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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 December 2024 (19.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/256081 A1

(51) International Patent Classification:
H04W 24/10 (2009.01) *H04W 92/20* (2009.01)
H04W 36/08 (2009.01)

(21) International Application Number:
PCT/EP2024/062375

(22) International Filing Date:
06 May 2024 (06.05.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20235666 14 June 2023 (14.06.2023) FI

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM,

(54) Title: OPERATIONS AT RADIO ACCESS NODES

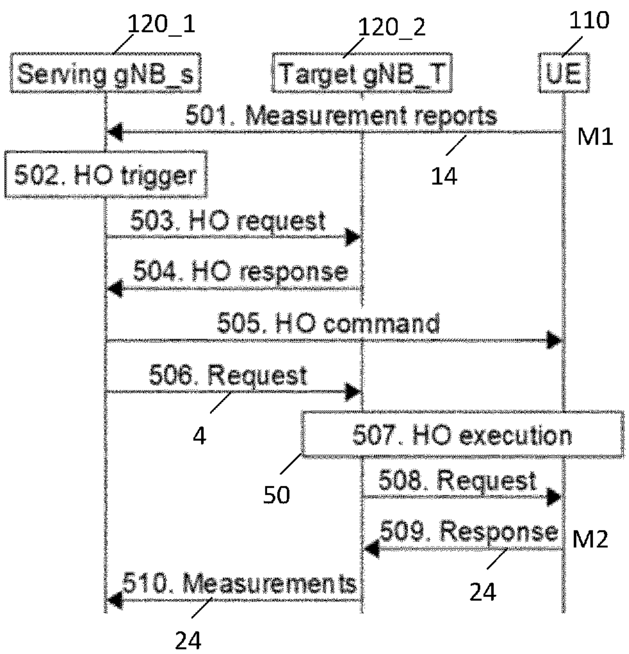

FIG 12

(57) Abstract: A network apparatus comprising: means for receiving, from a user equipment (UE) in a wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node; means for receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node; means for controlling allocation of wireless network resources in dependence upon: i) the received first information and ii) the received second information.

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

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

Published:

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

TITLE

Operations at radio access nodes.

TECHNOLOGICAL FIELD

Examples of the disclosure relate to new operations at radio access nodes and at user equipment

BACKGROUND

A radio access network can be comprised of core network and an edge network. The edge network can, for example, comprise radio access nodes and user equipment that connect wirelessly with at least the radio access nodes. In some example, user equipment can connect wirelessly with another user equipment.

In some examples, a user equipment has one wireless link for reception. In other examples, a user equipment has multiple simultaneous wireless links for reception.

In some examples, a user equipment has one wireless link for transmission. In other examples, a user equipment has multiple simultaneous wireless links for transmission.

It would be desirable to provide new operations at the edge, that is, at the radio access nodes and at the user equipment.

BRIEF SUMMARY

According to various, but not necessarily all, examples there is provided
a network apparatus comprising:
means for receiving, from a user equipment (UE) in a wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node ;
means for receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled

by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node;
means for controlling allocation of wireless network resources in dependence upon:
i) the received first information and
ii) the received second information.

According to various, but not necessarily all, examples there is provided an apparatus comprising:
means for receiving, from a user equipment (UE) or a radio access node, first information dependent on a first UE measurement for the UE before a change of a primary radio access node radio access node for the UE from a first radio access node radio access node associated with the apparatus to a second radio access node radio access node associated with another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node radio access node;
means for receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after a change of the primary radio access node radio access node for the UE from the first radio access node radio access node associated with the apparatus to the second radio access node radio access node associated with the other apparatus, wherein the second UE measurement for the UE is a measurement at the UE for a signal transmitted by the first radio access node radio access node; and
means for controlling training of a machine learning model to use:
i) the received first information and
ii) the received second information.
In some but not necessarily all examples, the means for controlling training of a machine learning model trains the machine learning model to control:
(i) allocation of communication resources associated with the first radio access node, or
(ii) user equipment mobility management for the first radio access node, wherein user equipment mobility management dynamically controls operation the first radio access node and, optionally, one or more other radio access nodes and dynamically controls operation of the user equipment;

or

(iii) tracking a length and/or direction and/or quality of a communication path between the first radio access node and the user equipment.

According to various, but not necessarily all, examples there is provided a network apparatus comprising:

means for receiving, from a user equipment (UE) in wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node;

means for receiving from the another apparatus, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node; and

means for configuring the other apparatus to report the second information wherein the configuration at least specifies an identity of the user equipment.

According to various, but not necessarily all, examples there is provided examples as claimed in the appended claims.

While the above examples of the disclosure and optional features are described separately, it is to be understood that their provision in all possible combinations and permutations is contained within the disclosure. It is to be understood that various examples of the disclosure can comprise any or all of the features described in respect of other examples of the disclosure, and vice versa. Also, it is to be appreciated that any one or more or all of the features, in any combination, may be implemented by/comprised in/performable by an apparatus, a method, and/or computer program instructions as desired, and as appropriate.

BRIEF DESCRIPTION

Some examples will now be described with reference to the accompanying drawings in which:

FIG. 1 shows an example of the subject matter described herein;

FIG. 2 shows another example of the subject matter described herein;

FIG. 3 shows another example of the subject matter described herein;

FIG. 4 shows another example of the subject matter described herein;

FIG. 5 shows another example of the subject matter described herein;

FIG. 6 shows another example of the subject matter described herein;

FIG. 7 shows another example of the subject matter described herein;

FIG. 8 shows another example of the subject matter described herein;

FIG. 9 shows another example of the subject matter described herein;

FIG. 10 shows another example of the subject matter described herein;

FIG. 11 shows another example of the subject matter described herein.

FIG. 12 shows another example of the subject matter described herein.

FIG. 13 shows another example of the subject matter described herein.

FIG. 14 shows another example of the subject matter described herein.

FIG. 15 shows another example of the subject matter described herein.

The figures are not necessarily to scale. Certain features and views of the figures can be shown schematically or exaggerated in scale in the interest of clarity and conciseness. For example, the dimensions of some elements in the figures can be exaggerated relative to other elements to aid explication. Similar reference numerals are used in the figures to designate similar features. For clarity, all reference numerals are not necessarily displayed in all figures.

In the following description a class (or set) can be referenced using a reference number without a subscript index (e.g. 120) and a specific instance of the class (member of the set) can be referenced using the reference number with a numerical type subscript index (e.g. 120_1) and a non-specific instance of the class (member of the set) can be referenced using the reference number with a variable type subscript index (e.g. 120_i).

DETAILED DESCRIPTION

The following description and FIGs describe examples of an apparatus 120.

In some but not necessarily all examples, the apparatus 120 comprises: means for receiving, from a user equipment (UE) 110 first information 14 dependent on a first UE measurement M1 for the UE 110 before a change 50 of a primary radio access node for the UE 110 from a first radio access node 120_1 associated with (e.g. controlled by) the apparatus 120 to a second radio access node 120_2 associated with (e.g. controlled by) another apparatus 120_2, wherein the first UE measurement M1 for the UE 110 is a measurement (e.g. a configured measurement) at the UE 110 of a signal 12 transmitted by the first radio access node 120_1;
means for receiving from the another apparatus 120_2 or from the UE 110, second information 24 dependent on a second UE measurement M2 for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 associated with (e.g. controlled by) the apparatus 120 to the second radio access node 120_2 associated with (e.g. controlled by) the other apparatus 120, wherein the second UE measurement M2 for the UE 110 is a measurement (e.g. a configured measurement) at the UE 110 of a signal 12 transmitted by the first radio access node 120_1.

In some example, the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node and all neighbor radio access nodes that the UE has been configured by the primary radio access node to measure and report. In some examples, the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node and all neighbor radio access nodes that the UE has been configured by the primary radio access node to measure and report. The UE can perform measurements for a “list” of radio access nodes including the serving radio access node 120_1 and one or more neighboring radio access nodes 120_2. So, the first measurements can contain signal levels received from serving radio access node plus other neighbor radio access nodes. The list of radio access nodes to be measured by the UE 110 can be sent as a configuration message by the network (serving node 120_1) using radio resource control (RRC) configuration message toward the UE 110. The same after HO, the UE 110 can measure a list of radio access nodes 120 including the previous serving radio access node 120_1 and the new serving radio access node 120_2, this according to what is set in the new RRC configuration message from the new serving radio access node 120_2. Before HO, in some example, the serving radio access node 120_1 configures the UE to 110 continue measuring during the HO process and report to the new serving radio access node 120_2.

The first radio access node 120_1 and the second radio access node 120_2 can be radio access nodes for the same radio access technology or for different radio access technology.

The first radio access node 120_1 can for example be a radio access node for a cellular radio telecommunications network.

The inter radio access node transfer of the second information 24 provides the apparatus with information dependent on UE measurements M1, M2 for the UE 110 before and after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2. The UE measurements M1, M2 are measurements at the UE 110 of signals 12,22 transmitted by the first radio access node 120_1 before and after the change 50 of the primary radio access node.

The inter radio access node transfer of the second information 24 provides for efficient signaling including low latency and high bandwidth and enables distributed processing at the edge of the network.

In some but not necessarily all examples, the apparatus 120 comprises means for controlling allocation of communication resources associated with the first radio access node 120_1 in dependence upon: the received first information 14 and the received second information 24. Communication resources can, for example, include available radio access nodes and/or available channels (defined spatially, and/or by frequency domain, and/or by time domain and/or defined otherwise).

In some but not necessarily all examples, the means for controlling allocation of communication resources is provided by a machine learning model.

In some but not necessarily all examples, the apparatus 120 comprises means for controlling training of a machine learning model to use: the received first information 14 and the received second information 24.

In some but not necessarily all examples, the apparatus 120 comprises: means for providing UE mobility management for the first radio access node 120_1 in dependence upon the received first information 14 and the received second information 24, wherein the mobility management is dependent upon a position of the UE 110 and/or a quality of the communication path to the UE 110.

In at least some examples, UE mobility management dynamically controls operation of the first radio access node 120_1 and, optionally, one or more other radio access nodes 120 and dynamically controls operation of the user equipment 110 and optionally one or more other user equipment 110.

In some but not necessarily all examples, the means for providing mobility management is configured to control one or more of: dynamic communication resource allocation based on changing network conditions including handover (HO) decisions, prediction of future signal quality, or positioning of the UE 110. The network conditions are for example dependent upon signal path quality and position of the UE 110.

In some but not necessarily all examples, the means for providing mobility management is provided by the machine learning model.

In some but not necessarily all examples, the apparatus 120 comprises: adaptive means for receiving as input at least a UE measurement for the UE 110, wherein the UE measurement for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1 and produces an output dependent upon a length and/or direction and/or quality of a communication path of the signal 12 transmitted by the first radio access node 120_1, wherein the adaptive means is adapted in dependence upon the received first information 14 and the received second information 24. The adaptive means tracks, over time, a length and/or direction and/or quality of a communication path between the first radio access node and the user equipment 110.

In some but not necessarily all examples, the adaptive means is provided by the machine learning model.

In some but not necessarily all examples, the apparatus 120 comprises means for communicating with the other apparatus 120 and means for configuring the other apparatus 120 to send the second information 24 dependent on the second UE measurement M2 for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2, wherein the second UE measurement M2 for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1.

In some but not necessarily all examples, the apparatus 120 comprises means for communicating with the user equipment 110 for configuring the user equipment to send the second information 24 dependent on the second UE measurement M2 for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 directly to the first radio access node 120_2, wherein the second UE measurement M2 for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1.

The user equipment 110 is synonymous with a node that communicates via a radio interface with a radio access node. It does not have to be in possession of a human user.

The primary radio access node is a radio access node with which the UE 110 has a primary relationship and to which it reports results of measurements. In at least some examples it is a serving radio access node, a radio access node with an established radio link to the UE 110, or a radio access node with an established data transfer channel with the UE 110.

In the Third generation Partnership Project (3GPP), there are different connectivity states for a user equipment 110 including connected state, inactive state, and idle state. The primary radio access node can be a radio access node of a serving cell when the UE 110 is in the idle, inactive, or connected state. The primary radio access node can be a radio access node of a serving cell when the UE 110 is in the connected state with an established radio link and/or an established data transfer channel between the radio access node 120 and the UE 110.

The UE measurements relate to measurements made at the UE 110 of a signal transmitted by a radio access node 120.

In at least some example, the UE measurements are configured UE measurements. Configured UE measurements are measurements performed by the UE 110 according to a network-controlled configuration received from a radio access node 120.
In at least some examples, the UE measurements are standard specified measurements. A standard specified measurement is a measurement specified as mandatory or optional by a telecommunications standard with which the apparatus 120 conforms.
The purpose of the measurements can, for example, be to enable a change in radio access node 120 (e.g. Handover), enable beam selection, for conditional access, for dual connectivity.
In at least some examples, the UE measurements are measurements of a downlink signal.
In at least some examples, the UE measurements are reference signal measurements of reference signal(s) transmitted by a radio access node 120. Examples of reference signals include but are not limited to Synchronization Signal Block (SSB) or Channel State Information Reference Signal (CSI-RS).
In at least some examples, the UE measurements are measurements of path loss. For example, measurements of one or more of : Reference Signal Received Power (RSRP), Received Signal Strength Indicator (RSSI), Reference Signal Received Quality (RSRQ). These path-loss measurements are dependent upon RSRP.

This document refers to information dependent on a UE measurement. The information can be the measurement itself or information that indicates the measurement (for example indicates a quantized value) or information that is derived from a process using the measurement (for example, an outcome of decision process based on the measurement).

FIG 1 illustrates an example of a network 100 comprising a plurality of network nodes including terminal nodes 110, access nodes 120 and one or more core nodes 129. The terminal nodes 110 and access nodes 120 communicate with each other. The one or more core nodes 129 communicate with the access nodes 120.

The network 100 is in this example a radio telecommunications network, in which at least some of the terminal nodes 110 and radio access nodes 120 communicate with each other using transmission/reception of radio waves. In this example, the interface between the terminal nodes 110 and a radio access node 120 is a radio (or air) interface 124.

The one or more core nodes 129 may, in some examples, communicate with each other. The one or more radio access nodes 120 are configured to communicate with each other.

The network 100 may be a cellular network comprising a plurality of cells 122 each served by a radio access node 120. The radio access node 120 comprises a cellular radio transceiver. The terminal nodes 110 are cellular radio transceivers.

In the example illustrated the cellular network 100 is a third generation Partnership Project (3GPP) network in which the terminal nodes 110 are ‘user equipment’ (UE) and the access nodes 120 are base stations.

In the example illustrated the network 100 is an Evolved Universal Terrestrial Radio Access network (E-UTRAN). The E-UTRAN consists of E-UTRAN NodeBs (eNBs) 120, providing the E-UTRA user plane and control plane (RRC) protocol terminations towards the UE 110. The eNBs 120 are interconnected with each other by means of an X2 interface 126. The eNBs are also connected by means of the S1 interface 128 to the Mobility Management Entity (MME) 129.

In other example the network 100 is a Next Generation (or New Radio, NR) Radio Access network (NG-RAN). The NG-RAN consists of gNodeBs (gNBs) 120, providing the user plane and control plane (RRC) protocol terminations towards the UE 110. The gNBs 120 are interconnected with each other by means of an X2/Xn interface 126. The gNBs are also connected by means of the N2 interface 128 to the Access and Mobility management Function (AMF).

A user equipment comprises a mobile equipment. Where reference is made to user equipment that reference includes and encompasses, wherever possible, a reference to mobile equipment and a reference to a terminal node.

In the following description reference is made to an apparatus and a radio access node. In some but not necessarily all examples, the apparatus and the radio access node are different apparatus. In some but not necessarily all examples, the apparatus and the radio access node are the same apparatus. In the following examples, the apparatus and the radio access node are the same apparatus and a single reference will be used for both the apparatus and the radio access node.

The apparatus 120 comprises adaptive means for receiving as input at least a UE measurement M1 for the UE 110, wherein the UE measurement M1 for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1 and produces an output dependent upon a length and direction of a communication path of the signal 12 transmitted by the first radio access node 120_1, wherein the adaptive means is adapted in dependence upon the received first information 14 and the received second information 24

The output can, for example be allocation of communication resources or mobility management.

In the examples described below the apparatus 120 comprises means for controlling future allocation of network communication resources in dependence upon an assessment, using at least the received first information 14 and the received second information 24, of an effect of an allocation of network resources made in dependence upon at least the first information 14.

Although the network communication resources could be resources in a time domain and/or frequency domain and/or spatial domain in the following examples the decision is a handover decision to handover the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

In the following examples, there is a change in the primary radio access node from the first radio access node 120_1 to the second radio access node 120_2 as a consequence of handover. It is however, possible for a primary radio access node to be changed under other circumstances e.g. dual connectivity.

Referring to FIG 2, the first radio access node 120_1 transmits a signal 12 which is measured M1 by the UE 110. The UE 110 sends first information 14 dependent on the measurement M1 to the first radio access node 120_1 (the primary radio access node). There is a handover of the user equipment 110 from the first radio access node 120_1 to the second radio access node 120_2. The first radio access node 120_1 transmits a signal 22 which is measured M2 by the UE 110. The UE 110 sends second information 24 dependent on the measurement M2 to the second radio access node 120_2 (the new primary radio access node after handover 50). The second radio access node 120_2 sends the second information 24 to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the second information 24.

Optionally, the first radio access node 120_1 configures this functionality in the second radio access node using configuration signal 4. Optionally, the first radio access node 120_1 configures this functionality in the user equipment 110 using a configuration signal 2.

FIG 2 illustrates an example of a network apparatus 120 comprising:
means for receiving, from a user equipment (UE) 110 in wireless network, first information 14 dependent on a first UE measurement M1 for the UE 110 before a

change 50 of a primary radio access node for the UE 110 from a first radio access node 120_1 controlled by the apparatus 120 to a second radio access node 120_2 controlled by another apparatus 120_2, wherein the first UE measurement M1 for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1;

means for receiving from the another apparatus 120_2, second information 24 dependent on a second UE measurement M2 for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 controlled by the apparatus 120 to the second radio access node 120_2 controlled by the other apparatus 120, wherein the second UE measurement M2 for the UE 110 is a configured measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1; and

means for controlling allocation of wireless network resources in dependence upon:

i) the received first information 14 and

ii) the received second information 24.

FIG 3, illustrate functionality that can be performed in addition or as an alternative to that described with reference to FIG 2. In this example, the user equipment supports dual access with the first radio access node 120_1 and the second radio access node 120_2 during handover.

As before, the first radio access node 120_1 transmits a signal 12 which is measured M1 by the UE 110 during handover 50. The UE 110 sends first information 14 dependent on the measurement M1 to the first radio access node 120_1 (the original primary radio access node).

As before, the first radio access node 120_1 transmits a signal 22 which is measured M2 by the UE 110. However, now the UE 110 sends the second information 24 dependent on the measurement M2 directly to the first radio access node 120_1.

This enables processing 60 at the first radio access node 120_1 using the second information 24.

Optionally the UE 110 also sends the first information 14 to the second radio access node 120_1. Optionally the UE 110 also sends the second information 24 to the second radio access node 120_2.

Optionally, the first radio access node 120_1 configures this functionality in the second radio access node using configuration signal 4. Optionally, the first radio access node 120_1 configures this functionality in the user equipment 110 using a configuration signal 2.

FIG 3 illustrates an example of a network apparatus 120 comprising:
means for receiving, from a user equipment (UE) 110 in wireless network, first information 14 dependent on a first UE measurement M1 for the UE 110 before a change 50 of a primary radio access node for the UE 110 from a first radio access node 120_1 controlled by the apparatus 120 to a second radio access node 120_2 controlled by another apparatus 120_2, wherein the first UE measurement M1 for the UE 110 is a measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1;
means for receiving from the user equipment 110, second information 24 dependent on a second UE measurement M2 for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 controlled by the apparatus 120 to the second radio access node 120_2 controlled by the other apparatus 120, wherein the second UE measurement M2 for the UE 110 is a configured measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1;
means for controlling allocation of wireless network resources in dependence upon:
i) the received first information 14 and
ii) the received second information 24.

Referring to FIG 4, the first radio access node 120_1 transmits a signal 12 which is measured M1 by the UE 110. The UE 110 sends first information 14 dependent on the measurement M1 to the first radio access node 120_1 (the primary radio access node).

The second radio access node 120_2 transmits a signal 32 which is measured M3 by the UE 110. The UE 110 sends third information 34 dependent on the measurement M3 to the first radio access node 120_1 (the primary radio access node).

There is a handover of the user equipment 110 from the first radio access node 120_1 to the second radio access node 120_2.

The first radio access node 120_1 transmits a signal 22 which is measured M2 by the UE 110. The UE 110 sends second information 24 dependent on the measurement M2 to the second radio access node 120_2 (the new primary radio access node after handover 50).

The second radio access node 120_2 transmits a signal 42 which is measured M4 by the UE 110. The UE 110 sends fourth information 44 dependent on the measurement M4 to the second radio access node 120_2 (the new primary radio access node after handover 50).

The second radio access node 120_2 sends the second information 24 to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the second information 24.

The second radio access node 120_2 sends the fourth information 44 to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the fourth information 44.

Optionally, the first radio access node 120_1 configures this functionality in the second radio access node using configuration signal 4. Optionally, the first radio access node 120_1 configures this functionality in the user equipment 110 using a configuration signal 2.

There are four combination of radio access node measurement and timing which give first information 14, second information 24, third information 34, fourth information 44.

The first information 14 and third information 34 relate to the time period before the change 50. The second information 24 and the fourth information 44 relate to the time period after the change 50. The change 50 is when the primary radio access node switches from being the first radio access node 120_1 to being the second radio access node 120_2.

The first information 14 and second information 24 relate to measurement at the UE 110 of a signal transmitted by the first radio access node 120_1. The first information 14 relates to measurement at the UE 110 of a signal 12 transmitted by the first radio access node 120_1. The second information 24 relates to measurement at the UE 110 of a signal 22 transmitted by the first radio access node 120_1. The signal 12, transmitted by the first radio access node 120_1 before the change 50 can be the same or different to the signal 22 transmitted by the first radio access node 120_1 after the change 50.

The third information 34 and fourth information 44 relate to measurement at the UE 110 of a signal transmitted by the second radio access node 120_2. The third information 34 relates to measurement at the UE 110 of a signal 32 transmitted by the second radio access node 120_2. The fourth information 44 relates to measurement at the UE 110 of a signal 42 transmitted by the second radio access node 120_2. The signal 32, transmitted by the second radio access node 120_2 before the change 50 can be the same or different to the signal 42 transmitted by the second radio access node 120_2 after the change 50.

FIG 5, illustrate functionality that can be performed in addition or as an alternative to that described with reference to FIG 4. In this example, the user equipment supports dual access with the first radio access node 120_1 and the second radio access node 120_2 during handover 50.

As before, the first radio access node 120_1 transmits a signal 12 which is measured M1 by the UE 110 during handover 50. The UE 110 sends first information 14 dependent on the measurement M1 to the first radio access node 120_1 (the original primary radio access node).

As before, the first radio access node 120_1 transmits a signal 22 which is measured M2 by the UE 110. However, now the UE 110 sends the second information 24 dependent on the measurement M2 directly to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the second information 24.

As before, the second radio access node 120_2 transmits a signal 32 which is measured M3 by the UE 110. However, now the UE 110 sends the third information 24 dependent on the measurement M3 directly to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the third information 24.

As before, the second radio access node 120_2 transmits a signal 42 which is measured M4 by the UE 110. However, now the UE 110 sends the fourth information 44 dependent on the measurement M4 directly to the first radio access node 120_1. This enables processing 60 at the first radio access node 120_1 using the fourth information 24.

Optionally the UE 110 also sends the first information 14 to the second radio access node 120_1. Optionally the UE 110 also sends the second information 24 to the second radio access node 120_2. Optionally the UE 110 also sends the third information 34 to the second radio access node 120_1. Optionally the UE 110 also sends the fourth information 44 to the second radio access node 120_2.

Optionally, the first radio access node 120_1 configures this functionality in the second radio access node using configuration signal 4. Optionally, the first radio access node 120_1 configures this functionality in the user equipment 110 using a configuration signal 2.

Therefore in at least some examples, before handover HO (change 50), the first radio access node 120_1 is the serving radio access node. The first radio access node 120_1 configures the UE 110 to measure M1 (optionally M3) and report back on signals transmitted by a list of radio access nodes 120. The list includes the first radio access node 120_1 (optionally it includes the second radio access node 120_2).

After HO, the second radio access node 120-2 is the new serving radio access node. The second radio access node 120_2 configures the UE 110 to measure M4 and report back on signals transmitted by a list of radio access nodes 120. The list includes the second radio access node 120_2.
The second radio access node 120_2 also configures the UE 110 to continue measuring M2 for a list of radio access node 120 (including the first radio access node 120_1) and report the measurements to the second radio access node 120_2 after HO. The target of this measurements is to be part of data needed by the first radio access node 120_1 and the second radio access node 120_2 for training their local models. Reported measurements to the second radio access node 120-2 after HO 50 can include part of the measurements M1 collected before HO while the UE 110 is served still by the first radio access node 120_1
The second radio access node forward the newly reported measurements from UE 110 after HO to BS1. Target of this measurements is to be part of data needed by BS1 for training its local models.

In at least some example, the radio access node 120 processes 60 the received information using use machine learning which can include statistical learning.

Machine learning is a field of computer science that gives computers the ability to learn without being explicitly programmed. The computer learns from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T, as measured by P, improves with experience E. The computer can often learn from prior training data to make predictions on future data. Machine learning includes wholly or partially supervised learning and wholly or partially unsupervised learning. It may enable discrete outputs (for example classification, clustering) and continuous outputs (for example regression). Machine learning may for example be implemented using different approaches such as cost function minimization, artificial neural networks, support vector machines and Bayesian networks for example. An acyclic machine learning network such as a single or multi hidden layer artificial neural network can be used. Cost function minimization may, for example, be used in linear and polynomial or logistic regression and K-means clustering. Artificial neural networks, for example with one or more hidden layers, model complex relationship between input vectors and output vectors. Support vector machines may be used for supervised learning. A Bayesian network is a directed acyclic graph that represents the conditional independence of a number of random variables.

The first radio access node is configured to enable the routing of the second information to it either directly from the UE 110 or indirectly via the second radio access node 120_2.

It will be appreciated from the foregoing that there is improved data collection at the first radio access node 120_1 and the collected information can be processed 60 used a machine learning model, for example as illustrated in FIG 6. The machine learning model is a local machine learning model in the sense that it is located at and training is performed at a radio access node 120 (not at the core network).

The machine learning model can be any suitable machine learning model. The machine learning model can, for example, use the collected information as unlabeled training data or as labeled training data.

A trained machine learning model 62 converts an input vector 61 to an output vector 63. In this example, the trained machine learning model 62 receives as input 61 at least the first information 14 dependent on the UE measurement M1 for the UE 110 and produces an output 63.

The machine learning model can be used by the first radio access node 120_1 to control:

(i) allocation of communication resources associated with the first radio access node 120_1, or

(ii) user equipment mobility management for the first radio access node 120_1, wherein

user equipment mobility management dynamically controls operation of the first radio access node 120_1 and, optionally, operation of one or more other radio access nodes 120 and dynamically controls operation of the user equipment 110;

or

(iii) tracking a length and/or direction and/or quality of a communication path between the first radio access node 120_1 and the user equipment 110.

In this example, the apparatus 10 comprises means for training a machine learning model for allocation of communication resources in the radio access network using, wherein the training uses at least the first information 14 and the second information 24.

The output can, for example be allocation of communication resources or mobility management.
In the examples described the machine learning model 66 is trained using training data 65 and feedback of an error value 67 (e.g. back propagation of a loss value 67 for a neural network). The training data 65 can be of a form similar to the input 61. The output of the machine learning model 66 in training can be used to determine an error value which is used to feedback and adapt the machine learning model 66. For example the first information 14 (and optionally the third information 34) can be used as input data to the trained machine learning model 62 and as training data 65 for the in-training machine learning model 66.
For example the second information 24 (and optionally the fourth information 44) can be used as data to assess the output of the machine learning model during training .

Thus, in some examples, the trained machine learning model 62 is used to control a future allocation of network communication resources in dependence upon feedback of an assessment, using at least the received first information 14 and the received second information 24, of an effect of an allocation of network resources made in dependence upon at least the first information 14.

FIG 7 illustrates an example of training a machine learning model 66. The input 65 used as training data is from before handover 50. The feedback 67 for training the machine learning model 66 compares the output of the machine learning algorithm (the preferred target radio access node for HO) against a hindsight assessment of the best cell for HO based on the information available after the handover 50. This information includes the second information 24 and optionally the fourth information 44. In this example the machine learning memory (LSTM) artificial neural network

In this example, the apparatus 10 comprises means for training a machine learning model for allocation of network communication resources associated with the first radio access node 120_1. The training uses at least the first information 14 and the second information 24. The training can use at least the first information 14 as training data and the second information 24 for labelling the training data. The fourth information 44 can also be used for labelling. The third information 34 can also be used for training data.

The information dependent on the UE measurement or measurements for the UE 110 before the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2 is used as training data for a machine learning model for allocation of resources. The information dependent on the UE measurement or measurements for the UE 110 after the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2 is used, directly or indirectly, to label the training data.

The machine learning model can be trained to determine an optimum decision in future rather than the actual decision in the past.

A classification/clustering used for labelling can performed over a time period configured to avoid or reduce avoid repetitive changes in radio access node (ping-ponging due to short stay)

FIG 8 illustrates a network according to a current 3GPP specification. The network is hierarchical. It comprises a core 127 and radio access nodes 120. The core 127 connects to the radio access nodes 120 via the interface 128 (NG Interface). The radio access nodes 120 connect to user equipment via the air interface 124 (Uu). The radio access nodes 120 connect to other radio access nodes 120 via the interface 126 (Xn interface).

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In this example, the radio access node 120 is logically split into a central unit (CU) 202 and a distributed unit (DU) 204. The DU 204 uses one or more transmission reception points (TRP) 126.

The CU 202 controls the operation of one or more DUs 204. The CU 202 terminates the F1 interface connected with the DU 204. The CU 202 hosts higher layer protocols e.g. at least radio resource control (RRC) protocol layer and packet data convergence protocol (PDCP) protocol layer.

The DU 204 is partly controlled by a CU 202. One DU 204 supports one or multiple radio transmission points 126.. One TRP 126 is supported by only one DU 204. The DU 204 terminates the F1 interface connected with the CU 202. The DU 204 hosts lower layer protocols e.g. radio link control (RLC) protocol layer, medium access control (MAC) protocol later and physical (PHY) protocol layer .

The interface 126 supports the exchange of information between two radio access nodes 120. The interface 126 enables the inter-connection of radio access nodes 120 supplied by different manufacturers. In at least some examples, data exchange over the interface 126 is between two radio access nodes 120 that belongs to the same operator or between operators with agreements.

A radio access node 120 can therefore comprise a radio transceiver (e.g. TRP 126) for radio communication over an air interface 124.
A radio access node 120 can therefore comprise a physical interface configured for direct radio-access-node to radio-access-node communication with another radio access node 120. The direct radio-access-node to radio-access-node communication can be via a physical interface, for example via the Xn interface.

In at least some examples, for example, as illustrated in FIGs 2 to 5, the first radio access node 120_1 sends a configuration signal 4 to configure the second radio access node 120_2 to configure the UE to measure (M2) and report the second information 24 to the second radio access node 120_2 and to send the received second information to the first radio access node 120_1. The configuration signal 4 at least specifies an identity of the user equipment 110. Optionally, the configuration signal 4 at least specifies a measurement configuration for the UE 110 e.g. specifies a measurement type and/or a measurement period.

In at least some examples, for example, as illustrated in FIGs 2 to 5, the first radio access node 120_1 sends a configuration signal 4 to configure the UE 110 to measure (M2) and then send the second information 24 directly to the first radio access node 120_1.

Thus in at least some examples (e.g. FIGs 2 & 4) the apparatus 10 comprises:
means for configuring the UE 110 to report first information 14 dependent on a first UE measurement M1 made at the UE 110 for the first radio access node 120_1, wherein the first UE measurement M1 is made *before* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2; and
means for configuring the UE 110 to report second information 24 dependent on a UE measurement made at the UE 110 for the first radio access node 120_1, wherein the first UE measurement M1 is made *after* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2

In at least some examples (e.g. FIGs 3 & 5), the apparatus 10 comprises: means for configuring the UE 110 to report first information 14 dependent on a first UE measurement M1 made at the UE 110 for the first radio access node 120_1, wherein the first UE measurement M1 is made *during* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2,
and/or
means for configuring the UE 110 to report second information 24 dependent on a second UE measurement M2 made at the UE 110 for the first radio access node 120_1, wherein the second UE measurement is made *during* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

In at least some examples the apparatus 10 comprises: means for configuring the UE 110 with a report destination to report second information 24 or other information. For example, report direct to the first apparatus 120_1 using dual access or report to the second radio access node 120_2.

In at least some examples (e.g. FIGs 4) the apparatus 10 comprises:
means for configuring the UE 110 to report *third* information 34 dependent on a third UE measurement M3 made at the UE 110 for the second radio access node 120_2, wherein the third UE measurement M3 is made *before* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2,
and/or
means for configuring the UE 110 to report *fourth* information 44 dependent on a fourth UE measurement M4 made at the UE 110 for the second radio access node 120_2, wherein the fourth UE measurement M4 is made *after* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

In at least some examples (e.g. FIG 5), the apparatus 10 comprises:
means for configuring the UE 110 to report third information 34 dependent on a third UE measurement M3 made at the UE 110 for the second radio access node 120_2, wherein the third UE measurement M3 is made *during* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2,
and/or
means for configuring the UE 110 to report *fourth* information 44 dependent on a fourth UE measurement M4 made at the UE 110 for the second radio access node 120_2, wherein the fourth UE measurement M4 is made *during* a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

In at least some examples the apparatus 10 comprises: means for communicating with the UE 110 to determine capability of the UE 110 to perform and report continuity measurements for a radio access node across a handover transition for that radio access node. The capability can, for example, provide: an indication of available memory, an indication of whether dual access at handover is supported, an indication of whether data reduction is supported. Example of data reduction include data compression, data quantization, consolidated reporting.

In at least some examples the apparatus 10 comprises: means for configuring the change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2, said means comprising means configured to enable serving-radio access node-handover of the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

The change 50 of radio access node 120 can be as a result of handover (HO).
The handover can be network controlled and configured. The handover can be network triggered. The handover can be triggered by the user equipment 110 (conditional handover).
Handover can per formed with simultaneous links to multiple radio access nodes (Dual Active HO, also know as soft handover). Handover can be without simultaneous links to multiple radio access nodes 120 (Mono Active HO, also known as hard handover)

A change of radio access node 120 can also occur in other situations such as Dual Connectivity.

The description has, so far, focused on the first radio access node 120_1 being the original primary radio access node before the change of primary radio access node to the second radio access node 120_2. However, the change 50 can happen in reverse. The first radio access node 120_1 can be the target that becomes the primary radio access node after the change of primary radio access node to the first radio access node 120_2.

The first radio access node 120_1 can therefore also be configured to operate with the functionality of the second radio access node 120_2.

The first radio access node 120_1 can for example comprise:

means for receiving, from a user equipment (UE) 110 or from the other network apparatus 120 third information 34 dependent on a UE measurement for the UE 110 before a change 50 of a primary radio access node for the UE 110 from the first radio access node 120_1 to a second radio access node 120_2 controlled by the apparatus 120, wherein the UE measurement for the UE 110 is a configured measurement at the UE 110 for the second radio access node 120_2; and/or means for receiving, from the user equipment (UE 110), fourth information 44 dependent on a configured UE 110 measurement, at the UE 110 for the second radio access node 120_2, wherein the UE measurement is made after a change 50 of the primary radio access node for the UE 110 from the first radio access node 120_1 to the second radio access node 120_2.

FIG 9 illustrates an example of a method 300.

The method 200 comprises, at block 302, receiving, from a user equipment (UE) in a wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node;

The method 200 comprises, at block 304, receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node;

The method 200 comprises, at block 306, controlling allocation of wireless network resources in dependence upon:

i) the received first information and

ii) the received second information.

In other examples the method 200 comprises at block 306, controlling training of a machine learning model to use:

i) the received first information and

ii) the received second information.

In at least some examples, controlling training of a machine learning model trains the machine learning model to control:

(i) allocation of communication resources associated with the first radio access node,

or

(ii) user equipment mobility management for the first radio access node, wherein user equipment mobility management dynamically controls operation the first radio access node and, optionally, one or more other radio access nodes and dynamically controls operation of the user equipment;

or

(iii) tracking a length and/or direction and/or quality of a communication path between the first radio access node and the user equipment.

In at least some example, the method also comprises configuring the other apparatus to report the second information wherein the configuration at least specifies an identity of the user equipment.

In at least some example, the method also additionally or alternatively comprises configuring the user equipment to report the second information directly to the network apparatus.

The various method and or blocks of the methods can be performed under control of a computer program as described below.

Fig 10 illustrates an example of a controller 400 suitable for use in an apparatus 120, 110. Implementation of a controller 400 may be as controller circuitry. The controller 400 may be implemented in hardware alone, have certain aspects in software including firmware alone or can be a combination of hardware and software (including firmware).

As illustrated in Fig 10 the controller 400 may be implemented using instructions that enable hardware functionality, for example, by using executable instructions of a computer program 406 in a general-purpose or special-purpose processor 402 that may be stored on a computer readable storage medium (disk, memory etc) to be executed by such a processor 402.

The processor 402 is configured to read from and write to the memory 404. The processor 402 may also comprise an output interface via which data and/or commands are output by the processor 402 and an input interface via which data and/or commands are input to the processor 402.

The memory 404 stores a computer program 406 comprising computer program instructions (computer program code) that controls the operation of the apparatus 120, 110 when loaded into the processor 402. The computer program instructions, of the computer program 406, provide the logic and routines that enables the apparatus to perform the methods illustrated in the accompanying Figs. The processor 402 by reading the memory 404 is able to load and execute the computer program 406.

The apparatus 120_1 comprises:
at least one processor 402; and
at least one memory 404 including computer program code,
the at least one memory storing instructions that, when executed by the at least one processor 402, cause the apparatus at least to:
control allocation of wireless network resources in dependence upon:
i) first information and
ii) second information,
wherein the first information is received, from a user equipment (UE) in a wireless network, and is dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node to a second radio access node, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node ;
and
wherein the second information is received from the second radio access node or from the user equipment, and is dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node to the second radio access node, wherein the second UE measurement

for the UE is a measurement at the UE of a signal transmitted by the first radio access node. As illustrated in Fig 11, the computer program 406 may arrive at the apparatus 120, 110 via any suitable delivery mechanism 408. The delivery mechanism 408 may be, for example, a machine readable medium, a computer-readable medium, a non-transitory computer-readable storage medium, a computer program product, a memory device, a record medium such as a Compact Disc Read-Only Memory (CD-ROM) or a Digital Versatile Disc (DVD) or a solid-state memory, an article of manufacture that comprises or tangibly embodies the computer program 406. The delivery mechanism may be a signal configured to reliably transfer the computer program 406. The apparatus 120, 110 may propagate or transmit the computer program 406 as a computer data signal.

Computer program instructions for causing an apparatus to perform at least the following or for performing at least the following:

receiving, from a user equipment (UE) in a wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node ;

receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node;

means for controlling allocation of wireless network resources in dependence upon:

i) the received first information and

ii) the received second information.

The computer program instructions may be comprised in a computer program, a non-transitory computer readable medium, a computer program product, a machine readable medium. In some but not necessarily all examples, the computer program instructions may be distributed over more than one computer program.

Although the memory 404 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable and/or may provide permanent/semi-permanent/ dynamic/cached storage.

Although the processor 402 is illustrated as a single component/circuitry it may be implemented as one or more separate components/circuitry some or all of which may be integrated/removable. The processor 402 may be a single core or multi-core processor.

References to 'computer-readable storage medium', 'computer program product', 'tangibly embodied computer program' etc. or a 'controller', 'computer', 'processor' etc. should be understood to encompass not only computers having different architectures such as single /multi- processor architectures and sequential (Von Neumann)/parallel architectures but also specialized circuits such as field-programmable gate arrays (FPGA), application specific circuits (ASIC), signal processing devices and other processing circuitry. References to computer program, instructions, code etc. should be understood to encompass software for a programmable processor or firmware such as, for example, the programmable content of a hardware device whether instructions for a processor, or configuration settings for a fixed-function device, gate array or programmable logic device etc.

As used in this application, the term 'circuitry' may refer to one or more or all of the following:
(a) hardware-only circuitry implementations (such as implementations in only analog and/or digital circuitry) and
(b) combinations of hardware circuits and software, such as (as applicable):
(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and
(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory or memories that work together to cause an apparatus, such as a mobile phone or server, to perform various functions and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (for example, firmware) for operation, but the software may not be present when it is not needed for operation.
This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit for a mobile device or a similar integrated circuit in a server, a cellular network device, or other computing or network device.

The blocks illustrated in the accompanying Figs may represent steps in a method and/or sections of code in the computer program 406. The illustration of a particular order to the blocks does not necessarily imply that there is a required or preferred order for the blocks and the order and arrangement of the block may be varied. Furthermore, it may be possible for some blocks to be omitted.

Handovers between cells are one of the main causes for possible service degradation/interruption. In the context of handovers, a major requirement for better automation is the determination (or even prediction) of points where handovers are triggered (both in time and space). With a precise knowledge of these handover points, handover triggers can be optimized to simultaneously minimize the number of handovers (and subsequently the ping-pong handovers) that are triggered as well as the radio link failures (too early and late handovers) that may result from improper handover settings. It is desired that the selected handover trigger settings are specific to a given cell-pair boundary and preferably to a given location and user mobility along that boundary. The minimization of service interruption caused by handovers is critical for Ultra-Reliable Low Latency Communication (URLLC), a major feature of 5G.

For prediction, the machine learning (ML) model needs a continuous stream of RSRP measurements, from specific cells, with certain measurement frequency. Close real-time ~10ms measurements are needed to get the highest performance gains.

For training, the ML model utilizes logged measurements from the specific cells with the same frequency as prediction. The training data is split into input and output frames. The input frame is N samples in time from K cells, and output frame is M samples after the input frame. The output frame is used to estimate the optimal handover target for the input, this process is called labeling. This allows the model to fingerprint the time series of measurements with the optimal handover decision (estimated by the labelling).

The predictive ML model can for example, be used to:
predict optimal handover conditions,
enhance CSI feedback,
provide better beam management, e.g., beam prediction in time, and/or spatial domain or beam selection accuracy improvement;
enhance UE positioning accuracy for different scenarios including, e.g., those with heavy no line of sight (NLOS) conditions

Many mobility failures are caused by the failure to receive the handover command on time from the source cell. To address this issue, conditional handover (CHO) has been introduced where the handover preparation is de-coupled from the execution phase. The source node 120_1 triggers the preparation of one or more target nodes 120_2 early when the UE 110 still has a very good radio link to the source node 120_1. The source node 120_1 provides the configurations of the prepared target nodes 120_2 to the UE 110 along with a CHO execution condition that is associated with each prepared target node 120_2. After receiving the configurations of the target nodes 120_2, the UE 110 evaluates the CHO execution conditions to trigger the handover execution when the condition is met. The remaining steps related to handover execution and completion are similar to baseline handover with some modifications to support early and late data forwarding from source node to the target node of the handover procedure
Dual Active (DA) Handover is a handover procedure that maintains the source node 120_1 connection after reception of RRC message (HO Command) for handover and until releasing the source node 120_1 after successful random access to the target node 120_2. The UE 110 continues to transmit and receive at the source cell 120_1 after receiving the HO request. The UE 110 performs simultaneous reception of user

data from source node 120_1 and target node 120_2. The UE 110 switches uplink transmission of user data to target cell after completion of RACH procedure. Without DA HO, normal HO can result in a an interruption of a few tens of milliseconds in the communication between the UE 110 and a node 120_1, 120_2. This interruption could be critical for a URLLC use case.

To support DAHO, the UE 110 keeps a Dual Stack in Active state. One user plane protocol stack, containing PHY, MAC and RLC layers, for the target node 120_2 while keeping the second user plane protocol stack, containing PHY, MAC and RLC layers, active for transmission and reception of user data with the source node 120_1. The UE receives user data simultaneously from both the source and target nodes 120_1, 120_2 . The Packet Data Convergence Protocol (PDCP) layer is reconfigured to a common PDCP entity for the source and target user plane protocol stacks. To secure in-sequence delivery of user data, PDCP Sequence Number (SN) continuation is maintained throughout the handover procedure. Ciphering/deciphering and header compression/decompression are handled separately in the common PDCP entity, depending on the origin/destination of the downlink/uplink data packet.

Training a local ML model using data collected locally requires information from before and after the change 50 in radio access node 120. It would be desirable to improve data sharing between serving radio access node 120_1 and targeted radio access node 120_2 before handover 50 and between the serving radio access node 120_2 and previously serving radio access node 120_1 after handover. This allows the shared date to be used to locally train a local ML model.

Using handover as a use case example, in order to perform ML HO prediction to predict the correct HO while avoiding the unnecessary HO (ping-pong due to short stay) it is required that training data contains future signal measurements M2 to be able to learn a ‘fingerprint’ from the signal pattens, which helps in deciding when to perform HO and when not (to avoid trigger false HO which may lead for radio link failure or ping-pong).

To enable historic/future data collection/sharing in radio network for local ML model training, it is proposed to introduce new procedures in two different use cases, namely with and without DA HO support.

FIG 12 shows an example within the context of mobility handover where measurements reported from the UE side are stored at serving base station 120_1 (before HO execution). Each measurement sample corresponds to a vector of radio measurements e.g. RSRP: $[R_1, R_2 \dots\dots.., R_N, R_{HO+1}, \dots. R_{HO+k}]$

During Period 1, before HO,: the vector is filled with received measurement reports from the UE at serving gNB 120_1. During Period 2, after HO, the vector is filled with data shared by the target gNB 120_2 through X2 interface (CU level) or f1 interface (DU level) interface.

The collection of labelled dataset during Period 2 is new and can be realized through different methods.

The length of Period1 and Period 2 of measurements that have to collected by the user terminal 110 and reported to network side 120_1, 120_2 then exchanged between the source node 120_1 and the target node 120_2 could be dependent on the quality and requirements of the local ML model that is to be trained.
In addition, it could depend also on the nature of the ML model output, for example, if it needs to predict ping-pong then it needs a longer period compared to just predicting HO regardless if it will end up in ping pong or not.

The reported information in period 2 could be also be, in addition or as an alternative to measurements, the outcomes of the a HO triggering based on period1 e.g. is it successful, not successful, ping-pong, wrong target, radio link failure, too early, too late, ….

Referring to FIG 12, in this example, the serving radio access node 122_1 (Serving gNB gNB_s) requests a target radio access node 120_2 (target gNB gNB_T) to trigger measurement reporting for the specific UE id of the UE 110.

At step 501, the UE 110 reports radio measurements (typically RSRP) to its serving gNB 120_1.

At step 502, the serving gNB_s120_1 identifies a HO event and identifies a possible targets gNB_T 120_2.

At step 503, the serving gNB_s 122_1 sends a HO request to the identified target gNB_T 120_2.

At step 504, the target gNB_T 120_2 sends and the serving gNB_s 122_1 receives the HO response with acceptance.

At step 505, the serving gNB_s triggers the HO by sending the HO command.

At step 506, the serving gNB 120_1 sends a measurement report request for the subject UE id including the desired configuration (such as the measurement type and period during which the measurements would be reported). This step could be combined as new information exchanged within HO request message or sent separately as a configuration message 4.

At step 507, the HO is successfully executed and the UE 110 is attached to the target node 120_2.

At step 508, the target gNB 120_2 requests measurements from the UE 110 following the indicated configuration from the previous serving gNB 120_1.

At step 509, the requested measurements are then reported by the UE 110 to the target gNB 120_2 (which is now the serving gNB).

At step 510, the gNB 120_2 transfers the collected measurements (corresponding to period 2 measurements and following the indicated configuration) to the gNB 120_1. In some but not necessarily all examples, target gNB 120_2 could transfer these measurements from many UEs 110 together instead of doing it for each UE, if measurements are not time critical.

Referring to FIG 13, in this example, the serving gNB 120_1 informs the UE 110 before HO execution to perform the required measurements on cells id(s) after HO execution. These measurements should then remain stored at UE 110 and shared with the new serving node 120_2 .

At step 521, the UE 110 reports radio measurements (typically RSRP) to its serving gNB 120_1.

At step 522, the serving gNB_s120_1 identifies a HO event and identifies a possible targets gNB_T 120_2.

At step 523, the serving gNB_s 122_1 sends a HO request to the identified target gNB_T 120_2.

At step 524, the target gNB_T 120_2 sends and the serving gNB_s 122_1 receives the HO response with acceptance.

At step 525, the serving gNB_s triggers the HO by sending the HO command.

At step 526, the serving gNB 120_1 sends to the UE 110 before HO execution, a measurement configuration 2 which indicates that the UE 110 should collect measurements following the indicated configuration (measurement type such as RSRP, period during which the measurements should be done as well as cells ids to measure). By this means, the serving gNB requests the UE to perform these specific measurements after HO is executed and the UE 110 is served by another gNB 120_2.

At step 527, the serving gNB 120_1 sends a measurement report request for the subject UE id including the desired configuration (such as the measurement type and period during which the measurements would be reported). This step could be combined as new information exchanged within HO request message or sent separately as a configuration message 4.

HO is successfully executed and the UE is attached to the target cell 120_2.

Once the HO is executed and the UE is attached to the target gNB, at step 528, the UE 110 sends, at step 530, an exceptional measurement reporting request which indicates that the UE 110 would like to report measurements stored at step 529 after HO.

At step 531, the target gNB 120_1 is then expected to respond to the UE 110 indicating acceptance.

Thereafter, once acceptance response is received from the target gNB 120_1, at step 532, the UE 110 sends the collected measurements to the target gNB 120_1.

At step 533, the gNB 120_2 transfers the collected measurements (corresponding to period 2 measurements and following the indicated configuration) to the gNB 120_1

Another use case example for conditional handover is illustrated in FIG 14.

In this case, the current source gNB (gNB1) 120_1 triggers the preparation of a set of gNBs (gNB2 and gNB3 in this example) 120_2 while the UE still has a very good radio link to the source gNB 120_1.

At steps 544, 545, the source gNB1 120_1 sends a Handover Request to the candidate cells gNB2 and gNB3 with additional measurement reporting request for the subject UE id (including related measurement configuration such as type and period)

Conventional CHO related steps for the admission control and sending back the handover response to the source gNB 120_1 follow at steps 546 to 549 .

Then at step 550, the source gNB1 120_1 sends to the UE 110 as part of RRC message a measurement configuration to collect measurements following the indicated configuration (measurement type such as RSRP, period during which the measurements should be done as well as cells ids to measure). In this way, the serving gNB 120_1 requests the UE 110 to perform these specific measurements after HO is executed and the UE 110 is served by another gNB 120_2.

The HO process will then proceed conventionally at steps 551 to 558.

After HO, at step 559, the UE 110 will then proceed with measurement collection as indicated by gNB1 120_1 while it is now attached to gNB2 120_2.

The collected measurements are stored at UE 110.

At step 560, the UE 110 requests its new serving gNB2 120_2 for exceptional measurement reporting.

At step 561, the UE 110 receives the response for gNB2 120_2 if it is allowed to proceed on the exceptional measurement reporting.

At step 562, the UE 110 sends the stored measurements to its serving gNB2 120_2.

At step 563, the gNB2 120_2 shares the received measurement reports to gNB1 120-1.

Another use case is illustrated in FIG 15. In this example, there is ML data transfer via Dual Active Handover via Xn interface between gNBs and/or UE UL reporting The UE 110 has a Dual Stack in Active state. One user plane protocol stack is maintained for active for transmission and reception of user data with the source node 120_1 while a second user plane protocol stack is maintained active for transmission and reception of user data with the target node 120_2. The necessary training data from both source gNB 120_1 and target gNB 120_2 can be transferred via the Xn interface. With the benefit introduced by DAPS framework, some of the critical training data such as measurement report can be directly transferred by the

UE 110 to both source node 120_1 and target node 120_2 simultaneously via UL channels .

At step 571, there is a capability signaling configuration exchange between the UE 110 and the source node 120_1. The capability exchange determines the type of the training data, the amount of the data transferred via inter-gNB signaling channels and via UE UL reporting. A new RRC signaling can be introduced to convey the configuration parameters based on the UE capability information.

At step 573, the source gNB 120_1 configures the UE measurement procedures and the UE 110 reports Measurement Report according to the Measurement Configuration .

At step 574, the source gNB 120_1 decides to handover the UE 110, based on Measurement Report and Radio Resource management (RRM) information.

At step 575, the source gNB 120_1 issues a Handover Request message to the target gNB passing a transparent RRC container with necessary information to prepare the handover at the target side.

At step 576, the target gNB 120_2 prepares the handover and sends the HANDOVER REQUEST ACKNOWLEDGE to the source gNB 120_1, which includes a transparent container to be sent to the UE 110 as an RRC message to perform the handover. The target gNB 120_2 also indicates to the UE 110 if a DAPS Handover is accepted.

At step 577, the source gNB 120_1 triggers the UE handover by sending an RRC Reconfiguration message (handover command) to the UE 110.

For Data Radio Bearers (DRBs) configured with DAPS, the source gNB 120_1 sends the EARLY STATUS TRANSFER at step 578.

At step 579, the UE 110 synchronizes to the target node 120_2 and completes the RRC handover procedure by sending, at step 580, the RRC Reconfiguration Complete message to target gNB 120_2.

At step 581, the target gNB 120_2 sends the HANDOVER SUCCESS message to the source gNB 120_1 to inform that the UE 110 has successfully accessed the target node 120_2.

At step 582, the source gNB 120_1 sends the SN STATUS TRANSFER message for Data Radio Bearers (DRBs) configured with DAPS as per EARLY STATUS TRANSFER.

As one of the main benefit of DAPS handover procedure, at step 583, the UE 110 can prepare the new training data for both source node 120_1 and target node 120_2 and transmit this data, at step 584, via the UL channels to both source node 120_1 and target node 120_2.

Where a structural feature has been described, it may be replaced by means for performing one or more of the functions of the structural feature whether that function or those functions are explicitly or implicitly described.

In some but not necessarily all examples, the user equipment 110 is configured to communicate data from the user equipment 110 with or without local storage of the data in a memory 404 at the user equipment 110 and with or without local processing of the data by circuitry or processors at the user equipment 110.

The data may, for example, be measurement data. The data may be stored in processed or unprocessed format remotely at one or more devices. The data may be stored in the Cloud. The data may be processed remotely at one or more devices. The data may be partially processed locally and partially processed remotely at one or more devices.

The data may be communicated to the remote devices wirelessly via short range radio communications such as Wi-Fi or Bluetooth, for example, or over long-range cellular radio links. The apparatus may comprise a communications interface such as, for example, a radio transceiver for communication of data.

The user equipment 110 may be part of the Internet of Things forming part of a larger, distributed network.

The processing of the data, whether local or remote, may be for the purpose of health monitoring, data aggregation, patient monitoring, vital signs monitoring or other purposes.

The processing of the data, whether local or remote, may involve artificial intelligence or machine learning algorithms. The data may, for example, be used as learning input to train a machine learning network or may be used as a query input to a machine learning network, which provides a response. The machine learning network may for example use linear regression, logistic regression, vector support machines or an acyclic machine learning network such as a single or multi hidden layer neural network.

The processing of the data, whether local or remote, may produce an output. The output may be communicated to the user equipment where it may produce an output sensible to the subject such as an audio output, visual output or haptic output.

As used here ‘module’ refers to a unit or apparatus that excludes certain parts/components that would be added by an end manufacturer or a user. The radio access node can be a module. The user equipment 110 can be a module.

In at least some example, the configuration signals are data structure encoding information and configured to achieve a technical effect (configuration) at the destination. In at least some examples, the data structures are formatted as extensible mark-up language (XML) and comprise nested information elements.

The above-described examples find application as enabling components of: automotive systems; telecommunication systems; electronic systems including consumer electronic products; distributed computing systems; media systems for generating or rendering media content including audio, visual and audio visual content and mixed, mediated, virtual and/or augmented reality; personal systems including personal health systems or personal fitness systems; navigation systems; user interfaces also known as human machine interfaces; networks including cellular, non-cellular, and optical networks; ad-hoc networks; the internet; the internet of things; virtualized networks; and related software and services.

The apparatus can be provided in an electronic device, for example, a mobile terminal, according to an example of the present disclosure. It should be understood, however, that a mobile terminal is merely illustrative of an electronic device that would benefit from examples of implementations of the present disclosure and, therefore, should not be taken to limit the scope of the present disclosure to the same. While in certain implementation examples, the apparatus can be provided in a mobile terminal, other types of electronic devices, such as, but not limited to: mobile communication devices, hand portable electronic devices, wearable computing devices, portable digital assistants (PDAs), pagers, mobile computers, desktop computers, televisions, gaming devices, laptop computers, cameras, video recorders, GPS devices and other types of electronic systems, can readily employ examples of the present disclosure. Furthermore, devices can readily employ examples of the present disclosure regardless of their intent to provide mobility.

The term ‘comprise’ is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising Y indicates that X may comprise only one Y or may comprise more than one Y. If it is intended to use ‘comprise’ with an exclusive meaning then it will be made clear in the context by referring to “comprising only one...” or by using “consisting”.

In this description, the wording ‘connect’, ‘couple’ and ‘communication’ and their derivatives mean operationally connected/coupled/in communication. It should be appreciated that any number or combination of intervening components can exist (including no intervening components), i.e., so as to provide direct or indirect connection/coupling/communication. Any such intervening components can include hardware and/or software components.

As used herein, the term "determine/determining" (and grammatical variants thereof) can include, not least: calculating, computing, processing, deriving, measuring, investigating, identifying, looking up (for example, looking up in a table, a database, or another data structure), ascertaining and the like. Also, "determining" can include receiving (for example, receiving information), accessing (for example, accessing data in a memory), obtaining and the like. Also, " determine/determining" can include resolving, selecting, choosing, establishing, and the like.

In this description, reference has been made to various examples. The description of features or functions in relation to an example indicates that those features or functions are present in that example. The use of the term ‘example’ or ‘for example’ or ‘can’ or ‘may’ in the text denotes, whether explicitly stated or not, that such features or functions are present in at least the described example, whether described as an example or not, and that they can be, but are not necessarily, present in some of or all other examples. Thus ‘example’, ‘for example’, ‘can’ or ‘may’ refers to a particular instance in a class of examples. A property of the instance can be a property of only that instance or a property of the class or a property of a sub-class of the class that includes some but not all of the instances in the class. It is therefore implicitly disclosed that a feature described with reference to one example but not with reference to another example, can where possible be used in that other example as part of a working combination but does not necessarily have to be used in that other example.

Although examples have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without departing from the scope of the claims.

Features described in the preceding description may be used in combinations other than the combinations explicitly described above.

Although functions have been described with reference to certain features, those functions may be performable by other features whether described or not.

Although features have been described with reference to certain examples, those features may also be present in other examples whether described or not.

The term ‘a’, ‘an’ or ‘the’ is used in this document with an inclusive not an exclusive meaning. That is any reference to X comprising a/an/the Y indicates that X may comprise only one Y or may comprise more than one Y unless the context clearly indicates the contrary. If it is intended to use ‘a’, ‘an’ or ‘the’ with an exclusive meaning then it will be made clear in the context. In some circumstances the use of ‘at least one’ or ‘one or more’ may be used to emphasis an inclusive meaning but the absence of these terms should not be taken to infer any exclusive meaning.

The presence of a feature (or combination of features) in a claim is a reference to that feature or (combination of features) itself and also to features that achieve substantially the same technical effect (equivalent features). The equivalent features include, for example, features that are variants and achieve substantially the same result in substantially the same way. The equivalent features include, for example, features that perform substantially the same function, in substantially the same way to achieve substantially the same result.

In this description, reference has been made to various examples using adjectives or adjectival phrases to describe characteristics of the examples. Such a description of a characteristic in relation to an example indicates that the characteristic is present in some examples exactly as described and is present in other examples substantially as described.

The above description describes some examples of the present disclosure however those of ordinary skill in the art will be aware of possible alternative structures and method features which offer equivalent functionality to the specific examples of such structures and features described herein above and which for the sake of brevity and clarity have been omitted from the above description. Nonetheless, the above description should be read as implicitly including reference to such alternative structures and method features which provide equivalent functionality unless such alternative structures or method features are explicitly excluded in the above description of the examples of the present disclosure.

Whilst endeavoring in the foregoing specification to draw attention to those features believed to be of importance it should be understood that the Applicant may seek protection via the claims in respect of any patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not emphasis has been placed thereon.

I/we claim:

CLAIMS

1. A network apparatus comprising:
means for receiving, from a user equipment (UE) in a wireless network, first information dependent on a first UE measurement for the UE before a change of a primary radio access node for the UE from a first radio access node controlled by the apparatus to a second radio access node controlled by another apparatus, wherein the first UE measurement for the UE is a measurement at the UE of a signal transmitted by the first radio access node ;
means for receiving from the another apparatus or from the user equipment, second information dependent on a second UE measurement for the UE after the change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the second UE measurement for the UE is a configured measurement at the UE of a signal transmitted by the first radio access node;
means for controlling allocation of wireless network resources in dependence upon:
i) the received first information and
ii) the received second information.

2. A network apparatus as claimed in claim 1 comprising:
means for controlling future allocation of network resources in dependence upon an assessment, using at least the received first information and the received second information, of an effect of an allocation of network resources made in dependence upon at least the first information.

3. A network apparatus as claimed in any preceding claim comprising:
means for receiving from the other apparatus or the UE, fourth information dependent on a fourth UE measurement for the UE after a change of the primary radio access node for the UE from the first radio access node controlled by the apparatus to the second radio access node controlled by the other apparatus, wherein the fourth UE measurement for the UE is a configured measurement at the UE for the second radio access node.

4. A network apparatus as claimed in any preceding claim comprising:

means for training a machine learning model for allocation of communication resources associated with the first radio access node using, wherein the training uses at least the first information and the second information.

5. A network apparatus as claimed in any preceding claim, when dependent upon claim 4, comprising:
means for training a machine learning model for allocation of communication resources associated with the first radio access node using, wherein the training uses at least the first information, the second information, the third information and the fourth information.

6. A network apparatus as claimed in any preceding claim, comprising:
means for configuring the other apparatus to report the second information wherein the configuration at least specifies an identity of the user equipment.

7. A network apparatus as claimed in claim 6,
wherein the configuration at least specifies a measurement configuration for the UE.

8. A network apparatus as claimed in any preceding claim, comprising:
means for configuring the UE to report first information dependent on a first UE measurement made at the UE for the first radio access node, wherein the first UE measurement is made before a change of the primary radio access node for the UE from the first radio access node to the second radio access node; and
means for configuring the UE to report second information dependent on a UE measurement made at the UE for the first radio access node, wherein the first UE measurement is made after a change of the primary radio access node for the UE from the first radio access node to the second radio access node

9. A network apparatus as claimed in any preceding claim, comprising:
means for configuring the UE to report first information dependent on a first UE measurement made at the UE for the first radio access node, wherein the first UE measurement is made during a change of the primary radio access node for the UE from the first radio access node to the second radio access node,
and/or

means for configuring the UE to report second information dependent on a second UE measurement made at the UE for the first radio access node, wherein the second UE measurement is made during a change of the primary radio access node for the UE from the first radio access node to the second radio access node

10. A network apparatus as claimed in any preceding claim, comprising:
means for configuring the UE with a report destination to report second information.

11. A network apparatus as claimed in any preceding claim, comprising means for configuring the UE to report third information dependent on a third UE measurement made at the UE for the second radio access node, wherein the third UE measurement is made before a change of the primary radio access node for the UE from the first radio access node to the second radio access node,
and/or
means for configuring the UE to report fourth information dependent on a fourth UE measurement made at the UE for the second radio access node, wherein the fourth UE measurement is made after a change of the primary radio access node for the UE from the first radio access node to the second radio access node.

12. A network apparatus as claimed in any preceding claim, comprising
means for configuring the UE to report third information dependent on a third UE measurement made at the UE for the second radio access node, wherein the third UE measurement is made during a change of the primary radio access node for the UE from the first radio access node to the second radio access node,
and/or
means for configuring the UE to report fourth information dependent on a fourth UE measurement made at the UE for the second radio access node, wherein the fourth UE measurement is made during a change of the primary radio access node for the UE from the first radio access node to the second radio access node.

13. A network apparatus as claimed in any preceding claim, comprising:
means for configuring the UE with a report destination to report third information,
and/or
means for configuring the UE with a report destination to report fourth information.

14. A network apparatus as claimed in any preceding claim, comprising:
means for receiving, from a user equipment (UE) or from the other network apparatus third information dependent on a UE measurement for the UE before a change of a primary radio access node for the UE from the first radio access node to a second radio access node controlled by the apparatus, wherein the UE measurement for the UE is a configured measurement at the UE for the second radio access node; and
means for receiving, from the user equipment (UE), fourth information dependent on a configured UE measurement, at the UE for the second radio access node, wherein the UE measurement is made after a change of the primary radio access node for the UE from the first radio access node to the second radio access node.

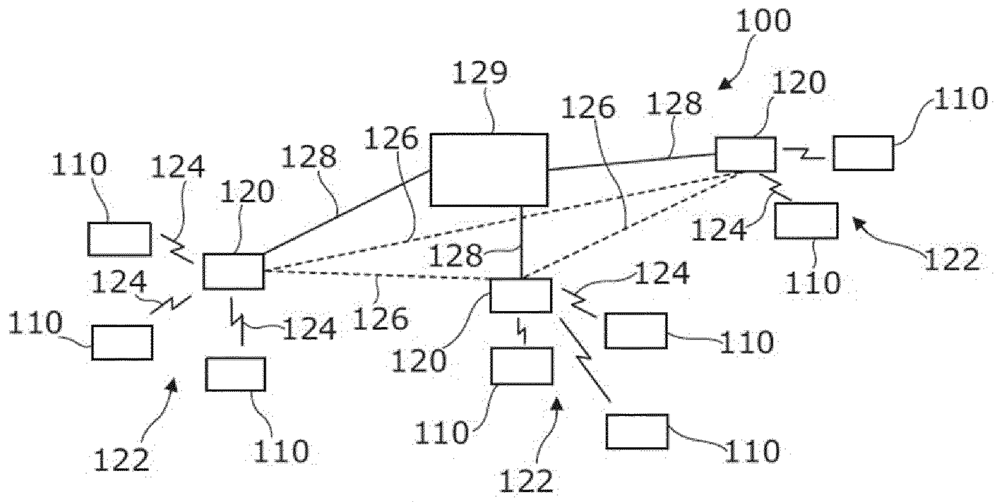

100
129
126
128
120
110
124
122

Fig. 1

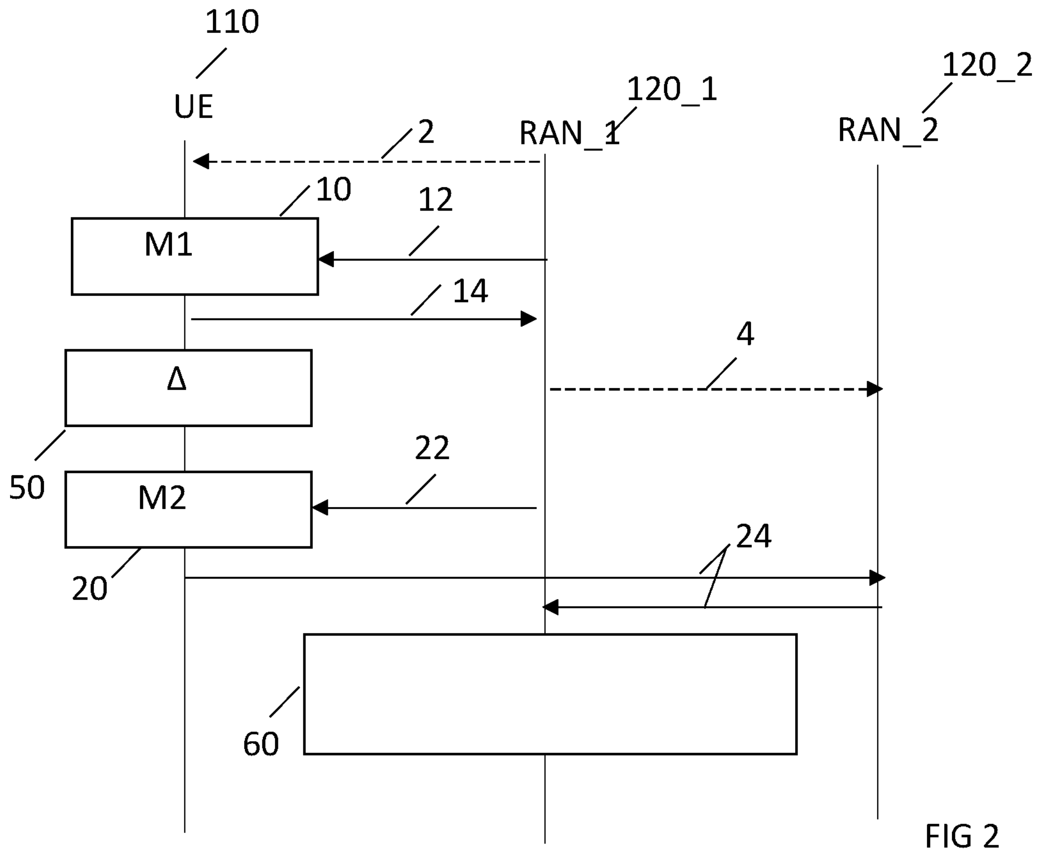

110
UE
120_1
RAN_1
120_2
RAN_2
2
10
M1
12
14
4
Δ
50
22
M2
20
24
60

FIG 2

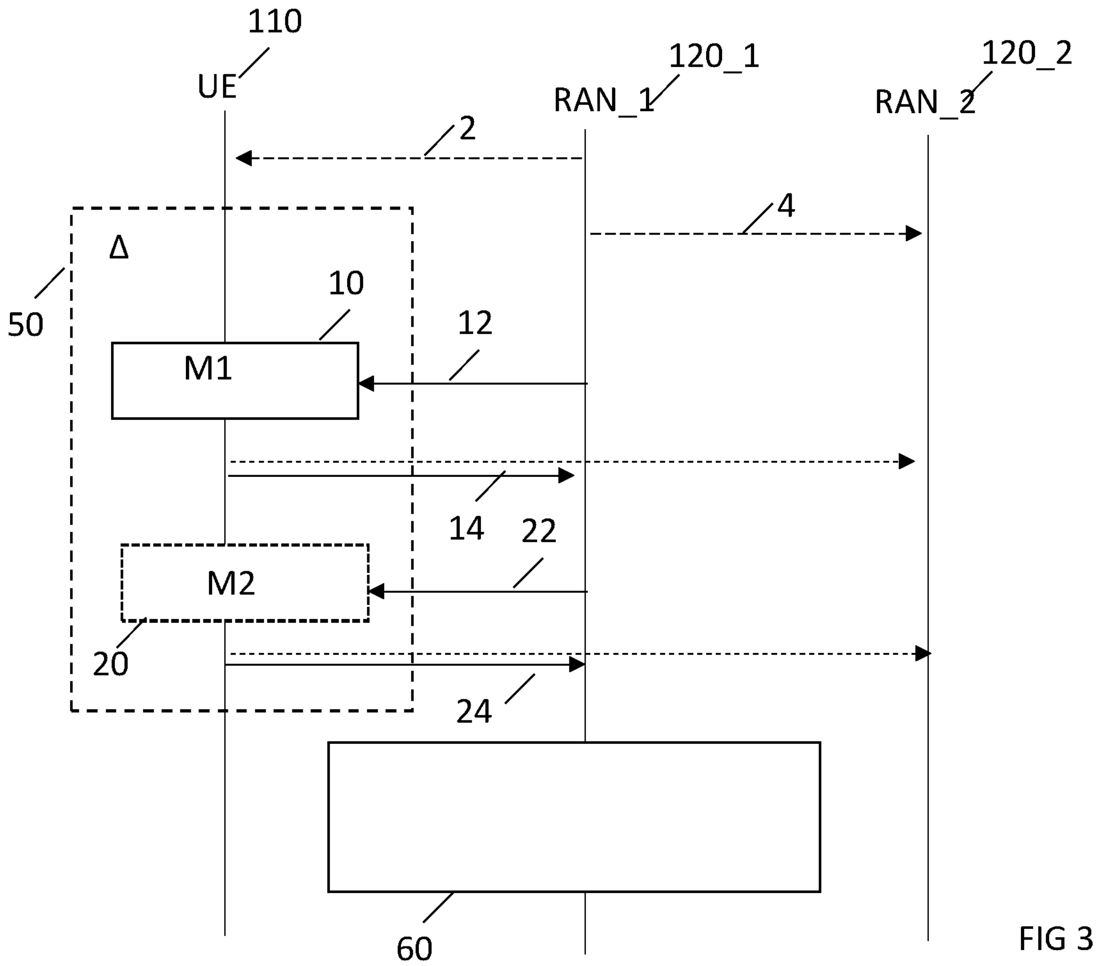
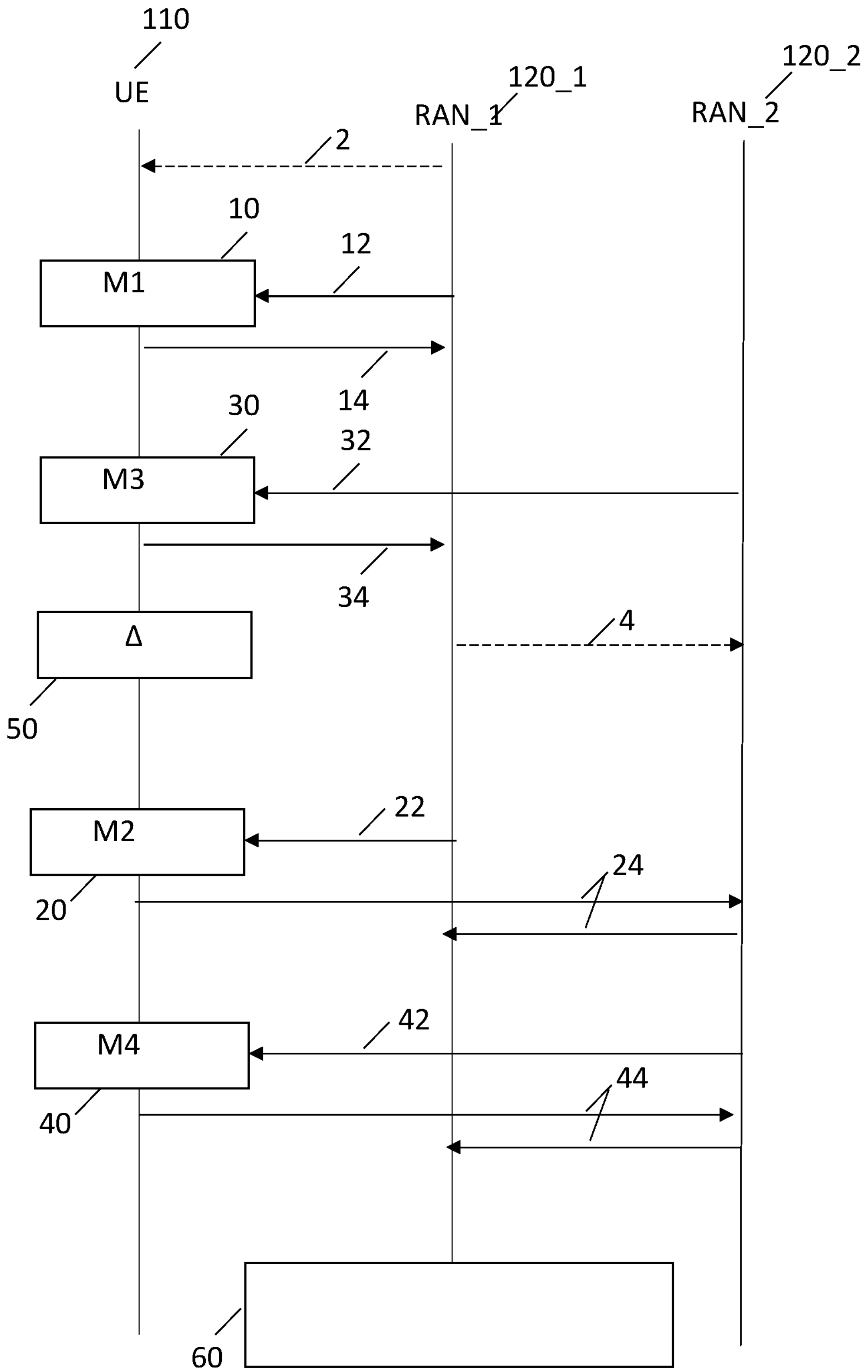


FIG 3



110
UE
120_1
RAN_1
120_2
RAN_2
2
10
M1
12
14
30
M3
32
34
Δ
4
50
M2
22
20
24
M4
42
40
44
60

FIG 4

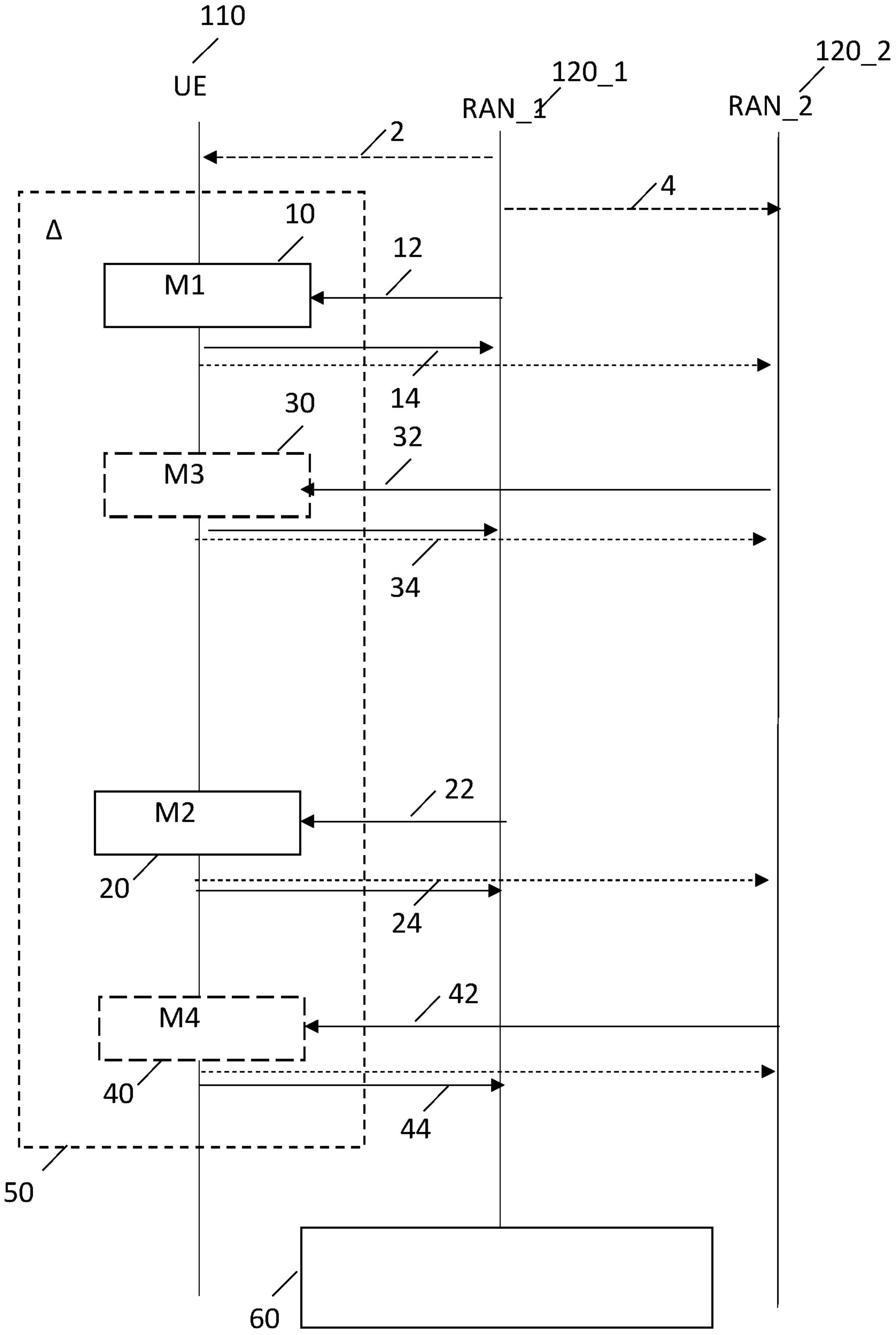

110
UE
120_1
RAN_1
120_2
RAN_2
2
4
Δ
10
M1
12
14
30
M3
32
34
M2
22
20
24
M4
42
40
44
50
60

FIG 5

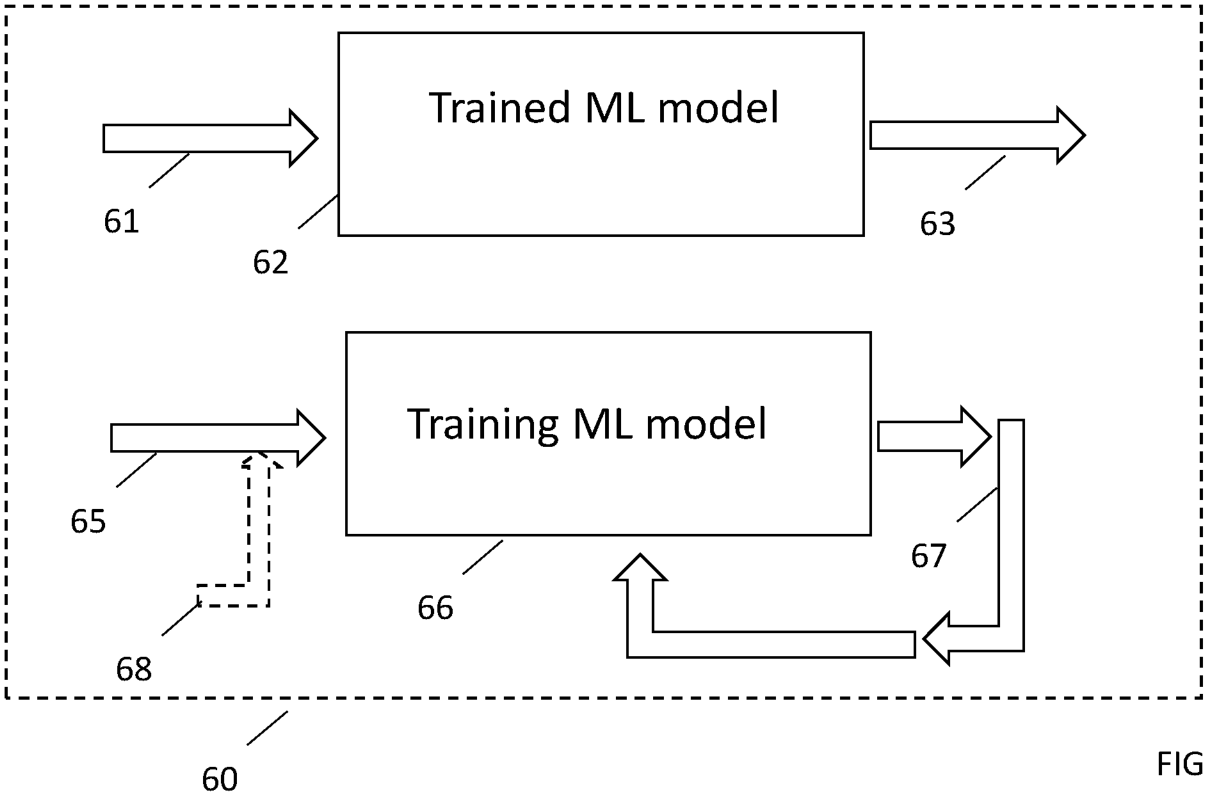

Trained ML model
61
62
63
Training ML model
65
66
67
68
60

FIG 6

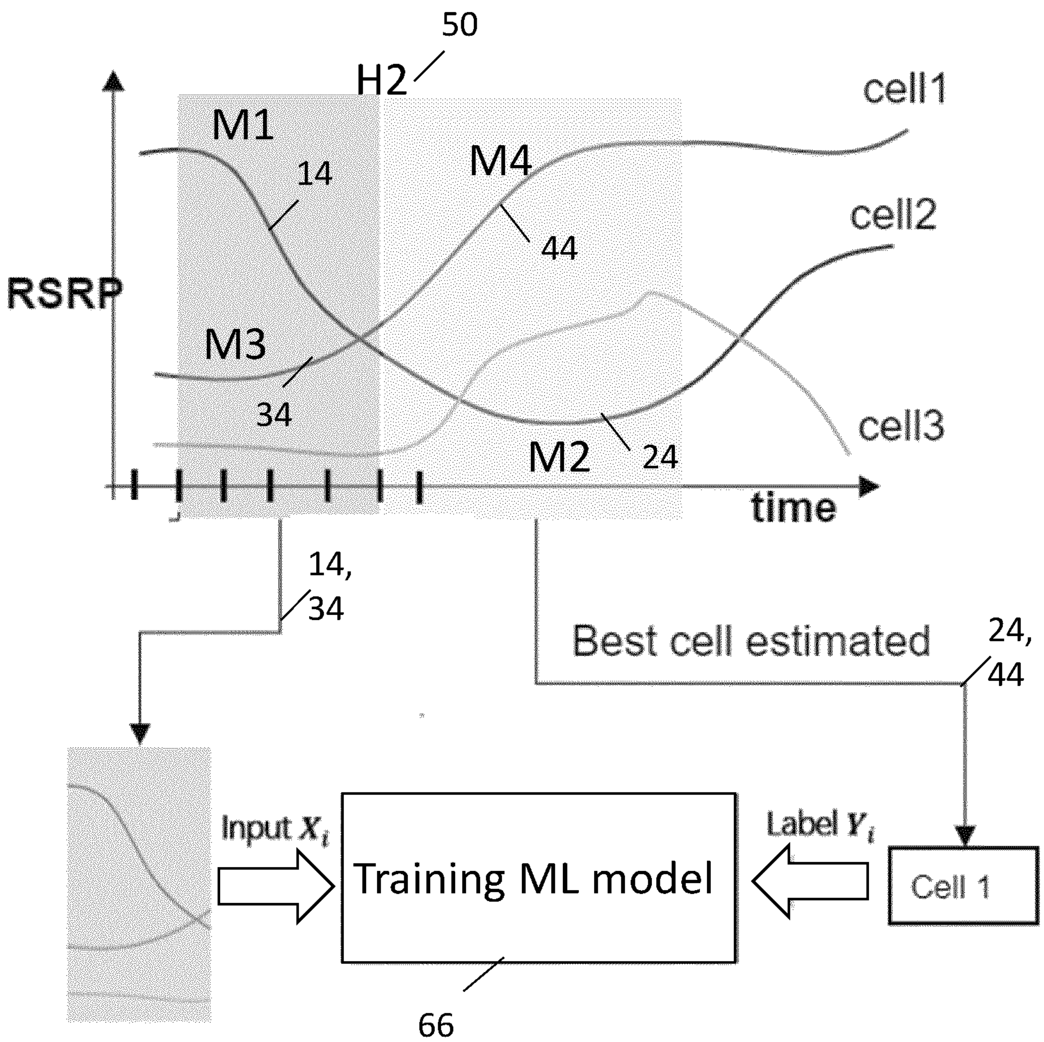
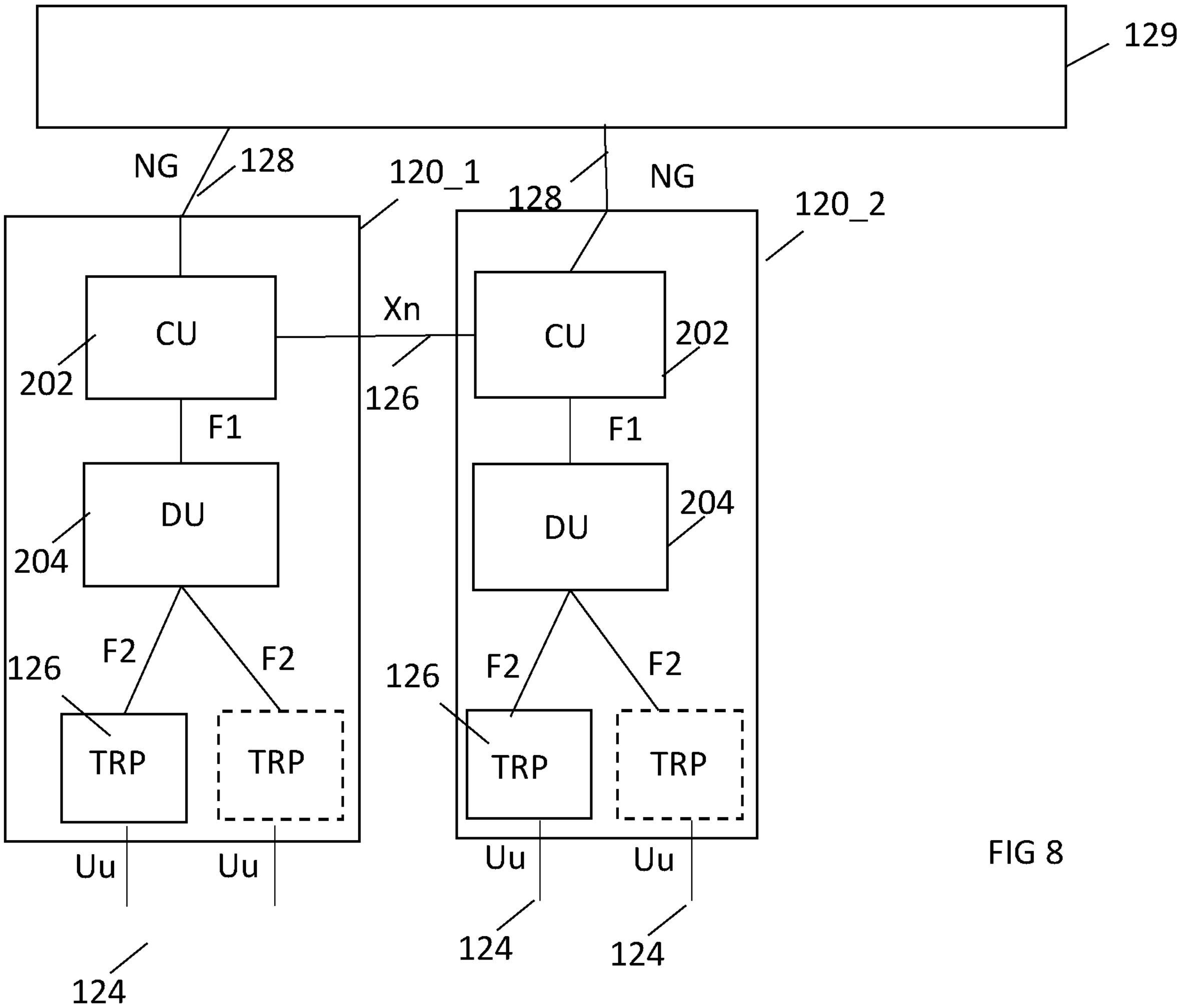

50
H2
cell1
M1
14
M4
44
cell2
RSRP
M3
34
cell3
M2
24
time
14,
34
Best cell estimated
24,
44
Input X_i
Training ML model
Label Y_i
Cell 1
66

FIG 7


129
NG
128
120_1
128
NG
120_2
CU
Xn
CU
202
202
126
F1
F1
DU
204
DU
204
F2
F2
126
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TRP
TRP
TRP
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Uu
Uu
Uu
Uu
124
124
124

FIG 8

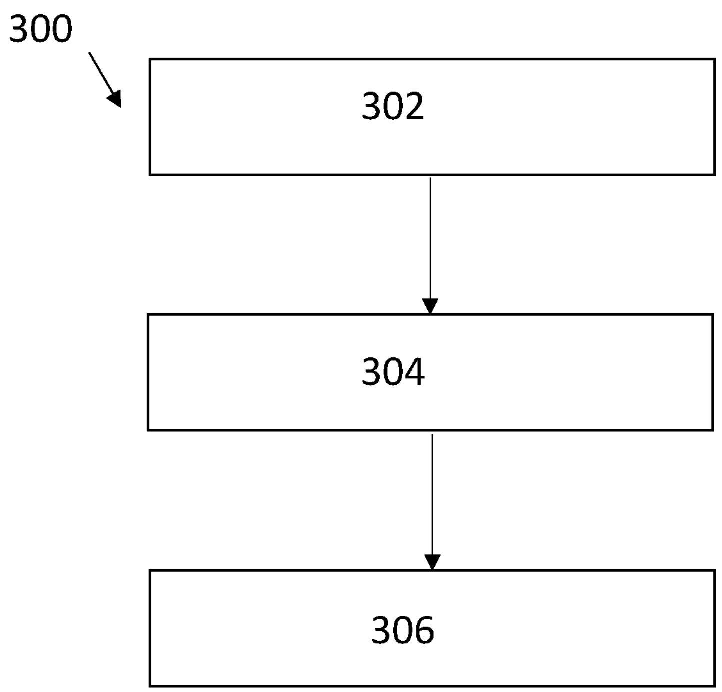

FIG 9

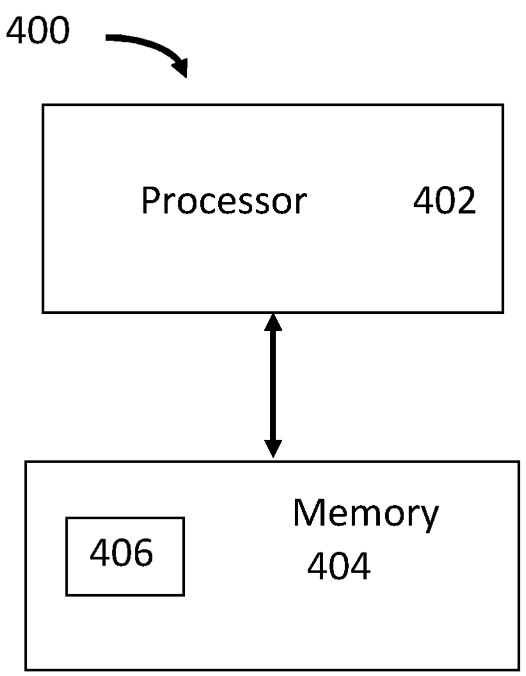

FIG 10

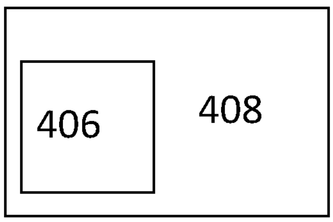

FIG 11

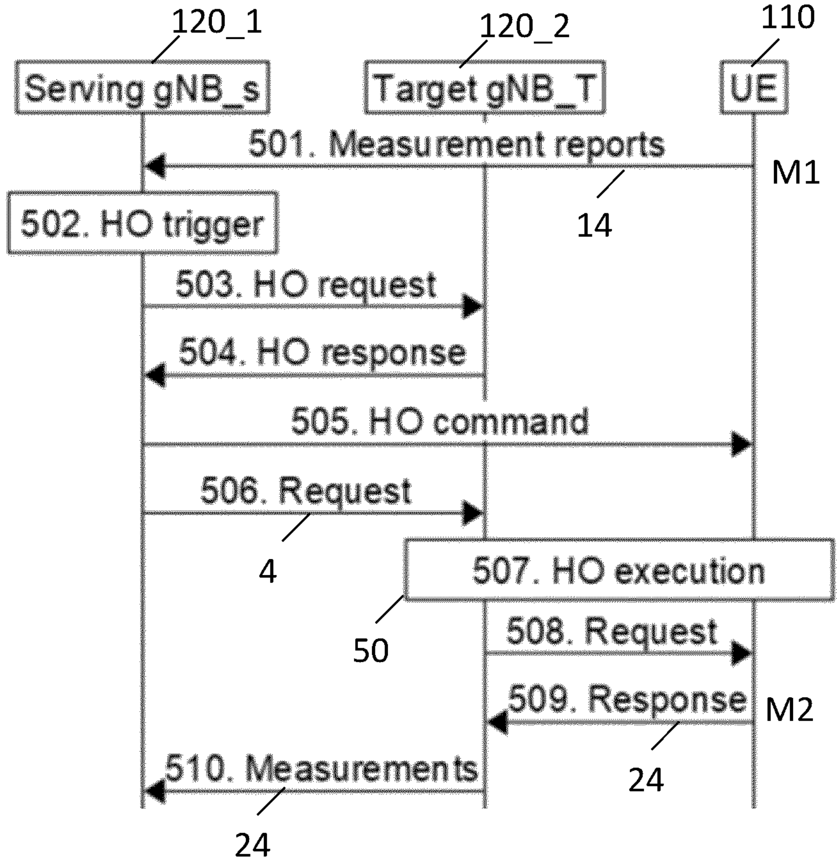
120_1
120_2
110
Serving gNB_s
Target gNB_T
UE
501. Measurement reports
M1
14
502. HO trigger
503. HO request
504. HO response
505. HO command
506. Request
4
507. HO execution
50
508. Request
509. Response
M2
24
510. Measurements
24

FIG 12

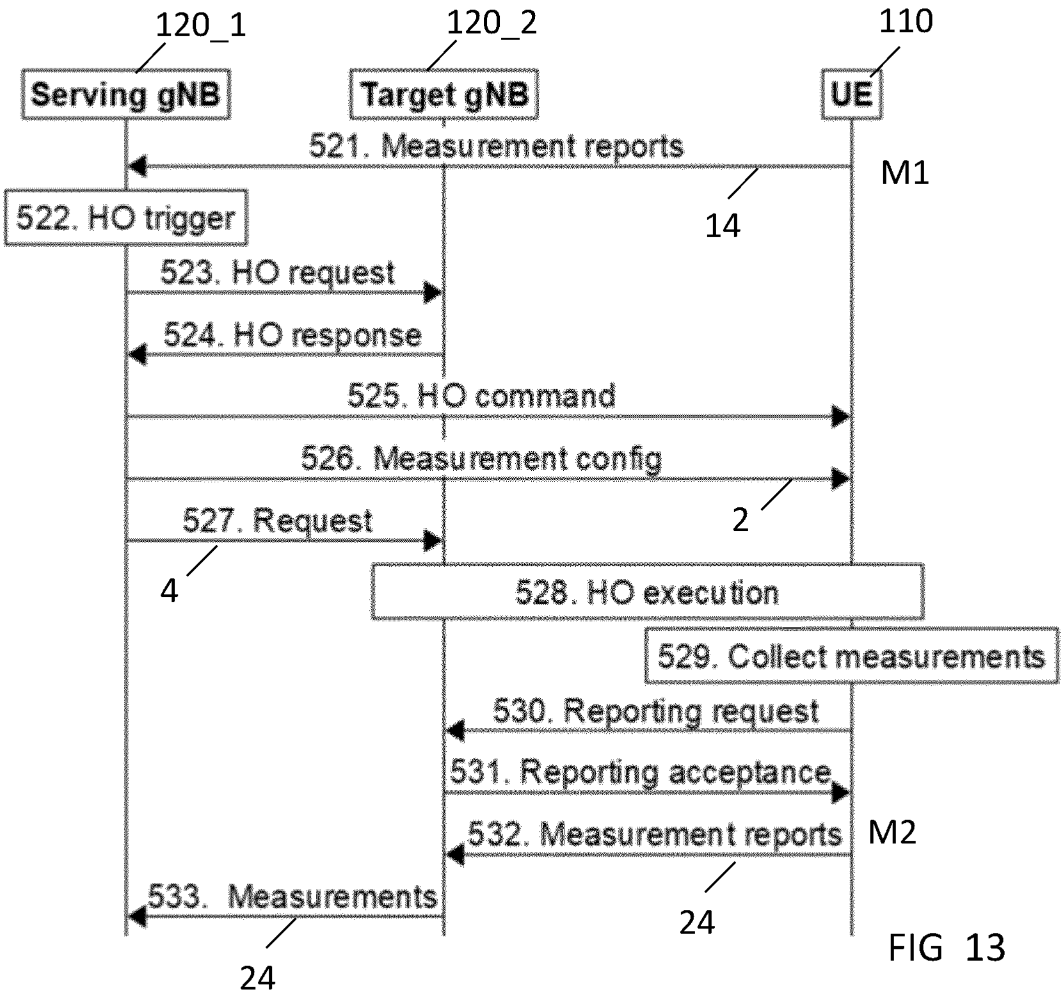
120_1
120_2
110
Serving gNB
Target gNB
UE
521. Measurement reports
M1
14
522. HO trigger
523. HO request
524. HO response
525. HO command
526. Measurement config
2
527. Request
4
528. HO execution
529. Collect measurements
530. Reporting request
531. Reporting acceptance
532. Measurement reports
M2
24
533. Measurements
24

FIG 13

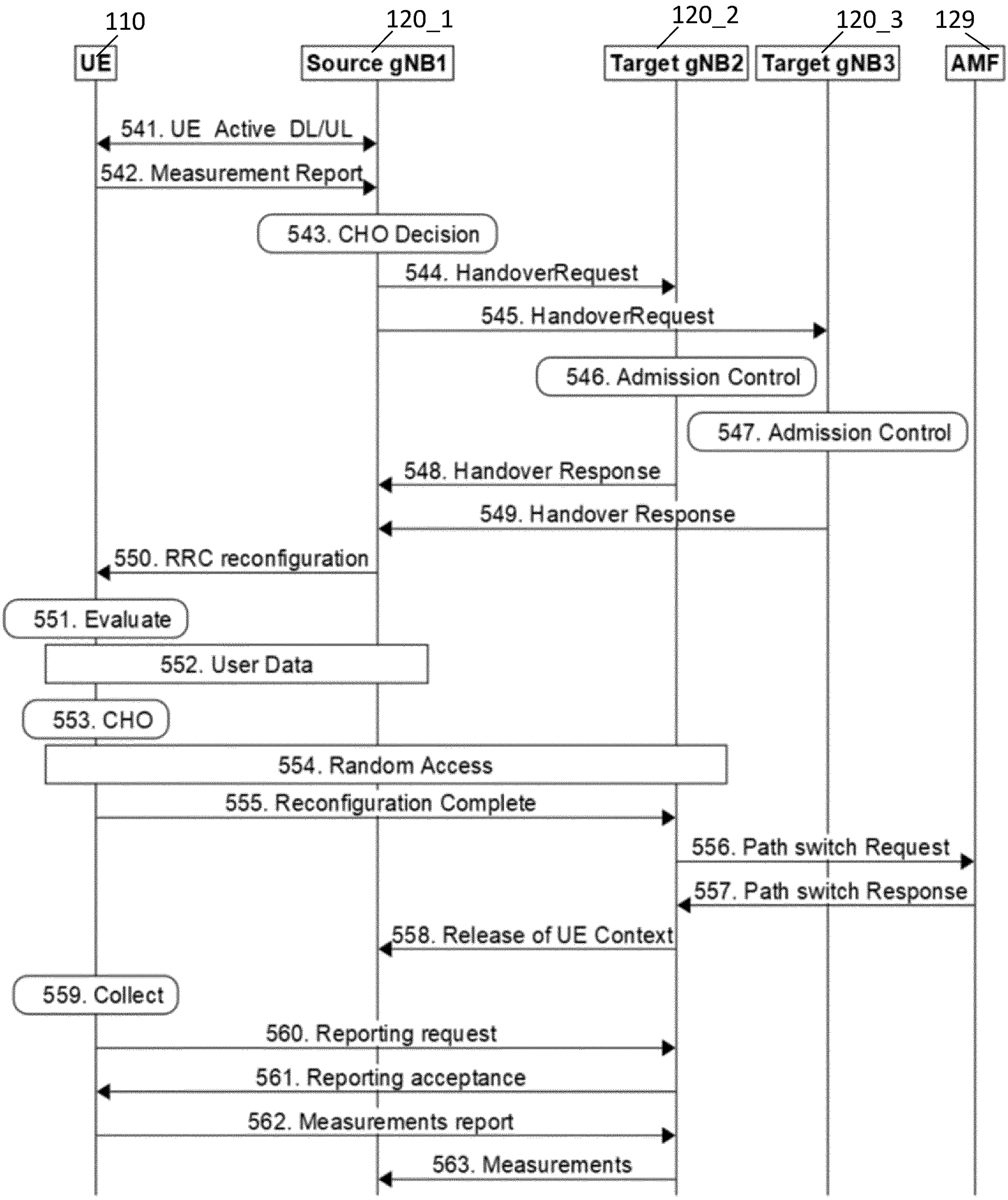
110
120_1
120_2
120_3
129
UE
Source gNB1
Target gNB2
Target gNB3
AMF
541. UE Active DL/UL
542. Measurement Report
543. CHO Decision
544. HandoverRequest
545. HandoverRequest
546. Admission Control
547. Admission Control
548. Handover Response
549. Handover Response
550. RRC reconfiguration
551. Evaluate
552. User Data
553. CHO
554. Random Access
555. Reconfiguration Complete
556. Path switch Request
557. Path switch Response
558. Release of UE Context
559. Collect
560. Reporting request
561. Reporting acceptance
562. Measurements report
563. Measurements

FIG 14

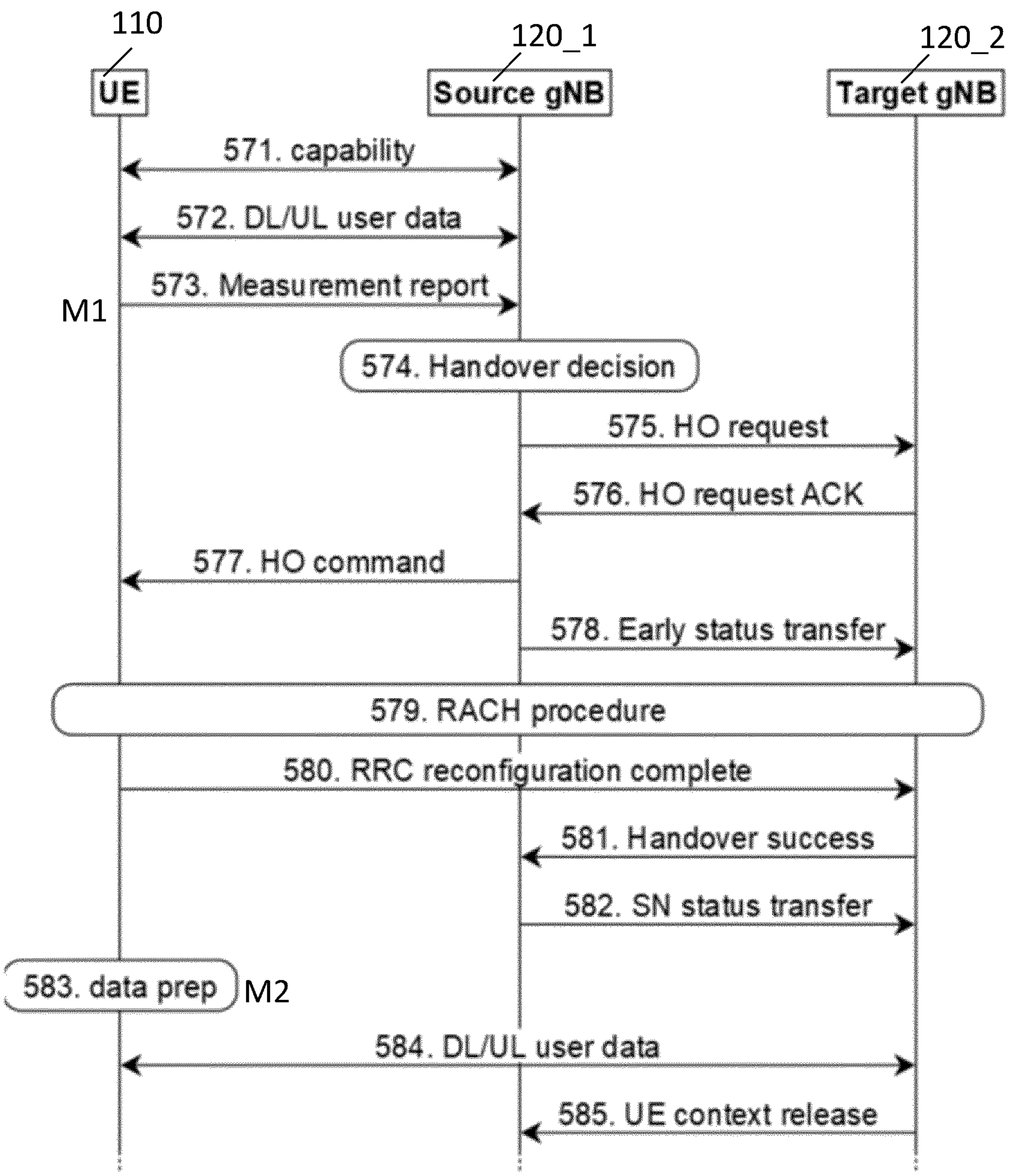
110
120_1
120_2
UE
Source gNB
Target gNB
571. capability
572. DL/UL user data
573. Measurement report
M1
574. Handover decision
575. HO request
576. HO request ACK
577. HO command
578. Early status transfer
579. RACH procedure
580. RRC reconfiguration complete
581. Handover success
582. SN status transfer
583. data prep
M2
584. DL/UL user data
585. UE context release

FIG 15

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/062375

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W24/10 H04W36/08 H04W92/20
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 Y T	WO 2022/209234 A1 (NEC CORP [JP]) 6 October 2022 (2022-10-06) the whole document & US 2024/163741 A1 (FILIN STANISLAV [JP] ET AL) 16 May 2024 (2024-05-16) column 181 - column 195; figures 15,27 column 275 - column 301 -----	1-6,8,9, 11,12,14 7,10,13 1,4,6
Y	WO 2022/269567 A1 (ERICSSON TELEFON AB L M [SE]) 29 December 2022 (2022-12-29) paragraph [0056] - paragraph [0089]; figure 5 -----	7,10,13

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[x] Further documents are listed in the continuation of Box C.

[x] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 July 2024	30/07/2024

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/062375

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	HUAWEI (SUMMARY RAPPORTEUR): "Pre-meeting summary of 8.13.3 (Huawei)", 3GPP DRAFT; R2-2208939, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. RAN WG2, no. electronic; 20220817 - 20220829 3 September 2022 (2022-09-03), XP052262208, Retrieved from the Internet: URL:https://ftp.3gpp.org/tsg_ran/WG2_RL2/TSGR2_119-e/Docs/R2-2208939.zip R2-2208939 Pre-meeting summary of 8.13.3.docx [retrieved on 2022-09-03] page 14	1-14

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/062375

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		JP WO2022209234 A1	06-10-2022
		US 2024163741 A1	16-05-2024
		WO 2022209234 A1	06-10-2022
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		EP 4360353 A1	01-05-2024
		WO 2022269567 A1	29-12-2022