfigId* is being modified it is optionally present and the UE uses the stored value if the field is absent.

In the different embodiments described herein, these IEs are used differently, e.g. sometimes generated by the MN, sometimes generated by the source SN, sometimes by a target candidate SN.

In the different embodiments, it is said the CPC is in MN format when the CPC configuration is not configured as an MR-DC configuration in *mrdc-SecondaryCellGroup* (as defined in TS 38.331). In other words, the UE receives an *RRCReconfiguration* from the MN that may contain the *mrdc-SecondaryCellGroup* (e.g. in case the UE is also configured with

an SCG MeasConfig for inter-SN CPC) but the CPC is not within that container. That means the IEs listed above (e.g. the IE ConditionalReconfiguration) are not included in mrdc-SecondaryCellGroup.

In the different embodiments it is said the CPC is in SN format when the CPC configuration is configured as an MR-DC configuration in mrdc-SecondaryCellGroup (as defined in TS 38.331). In other words, the UE receives an *RRCReconfiguration* from the MN that may contain the mrdc-SecondaryCellGroup and the CPC is within that container. That means the IEs listed above (e.g. the IE ConditionalReconfiguration) are included in mrdc-SecondaryCellGroup (e.g. within a series of other nested IEs).

The execution conditions for conditional reconfigurations often comprise a single condition, but currently (in Rel-17 specifications) up to two execution conditions may be configured for each conditional reconfiguration. More execution conditions may be added in later releases.

CHO with conditions for keeping/releasing the serving PSCell at CHO execution

In a set of embodiments, a User Equipment (UE) is configured with at least one Conditional Handover (CHO) configuration, with at least associated execution conditions, and one or more associated conditions, and/or conditional reconfigurations, regarding the handling of the serving PSCell at execution of the CHO, where the conditions are related to whether the serving PSCell is to be kept or released as part of the CHO execution. In some alternatives, the UE is also configured with one or more candidate target PSCells/SCGs (e.g. as CPC configurations associated to the CHO configuration), i.e. for other cells than the current serving PSCell. In some embodiments the UE performs simultaneous evaluation of the execution conditions for CHO and of the execution conditions for the conditional reconfiguration(s) for the serving PSCell, and/or of the conditions for whether to keep or release the serving PSCell. When the execution conditions for CHO are fulfilled, the UE also checks the associated execution conditions for the serving PSCell (and/or conditions for handling of the serving PSCell). If the result of the evaluation of those (execution) conditions indicates/corresponds to that the serving PSCell should be kept, the UE executes CHO with the serving PSCell maintained, whereas if it indicates/corresponds to that the serving PSCell should be released, the UE executes CHO with release of the serving PSCell.

This allows for the status of the serving PSCell to be taken into account when the CHO is to be executed, in order to determine whether it is to be kept or released at the execution of the CHO. The conditions for keeping the serving PSCell could then be set, e.g., in a way so that the serving PSCell coverage needs to be rather good in order to keep it as part of the CHO execution. This way, in case there is e.g. a need to perform a random access procedure towards the PSCell if it is kept at CHO execution, that additional Random Access procedure

towards the PSCell can then be skipped in case the PSCell coverage is not good enough. The reason to perform a random access procedure towards the kept PSCell at CHO execution could be, e.g., due to the security key being changed as part of the CHO execution, as this then would lead to a security key change also towards the SN, which then means that the UE
5 needs to perform a random access procedure also towards the PSCell. By having a condition for keeping the serving PSCell at CHO execution, the PSCell could be kept (i.e. not yet be released) while the UE is still in the source PCell, but at CHO execution it would be released if the UE has a rather poor coverage for that PSCell.

In some alternatives, the UE is configured with at least one associated conditional
10 configuration for the serving PSCell (with at least associated execution conditions) or conditions concerning the serving PSCell, where fulfilment of the corresponding (execution) conditions corresponds to the serving PSCell being kept as part of the execution of the CHO. When the PSCell is kept as part of the CHO execution, the corresponding PSCell/SCG configuration may be kept the same as before the CHO execution or it may be modified. The
15 UE is thus configured with (execution) conditions associated to that the PSCell (or SCG) should be kept as part of the execution of the CHO.

- In one example, an (execution) condition (for keeping the current PSCell as part of the CHO execution) consists of a conditional event A1 (i.e. serving becomes better than threshold) for the serving PSCell and where fulfilment of the (execution) condition
20 corresponds to the entering condition for this event A1 being satisfied. The conditional event is then evaluated for the current/serving PSCell in parallel to the evaluation of the CHO execution conditions and if the entering condition for the A1 event is fulfilled when those associated CHO execution conditions are fulfilled, the UE then keeps the current PSCell as part of the CHO execution.
- In one example, an (execution) condition (for keeping the current PSCell as part of the CHO execution) consists of a conditional event A2 (i.e. serving becomes worse than threshold) for the serving PSCell and where fulfilment of the (execution) condition
25 corresponds to the leaving condition for this A2 event being satisfied. The conditional event is then evaluated for the current/serving PSCell in parallel to the evaluation of the CHO execution conditions. If the leaving condition for the event is fulfilled when those associated CHO execution conditions are fulfilled, the UE then keeps the current PSCell as part of the CHO execution.
- In one alternative, an (execution) condition (for keeping the current PSCell as part of the CHO execution) consists of a conditional event A4, but where the measurements are for
30 the current serving PSCell instead of for a neighbouring cell. Fulfilment of the (execution) condition corresponds to the entering condition for the A4 event being satisfied. If this is the case when the associated CHO execution conditions are fulfilled, the condition for
35

keeping the current PSCell is fulfilled and the UE then keeps the current PSCell as part of the CHO execution.

- In one alternative, an (execution) condition (for keeping the current PSCell as part of the CHO execution) corresponds to/consists of a new conditional event that is used for determining whether the coverage and/or radio quality for the serving PSCell is good enough to be kept as part of the CHO execution. In one example the entering condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being above a configured threshold and the leaving condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being below a configured threshold.
- In one example, the condition to keep the current PSCell as part of the CHO execution corresponds to no (execution) condition being fulfilled that is associated with the release of the PSCell.
- In one alternative for the above, the action to keep the current PSCell as part of the CHO execution corresponds to the UE applying a target configuration that is associated to both the CHO execution condition and the execution condition for keeping the serving PSCell being fulfilled. The target configuration then includes an MCG configuration for the candidate target PCell of the CHO configuration and an SCG configuration for the same PSCell as before the execution, i.e. the where the serving PSCell is kept. In one example, the SCG configuration is then the same as before the CHO execution is triggered. In another example, the SCG configuration is a modified SCG configuration with the same PSCell.

In some alternatives, the UE is configured with at least one associated conditional configuration for the serving PSCell (with at least associated execution conditions) or conditions concerning the serving PSCell, where fulfilment of the corresponding (execution) conditions corresponds to the serving PSCell being released as part of the execution of the CHO. The UE is thus configured with (execution) conditions associated to the PSCell (or SCG) being released as part of the execution of the CHO.

- In one example, an (execution) condition (for releasing the current PSCell/SCG configuration as part of the CHO execution) consists of a conditional event A2 (i.e. serving becomes worse than threshold) for the serving PSCell and where fulfilment of the (execution) condition corresponds to the entering condition for this A2 event being satisfied. The conditional event is then evaluated for the current/serving PSCell in parallel to the evaluation of the CHO execution conditions. If the entering condition for the A2 event is fulfilled when those associated CHO execution conditions are fulfilled, the UE then releases the serving PSCell as part of the CHO execution.
- In one example, an (execution) condition (for releasing the current PSCell as part of the

CHO execution) consists of a conditional event A1 (i.e. serving becomes better than threshold) for the serving PSCell and where fulfilment of the (execution) condition corresponds to the leaving condition for this A1 event being satisfied. The conditional event is then evaluated for the current/serving PSCell in parallel to the evaluation of the CHO execution conditions. If the leaving condition for the A1 event is fulfilled when those associated CHO execution conditions are fulfilled, the UE then releases the serving PSCell as part of the CHO execution.

- In one example, an (execution) condition (for releasing the current PSCell as part of the CHO execution) consists of a conditional event A4, but where the measurements are for the current serving PSCell instead of for a neighbouring cell, and where the execution condition is fulfilled if the leaving condition for the A4 event is fulfilled. The conditional event is then evaluated for the current/serving PSCell in parallel to the evaluation of the CHO execution conditions. If the leaving condition for the A4 event (for the current serving PSCell) is fulfilled when those associated CHO execution conditions are fulfilled, the UE releases the current PSCell.
- In one alternative, the execution condition (for releasing the current PSCell as part of the CHO execution) corresponds to/consists of a new conditional event that is used for determining whether the coverage and/or radio quality for the current/serving PSCell is not good enough to be kept as part of the CHO execution. In one example the entering condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being below a configured threshold, and the leaving condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being above a configured threshold.
- In one example, the condition to release the current PSCell as part of the CHO execution corresponds to no (execution) condition being fulfilled that is associated with the PSCell being kept.
- In one alternative for the above, the action to release the current PSCell as part of the CHO execution corresponds to the UE applying a target configuration that is associated to both the CHO execution condition and the condition for releasing the serving/current PSCell being fulfilled. The target configuration then only includes an MCG configuration for the candidate target PCell of the CHO configuration, i.e. it does not include any SCG configuration for the PSCell that the UE had before the execution, i.e. the PSCell is released. In one example, this corresponds to the target configuration including an indication that the current SCG configuration and/or the current PSCell should be released.
- In one alternative, the current PSCell is released as part of the CHO execution if the PSCell is not configured as a target candidate PSCell, e.g. with a conditional reconfiguration (CPC or CPA) using e.g. any of conditional events A3, A4 or A5, where the measurements are

not performed by the UE.

In some alternatives to the above embodiment(s), the UE is configured with CHO configuration(s), for the same candidate target PCell, which is/are associated to at least one condition (and/or conditional configuration with associated execution condition), concerning the serving PCell, where fulfilment of the (execution) condition corresponds to the serving PCell being kept as part of the execution of the associated CHO, and associated to at least one condition (and/or conditional configuration with associated execution condition), concerning the serving PCell, where fulfilment of the (execution) condition corresponds to the serving PCell being released as part of the execution of the associated CHO. The associated CHO configurations, or at least the corresponding target configurations (e.g. as defined through *condRRCReconfig*), can be different for these configurations. For example, the CHO target configuration that is associated to a condition for which fulfilment corresponds to the serving PCell being kept as part of the CHO execution, does not include a configuration to release the SCG/PSCell, and/or it includes a modified SCG configuration for the same PSCell. Meanwhile, the CHO target configuration that is associated to a condition for which fulfilment corresponds to that the serving PSCell should be released as part of the CHO execution, includes a release of the serving PSCell.

In the different embodiments of this disclosure, it may be considered that (but not limited to) the execution conditions of the conditional reconfigurations for the serving PSCell, or the conditions concerning the serving PSCell, refer to a measurement configuration that the UE is configured with (or that it can deduce from received signalling). In one alternative the corresponding (execution) conditions refer to the current measurement configuration of the MCG in the serving (source) MN/PCell, i.e. the current MCG MeasConfig. In one alternative the corresponding (execution) conditions refer to the current measurement configuration of the SCG in the serving (source) SN/PSCell, i.e. the current SCG MeasConfig. In another alternative, the corresponding (execution) conditions refer to the measurement configuration from the candidate target MN of the associated CHO configuration. In this case, the corresponding target MN MCG measurement configuration may be provided to the UE within the CHO target configuration (or at least within one such CHO target configuration, if there are several), i.e. within *condRRCReconfig* of the CHO configuration.

Configuration of events for comparing the serving PSCell and the candidate target PSCells

In one set of embodiments, a User Equipment (UE) in MR-DC is configured with at least one Conditional Handover (CHO) configuration for a candidate target PCell (with associated execution conditions), one or more Conditional PSCell Change (or Conditional PSCell Addition) configuration(s) (for candidate target PSCells), which is/are associated to the CHO configuration, and with one or more conditional configurations (with associated execution

conditions) or conditions for the serving PSCell.

In some alternatives, the (execution) conditions for the serving PSCell and the execution conditions for the one or more CPC configurations (for other candidate target PSCells) correspond to either the conditional event A1 or the conditional event A4 (i.e. that the serving cell or the neighbouring cell, respectively, becomes better than a configured threshold). When execution conditions for the candidate target PCell (i.e. for CHO) is fulfilled, the UE checks which of the execution conditions for candidate target PSCells and/or for the serving PSCell is/are fulfilled, if any, and applies/executes the corresponding configuration. The configuration to apply/execute is then the associated target configuration for the candidate PCell and the corresponding target PSCell, which could then be a candidate target PSCell of a CPC/CPA configuration, or for the serving PSCell. In case none of the execution conditions for the candidate target PSCells (i.e. for the CPC/CPA configurations) or for the serving PSCell is fulfilled, the UE instead applies/executes a received target configuration for only the candidate PCell. In one example this target configuration includes an indication to release the serving SCG/PSCell as part of the execution.

In case execution conditions are fulfilled for more than one of the candidate target PSCells and the serving PSCell (i.e. the CPC/CPA configurations and the conditional reconfiguration or conditions for the serving PSCell), e.g. for more than one of the candidate target PSCells or for the serving PSCell and one or more of the candidate target PSCells, then the UE selects one of the configurations/PSCells for which the associated execution conditions are fulfilled.

In one option, the UE considers a conditional event that is configured as A1 to become/correspond to a conditional A4 event, when the corresponding cell changes from being a serving cell to a neighbouring cell, e.g. in case the cell is changed from being a serving PSCell, to not being a serving PSCell, for the UE. In one option, the UE considers a conditional event that is configured as A4 to become/correspond to a conditional event A1 event, when the corresponding cell changes from being a neighbouring cell to a serving cell, e.g. when the cell is changed to being the serving PSCell for the UE.

Configuration of CPC for both the serving PSCell and for the candidate PSCells

In one set of embodiments, a User Equipment (UE) in MR-DC is configured with at least one Conditional Handover (CHO) configuration (with associated execution conditions and possibly an associated target configuration), with one or more Conditional PSCell Change configuration(s) that is/are associated to the CHO configuration, and with at least one conditional reconfiguration (CPC), (with associated execution conditions and possibly an associated target configuration) for the serving PSCell.

- In some alternatives, the UE does not evaluate the execution conditions for the conditional

reconfiguration where the current serving PSCell is the candidate target PSCell (in the target candidate configuration of the corresponding CPC configuration). In one example, the UE does not perform the associated measurements for the execution conditions. The UE may in this option thus ignore the measurements for the conditional reconfiguration (CPC) if the target candidate PSCell is the same as the serving PSCell. At execution of the associated CHO, if conditions are not fulfilled for any of the CPC configurations (for other candidate target PSCells), the UE then keeps the same PSCell at execution of the CHO. In one example, this corresponds to the UE applying the target configuration that is associated to the CPC configuration for the serving PSCell (which is associated to the CHO). This may then correspond to the conditional reconfiguration (CPC) that was not measured/evaluated by the UE at the time when the CHO execution was triggered (i.e. when the CHO condition(s) are fulfilled).

- In one option the execution condition associated to the conditional reconfiguration for the serving PSCell corresponds to a conditional event A3, but the UE does not perform the measurements (or evaluate) the execution conditions as long as the target candidate PSCell of that conditional reconfiguration (CPC) is the same as the current PSCell.
- In one option the execution condition associated to the conditional reconfiguration for the serving PSCell corresponds to a conditional event A5, but the UE does not perform the measurements (or evaluate) the execution conditions as long as the target candidate PSCell of that conditional reconfiguration (CPC) is the same as the current PSCell.
- In one option the execution condition associated to the conditional reconfiguration for the serving PSCell corresponds to a conditional event A4, but the UE does not perform the measurements (or evaluate) the execution conditions as long as the target candidate PSCell of that conditional reconfiguration (CPC) is the same as the current PSCell.
- In one alternative the execution condition associated to the conditional reconfiguration for the serving PSCell, which is associated to a CHO configuration, and the execution conditions for the other candidate PSCells, i.e. the other CPC configurations that are associated to CHO for the same target PCell (e.g. the same CHO configuration or different CHO configuration with the same candidate target PCell), correspond to the same conditional events. In another alternative, they may correspond to different conditional events (e.g. different conditional events that are used for CPC evaluation).

The UE may thus avoid performing measurements for the conditional reconfiguration (CPC) where the target candidate PSCell is the same as the serving PSCell, and at execution of the CHO (when the CHO condition(s) are fulfilled) keep the same PSCell in the target configuration. This is then the case if execution conditions for none of the other associated candidate target PSCells are fulfilled.

The solution in these embodiments has the advantage that all target candidate PSCells

can be configured in the same way, including the current serving PSCell. If the serving PSCell changes before the conditional reconfiguration for CHO with associated CPC/CPA is executed, the reconfiguration of the associated conditional reconfigurations (CPC/CPA) can be avoided in many cases. Instead, the change corresponds to that, as the serving PSCell has changed, the UE changes to avoid measurements (or evaluation or execution) of the conditional reconfiguration (CPC), if any, for the new serving PSCell. At the same time, the UE then starts measuring/evaluating of the previous serving PSCell, which now has become a candidate target PSCell. This may be valid as long as a serving PSCell is still configured when the CHO condition(s) are fulfilled, i.e. the PSCell has not been released.

In one alternative, the above solution is used also in case the SCG is released, i.e. the UE configuration is changed so that it does not include any SCG/PSCell configuration. In this case, the conditional reconfigurations (associated to CHO) for the candidate target PSCells become CPA configurations, including the conditional reconfiguration for the PSCell that was the serving PSCell before the release of the SCG/PSCell. In case the UE is configured with SCG/PSCell, i.e. a PSCell/SCG addition procedure is performed, it then keeps the conditional reconfiguration (associated to CHO), if any, for the new serving PSCell, but it does then not measure/evaluate that conditional reconfiguration since it corresponds to the serving PSCell. The conditional reconfigurations for the other candidate PSCells can then be changed from CPA configurations (associated to the CHO) to CPC configurations (associated to the CHO). For these the UE would then perform measurements and evaluation.

Events for conditional SCG release

In one set of embodiments, a User Equipment (UE) in MR-DC is configured with one or more conditional reconfiguration(s) associated to the current serving PSCell, with associated execution conditions and a target configuration to be applied if the execution conditions are fulfilled, where the target configuration includes a reconfiguration where the serving SCG/PSCell is released. In this set of embodiments these conditional reconfigurations are not associated to any CHO configuration and the release of the SCG/serving PSCell is triggered when the execution conditions for such conditional reconfiguration is fulfilled.

In one alternative, fulfilment of at least one of the associated execution conditions corresponds to a conditional event corresponding to the radio signal strength or quality for the serving PSCell being poor, e.g. below a configured threshold.

- In one example the execution condition consists of a conditional event A2 (i.e. serving becomes worse than threshold) for the serving PSCell and where fulfilment of the execution condition corresponds to the entering condition for this A2 event being satisfied.
- In one example the execution condition consists of a conditional event A1 (i.e. serving becomes better than threshold) for the serving PSCell and where fulfilment of the

execution condition corresponds to the leaving condition for this A1 event being satisfied.

- In one example the execution condition consists of a conditional event A4, but where the measurements are for the current serving PSCell instead of for a neighbouring cell, and where the execution condition is fulfilled if the leaving condition for the A4 event is fulfilled.
- 5 - In one alternative the execution condition (for releasing the current PSCell) corresponds to/consists of a new conditional event that is used for determining whether the coverage and/or radio quality for the current/serving PSCell is not good enough to be kept. In one example the entering condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being below a configured threshold and the leaving
- 10 condition for the event corresponds to the signal strength and/or signal quality for the serving PSCell being above a configured threshold.
- In one example, the condition to release the current PSCell corresponds to no execution condition being fulfilled that is associated to the PSCell being kept.

In one alternative for the above, the action to release the current PSCell corresponds to

15 the UE applying/executing a target configuration that only includes an MCG configuration for the current serving PCell, i.e. it does not include any SCG configuration for the serving PSCell, i.e. the PSCell is released. In one example, this corresponds to the target configuration including an indication that the current SCG configuration and/or the current PSCell should be released.

20 In one alternative, the target configuration that the UE applies/executes includes an SCG configuration for another PSCell, i.e. that the serving PSCell is released and that another PSCell (and or SCG configuration) is configured instead.

The following relates to methods performed by the nodes in the radio access network

25 (RAN).

Source Master Node (S-MN)

One set of embodiments includes methods for a network node, e.g. a node acting as a Master Node (MN) for a UE (the source/serving MN, S-MN), for configuring the UE with at

30 least one conditional reconfiguration and/or condition for the serving PSCell. The network node sends a message (e.g. *RRCReconfiguration*) to the UE including a conditional reconfiguration for the serving PSCell (with associated execution conditions and an associated target candidate configuration to be applied when the conditions are fulfilled).

In some embodiments, the execution conditions refer to the current MCG measurement

35 configuration, i.e. the MCG MeasConfig that is configured by the source/serving MN.

- In one example, the S-MN generates the corresponding execution conditions and includes them in the configuration that is sent to the UE.

- In another example, the conditional reconfiguration for the serving PSCell is related to how the serving PSCell should be handled at execution of an associated CHO, e.g. whether the serving PSCell then should be released or kept, and the S-MN receives information related to configuration of the associated execution conditions from the candidate target MN (T-MN) for the CHO.

In some embodiments, the execution conditions refer to the current SCG measurement configuration, i.e. the SCG MeasConfig that is configured by the source/serving SN (S-SN).

- In one example, the S-MN receives the corresponding execution condition configuration from the S-SN and includes it in the configuration that is sent to the UE.

- o In one option, the S-MN sends a request for the execution condition configuration to the S-SN, e.g. in an XnAP message, and then receives the corresponding execution condition configuration from the S-SN, e.g. in another XnAP message. The information in the XnAP messages may then be included in a container within the message, e.g. in the CG-Config and CG-ConfigInfo messages.

- In another example, the S-MN receives the corresponding execution condition configuration (related to the SCG MeasConfig) from the candidate target MN (T-MN) and includes it in the configuration that is sent to the UE.

Candidate target Master Node (T-MN)

One set of embodiments includes methods for a network node, e.g. a node acting as (or is about to be configured as) a candidate target Master Node (T-MN) for a UE, for configuring the UE with at least one Conditional Handover (CHO) with at least one associated conditional reconfiguration and/or condition regarding the handling of the serving PSCell at execution of the CHO, e.g. whether the serving PSCell should be kept or released at the CHO execution.

The T-MN receives a request for a CHO configuration from the source/serving MN (S-MN), where the UE is configured with MR-DC (i.e. a serving PSCell), and sends a corresponding execution condition configuration (or related information) for the conditional reconfiguration regarding the handling of the serving PSCell to the S-MN.

In some embodiments, the execution conditions refer to the current MCG measurement configuration, i.e. the MCG MeasConfig that is configured by the source/serving MN and the T-MN sends information to the S-MN that can be used by the S-MN to generate the corresponding execution conditions towards the UE using the (S-MN) MCG MeasConfig, e.g. related parameters that are included in the measurement object configuration and/or in the reporting configuration.

In some embodiments, the execution conditions refer to the current SCG measurement configuration, i.e. the SCG MeasConfig that is configured by the source/serving SN (S-SN). In one option, the T-MN, after receiving the request for CHO from the S-MN, sends a request

for the execution condition configuration related to the handling of the serving PSCell at the CHO execution to the S-SN, e.g. in an XnAP message, and then receives the corresponding execution condition configuration from the S-SN, e.g. in another XnAP message. The information in the XnAP messages may then be included in a container within the message, e.g. in the CG-Config and CG-ConfigInfo messages. The T-MN then sends the corresponding execution condition configuration (referring to the SCG MeasConfig) to the S-MN, e.g. in the same message that includes the CHO target configuration.

Source Secondary Node (S-SN)

One set of embodiments includes methods for a network node, e.g. a node acting as a Secondary Node (SN) for a UE (the source/serving SN, S-SN), for configuring the UE with at least one conditional reconfiguration and/or condition for the serving PSCell. The S-SN receives a request from a node acting as either a serving Master Node (S-MN) or a node acting as (or to be configured as) a candidate target MN (T-MN) for a CHO for the UE, for execution conditions related to keeping and/or releasing the serving PSCell, generates the corresponding execution condition configuration, and sends it to the S-MN or to the T-MN. In one example, the execution condition configuration is related to whether the serving PSCell should be kept or released at execution of a CHO.

Fig. 6 is a flow chart illustrating an exemplary method in a UE. The UE may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 6 may be performed by a UE or wireless device (e.g. the UE 1412 or UE 1500 as described later with reference to Figs. 14 and 15 respectively). The UE is operating with MR-DC with at least a MCG and a SCG. The MCG comprises a Primary cell (PCell) and the SCG comprises a serving PSCell.

In step 601, the UE evaluates a first CHO configuration to determine whether to keep or release the serving PSCell. The first CHO reconfiguration comprises one or more CHO execution conditions relating to a PCell, and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

The first execution conditions can relate to one or more of: measurements of the serving PSCell; measurements of a neighbouring cell; coverage of the serving PSCell; radio quality of the serving PSCell; radio signal strength for the serving PSCell; radio signal quality for the serving PSCell; conditional event A1 for the serving PSCell; conditional event A2 for the serving PSCell; conditional event A3 for the serving PSCell; conditional event A4 for the

serving PSCell; and conditional event A5 for the serving PSCell.

The first CHO configuration may indicate a candidate target PCell for the CHO.

The method performed by the UE can further comprise the UE receiving the first CHO configuration.

5 The UE may be further configured with a first Conditional PSCell Addition or Change (CPAC) configuration that is comprised in the first CHO configuration. The first CPAC configuration indicates the target PSCell and the one or more first execution conditions. In these embodiments, the UE can be further configured with a second CPAC configuration that is comprised in the first CHO configuration. The second CPAC configuration indicates a
10 different target PSCell and one or more second execution conditions relating to the PSCell.

Step 601 can comprise evaluating the one or more CHO execution conditions; and evaluating the one or more first execution conditions.

The first CHO configuration can indicate the serving PSCell as the target PSCell, and the method can further comprise, responsive to determining that the one or more CHO
15 execution conditions and the one or more first execution conditions are fulfilled, executing the CHO with the serving PSCell maintained.

In alternative embodiments, the first CHO configuration can indicate another cell as the target PSCell, and the method can further comprise, responsive to determining that the one or more CHO execution conditions and the one or more first execution conditions are fulfilled,
20 executing the CHO with a change to that other cell as the serving PSCell.

In other alternative embodiments the first CHO configuration can indicate the serving PSCell as the target PSCell, and the method can further comprise evaluating a second CHO configuration. The second CHO reconfiguration may comprise one or more further CHO execution conditions relating to a PCell (which may be the same target PCell as the first CHO
25 configuration), and one or more second execution conditions relating to a PSCell. The second CHO configuration may indicate another cell as a target PSCell for the second CHO configuration. In these embodiments, the UE can execute the CHO with the serving PSCell maintained if the execution conditions for the first CHO configuration are fulfilled, and execute the CHO with a release of the serving PSCell and a change to the other cell as the serving
30 PSCell if the execution conditions for the second CHO configuration are fulfilled. In some embodiments, if the execution conditions for the first CHO configuration are fulfilled and the execution conditions for the second CHO configuration are fulfilled, the UE can execute one of the first CHO configuration and the second CHO configuration.

In other alternative embodiments, the UE can evaluate a second CHO configuration.
35 The second CHO reconfiguration comprises one or more further CHO execution conditions relating to a PCell (which may be the same target PCell as the first CHO configuration), and does not comprise execution conditions relating to a PSCell or a target PSCell. The UE may

execute the CHO with the serving PSCell as the target PSCell indicated in the first CHO configuration if the execution conditions for the first CHO configuration are fulfilled, and execute the CHO and release the serving PSCell if the execution conditions for the second CHO configuration are fulfilled. In some embodiments, if the execution conditions for the first CHO configuration are fulfilled and the execution conditions for the second CHO configuration are fulfilled, the UE can execute one of the first CHO configuration and the second CHO configuration.

Fig. 7 is a flow chart illustrating an exemplary method in a Master Node (MN). The MN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 7 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

The MN is associated with a MCG for a UE that is operating with MR-DC with the MCG and a SCG. The MCG comprises a serving PCell, and the SCG comprises a serving PSCell.

In step 701, the MN transmits a first message comprising a first CHO configuration to the UE. The first CHO configuration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

The first message may be an RRCReconfiguration message or a RRC message.

Prior to sending the first message, the MN may generate the one or more CHO execution conditions and/or the one or more first execution conditions.

Alternatively, prior to transmitting the first message, the MN may receive a second message related to the first CHO configuration for the serving PSCell from a candidate target MN for the CHO. The second message may comprise the one or more CHO execution conditions and/or the one or more first execution conditions. In these embodiments, prior to receiving the second message, the MN may transmit a request for a CHO configuration to the T-MN.

In some embodiments, prior to transmitting the first message, the MN can receive the one or more CHO execution conditions and/or the one or more first execution conditions from a second network node. In some embodiments, prior to receiving the one or more CHO execution conditions and/or the one or more first execution conditions, the MN can transmit a request for information related to the first CHO configuration to the second network node. The request for the information can be comprised in one or more of: an XnAP message; a CG-Config message; a CG-ConfigInfo message; CG-CandidateList message, a

HandoverPreparationInformation message; and a HandoverCommand message.

The one or more CHO execution conditions and/or one or more first execution conditions are comprised in one or more of: an XnAP message; a CG-Config message; a CG-ConfigInfo message; a CG-CandidateList message; a HandoverPreparationInformation message; and a HandoverCommand message.

Fig. 8 is a flow chart illustrating an exemplary method in a Secondary Node (SN). The SN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 8 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

The SN is associated with a SCG for a UE that is operating with MR-DC with a MCG and the SCG. The MCG comprises a serving PCell, and the SCG comprises a serving PSCell.

In step 801, the SN transmits information related to a first CHO configuration that comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration. The information can be transmitted to the MN or a target T-MN.

Prior to transmitting the information, the SN may receive a request for information related to the first CHO configuration. This request may be received from the MN or a T-MN.

Fig. 9 is a flow chart illustrating an exemplary method in a target Master Node (T-MN). The T-MN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 9 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

The T-MN is a target MN for a UE that is operating with at least a MCG and a SCG. The MCG comprises a serving PCell and the SCG comprises a serving PSCell.

In step 901, the T-MN transmits a second message comprising information related to a first CHO configuration to a MN associated with the MCG. The first CHO configuration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell. The first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

The second message may comprise one or more CHO execution conditions and/or the one or more first execution conditions.

Prior to transmitting the second message, the T-MN may receive a request for a CHO configuration for CHO to the T-MN from the (current) MN. After receiving the request for the CHO configuration, and prior to transmitting the second message, the T-MN may transmit a third message comprising a request for information related to the first CHO configuration to a SN associated with the SCG. The T-MN can receive a fourth message comprising the information related to the first CHO configuration from the SN. The third message may be comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message. The fourth message may be comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message.

Fig. 10 is a flow chart illustrating another exemplary method in a UE. The UE may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 10 may be performed by a UE or wireless device (e.g. the UE 1412 or UE 1500 as described later with reference to Figs. 14 and 15 respectively). The UE is operating with MR-DC with at least a MCG and a SCG. The SCG comprises a serving PSCell.

In step 1001, the UE determines whether to keep or release the serving PSCell based on at least one conditional reconfiguration for the serving PSCell. The at least one conditional reconfiguration comprises one or more execution conditions.

Fig. 11 is a flow chart illustrating another exemplary method in a Master Node (MN). The MN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 11 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

The MN is associated with a MCG for a UE that is operating with MR-DC with the MCG and a SCG. The SCG comprises a serving PSCell.

In step 1101, the MN transmits, to the UE, a first message comprising at least one conditional reconfiguration for the serving PSCell, with the at least one conditional reconfiguration comprising one or more execution conditions.

Fig. 12 is a flow chart illustrating another exemplary method in a Secondary Node (SN). The SN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig.

12 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

The SN is associated with a SCG for a UE that is operating with MR-DC with at least a MCG and a SCG. The SCG comprises a serving PSCell.

5 In step 1201, the SN transmits information related to at least one conditional reconfiguration for the serving PSCell, with the at least one conditional reconfiguration comprising one or more execution conditions.

Fig. 13 is a flow chart illustrating another exemplary method in a target MN (T-MN). The T-MN may perform the method in response to executing suitably formulated computer readable code. The computer readable code may be embodied or stored on a computer readable medium, such as a memory chip, optical disc, or other storage medium. The computer readable medium may be part of a computer program product. The method in Fig. 13 may be performed by a RAN network node (e.g. the RAN network node 1410 or RAN network node 1600 as described later with reference to Fig. 14 and 16 respectively).

15 The T-MN is a target MN for a UE that is operating with at least a MCG and a SCG. The SCG comprises a serving PSCell.

In step 1301, the T-MN transmits, to a MN associated with the MCG, a second message comprising information related to at least one conditional reconfiguration for the serving PSCell.

20 Fig. 14 shows an example of a communication system 1400 in accordance with some embodiments. In the example, the communication system 1400 includes a telecommunication network 1402 that includes an access network 1404, such as a radio access network (RAN), and a core network 1406, which includes one or more core network nodes 1408. The access network 1404 includes one or more access network nodes, such as access network nodes 25 1410a and 1410b (which are interchangeably referred to as RAN network nodes 1410 herein), or any other similar 3rd Generation Partnership Project (3GPP) access node or non-3GPP access point (AP). Moreover, as will be appreciated by those of skill in the art, a RAN network node is not necessarily limited to an implementation in which a radio portion and a baseband portion are supplied and integrated by a single vendor. Thus, it will be understood that network nodes include disaggregated implementations or portions thereof. For example, in some 30 embodiments, the telecommunication network 1402 includes one or more Open-RAN (ORAN) network nodes. An ORAN network node is a node in the telecommunication network 1402 that supports an ORAN specification (e.g., a specification published by the O-RAN Alliance, or any similar organization) and may operate alone or together with other nodes to implement one or more functionalities of any node in the telecommunication network 1402, including one 35 or more network nodes 1410 and/or core network nodes 1408.

Examples of an ORAN network node include an open radio unit (O-RU), an open

distributed unit (O-DU), an open central unit (O-CU), including an O-CU control plane (O-CU-CP) or an O-CU user plane (O-CU-UP), a RAN intelligent controller (RIC) (near-real time or non-real time) hosting software or software plug-ins, such as a near-real time control application (e.g., xApp) or a non-real time control application (e.g., rApp), or any combination thereof (the adjective “open” designating support of an ORAN specification). The network node may support a specification by, for example, supporting an interface defined by the ORAN specification, such as an A1, F1, W1, E1, E2, X2, Xn interface, an open fronthaul user plane interface, or an open fronthaul management plane interface. Moreover, an ORAN access node may be a logical node in a physical node. Furthermore, an ORAN network node may be implemented in a virtualization environment (described further below) in which one or more network functions are virtualized. For example, the virtualization environment may include an O-Cloud computing platform orchestrated by a Service Management and Orchestration Framework via an O-2 interface defined by the O-RAN Alliance or comparable technologies.

The access network nodes 1410 facilitate direct or indirect connection of wireless devices (also referred to interchangeably herein as user equipment (UE)), such as by connecting UEs 1412a, 1412b, 1412c, and 1412d (one or more of which may be generally referred to as UEs 1412) to the core network 1406 over one or more wireless connections. The access network nodes 1410 may be, for example, access points (APs) (e.g. radio access points), base stations (BSs) (e.g. radio base stations, Node Bs, evolved Node Bs (eNBs) and New Radio (NR) NodeBs (gNBs)).

Unless otherwise indicated, the general term ‘network node’ as used herein refers to access network nodes 1410 and core network nodes 1408.

Example wireless communications over a wireless connection include transmitting and/or receiving wireless signals using electromagnetic waves, radio waves, infrared waves, and/or other types of signals suitable for conveying information without the use of wires, cables, or other material conductors. Moreover, in different embodiments, the communication system 1400 may include any number of wired or wireless networks, network nodes, UEs, and/or any other components or systems that may facilitate or participate in the communication of data and/or signals whether via wired or wireless connections. The communication system 1400 may include and/or interface with any type of communication, telecommunication, data, cellular, radio network, and/or other similar type of system.

The wireless devices/UEs 1412 may be any of a wide variety of communication devices, including wireless devices arranged, configured, and/or operable to communicate wirelessly with the network nodes 1410 and other communication devices. Similarly, the access network nodes 1410 are arranged, capable, configured, and/or operable to communicate directly or indirectly with the UEs 1412 and/or with other network nodes or equipment in the

telecommunication network 1402 to enable and/or provide network access, such as wireless network access, and/or to perform other functions, such as administration in the telecommunication network 1402.

In the depicted example, the core network 1406 connects the access network nodes 1410 to one or more hosts, such as host 1416. These connections may be direct or indirect via one or more intermediary networks or devices. In other examples, network nodes may be directly coupled to hosts. The core network 1406 includes one more core network nodes (e.g. core network node 1408) that are structured with hardware and software components. Features of these components may be substantially similar to those described with respect to the wireless devices/UEs, access network nodes, and/or hosts, such that the descriptions thereof are generally applicable to the corresponding components of the core network node 1408. Example core network nodes include functions of one or more of a Mobile Switching Center (MSC), Mobility Management Entity (MME), Home Subscriber Server (HSS), Access and Mobility Management Function (AMF), Session Management Function (SMF), Authentication Server Function (AUSF), Subscription Identifier De-concealing function (SIDF), Unified Data Management (UDM), Security Edge Protection Proxy (SEPP), Network Exposure Function (NEF), and/or a User Plane Function (UPF).

The host 1416 may be under the ownership or control of a service provider other than an operator or provider of the access network 1404 and/or the telecommunication network 1402, and may be operated by the service provider or on behalf of the service provider. The host 1416 may host a variety of applications to provide one or more services. Examples of such applications include the provision of live and/or pre-recorded audio/video content, data collection services, for example, retrieving and compiling data on various ambient conditions detected by a plurality of UEs, analytics functionality, social media, functions for controlling or otherwise interacting with remote devices, functions for an alarm and surveillance center, or any other such function performed by a server.

As a whole, the communication system 1400 of Fig. 14 enables connectivity between the wireless devices/UEs, network nodes, and hosts. In that sense, the communication system may be configured to operate according to predefined rules or procedures, such as specific standards that include, but are not limited to: Global System for Mobile Communications (GSM); Universal Mobile Telecommunications System (UMTS); Long Term Evolution (LTE), and/or other suitable 2nd Generation (2G), 3rd Generation (3G), 4th Generation (4G), 5th Generation (5G) standards, or any applicable future generation standard (e.g. 6th Generation (6G)); wireless local area network (WLAN) standards, such as the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standards (WiFi); and/or any other appropriate wireless communication standard, such as the Worldwide Interoperability for Microwave Access (WiMax), Bluetooth, Z-Wave, Near Field Communication (NFC) ZigBee,

LiFi, and/or any low-power wide-area network (LPWAN) standards such as LoRa and Sigfox.

In some examples, the telecommunication network 1402 is a cellular network that implements 3GPP standardized features. Accordingly, the telecommunications network 1402 may support network slicing to provide different logical networks to different devices that are connected to the telecommunication network 1402. For example, the telecommunications network 1402 may provide Ultra Reliable Low Latency Communication (URLLC) services to some UEs, while providing Enhanced Mobile Broadband (eMBB) services to other UEs, and/or Massive Machine Type Communication (mMTC)/Massive Internet of Things (IoT) services to yet further UEs.

In some examples, the UEs 1412 are configured to transmit and/or receive information without direct human interaction. For instance, a UE may be designed to transmit information to the access network 1404 on a predetermined schedule, when triggered by an internal or external event, or in response to requests from the access network 1404. Additionally, a UE may be configured for operating in single- or multi-radio access technology (RAT) or multi-standard mode. For example, a UE may operate with any one or combination of Wi-Fi, NR (New Radio) and LTE, i.e. being configured for multi-radio dual connectivity (MR-DC), such as E-UTRAN (Evolved-UTRA (UMTS Terrestrial Radio Access) Network) New Radio – Dual Connectivity (EN-DC).

In the example illustrated in Fig. 14, the hub 1414 communicates with the access network 1404 to facilitate indirect communication between one or more UEs (e.g. UE 1412c and/or 1412d) and access network nodes (e.g. access network node 1410b). In some examples, the hub 1414 may be a controller, router, a content source and analytics node, or any of the other communication devices described herein regarding UEs. For example, the hub 1414 may be a broadband router enabling access to the core network 1406 for the UEs. As another example, the hub 1414 may be a controller that sends commands or instructions to one or more actuators in the UEs. Commands or instructions may be received from the UEs, network nodes 1410, or by executable code, script, process, or other instructions in the hub 1414. As another example, the hub 1414 may be a data collector that acts as temporary storage for UE data and, in some embodiments, may perform analysis or other processing of the data. As another example, the hub 1414 may be a content source. For example, for a UE that is a Virtual Reality VR headset, display, loudspeaker or other media delivery device, the hub 1414 may retrieve VR assets, video, audio, or other media or data related to sensory information via a network node, which the hub 1414 then provides to the UE either directly, after performing local processing, and/or after adding additional local content. In still another example, the hub 1414 acts as a proxy server or orchestrator for the UEs, in particular if one or more of the UEs are low energy Internet of Things (IoT) devices.

The hub 1414 may have a constant/persistent or intermittent connection to the network

node 1410b. The hub 1414 may also allow for a different communication scheme and/or schedule between the hub 1414 and UEs (e.g. UE 1412c and/or 1412d), and between the hub 1414 and the core network 1406. In other examples, the hub 1414 is connected to the core network 1406 and/or one or more UEs via a wired connection. Moreover, the hub 1414 may be configured to connect to a Machine-to-Machine (M2M) service provider over the access network 1404 and/or to another UE over a direct connection. In some scenarios, UEs may establish a wireless connection with the network nodes 1410 while still connected via the hub 1414 via a wired or wireless connection. In some embodiments, the hub 1414 may be a dedicated hub – that is, a hub whose primary function is to route communications to/from the UEs from/to the network node 1410b. In other embodiments, the hub 1414 may be a non-dedicated hub – that is, a device which is capable of operating to route communications between the UEs and network node 1410b, but which is additionally capable of operating as a communication start and/or end point for certain data channels.

Fig. 15 shows a wireless device or UE 1500 in accordance with some embodiments. As used herein, a UE refers to a device capable, configured, arranged and/or operable to communicate wirelessly with network nodes and/or other UEs. Examples of a wireless device/UE include, but are not limited to, a smart phone, mobile phone, cell phone, voice over IP (VoIP) phone, wireless local loop phone, desktop computer, personal digital assistant (PDA), wireless camera, gaming console or device, music storage device, playback appliance, wearable terminal device, wireless endpoint, mobile station, tablet, laptop, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), smart device, wireless customer-premise equipment (CPE), vehicle, vehicle-mounted or vehicle embedded/integrated wireless device, etc. Other examples include any UE identified by the 3rd Generation Partnership Project (3GPP), including a narrow band internet of things (NB-IoT) UE, a machine type communication (MTC) UE, and/or an enhanced MTC (eMTC) UE.

A wireless device/UE may support device-to-device (D2D) communication, for example by implementing a 3GPP standard for sidelink communication, Dedicated Short-Range Communication (DSRC), vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), or vehicle-to-everything (V2X). In other examples, a UE may not necessarily have a user in the sense of a human user who owns and/or operates the relevant device. Instead, a UE may represent a device that is intended for sale to, or operation by, a human user but which may not, or which may not initially, be associated with a specific human user (e.g. a smart sprinkler controller). Alternatively, a UE may represent a device that is not intended for sale to, or operation by, an end user but which may be associated with or operated for the benefit of a user (e.g. a smart power meter).

The UE 1500 includes processing circuitry 1502 that is operatively coupled via a bus 1504 to an input/output interface 1506, a power source 1508, a memory 1510, a

communication interface 1512, and/or any other component, or any combination thereof. Certain UEs may utilize all or a subset of the components shown in Fig. 15. The level of integration between the components may vary from one UE to another UE. Further, certain UEs may contain multiple instances of a component, such as multiple processors, memories, transceivers, transmitters, receivers, etc.

The processing circuitry 1502 is configured to process instructions and data and may be configured to implement any sequential state machine operative to execute instructions stored as machine-readable computer programs in the memory 1510. The processing circuitry 1502 may be implemented as one or more hardware-implemented state machines (e.g. in discrete logic, field-programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), etc.); programmable logic together with appropriate firmware; one or more stored computer programs, general-purpose processors, such as a microprocessor or digital signal processor (DSP), together with appropriate software; or any combination of the above. For example, the processing circuitry 1502 may include multiple central processing units (CPUs). The processing circuitry 1502 may be operable to provide, either alone or in conjunction with other UE 1500 components, such as the memory 1510, to provide UE 1500 functionality. For example, the processing circuitry 1502 may be configured to cause the UE 1502 to perform any of the methods described herein.

In the example, the input/output interface 1506 may be configured to provide an interface or interfaces to an input device, output device, or one or more input and/or output devices. Examples of an output device include a speaker, a sound card, a video card, a display, a monitor, a printer, an actuator, an emitter, a smartcard, another output device, or any combination thereof. An input device may allow a user to capture information into the UE 1500. Examples of an input device include a touch-sensitive or presence-sensitive display, a camera (e.g. a digital camera, a digital video camera, a web camera, etc.), a microphone, a sensor, a mouse, a trackball, a directional pad, a trackpad, a scroll wheel, a smartcard, and the like. The presence-sensitive display may include a capacitive or resistive touch sensor to sense input from a user. A sensor may be, for instance, an accelerometer, a gyroscope, a tilt sensor, a force sensor, a magnetometer, an optical sensor, a proximity sensor, a biometric sensor, etc., or any combination thereof. An output device may use the same type of interface port as an input device. For example, a Universal Serial Bus (USB) port may be used to provide an input device and an output device.

In some embodiments, the power source 1508 is structured as a battery or battery pack. Other types of power sources, such as an external power source (e.g. an electricity outlet), photovoltaic device, or power cell, may be used. The power source 1508 may further include power circuitry for delivering power from the power source 1508 itself, and/or an external power source, to the various parts of the UE 1500 via input circuitry or an interface such as

an electrical power cable. Delivering power may be, for example, for charging of the power source 1508. Power circuitry may perform any formatting, converting, or other modification to the power from the power source 1508 to make the power suitable for the respective components of the UE 1500 to which power is supplied.

5 The memory 1510 may be or be configured to include memory such as random access memory (RAM), read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable programmable read-only memory (EEPROM), magnetic disks, optical disks, hard disks, removable cartridges, flash drives, and so forth. In one example, the memory 1510 includes one or more
10 application programs 1514, such as an operating system, web browser application, a widget, gadget engine, or other application, and corresponding data 1516. The memory 1510 may store, for use by the UE 1500, any of a variety of various operating systems or combinations of operating systems.

 The memory 1510 may be configured to include a number of physical drive units, such
15 as redundant array of independent disks (RAID), flash memory, USB flash drive, external hard disk drive, thumb drive, pen drive, key drive, high-density digital versatile disc (HD-DVD) optical disc drive, internal hard disk drive, Blu-Ray optical disc drive, holographic digital data storage (HDDS) optical disc drive, external mini-dual in-line memory module (DIMM), synchronous dynamic random access memory (SDRAM), external micro-DIMM SDRAM,
20 smartcard memory such as tamper resistant module in the form of a universal integrated circuit card (UICC) including one or more subscriber identity modules (SIMs), such as a Universal Subscriber Identity Module (USIM) and/or integrated SIM (ISIM), other memory, or any combination thereof. The UICC may for example be an embedded UICC (eUICC), integrated UICC (iUICC) or a removable UICC commonly known as 'SIM card.' The memory 1510 may
25 allow the UE 1500 to access instructions, application programs and the like, stored on transitory or non-transitory memory media, to off-load data, or to upload data. An article of manufacture, such as one utilizing a communication system may be tangibly embodied as or in the memory 1510, which may be or comprise a device-readable storage medium.

 The processing circuitry 1502 may be configured to communicate with an access
30 network or other network using the communication interface 1512. The communication interface 1512 may comprise one or more communication subsystems and may include or be communicatively coupled to an antenna 1522. The communication interface 1512 may include one or more transceivers used to communicate, such as by communicating with one or more remote transceivers of another device capable of wireless communication (e.g. another UE or
35 a network node in an access network). Each transceiver may include a transmitter 1518 and/or a receiver 1520 appropriate to provide network communications (e.g. optical, electrical, frequency allocations, and so forth). Moreover, the transmitter 1518 and receiver 1520 may

be coupled to one or more antennas (e.g. antenna 1522) and may share circuit components, software or firmware, or alternatively be implemented separately.

In some embodiments, communication functions of the communication interface 1512 may include cellular communication, Wi-Fi communication, LPWAN communication, data communication, voice communication, multimedia communication, short-range communications such as Bluetooth, near-field communication, location-based communication such as the use of the global positioning system (GPS) or other Global Navigation Satellite System (GNSS) to determine a location, another like communication function, or any combination thereof. Communications may be implemented in according to one or more communication protocols and/or standards, such as IEEE 802.11, Code Division Multiplexing Access (CDMA), Wideband Code Division Multiple Access (WCDMA), GSM, LTE, NR, UMTS, WiMax, Ethernet, transmission control protocol/internet protocol (TCP/IP), synchronous optical networking (SONET), Asynchronous Transfer Mode (ATM), QUIC, Hypertext Transfer Protocol (HTTP), and so forth.

Regardless of the type of sensor, a UE may provide an output of data captured by its sensors, through its communication interface 1512, via a wireless connection to a network node. Data captured by sensors of a UE can be communicated through a wireless connection to a network node via another UE. The output may be periodic (e.g. once every 15 minutes if it reports the sensed temperature), random (e.g. to even out the load from reporting from several sensors), in response to a triggering event (e.g. when moisture is detected an alert is sent), in response to a request (e.g. a user initiated request), or a continuous stream (e.g. a live video feed of a patient).

As another example, a UE comprises an actuator, a motor, or a switch, related to a communication interface configured to receive wireless input from a network node via a wireless connection. In response to the received wireless input the states of the actuator, the motor, or the switch may change. For example, the UE may comprise a motor that adjusts the control surfaces or rotors of a drone in flight according to the received input or controls a robotic arm performing a medical procedure according to the received input.

A UE, when in the form of an IoT device, may be a device for use in one or more application domains, these domains comprising, but not limited to, city wearable technology, extended industrial application and healthcare. Non-limiting examples of such an IoT device are devices which are or which are embedded in: a connected refrigerator or freezer, a TV, a connected lighting device, an electricity meter, a robot vacuum cleaner, a voice controlled smart speaker, a home security camera, a motion detector, a thermostat, a smoke detector, a door/window sensor, a flood/moisture sensor, an electrical door lock, a connected doorbell, an air conditioning system like a heat pump, an autonomous vehicle, a surveillance system, a weather monitoring device, a vehicle parking monitoring device, an electric vehicle charging

station, a smart watch, a fitness tracker, a head-mounted display for Augmented Reality (AR) or VR, a wearable for tactile augmentation or sensory enhancement, a water sprinkler, an animal- or item-tracking device, a sensor for monitoring a plant or animal, an industrial robot, an Unmanned Aerial Vehicle (UAV), and any kind of medical device, like a heart rate monitor or a remote controlled surgical robot. A UE in the form of an IoT device comprises circuitry and/or software in dependence on the intended application of the IoT device in addition to other components as described in relation to the UE 1500 shown in Fig. 15.

As yet another specific example, in an IoT scenario, a UE may represent a machine or other device that performs monitoring and/or measurements, and transmits the results of such monitoring and/or measurements to another UE and/or a network node. The UE may in this case be an M2M device, which may in a 3GPP context be referred to as an MTC device. As one particular example, the UE may implement the 3GPP NB-IoT standard. In other scenarios, a UE may represent a vehicle, such as a car, a bus, a truck, a ship and an airplane, or other equipment that is capable of monitoring and/or reporting on its operational status or other functions associated with its operation.

In practice, any number of UEs may be used together with respect to a single use case. For example, a first UE might be or be integrated in a drone and provide the drone's speed information (obtained through a speed sensor) to a second UE that is a remote controller operating the drone. When the user makes changes from the remote controller, the first UE may adjust the throttle on the drone (e.g. by controlling an actuator) to increase or decrease the drone's speed. The first and/or the second UE can also include more than one of the functionalities described above. For example, a UE might comprise the sensor and the actuator, and handle communication of data for both the speed sensor and the actuators.

Fig. 16 shows an access network node 1600 or RAN network node 1600 in accordance with some embodiments. As used herein, access network node or RAN network node refers to equipment capable, configured, arranged and/or operable to communicate directly or indirectly with a UE and/or with other RAN network nodes or equipment or core network nodes, in a telecommunication network. Examples of access network nodes include, but are not limited to, access network nodes such as APs (e.g. radio access points), base stations (BSs) (e.g. radio base stations, Node Bs, evolved Node Bs (eNBs) and NR NodeBs (gNBs)), Open RAN (O-RAN) nodes or components of an O-RAN node (e.g., O-RU, O-DU, O-CU).

Base stations may be categorized based on the amount of coverage they provide (or, stated differently, their transmit power level) and so, depending on the provided amount of coverage, may be referred to as femto base stations, pico base stations, micro base stations, or macro base stations. A base station may be a relay node or a relay donor node controlling a relay. A RAN network node may also include one or more (or all) parts of a distributed radio base station such as centralized digital units, distributed units (e.g., in an O-RAN access

node), and/or remote radio units (RRUs), sometimes referred to as Remote Radio Heads (RRHs). Such remote radio units may or may not be integrated with an antenna as an antenna integrated radio. Parts of a distributed radio base station may also be referred to as nodes in a distributed antenna system (DAS).

5 Other examples of access network nodes include multiple transmission point (multi-TRP) 5G access nodes, multi-standard radio (MSR) equipment such as MSR BSs, network controllers such as radio network controllers (RNCs) or base station controllers (BSCs), base transceiver stations (BTSs), transmission points, transmission nodes, multi-cell/multicast coordination entities (MCEs), Operation and Maintenance (O&M) nodes, Operations Support
10 System (OSS) nodes, Self-Organizing Network (SON) nodes, positioning nodes (e.g. Evolved Serving Mobile Location Centers (E-SMLCs)), and/or Minimization of Drive Tests (MDTs).

The RAN network node 1600 includes processing circuitry 1602, a memory 1604, a communication interface 1606, and a power source 1608, and/or any other component, or any combination thereof. The RAN network node 1600 may be composed of multiple physically
15 separate components (e.g. a NodeB component and a RNC component, or a BTS component and a BSC component, etc.), which may each have their own respective components. In certain scenarios in which the RAN network node 1600 comprises multiple separate components (e.g. BTS and BSC components), one or more of the separate components may be shared among several network nodes. For example, a single RNC may control multiple
20 NodeBs. In such a scenario, each unique NodeB and RNC pair, may in some instances be considered a single separate network node. In some embodiments, the RAN network node 1600 may be configured to support multiple radio access technologies (RATs). In such embodiments, some components may be duplicated (e.g. separate memory 1604 for different RATs) and some components may be reused (e.g. a same antenna 1610 may be shared by
25 different RATs). The RAN network node 1600 may also include multiple sets of the various illustrated components for different wireless technologies integrated into RAN network node 1600, for example GSM, WCDMA, LTE, NR, WiFi, Zigbee, Z-wave, LoRaWAN, Radio Frequency Identification (RFID) or Bluetooth wireless technologies. These wireless technologies may be integrated into the same or different chip or set of chips and other
30 components within RAN network node 1600.

The processing circuitry 1602 may comprise a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application-specific integrated circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software and/or encoded logic
35 operable to provide, either alone or in conjunction with other RAN network node 1600 components, such as the memory 1604, to provide network node 1600 functionality. For example, the processing circuitry 1602 may be configured to cause the RAN network node to

perform the methods described herein.

In some embodiments, the processing circuitry 1602 includes a system on a chip (SOC). In some embodiments, the processing circuitry 1602 includes one or more of radio frequency (RF) transceiver circuitry 1612 and baseband processing circuitry 1614. In some
5 embodiments, the radio frequency (RF) transceiver circuitry 1612 and the baseband processing circuitry 1614 may be on separate chips (or sets of chips), boards, or units, such as radio units and digital units. In alternative embodiments, part or all of RF transceiver circuitry 1612 and baseband processing circuitry 1614 may be on the same chip or set of chips, boards, or units.

10 The memory 1604 may comprise any form of volatile or non-volatile computer-readable memory including, without limitation, persistent storage, solid-state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), mass storage media (for example, a hard disk), removable storage media (for example, a flash drive, a Compact Disk (CD) or a Digital Video Disk (DVD)), and/or any
15 other volatile or non-volatile, non-transitory device-readable and/or computer-executable memory devices that store information, data, and/or instructions that may be used by the processing circuitry 1602. The memory 1604 may store any suitable instructions, data, or information, including a computer program, software, an application including one or more of logic, rules, code, tables, and/or other instructions capable of being executed by the
20 processing circuitry 1602 and utilized by the RAN network node 1600. The memory 1604 may be used to store any calculations made by the processing circuitry 1602 and/or any data received via the communication interface 1606. In some embodiments, the processing circuitry 1602 and memory 1604 is integrated.

The communication interface 1606 is used in wired or wireless communication of
25 signalling and/or data between network nodes, the access network, the core network, and/or a UE. As illustrated, the communication interface 1606 comprises port(s)/terminal(s) 1616 to send and receive data, for example to and from a network over a wired connection.

The communication interface 1606 also includes radio front-end circuitry 1618 that may be coupled to, or in certain embodiments a part of, the antenna 1610. Radio front-end circuitry
30 1618 comprises filters 1620 and amplifiers 1622. The radio front-end circuitry 1618 may be connected to an antenna 1610 and processing circuitry 1602. The radio front-end circuitry may be configured to condition signals communicated between antenna 1610 and processing circuitry 1602. The radio front-end circuitry 1618 may receive digital data that is to be sent out to other network nodes or UEs via a wireless connection. The radio front-end circuitry 1618
35 may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters using a combination of filters 1620 and/or amplifiers 1622. The radio signal may then be transmitted via the antenna 1610. Similarly, when receiving data, the antenna 1610

may collect radio signals which are then converted into digital data by the radio front-end circuitry 1618. The digital data may be passed to the processing circuitry 1602. In other embodiments, the communication interface may comprise different components and/or different combinations of components.

5 In certain alternative embodiments, the access network node 1600 does not include separate radio front-end circuitry 1618, instead, the processing circuitry 1602 includes radio front-end circuitry and is connected to the antenna 1610. Similarly, in some embodiments, all or some of the RF transceiver circuitry 1612 is part of the communication interface 1606. In still other embodiments, the communication interface 1606 includes one or more ports or
10 terminals 1616, the radio front-end circuitry 1618, and the RF transceiver circuitry 1612, as part of a radio unit (not shown), and the communication interface 1606 communicates with the baseband processing circuitry 1614, which is part of a digital unit (not shown).

The antenna 1610 may include one or more antennas, or antenna arrays, configured to send and/or receive wireless signals. The antenna 1610 may be coupled to the radio front-
15 end circuitry 1618 and may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In certain embodiments, the antenna 1610 is separate from the network node 1600 and connectable to the RAN network node 1600 through an interface or port.

The antenna 1610, communication interface 1606, and/or the processing circuitry 1602
20 may be configured to perform any receiving operations and/or certain obtaining operations described herein as being performed by the network node. Any information, data and/or signals may be received from a UE, another network node and/or any other network equipment. Similarly, the antenna 1610, the communication interface 1606, and/or the processing circuitry 1602 may be configured to perform any transmitting operations described
25 herein as being performed by the network node. Any information, data and/or signals may be transmitted to a UE, another network node and/or any other network equipment.

The power source 1608 provides power to the various components of RAN network node 1600 in a form suitable for the respective components (e.g. at a voltage and current level needed for each respective component). The power source 1608 may further comprise, or be
30 coupled to, power management circuitry to supply the components of the network node 1600 with power for performing the functionality described herein. For example, the RAN network node 1600 may be connectable to an external power source (e.g. the power grid, an electricity outlet) via an input circuitry or interface such as an electrical cable, whereby the external power source supplies power to power circuitry of the power source 1608. As a further example, the
35 power source 1608 may comprise a source of power in the form of a battery or battery pack which is connected to, or integrated in, power circuitry. The battery may provide backup power should the external power source fail.

Embodiments of the RAN network node 1600 may include additional components beyond those shown in Fig. 16 for providing certain aspects of the network node's functionality, including any of the functionality described herein and/or any functionality necessary to support the subject matter described herein. For example, the RAN network node 1600 may include user interface equipment to allow input of information into the RAN network node 1600 and to allow output of information from the RAN network node 1600. This may allow a user to perform diagnostic, maintenance, repair, and other administrative functions for the RAN network node 1600.

Fig. 17 is a block diagram illustrating a virtualization environment 1700 in which functions implemented by some embodiments may be virtualized. In the present context, virtualizing means creating virtual versions of apparatuses or devices which may include virtualizing hardware platforms, storage devices and networking resources. As used herein, virtualization can be applied to any device described herein, or components thereof, and relates to an implementation in which at least a portion of the functionality is implemented as one or more virtual components. Some or all of the functions described herein may be implemented as virtual components executed by one or more virtual machines (VMs) implemented in one or more virtual environments 1700 hosted by one or more of hardware nodes, such as a hardware computing device that operates as an access network node, or a wireless device/UE. Further, in embodiments in which the virtual node does not require radio connectivity (e.g. a core network node), then the node may be entirely virtualized. In some embodiments, the virtualization environment 1700 includes components defined by the Open-RAN (O-RAN) Alliance, such as an O-Cloud environment orchestrated by a Service Management and Orchestration Framework via an O-2 interface.

Applications 1702 (which may alternatively be called software instances, virtual appliances, network functions, virtual nodes, virtual network functions, etc.) are run in the virtualization environment 1700 to implement some of the features, functions, and/or benefits of some of the embodiments disclosed herein.

Hardware 1704 includes processing circuitry, memory that stores software and/or instructions executable by hardware processing circuitry, and/or other hardware devices as described herein, such as a network interface, input/output interface, and so forth. Software may be executed by the processing circuitry to instantiate one or more virtualization layers 1706 (also referred to as hypervisors or virtual machine monitors (VMMs)), provide VMs 1708a and 1708b (one or more of which may be generally referred to as VMs 1708), and/or perform any of the functions, features and/or benefits described in relation with some embodiments described herein. The virtualization layer 1706 may present a virtual operating platform that appears like networking hardware to the VMs 1708.

The VMs 1708 comprise virtual processing, virtual memory, virtual networking or

interface and virtual storage, and may be run by a corresponding virtualization layer 1706. Different embodiments of the instance of a virtual appliance 1702 may be implemented on one or more of VMs 1708, and the implementations may be made in different ways. Virtualization of the hardware is in some contexts referred to as network function virtualization (NFV). NFV
5 may be used to consolidate many network equipment types onto industry standard high volume server hardware, physical switches, and physical storage, which can be located in data centers, and customer premise equipment.

In the context of NFV, a VM 1708 may be a software implementation of a physical machine that runs programs as if they were executing on a physical, non-virtualized machine.
10 Each of the VMs 1708, and that part of hardware 1704 that executes that VM, be it hardware dedicated to that VM and/or hardware shared by that VM with others of the VMs, forms separate virtual network elements. Still in the context of NFV, a virtual network function is responsible for handling specific network functions that run in one or more VMs 1708 on top of the hardware 1704 and corresponds to the application 1702.

Hardware 1704 may be implemented in a standalone network node with generic or specific components. Hardware 1704 may implement some functions via virtualization. Alternatively, hardware 1704 may be part of a larger cluster of hardware (e.g. such as in a data center or CPE) where many hardware nodes work together and are managed via management and orchestration 1710, which, among others, oversees lifecycle management
20 of applications 1702. In some embodiments, hardware 1704 is coupled to one or more radio units that each include one or more transmitters and one or more receivers that may be coupled to one or more antennas. Radio units may communicate directly with other hardware nodes via one or more appropriate network interfaces and may be used in combination with the virtual components to provide a virtual node with radio capabilities, such as a radio access
25 node or a base station. In some embodiments, some signalling can be provided with the use of a control system 1712 which may alternatively be used for communication between hardware nodes and radio units.

Although the computing devices described herein (e.g. UEs, RAN network nodes, core network node) may include the illustrated combination of hardware components, other
30 embodiments may comprise computing devices with different combinations of components. It is to be understood that these computing devices may comprise any suitable combination of hardware and/or software needed to perform the tasks, features, functions and methods disclosed herein. Determining, calculating, obtaining or similar operations described herein may be performed by processing circuitry, which may process information by, for example,
35 converting the obtained information into other information, comparing the obtained information or converted information to information stored in the network node, and/or performing one or more operations based on the obtained information or converted information, and as a result

of said processing making a determination. Moreover, while components are depicted as single boxes located within a larger box, or nested within multiple boxes, in practice, computing devices may comprise multiple different physical components that make up a single illustrated component, and functionality may be partitioned between separate components. For example, a communication interface may be configured to include any of the components described herein, and/or the functionality of the components may be partitioned between the processing circuitry and the communication interface. In another example, non-computationally intensive functions of any of such components may be implemented in software or firmware and computationally intensive functions may be implemented in hardware.

In certain embodiments, some or all of the functionality described herein may be provided by processing circuitry executing instructions stored on in memory, which in certain embodiments may be a computer program product in the form of a non-transitory computer-readable storage medium. In alternative embodiments, some or all of the functionality may be provided by the processing circuitry without executing instructions stored on a separate or discrete device-readable storage medium, such as in a hard-wired manner. In any of those particular embodiments, whether executing instructions stored on a non-transitory computer-readable storage medium or not, the processing circuitry can be configured to perform the described functionality. The benefits provided by such functionality are not limited to the processing circuitry alone or to other components of the computing device, but are enjoyed by the computing device as a whole, and/or by end users and a wireless network generally.

The foregoing merely illustrates the principles of the disclosure. Various modifications and alterations to the described embodiments will be apparent to those skilled in the art in view of the teachings herein. It will thus be appreciated that those skilled in the art will be able to devise numerous systems, arrangements, and procedures that, although not explicitly shown or described herein, embody the principles of the disclosure and can be thus within the scope of the disclosure. Various exemplary embodiments can be used together with one another, as well as interchangeably therewith, as should be understood by those having ordinary skill in the art.

EMBODIMENTS

Group A Embodiments

1. A method performed by a user equipment, UE, operating with multi-radio dual connectivity, MR-DC, with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, the SCG comprising a serving primary SCG cell, PSCell, the method comprising:
determining whether to keep or release the serving PSCell based on at least one conditional reconfiguration for the serving PSCell, the at least one conditional reconfiguration comprising one or more execution conditions.

2. The method of embodiment 1, wherein the at least one conditional reconfiguration further comprises one or more target configurations associated with one or more of the execution conditions.

For example, each conditional reconfiguration could comprise a plurality of execution conditions and a plurality of target configuration. Some of the execution conditions may be related to one target configuration and other execution conditions may be related to another target configuration. In an alternative example, there may be separate conditional reconfigurations, e.g., for the keep and release cases, and all the execution conditions of each conditional reconfiguration are associated to one target configuration. In this instance, all the execution conditions may need to be satisfied to apply the corresponding target configuration.

3. The method of embodiment 2, wherein the one or more target configurations indicate configurations in which the serving PSCell is kept or released.

4. The method of any of embodiments 2-3, wherein at least one of the one or more execution conditions associated with a target configuration must be satisfied for the associated target configuration to be implemented.

5. The method of any of embodiments 2-3, wherein all of the one or more execution conditions associated with a target configuration must be satisfied for the associated target configuration to be implemented.

6. The method of any preceding embodiment, wherein the one or more execution conditions relate to one or more of: measurements of the serving PSCell; measurements of a neighbouring cell; coverage of the serving PSCell; radio quality of the serving PSCell; radio signal strength for the serving PSCell; radio signal quality for the serving PSCell; conditional

event A1 for the serving PSCell; conditional event A2 for the serving PSCell; conditional event A3 for the serving PSCell; conditional event A4 for the serving PSCell; and conditional event A5 for the serving PSCell.

5 7. The method of any preceding embodiment, wherein the UE is configured with at least one CHO configuration for a candidate target PCell.

8. The method of embodiment 9, wherein the at least one conditional reconfiguration is comprised in the at least one CHO configuration.

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9. The method of any of embodiments 7-8, wherein the at least one conditional reconfiguration indicates whether the serving PSCell is to be kept or released as part of a conditional handover, CHO, execution.

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10. The method of any of embodiments 7-9, wherein the UE is configured with the at least one conditional reconfiguration.

11. The method of any of embodiments 7-10, wherein the at least one conditional reconfiguration is associated to the at least one CHO configuration.

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12. The method of any of embodiments 7-11, wherein the method comprises:
receiving the at least one CHO configuration.

25

13. The method of any of embodiments 7-12, wherein the UE is further configured with at least one Conditional PSCell Addition or Change, CPAC, configuration for one or more candidate target PSCells comprising associated execution conditions.

14. The method of embodiment 13, wherein the at least one Conditional PSCell Addition or Change, CPAC, configuration is comprised in the at least one CHO configuration.

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15. The method of any of embodiments 7-14, wherein the at least one conditional reconfiguration indicates whether the serving PSCell is to be kept or released as part of a conditional handover, CHO, execution.

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16. The method of any of embodiments 7-15, wherein the at least one conditional reconfiguration indicates whether the serving PSCell is to be kept or released as part of a conditional handover, CHO, execution.

17. The method of any of embodiments 7-16, wherein the at least one CHO configuration comprises CHO execution conditions.

18. The method of any of embodiments 7-17, wherein the method further comprises:
evaluating the CHO execution conditions; and
evaluating the execution conditions comprised in the at least one conditional reconfiguration for the serving PSCell.

19. The method of any of embodiments 7-18, wherein determining whether to keep or release the serving PSCell is performed responsive to determining that the CHO execution conditions are satisfied.

20. The method of any of embodiments 7-19, wherein the determining is performed responsive to determining that a conditional handover, CHO, is to be executed.

21. The method of any of embodiments 7-20, wherein the method further comprises:
responsive to determining to keep the serving PSCell, executing the CHO with the serving PSCell maintained.

22. The method of any of embodiments 7-21, wherein the method further comprises:
after executing a CHO in which the serving PSCell is kept, maintaining an existing PSCell configuration based on one of the at least one conditional reconfiguration.

23. The method of any of embodiments 7-22, wherein the method further comprises:
after executing the CHO in which the serving PSCell is kept, modifying an existing PSCell configuration based on a target configuration of the at least one conditional reconfiguration.

24. The method of any of embodiments 7-23, wherein the method further comprises:
responsive to determining to release the serving PSCell, executing the CHO with release of the serving PSCell.

25. The method of any preceding embodiment, wherein determining whether to keep or release the serving PSCell comprises:
responsive to determining that none of the one or more execution conditions comprised in the at least one conditional reconfiguration for the serving PSCell are fulfilled,

determining to release the PSCell.

26. The method of any preceding embodiment, wherein determining whether to keep or release the serving PSCell comprises:

- 5 responsive to determining that an execution condition comprised in one of the at least one conditional reconfigurations for the serving PSCell in which the serving PSCell is released is fulfilled, determining to release the PSCell.

10 27. The method of any preceding embodiment, wherein determining whether to keep or release the serving PSCell comprises:

responsive to determining that an execution condition comprised in one of the at least one conditional reconfigurations for the serving PSCell in which the serving PSCell is maintained is fulfilled, determining to keep the PSCell.

15 28. The method of any preceding embodiment, wherein the one or more execution conditions comprised in the at least one conditional reconfiguration for the serving PSCell comprise conditions under which the serving PSCell is to be kept as part of a CHO execution.

20 29. The method of any previous embodiment, wherein the UE is configured with:
at least one CHO configuration for a candidate target PCell;
at least one Conditional PSCell Addition or Change, CPAC, configuration for one or more candidate target PSCells comprising associated execution conditions, wherein the at least one CPAC configuration is associated with the at least one CHO configuration; and
25 the at least one conditional reconfiguration for the serving PSCell.

30. The method of embodiment 29, wherein determining whether to keep or release the serving PSCell comprises:

responsive to determining that execution conditions for a first CHO configuration of the
30 at least one CHO configuration is satisfied, determining whether any of a first set of execution conditions are satisfied, wherein the first set of execution conditions comprise the execution conditions associated with the at least one CPAC configuration for the one or more candidate target PSCells and the execution conditions associated with the at least one conditional reconfiguration for the serving PSCell.

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31. The method of any of embodiments 29-30, wherein the method further comprises:
responsive to determining that an execution condition for a first CPAC configuration of

the at least one CPAC configuration for a first candidate target PSCell is satisfied, executing the first CHO configuration and the first CPAC configuration.

32. The method of any of embodiments 29-31, wherein the method further comprises:

responsive to determining that none of the first set of execution conditions are satisfied, executing the first CHO configuration and releasing the serving PSCell.

33. The method of any of embodiments 29-32, wherein the method further comprises:

responsive to determining that more than one of the first set of execution conditions are satisfied, selecting one of the corresponding configurations for which the associated execution conditions are fulfilled.

In some embodiments, the selecting may be based on the measured radio signal strength or quality for the different PSCells, e.g., the strongest may be selected. In some embodiments, the selecting may be based on UE implementation.

34. The method of embodiment 29, wherein determining whether to keep or release the serving PSCell comprises:

if the serving PSCell is one of the one or more candidate target PSCells, evaluating the execution conditions comprised in the at least one CPAC configuration for any of the one or more candidate target PSCells that are not the serving PSCell.

For example, the UE may only measure/evaluate the execution conditions for the associated conditional reconfigurations for the candidate target PSCells, i.e. the ones that are not the serving PSCell. In response to a change of the serving PSCell, the CPAC configurations, including the one for the previous serving PSCell are kept, but the UE changes to not measure/evaluate the execution conditions for the conditional reconfiguration for the new serving PSCell, and starts to measure/evaluate the execution conditions for the conditional reconfiguration for the previous serving PSCell (which is now a candidate target PSCell).

35. The method of any previous embodiment, wherein determining whether to keep or release the serving PSCell comprises:

evaluating the one or more execution conditions.

36. The method of any previous embodiment, wherein determining whether to keep or release the serving PSCell comprises:

responsive to determining that at least one of the one or more execution conditions is satisfied, determining to release the serving PSCell.

37. The method of any previous embodiment, wherein the at least one of the one or more execution conditions correspond to a target configuration comprised in the conditional reconfiguration that does not comprise an SCG configuration for the serving PSCell.

5 Group B Embodiments

38. A method performed by a master node, MN, wherein the MN is associated with a Master Cell Group, MCG, for a user equipment, UE, that is operating with multi-radio dual connectivity, MR-DC, with the MCG and a Secondary Cell Group, SCG, wherein the SCG comprises a serving primary secondary cell, PSCell, the method comprising:

10 transmitting, to the UE, a first message comprising at least one conditional reconfiguration for the serving PSCell, the at least one conditional reconfiguration comprising one or more execution conditions.

39. The method of embodiment 38, wherein the at least one conditional reconfiguration
15 relates to one or more target configurations associated with respective execution conditions of the one or more execution condition.

40. The method of embodiment 38 or 39, wherein the first message is one or both of: an RRCReconfiguration message and a RRC message.

20

41. The method of any of embodiments 38-40, wherein the method further comprises, prior to sending the first message:
generating the one or more execution conditions.

25 42. The method of any of embodiments 38-41, wherein the at least one conditional reconfiguration is for use at a conditional handover, CHO.

43. The method of any of embodiments 38-42, wherein the at least one conditional reconfiguration relates to how the serving PSCell should be handled at execution of a
30 conditional handover, CHO.

44. The method of any of embodiments 38-43, wherein the method further comprises, prior to transmitting the first message:

35 receiving, from a candidate target master node, T-MN, for the CHO, a second message related to the at least one conditional reconfiguration for the serving PSCell.

45. The method of embodiment 44, wherein the second message comprises the one or more execution conditions.

46. The method of embodiment 44 or 45, wherein the method further comprises, prior to receiving the second message:

transmitting, to the T-MN, a request for a conditional handover, CHO, configuration.

47. The method of any of embodiments 38-46, wherein the method further comprises, prior to transmitting the first message:

receiving, from a second network node, the one or more execution conditions.

48. The method of any of embodiments 38-47, wherein the one or more execution conditions are comprised in one or more of: an XnAP message; a CG-Config message; a CG-ConfigInfo message; a CG-CandidateList message; a HandoverPreparationInformation message; and a HandoverCommand message.

49. The method of embodiment 47 or 48, wherein the method further comprises, prior to receiving the one or more execution conditions:

transmitting, to the second network node, a request for information related to the at least one conditional reconfiguration for the serving PSCell.

50. The method of embodiment 49, wherein the request for the information related to the at least one conditional reconfiguration for the serving PSCell is comprised in one or more of: an XnAP message; a CG-Config message; a CG-ConfigInfo message; CG-CandidateList message, a HandoverPreparationInformation message; and a HandoverCommand message.

51. A method performed by a secondary node, SN, wherein the SN is associated with a Secondary Cell Group, SCG, for a user equipment, UE, that is operating with multi-radio dual connectivity, MR-DC, with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, the SCG comprising a serving primary secondary cell, PSCell, the method comprising:

transmitting information related to at least one conditional reconfiguration for the serving PSCell, the at least one conditional reconfiguration comprising one or more execution conditions.

52. The method of embodiment 51, wherein the information relates to keeping and/or releasing the serving PSCell at execution of a conditional handover, CHO, of the UE.

53. The method of embodiment 51 or 52, wherein the information is transmitted to the MN or a target master node, T-MN.

54. The method of any of embodiments 51-53, wherein the method further comprises: prior to transmitting the information, receiving a request for information related to the at least one conditional reconfiguration for the serving PSCell.

55. The method of embodiment 54, wherein the request is received from the MN or a target master node, T-MN.

56. A method performed by a target master node, T-MN, for a user equipment, UE, that is operating with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, the SCG comprising a serving primary secondary cell, PSCell, the method comprising: transmitting, to a master node, MN, associated with the MCG, a second message comprising information related to at least one conditional reconfiguration for the serving PSCell.

57. The method of embodiment 56, wherein the second message comprises one or more execution conditions associated with the at least one conditional reconfiguration.

58. The method of embodiment 56 or 57, wherein the second message further comprises a conditional handover, CHO, target configuration for CHO to the T-MN.

59. The method of any of embodiments 56-58, wherein the method further comprises, prior to transmitting the second message: receiving, from the MN, a request for a conditional handover, CHO, target configuration for CHO to the T-MN.

60. The method of embodiment 59, wherein the method further comprises, after receiving the request for the CHO target configuration and prior to transmitting the second message: transmitting, to a secondary node, SN, associated with the SCG, a third message comprising a request for information related to the at least one conditional reconfiguration for the serving PSCell; and

receiving, from the SN, a fourth message comprising the information related to the at least one conditional reconfiguration for the serving PSCell.

61. The method of embodiment 60, wherein the third message is comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message.

62. The method of embodiment 60 or 61, wherein the fourth message is comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message.

Group C Embodiments

63. A computer program product comprising a computer readable medium having computer readable code embodied therein, the computer readable code being configured such that, on execution by a suitable computer or processor, the computer or processor is caused to perform the method of any of the Group A embodiments or the Group B embodiments.

64. A user equipment, UE, configured to perform the method of any of the Group A embodiments.

65. A user equipment, UE, comprising a processor and a memory, said memory containing instructions executable by said processor whereby said UE is operative to perform the method of any of the Group A embodiments.

66. A first radio access network, RAN, node, configured to perform the method of any of the Group B embodiments.

67. A first radio access network, RAN, node comprising a processor and a memory, said memory containing instructions executable by said processor whereby said first RAN node is operative to perform the method of any of the Group B embodiments.

68. A user equipment, comprising:
processing circuitry configured to cause the user equipment to perform any of the steps of any of the Group A embodiments; and
power supply circuitry configured to supply power to the processing circuitry.

69. A network node, the network node comprising:
processing circuitry configured to cause the network node to perform any of the steps of any of the Group B embodiments;

power supply circuitry configured to supply power to the processing circuitry.

70. A user equipment (UE), the UE comprising:

an antenna configured to send and receive wireless signals;

5 radio front-end circuitry connected to the antenna and to processing circuitry, and configured to condition signals communicated between the antenna and the processing circuitry;

the processing circuitry being configured to perform any of the steps of any of the Group A embodiments;

10 an input interface connected to the processing circuitry and configured to allow input of information into the UE to be processed by the processing circuitry;

an output interface connected to the processing circuitry and configured to output information from the UE that has been processed by the processing circuitry; and

a battery connected to the processing circuitry and configured to supply power to the UE.

15

Claims

1. A method performed by a user equipment, UE, operating with multi-radio dual connectivity, MR-DC, with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, the MCG comprising a serving Primary Cell, PCell, and the SCG comprising a serving primary SCG cell, PSCell, the method comprising:

evaluating (601) a first Conditional Handover, CHO, configuration to determine whether to keep or release the serving PSCell, wherein the first CHO reconfiguration comprises one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, wherein the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

2. The method of claim 1, wherein the one or more first execution conditions relate to one or more of: measurements of the serving PSCell; measurements of a neighbouring cell; coverage of the serving PSCell; radio quality of the serving PSCell; radio signal strength for the serving PSCell; radio signal quality for the serving PSCell; conditional event A1 for the serving PSCell; conditional event A2 for the serving PSCell; conditional event A3 for the serving PSCell; conditional event A4 for the serving PSCell; and conditional event A5 for the serving PSCell.

3. The method of any preceding claim, wherein the first CHO configuration indicates a candidate target PCell for the CHO.

4. The method of any of claims 1-3, wherein the method comprises: receiving the first CHO configuration.

5. The method of any of claims 1-4, wherein the UE is further configured with a first Conditional PSCell Addition or Change, CPAC, configuration that is comprised in the first CHO configuration, wherein the first CPAC configuration indicates the target PSCell and the one or more first execution conditions.

6. The method of claim 5, wherein the UE is further configured with a second CPAC configuration that is comprised in the first CHO configuration, wherein the second CPAC configuration indicates a different target PSCell and one or more second execution conditions relating to the PSCell.

7. The method of any of claims 1-6, wherein evaluating (601) the first CHO configuration

comprises:

- evaluating the one or more CHO execution conditions; and
- evaluating the one or more first execution conditions.

5 8. The method of any of claims 1-7, wherein the first CHO configuration indicates the serving PSCell as the target PSCell, the method further comprises:

responsive to determining that the one or more CHO execution conditions and the one or more first execution conditions are fulfilled, executing the CHO with the serving PSCell maintained.

10

9. The method of any of claims 1-7, wherein the first CHO configuration indicates another cell as the target PSCell, the method further comprises:

responsive to determining that the one or more CHO execution conditions and the one or more first execution conditions are fulfilled, executing the CHO with a change to said another cell as the serving PSCell.

15

10. The method of any of claims 1-7, wherein the first CHO configuration indicates the serving PSCell as the target PSCell, the method further comprises:

evaluating a second CHO configuration, wherein the second CHO reconfiguration comprises one or more further CHO execution conditions relating to a PCell and one or more second execution conditions relating to a PSCell, wherein the second CHO configuration indicates another cell as a target PSCell for the second CHO configuration.

20

11. The method of claim 10, wherein the method further comprises:

if the execution conditions for the first CHO configuration are fulfilled, executing the CHO with the serving PSCell maintained; and

if the execution conditions for the second CHO configuration are fulfilled, executing the CHO with a release of the serving PSCell and a change to said another cell as the serving PSCell.

30

12. The method of any of claims 1-7, wherein the method further comprises:

evaluating a second CHO configuration, wherein the second CHO reconfiguration comprises one or more further CHO execution conditions relating to a PCell, and does not comprise execution conditions relating to a PSCell or a target PSCell.

35

13. The method of claim 12, wherein the method further comprises:

if the execution conditions for the first CHO configuration are fulfilled, executing the

CHO with the serving PSCell as the target PSCell indicated in the first CHO configuration;
and

if the execution conditions for the second CHO configuration are fulfilled, executing the
CHO and releasing the serving PSCell.

5

14. The method of claim 11 or 13, wherein if the execution conditions for the first CHO
configuration are fulfilled and the execution conditions for the second CHO configuration are
fulfilled, executing one of the first CHO configuration and the second CHO configuration.

10 15. The method of any of claims 10-14, wherein the first CHO configuration and the
second CHO configuration indicate the same target PCell.

16. A method performed by a master node, MN, wherein the MN is associated with a
Master Cell Group, MCG, for a user equipment, UE, that is operating with multi-radio dual
15 connectivity, MR-DC, with the MCG and a Secondary Cell Group, SCG, wherein the MCG
comprises a serving Primary Cell, PCell, and the SCG comprises a serving primary SCG
cell, PSCell, the method comprising:

transmitting (701), to the UE, a first message comprising a first Conditional Handover,
CHO, configuration, the first CHO configuration comprising one or more CHO execution
20 conditions relating to a PCell and one or more first execution conditions relating to a PSCell,
wherein the first CHO configuration indicates the serving PSCell or another cell as a target
PSCell for the first CHO configuration.

17. The method of claim 16, wherein the first message is one or both of: an
25 RRCReconfiguration message and a RRC message.

18. The method of claim 16 or 17, wherein the method further comprises, prior to
transmitting the first message:

generating the one or more CHO execution conditions and/or the one or more first
30 execution conditions.

19. The method of any of claims 16-18, wherein the method further comprises, prior to
transmitting the first message:

receiving, from a candidate target master node, T-MN, for the CHO, a second
35 message related to the first CHO configuration for the serving PSCell.

20. The method of claim 19, wherein the second message comprises the one or more CHO execution conditions and/or the one or more first execution conditions.

21. The method of claim 19 or 20, wherein the method further comprises, prior to receiving
5 the second message:

transmitting, to the T-MN, a request for a CHO configuration.

22. The method of any of claims 16-21, wherein the method further comprises, prior to transmitting the first message:

10 receiving, from a second network node, the one or more CHO execution conditions and/or the one or more first execution conditions.

23. The method of claim 22, wherein the method further comprises, prior to receiving the one or more CHO execution conditions and/or the one or more first execution conditions:

15 transmitting, to the second network node, a request for information related to the first CHO configuration.

24. The method of claim 23, wherein the request for the information related to the first CHO configuration is comprised in one or more of: an XnAP message; a CG-Config

20 message; a CG-ConfigInfo message; CG-CandidateList message; a HandoverPreparationInformation message; and a HandoverCommand message.

25. The method of any of claims 16-24, wherein the one or more CHO execution conditions and/or one or more first execution conditions are comprised in one or more of: an

25 XnAP message; a CG-Config message; a CG-ConfigInfo message; a CG-CandidateList message; a HandoverPreparationInformation message; and a HandoverCommand message.

26. A method performed by a secondary node, SN, wherein the SN is associated with a
30 Secondary Cell Group, SCG, for a user equipment, UE, that is operating with multi-radio dual connectivity, MR-DC, with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, wherein the MCG comprises a serving Primary Cell, PCell, and the SCG comprises a serving primary SCG cell, PSCell, the method comprising:

transmitting (801) information related to a first Conditional Handover, CHO,
35 configuration, the first CHO configuration comprising one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, wherein

the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

27. The method of claim 26, wherein the information is transmitted to the MN or a target master node, T-MN.

28. The method of claim 26 or 27, wherein the method further comprises:
prior to transmitting the information, receiving a request for information related to the first CHO configuration.

29. The method of claim 28, wherein the request is received from the MN or a target master node, T-MN.

30. A method performed by a target master node, T-MN, for a user equipment, UE, that is operating with at least a Master Cell Group, MCG, and a Secondary Cell Group, SCG, wherein the MCG comprises a serving Primary Cell, PCell, and the SCG comprises a serving primary SCG cell, PSCell, the method comprising:

transmitting (901), to a master node, MN, associated with the MCG, a second message comprising information related to a first Conditional Handover, CHO, configuration, the first CHO configuration comprising one or more CHO execution conditions relating to a PCell and one or more first execution conditions relating to a PSCell, wherein the first CHO configuration indicates the serving PSCell or another cell as a target PSCell for the first CHO configuration.

31. The method of claim 30, wherein the second message comprises the one or more CHO execution conditions and/or the one or more first execution conditions.

32. The method of claim 30 or 31, wherein the method further comprises, prior to transmitting the second message:

receiving, from the MN, a request for a CHO configuration for CHO to the T-MN.

33. The method of claim 32, wherein the method further comprises, after receiving the request for the CHO configuration and prior to transmitting the second message:

transmitting, to a secondary node, SN, associated with the SCG, a third message comprising a request for information related to the first CHO configuration; and

receiving, from the SN, a fourth message comprising the information related to the first CHO configuration.

34. The method of claim 33, wherein the third message is comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message.

5 35. The method of claim 33 or 34, wherein the fourth message is comprised in one or more of: an XnAP message; a CG-Config message; and a CG-ConfigInfo message.

36. A computer program product comprising a computer readable medium having computer readable code embodied therein, the computer readable code being configured such that, on
10 execution by a suitable computer or processor, the computer or processor is caused to perform the method of any of claims 1-35.

37. A user equipment, UE, configured to perform the method of any of claims 1-15.

15 38. A user equipment, UE, comprising a processor and a memory, said memory containing instructions executable by said processor whereby said UE is operative to perform the method of any of claim 1-15.

39. A first radio access network, RAN, node, configured to perform the method of any of
20 claims 16-35.

40. A first radio access network, RAN, node comprising a processor and a memory, said memory containing instructions executable by said processor whereby said first RAN node is operative to perform the method of any of claims 16-35.

25

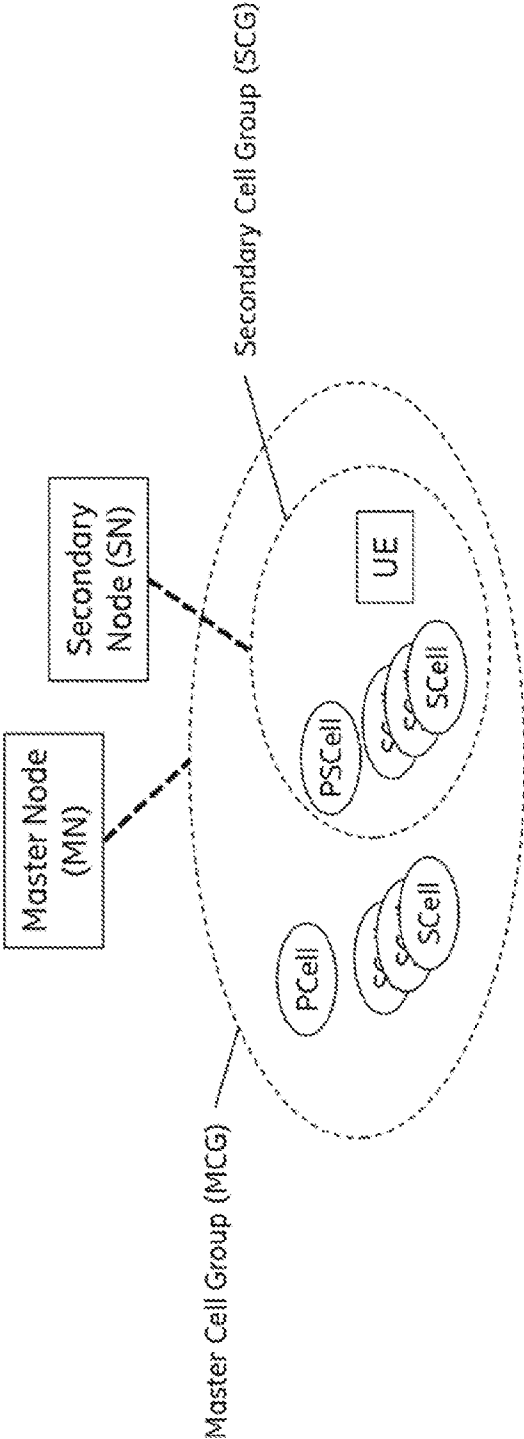


Fig. 1

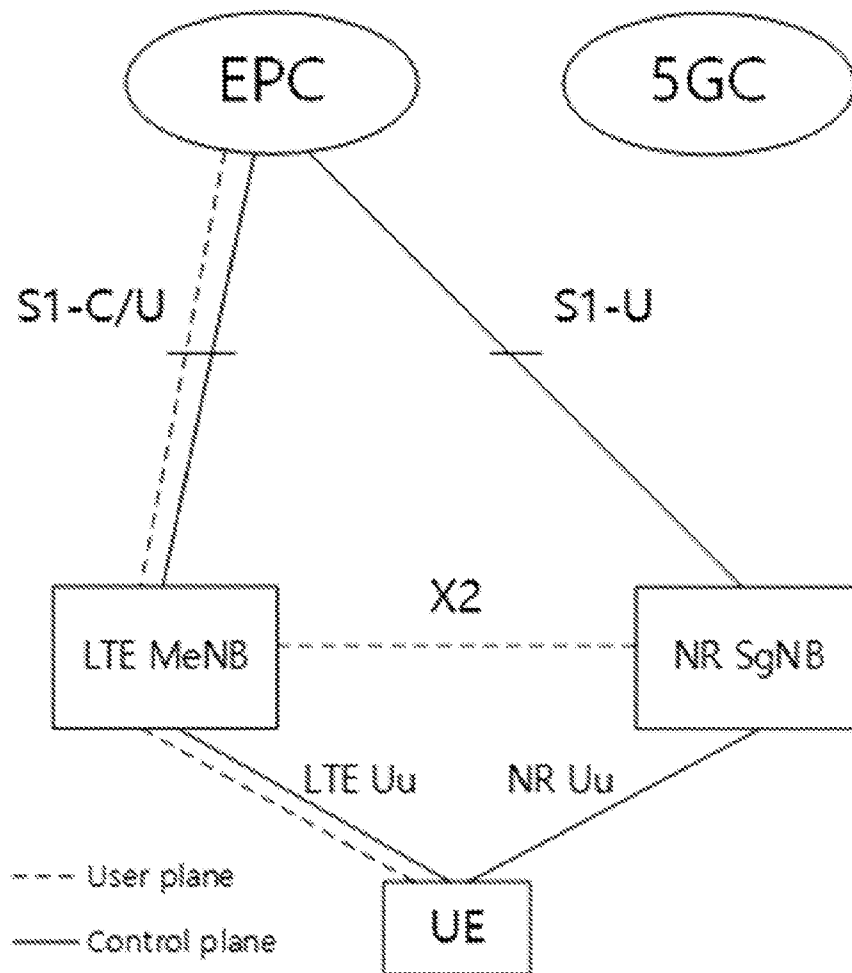


Fig. 2

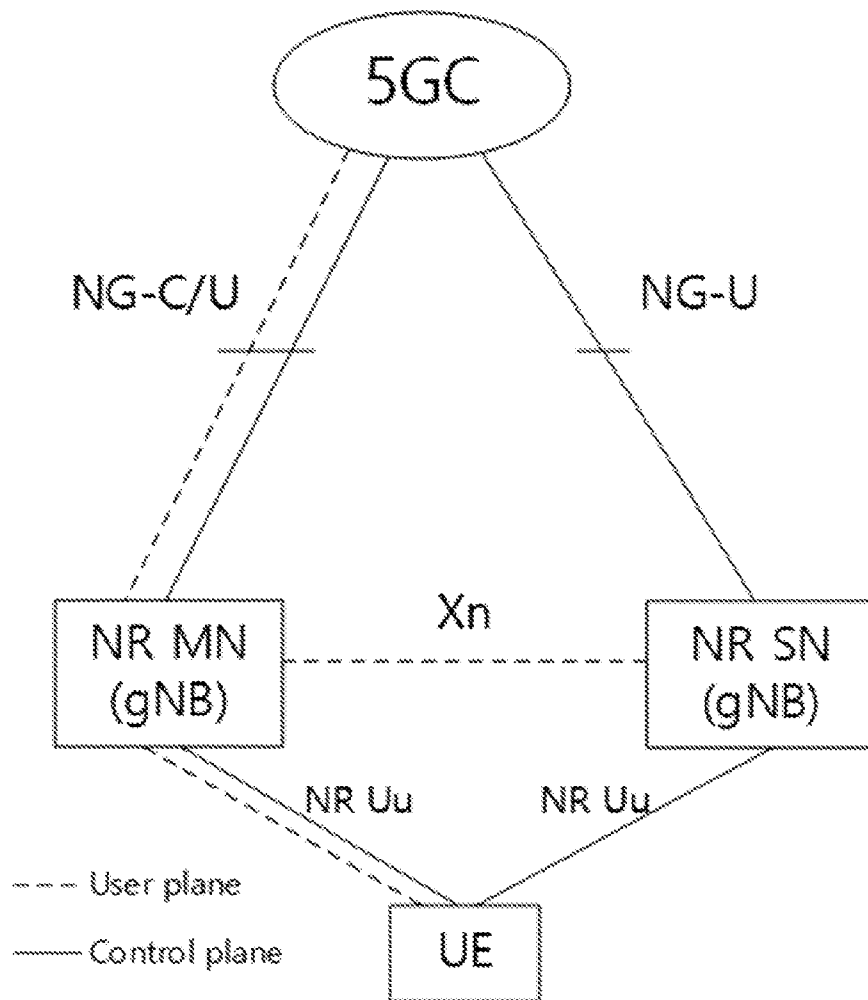


Fig. 3

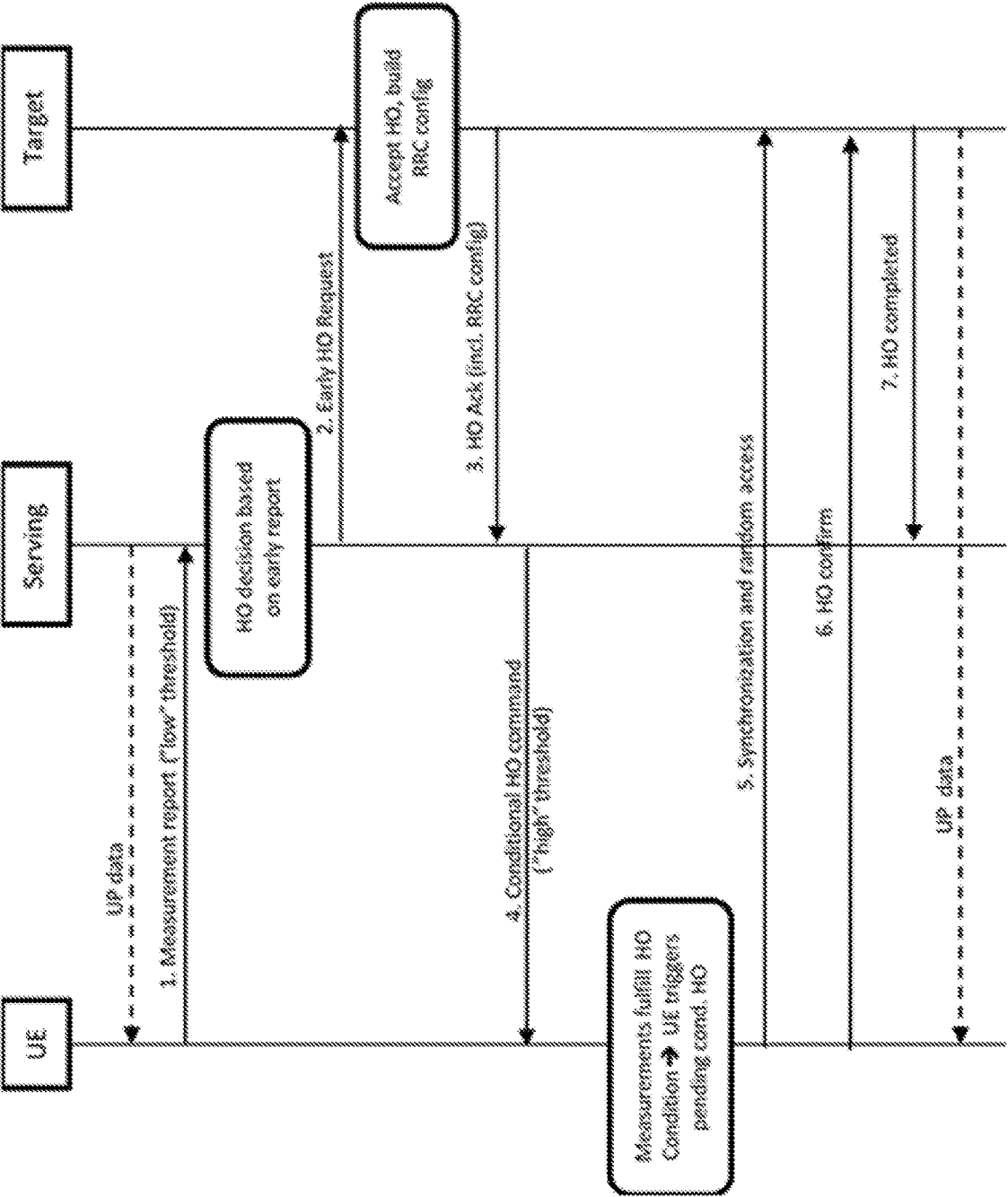


Fig. 4

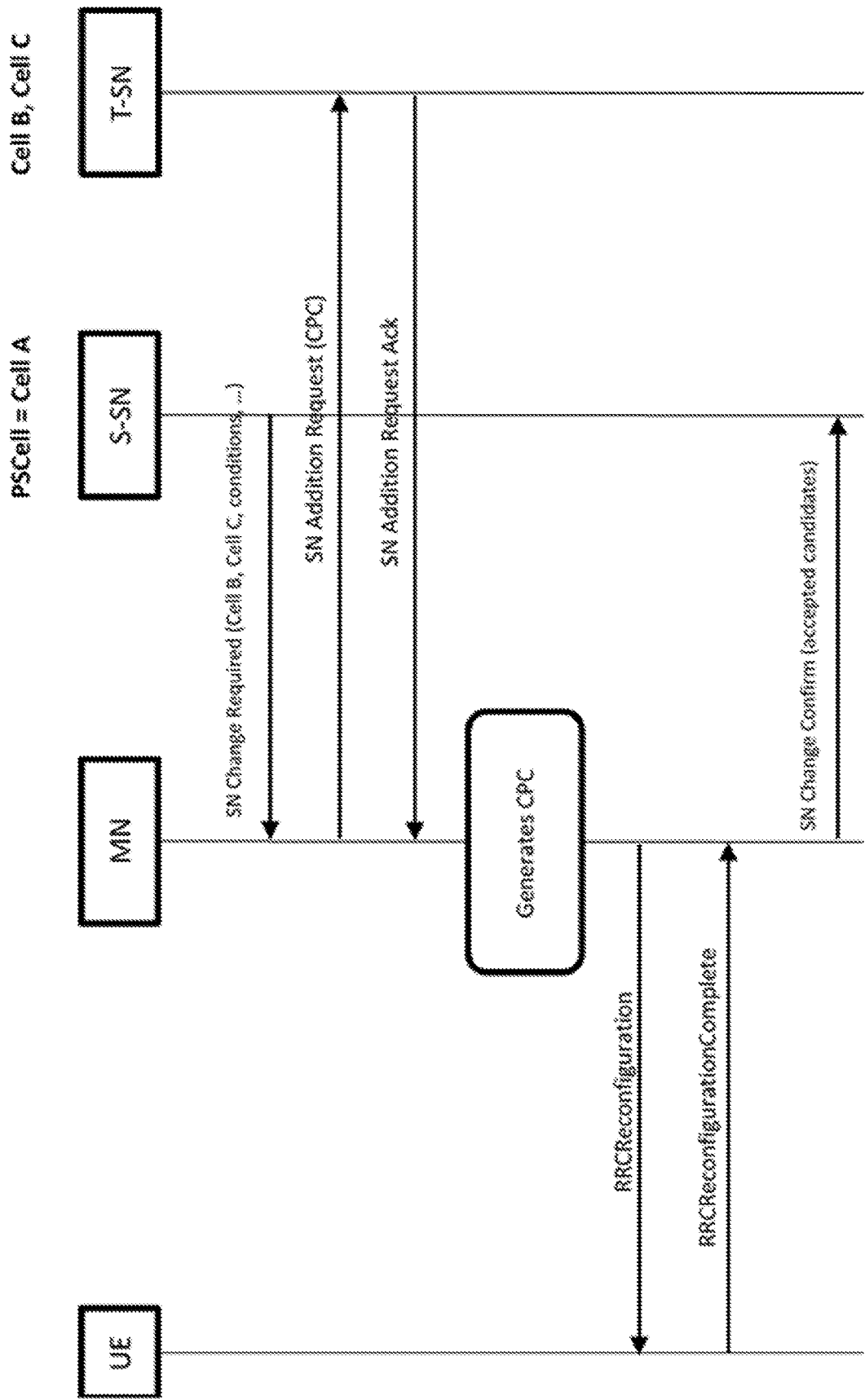


Fig. 5

Evaluate a first CHO configuration to determine whether to keep or release the serving PSCell

601

Fig. 6

Transmit a first message comprising a first CHO configuration to a UE

701

Fig. 7

Transmit information related to a first CHO configuration

801

Fig. 8

Transmit a second message comprising information related to a first CHO configuration to a MN associated with a MCG

901

Fig. 9

Determine whether to keep or release the serving PSCell based on at least one conditional reconfiguration for the serving PSCell

1001

Fig. 10

Transmit a first message comprising at least one conditional reconfiguration for the serving PSCell to the UE

1101

Fig. 11

Transmit information related to at least one conditional reconfiguration for the serving PSCell

1201

Fig. 12

Transmit a second message comprising information related to at least one conditional reconfiguration for the serving PSCell to a MN associated with a MCG

1301

Fig. 13

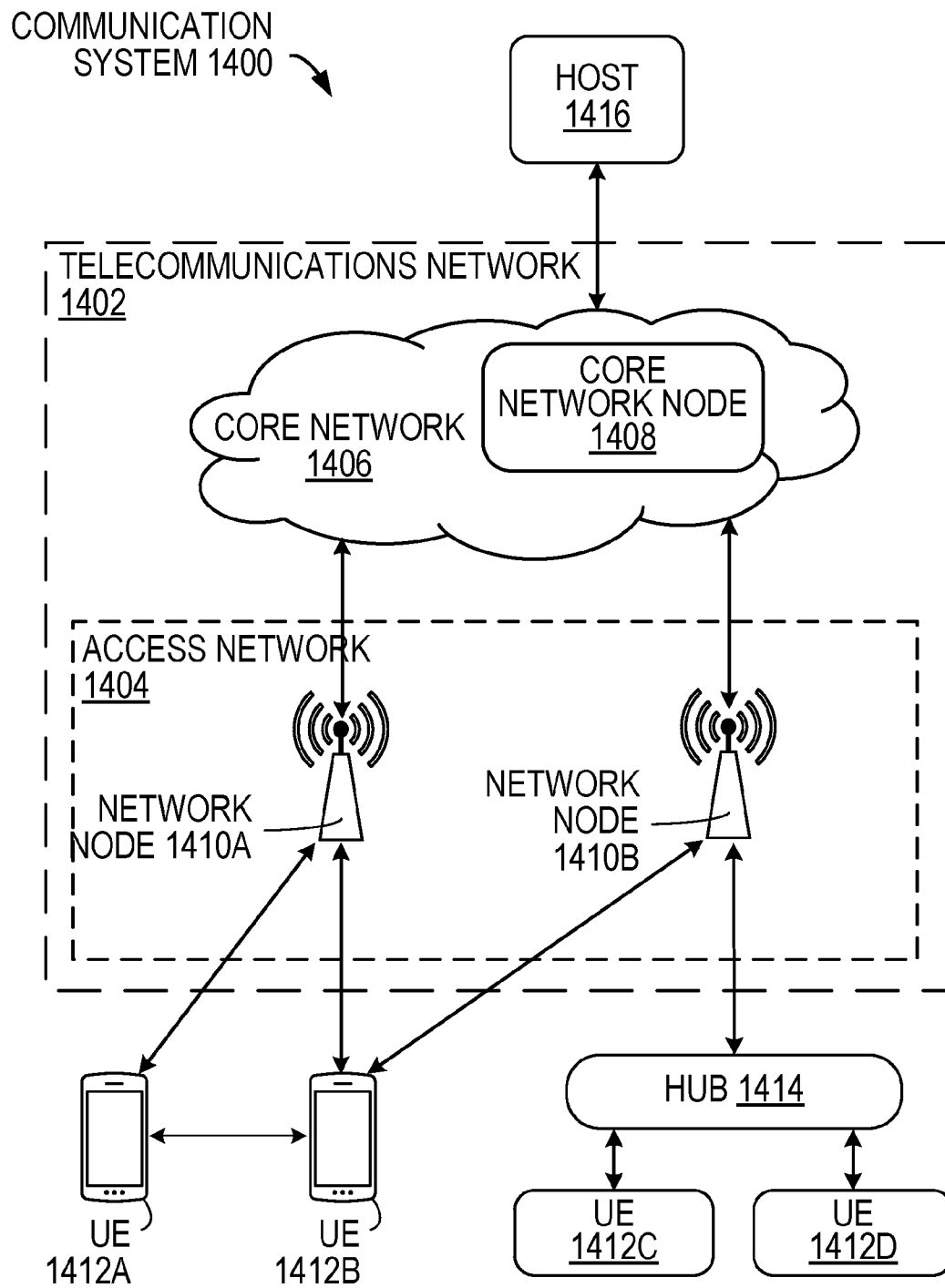


Fig. 14

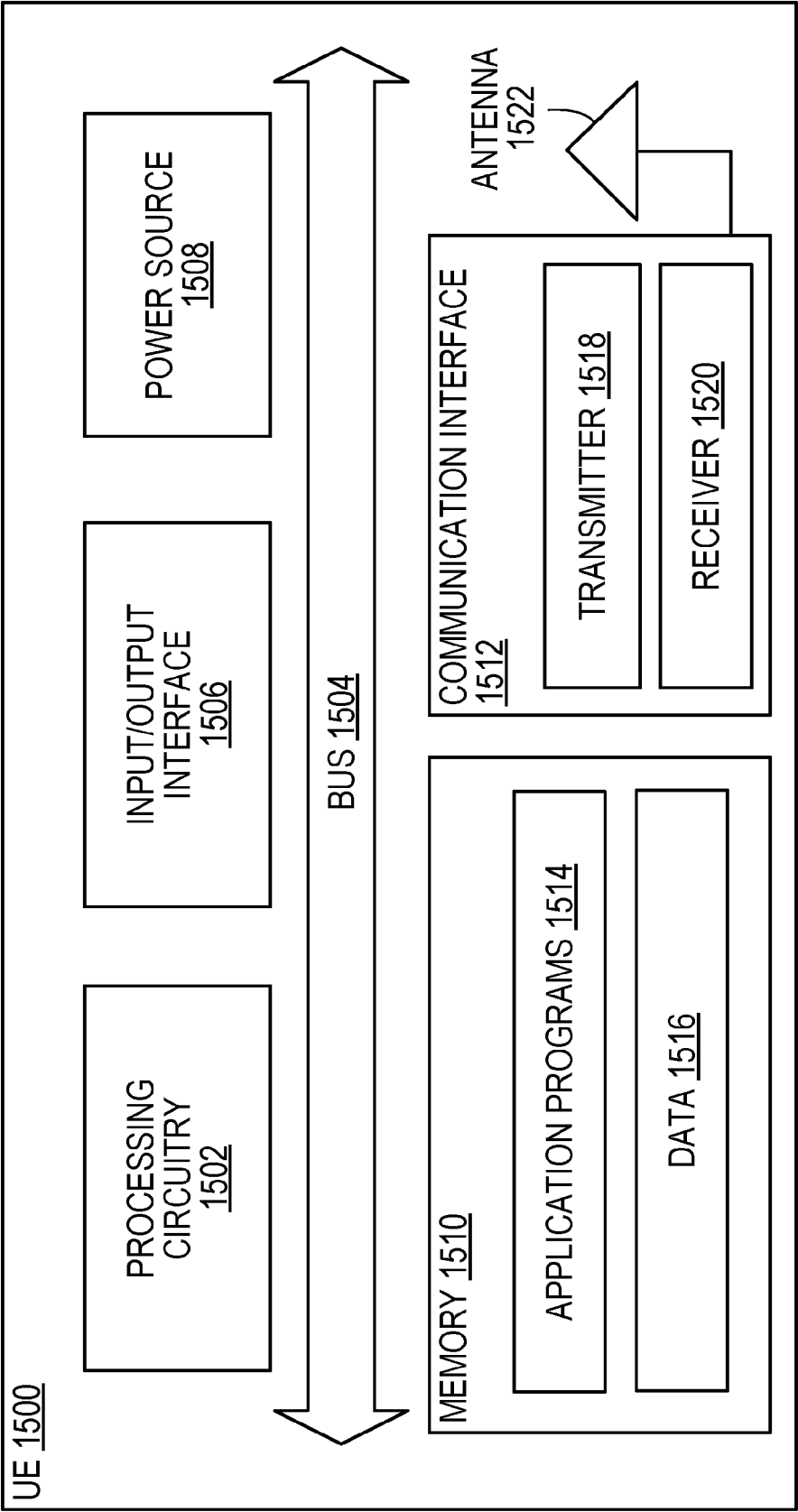


Fig. 15

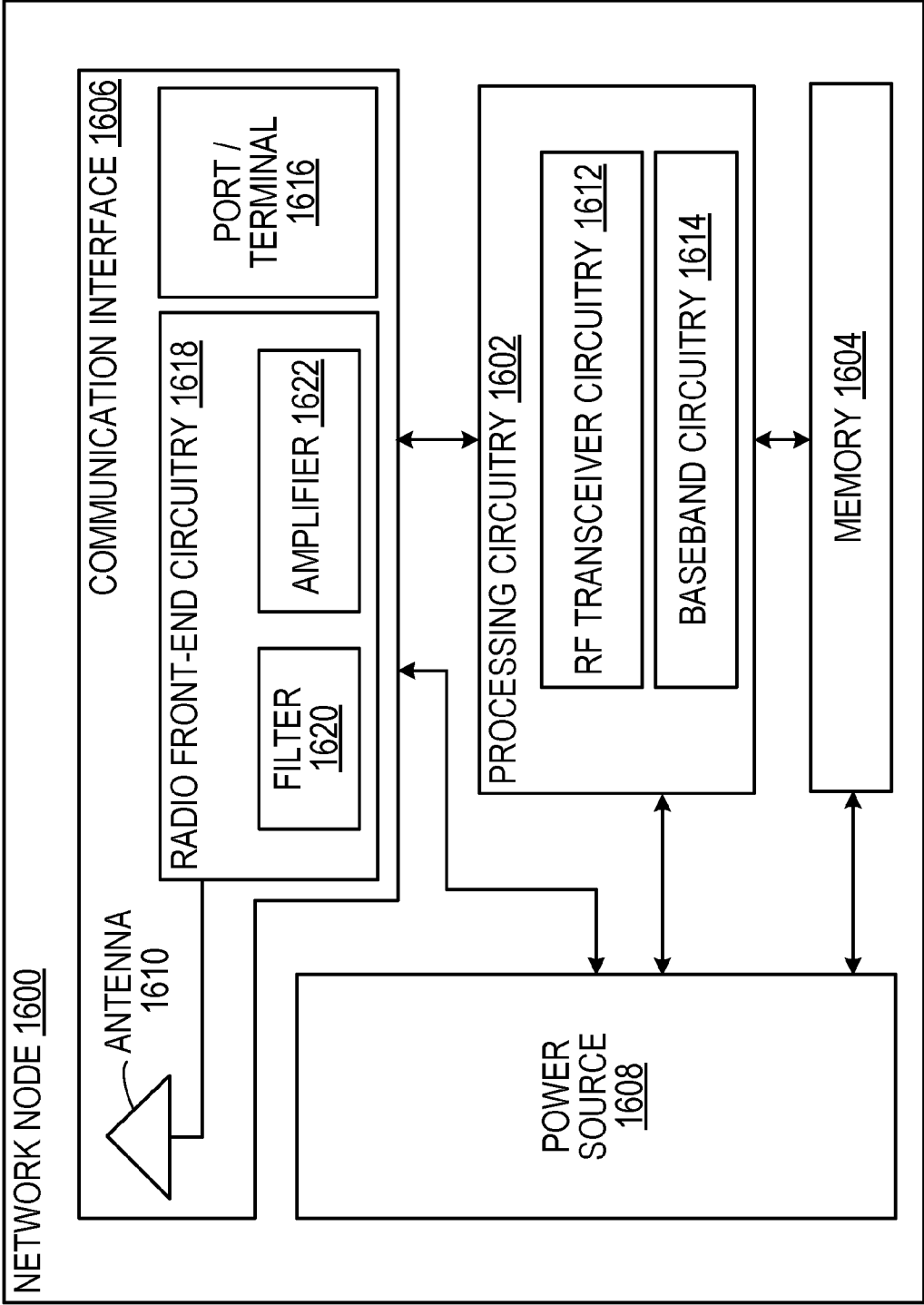


Fig. 16

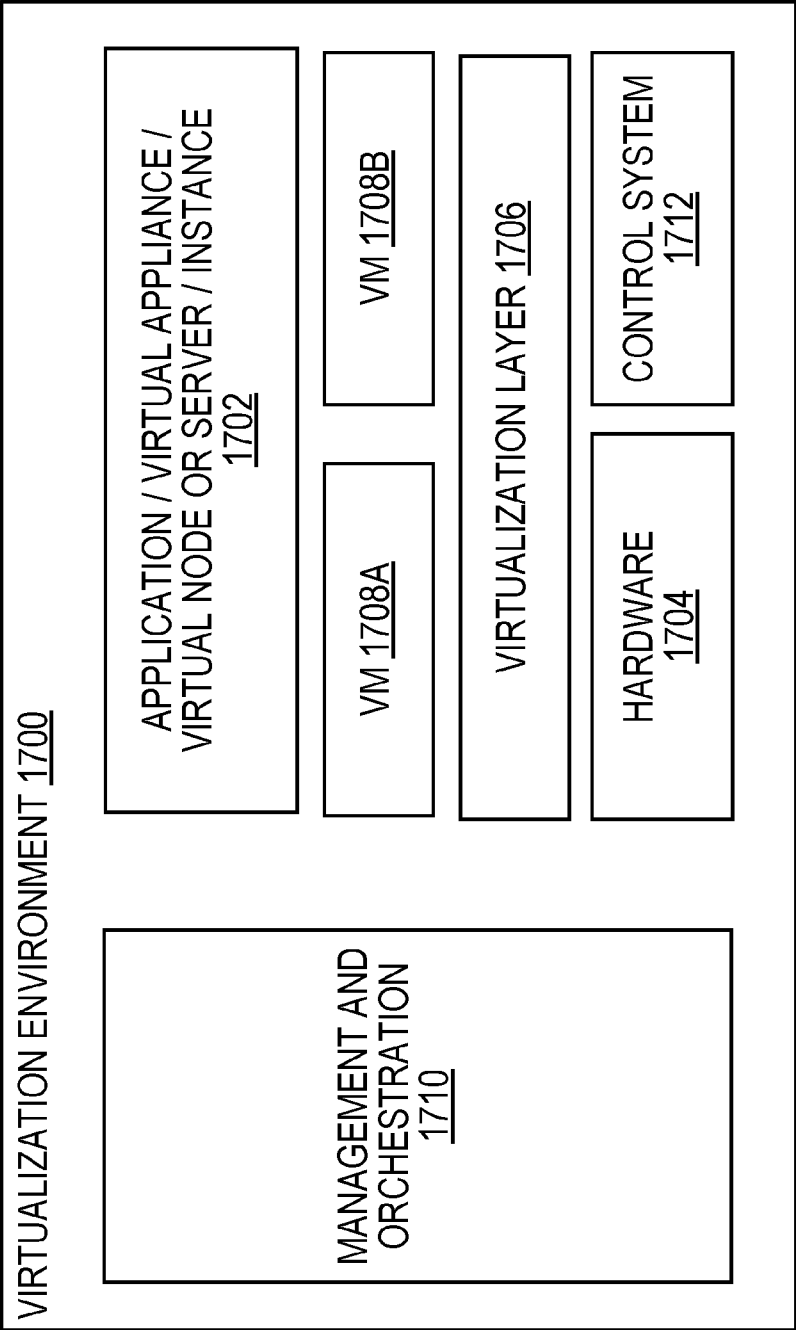


Fig. 17

INTERNATIONAL SEARCH REPORT

International application No

PCT/SE2024/050451

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W36/00 H04W36/36

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	YULONG SHI ET AL: "CHO including target MCG and candidate SCGs for CPC/CPA", 3GPP DRAFT; R2-2303551; TYPE DISCUSSION; NR MOB ENH2-CORE, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. 3GPP RAN 2, no. Online; 20230417 - 20230426 7 April 2023 (2023-04-07), XP052289946, Retrieved from the Internet: URL:https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303551.zip R2-2303551 CHO including target MCG and candidate SCGs for CPCCPA.docx [retrieved on 2023-04-07]	1-7,9, 10, 14-23, 26-33, 36-40
Y	pages 1-7 - / - -	8, 11-13

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

☒ See patent family annex.

* Special categories of cited documents :

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"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

9 July 2024

Date of mailing of the international search report

25/07/2024

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INTERNATIONAL SEARCH REPORT

International application No

PCT/SE2024/050451

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	pages 1-9	8,11-13
Y	----- EP 3 972 338 A1 (NOKIA TECHNOLOGIES OY [FI]) 23 March 2022 (2022-03-23) paragraphs [0073] - [0088] -----	8,11-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/SE2024/050451

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			EP 3972338 A1	23-03-2022
			JP 2023542692 A	11-10-2023
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			WO 2022058069 A1	24-03-2022
