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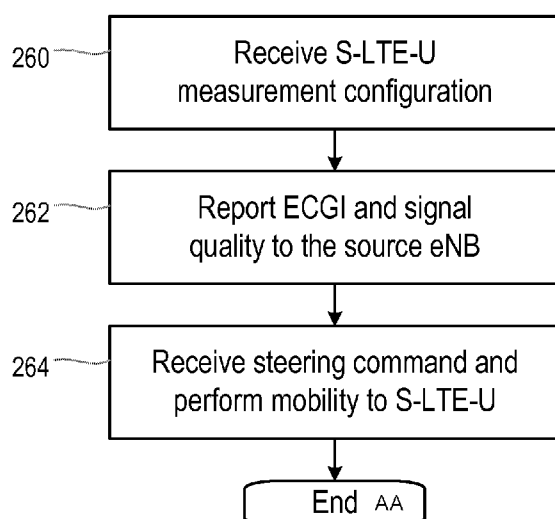


Figure 7

(57) Abstract: A wireless device receives a measurement configuration command from a network node and, if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the network node, it reads a cell identity from system broadcast information from a target cell, measures a signal quality of the target cell and reports the cell identity and the measured signal quality of the target cell to the network node. Otherwise, if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the network node, then it reads a non-unique cell identity of a target cell, measures a signal quality of the target cell and reports the non-unique cell identity, a carrier frequency, and the measured signal quality of the target cell to the network node.



STANDALONE LTE UNLICENSED MOBILITY**Technical Field**

The present disclosure relates to methods and devices for enabling mobility when using
5 Standalone LTE Unlicensed nodes in a network.

Background

Long-Term Evolution (LTE) is a radio access technology (RAT) that is currently widely used in
cellular communication networks. Typically, the radio spectrum (frequency/bandwidth) used by
10 LTE is dedicated to LTE. This has the advantage that an LTE system does not need to deal
with the issue of coexistence (where multiple nodes attempt to use the same radio resource),
and the spectrum efficiency can be maximized. However, the spectrum allocated to LTE is
limited and cannot meet the ever increasing demand for larger throughput from
applications/services.

Therefore, the Third Generation Partnership Project (3GPP) is considering extending LTE to
exploit unlicensed spectrum in addition to licensed spectrum. Unlicensed spectrum can, by
definition, be simultaneously used by multiple different technologies. Therefore, in this case,
LTE needs to consider the coexistence issue with other systems such as IEEE 802.11 ("Wi-Fi").
20 Operating LTE in the same manner in unlicensed spectrum as in licensed spectrum can
seriously degrade the performance of Wi-Fi as Wi-Fi will not transmit once it detects that a
channel is occupied.

One way for LTE to utilize unlicensed spectrum reliably is to transmit essential control signals
25 and channels on a licensed carrier. This is known as Licensed Assisted Access (LAA) to
unlicensed spectrum using LTE. A user equipment, UE (the term used to refer to mobile
devices, terminal devices, etc.) is connected to a primary cell (PCell) in the licensed band and
one or more secondary cells (SCells) in the unlicensed band. A secondary cell in unlicensed
spectrum is denoted as a license-assisted secondary cell (LA SCell). Carriers in the PCell and
30 SCell can be aggregated for uplink (UL) and/or downlink (DL) data transmissions for the UE.

The demand for operating in unlicensed spectrum has risen recently, and the industry has
shown significant interest in standalone operation in unlicensed spectrum using an LTE-based
air interface, Stand-alone LTE in unlicensed spectrum (denoted S-LTE-U), without assistance
35 from a licensed carrier. For example, one of the standalone designs is called MulteFire (MF)
and is being standardized in by the MulteFire Alliance, where S-LTE-U eNB realization can be a
MulteFire Access Point (MF AP).

In S-LTE-U operations, the PCell will also operate on the unlicensed carrier and thus essential
40 control signals and channels will also be subject to unmanaged interference and Listen-Before-

Talk (LBT) procedures. Compared to conventional LTE usage of licensed spectrum, S-LTE-U differs in that the PCell is on unlicensed spectrum, the UE is required to initiate, establish and maintain the connection with the PCell, mobility (e.g. handovers) must work in an unsynchronized unplanned network, and mobility must work in an environment with dynamic neighbour relations.

S-LTE-U can be deployed with different core network (CN) architectures, as illustrated in Figures 1 and 2.

In one type of deployment, shown in Figure 1, the S-LTE-U radio access network (RAN) 2 is directly connected to an Evolved Packet Core (EPC) 4, 6, 8 from one or multiple mobile network operators (MNOs). Each MNO may have their own 3GPP RAN (i.e. a RAN standardised by 3GPP, such as LTE) 10, 12, or may share a 3GPP RAN with other MNOs. An MNO provides mobility support to its subscribers between its 3GPP RAN 10 and the S-LTE-U RAN 2.

In another type of deployment, shown in Figure 2, S-LTE-U RAN 2 is connected to a standalone core network (S-LTE-U CN) 14 for example a Neutral Host Core Network (NH CN), that is connected to MNOs and non-MNO service providers 16. S-LTE-U CN 14 has roaming agreements with one or multiple MNOs. S-LTE-U RAN 10 and S-LTE-CN 14 may have the same or different owners.

Although the following issues are discussed with reference to LTE and MulteFire, it will be appreciated that the issues can apply to the use of any type of licensed spectrum network with a corresponding network that is adapted to use unlicensed spectrum, e.g. NR.

With the introduction of MulteFire, a UE may be served both by LTE networks and by the MF networks (not necessarily concurrently).

Mobility within the LTE domain (i.e. between LTE cells) is controlled by the eNB (the network node that provides the radio interface to the UEs) based on e.g. measurements reported to the eNB by the UE which the eNB then considers when sending handover commands to direct the UE from one LTE cell to another.

Summary

According to an aspect, there is provided a method of operation of a radio access network node. The method comprises: transmitting a measurement configuration command to a wireless device; receiving a measurement report from the wireless device relating to a target cell; determining whether the target cell can be uniquely identified by information contained in the measurement report; and if the target cell cannot be uniquely identified by information contained in the measurement report, sending a DRX configuration command to the wireless device.

According to an aspect, there is provided a radio access network node, being configured to operate according to the preceding aspect.

5 According to an aspect, there is provided a radio access network node for use in a communications network. The radio access network node comprises a processor and a memory. The memory contains instructions executable by the processor, such that the radio access network node is operable to: transmit a measurement configuration command to a wireless device; receive a measurement report from the wireless device relating to a target cell;
10 determine whether the target cell can be uniquely identified by information contained in the measurement report; and, if the target cell cannot be uniquely identified by information contained in the measurement report, send a DRX configuration command to the wireless device.

15 According to an aspect, there is provided a radio access network node for use in a communications network. The radio access network node comprises: a transmitting module for transmitting a measurement configuration command to a wireless device; a receiving module for receiving a measurement report from the wireless device relating to a target cell; a determining module for determining whether the target cell can be uniquely identified by information
20 contained in the measurement report; and a sending module for, if the target cell cannot be uniquely identified by information contained in the measurement report, sending a DRX configuration command to the wireless device.

According to an aspect, there is provided a method of operation of a wireless device. The
25 method comprises: receiving a measurement configuration command from a radio access network node; and, if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node: reading a cell identity from system broadcast information from at least one target cell; measuring a signal quality of the at least one target cell; and reporting the cell identity and the
30 measured signal quality of the at least one target cell to the radio access network node.

According to an aspect, there is provided a wireless device for use in a communications network, the device being configured to operate according to the preceding aspect.

35 According to an aspect, there is provided a wireless device for use in a communications network. The wireless device comprises a processor and a memory. The memory contains instructions executable by the processor, such that the wireless device is operable to: receive a measurement configuration command from a radio access network node; and, if the wireless device is capable of reading system broadcast information from target cells without interrupting
40 reception of signals from the radio access network node: read a cell identity from system

broadcast information from at least one target cell; measure a signal quality of the at least one target cell; and report the cell identity and the measured signal quality of the at least one target cell to the radio access network node.

- 5 According to an aspect, there is provided a wireless device for use in a communications network comprising: a receiving module for receiving a measurement configuration command from a radio access network node; a reading module for, if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node, reading a cell identity from system broadcast information
10 from at least one target cell; a measuring module for measuring a signal quality of the at least one target cell; and a reporting module for reporting the cell identity and the measured signal quality of the at least one target cell to the radio access network node.

- According to an aspect, there is provided a method of operation of a wireless device. The
15 method comprises: receiving a measurement configuration command from a radio access network node; and, if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node: reading a non-unique cell identity of at least one target cell; measuring a signal quality of the at least one target cell; and reporting the non-unique cell identity, a carrier
20 frequency, and the measured signal quality of the at least one target cell to the radio access network node.

- According to an aspect, there is provided a wireless device for use in a communications network, the device being configured to operate according to the preceding aspect.

- 25 According to an aspect, there is provided a wireless device for use in a communications network. The device comprises a processor and a memory. The memory contains instructions executable by the processor, such that the wireless device is operable to: receive a measurement configuration command from a radio access network node; and, if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node: read a non-unique cell
30 identity of at least one target cell; measure a signal quality of the at least one target cell; and report the non-unique cell identity, a carrier frequency, and the measured signal quality of the at least one target cell to the radio access network node.

- 35 According to an aspect, there is provided a wireless device for use in a communications network, comprising: a receiving module for receiving a measurement configuration command from a radio access network node; a reading module for, if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals
40 from the radio access network node, reading a non-unique cell identity of at least one target

cell; a measuring module for measuring a signal quality of the at least one target cell; and a reporting module for reporting the non-unique cell identity, a carrier frequency, and the measured signal quality of the at least one target cell to the radio access network node.

- 5 According to an aspect, there is provided a computer program configured, when run on a computer, to carry out a method according to any one of the previous method aspects.

According to an aspect, there is provided a computer program product comprising a computer readable medium and a computer program according to the preceding aspect.

10

Brief description of the drawings

Exemplary embodiments of the techniques introduced in this document are described below with reference to the following figures, in which:

- 15 Figure 1 illustrates an S-LTE-U RAN that is connected to an EPC from one or multiple MNOs;

Figure 2 illustrates an S-LTE-U RAN that is connected to an S-LTE-U CN;

- 20 Figure 3 is a non-limiting example block diagram of a Long Term Evolution (LTE) cellular communications network;

Figure 4 is a block diagram of a node according to an embodiment;

- 25 Figure 5 is a block diagram of a wireless device according to an embodiment;

Figure 6 is a flow chart illustrating a first method of operating a wireless device according to an embodiment;

- 30 Figure 7 is a flow chart illustrating a second method of operating a wireless device according to an embodiment;

Figure 8 is a flow chart illustrating a method of operating a radio access network node according to an embodiment.

- 35 Figure 9 illustrates a wireless network.

Detailed description

- 40 The following sets forth specific details, such as particular embodiments for purposes of explanation and not limitation. But it will be appreciated by one skilled in the art that other embodiments may be employed apart from these specific details. In some instances, detailed

descriptions of well known methods, nodes, interfaces, circuits, and devices are omitted so as not obscure the description with unnecessary detail. Those skilled in the art will appreciate that the functions described may be implemented in one or more nodes using hardware circuitry (e.g., analog and/or discrete logic gates interconnected to perform a specialized function, ASICs, PLAs, etc.) and/or using software programs and data in conjunction with one or more digital microprocessors or general purpose computers. Nodes that communicate using the air interface also have suitable radio communications circuitry. Moreover, where appropriate the technology can additionally be considered to be embodied entirely within any form of computer-readable memory, such as solid-state memory, magnetic disk, or optical disk containing an appropriate set of computer instructions that would cause a processor to carry out the techniques described herein.

Hardware implementation may include or encompass, without limitation, digital signal processor (DSP) hardware, a reduced instruction set processor, hardware (e.g., digital or analog) circuitry including but not limited to application specific integrated circuit(s) (ASIC) and/or field programmable gate array(s) (FPGA(s)), and (where appropriate) state machines capable of performing such functions.

In terms of computer implementation, a computer is generally understood to comprise one or more processors, one or more processing units, one or more processing modules or one or more controllers, and the terms computer, processor, processing unit, processing module and controller may be employed interchangeably. When provided by a computer, processor, processing unit, processing module or controller, the functions may be provided by a single dedicated computer, processor, processing unit, processing module or controller, by a single shared computer, processor, processing unit, processing module or controller, or by a plurality of individual computers, processors, processing units, processing modules or controllers, some of which may be shared or distributed. Moreover, these terms also refer to other hardware capable of performing such functions and/or executing software, such as the example hardware recited above.

Although in the description below the term user equipment (UE) is used, it should be understood by the skilled in the art that "UE" is a non-limiting term comprising any mobile or wireless device or node equipped with a radio interface allowing for at least one of: transmitting signals in uplink (UL) and receiving and/or measuring signals in downlink (DL). A UE herein may comprise a UE (in its general sense) capable of operating or at least performing measurements in one or more frequencies, carrier frequencies, component carriers or frequency bands. It may be a "UE" operating in single- or multi-radio access technology (RAT) or multi-standard mode. As well as "UE", the terms "wireless device", "mobile device" and "terminal device" may be used interchangeably in the following description, and it will be appreciated that such a device does not necessarily have to be 'mobile' in the sense that it is

carried by a user. Instead, the terms “mobile device” and “terminal device” encompass any device that is capable of communicating with communication networks that operate according to one or more mobile communication standards, such as the Global System for Mobile communications, GSM, Universal Mobile Telecommunications System (UMTS), Wideband
5 Code-Division Multiple Access (WCDMA), Long-Term Evolution (LTE), New Radio (NR), etc., and communication networks where a mobile communication standard is used with unlicensed spectrum, such as MulteFire, where LTE is used or adapted for use on unlicensed spectrum.

A cell is associated with a base station, where a base station comprises in a general sense any
10 network node transmitting radio signals in the downlink and/or receiving radio signals in the uplink. Some example base stations, or terms used for describing base stations, are gNB, eNodeB, eNB, NodeB, MulteFire Access Point (AP), Wireless Local Area Network (WLAN) AP, macro/micro/pico/femto radio base station, home eNodeB (also known as femto base station), relay, repeater, sensor, transmitting-only radio nodes or receiving-only radio nodes. A base
15 station may operate or at least perform measurements in one or more frequencies, carrier frequencies or frequency bands and may be capable of carrier aggregation. It may also be a single-radio access technology (RAT), multi-RAT, or multi-standard node, e.g., using the same or different base band modules for different RATs.

It should be noted that the term “radio access network node” as used herein can refer to a base
20 station, such as an eNodeB, a S-LTE-U AP such as a MulteFire AP or a WLAN AP, or a network node in the radio access network (RAN) responsible for resource management, such as a radio network controller (RNC). More generally, the term “node” as used herein can refer to a terminal device or a radio access network node.

25 Unless otherwise indicated herein, the signalling described is either via direct links or logical links (e.g. via higher layer protocols and/or via one or more network nodes).

Figure 3 shows an example diagram of an evolved UMTS Terrestrial Radio Access Network (E-
30 UTRAN) architecture as part of an LTE-based communications system 32 to which the techniques described herein can be applied. Nodes in a core network 34 part of the system 32 include one or more Mobility Management Entities (MMEs) 36, a key control node for the LTE access network, and one or more Serving Gateways (SGWs) 38 which route and forward user data packets while acting as a mobility anchor. They communicate with base stations or radio
35 access nodes 40 referred to in LTE as eNBs, over an interface, for example an S1 interface. The eNBs 40 can include the same or different categories of eNBs, e.g. macro eNBs, and/or micro/pico/femto eNBs. The eNBs 40 communicate with each other over an inter-node interface, for example an X2 interface. The S1 interface and X2 interface are defined in the LTE standard.

Figure 3 also shows access points or APs 42 that are acting as base stations in respective standalone LTE unlicensed (S-LTE-U) cells. For example, the APs 42 may be MulteFire APs.

A UE 44 is shown, and the UE 44 can receive downlink data from and send uplink data to one of the base stations 40 or APs 42, with that base station 40 or AP 42 being referred to as the serving base station or AP of the UE 44.

Figure 4 shows a node 40; 42 that can be adapted or configured to operate according to one or more of the non-limiting example embodiments described. The node can be a radio access network node 40 or 42, such as an eNB, a WLAN AP or a S-LTE-U AP such as a MulteFire AP.

The node 40; 42 comprises a processor or processing unit 50 that controls the operation of the node 40; 42. The processing unit 50 is connected to a transceiver unit 52 (which comprises a receiver and a transmitter) with associated antenna(s) 54 which are used to transmit signals to and receive signals from other nodes in the network 32. In some embodiments, the processing unit 50 can comprise one or more modules for implementing individual processing steps of the techniques described herein.

Where the node is a radio access node 40, the processing unit 50 and transceiver unit 52 are used to transmit signals to and receive signals from one or more wireless devices 44.

The node 40; 42 also comprises a memory or memory unit 56 that is connected to the processing unit 50 and that contains instructions or computer code executable by the processing unit 50 and other information or data required for the operation of the node 40; 42.

It will be appreciated that only the components of the node 40; 42 required to explain the embodiments presented herein are illustrated in Figure 4.

Figure 5 shows a wireless device, or UE, 44 that can be adapted or configured to operate according to one or more of the non-limiting example embodiments described.

The UE 44 comprises a processor or processing unit 60 that controls the operation of the UE 44. The processing unit 60 is connected to a transceiver unit 62 (which comprises a receiver and a transmitter) with associated antenna(s) 64 which are used to transmit signals to and receive signals from other nodes in the network 32. In some embodiments, the processing unit 60 can comprise one or more modules for implementing individual processing steps of the techniques described herein.

The processing unit 60 and transceiver unit 62 are used to transmit signals to and receive signals from one or more radio access nodes 40; 42 (including different types of radio access

nodes, such as eNBs, WLAN APs and S-LTE-U such as MulteFire APs). The processing unit 60 and transceiver unit 62 can be adapted to communicate with multiple types of radio access technology (RAT), e.g. NR, LTE, WLAN and/or S-LTE-U including MulteFire.

- 5 The UE 44 also comprises a memory or memory unit 66 that is connected to the processing unit 60 and that contains instructions or computer code executable by the processing unit 60 and other information or data required for the operation of the UE 44.

10 It will be appreciated that only the components of the UE 44 required to explain the embodiments presented herein are illustrated in Figure 5.

Although the embodiments of the present disclosure will mainly be described in the context of LTE and S-LTE-U (with MulteFire as a specific example thereof), it will be appreciated by those skilled in the art that the problems and solutions described herein are equally applicable to other
15 types of wireless access networks and user equipments (UEs) implementing other access technologies and standards e.g. NR, and thus LTE and/or MulteFire (and the other LTE/MulteFire specific terminology used herein) should only be seen as examples of the technologies to which the techniques can be applied.

20 Network controlled mobility from LTE to S-LTE-U can utilize WLAN measurement configuration and report signalling for S-LTE-U measurement. The S-LTE-U networks can be addressed by fields for identifiers of WLAN networks where said fields are interpreted in S-LTE-U specific manner.

25 Seamless mobility can only be performed between two nodes with a neighbor relationship. In LTE and S-LTE-U this requires that the source eNB has the knowledge of the neighbor eNB's identifier that uniquely identifies the eNB globally, for example the E-UTRAN Cell Global Identifier (ECGI) thereof. The ECGI is constructed from the Public Land Mobile Network (PLMN) identity the cell belongs to and the Cell Identity (CI) of the cell.

30 Before performing mobility, the UE is requested to report the physical cell identity (PCI) and signal quality on a given carrier frequency. Based on the combination of PCI and carrier frequency, the source eNB derives the target ECGI if the neighbor relation is present, and communicates with the target to proceed with the mobility process.

35 If the neighbor relationship is not present, the source eNB requests the UE to receive the ECGI that the UE discovered as mobility target candidate. This normally requires that the UE is configured to monitor the source eNB discontinuously (e.g. DRX configuration), and use the idle period to read broadcast information of the target candidate in order to get the target ECGI and

report to the source eNB. The source eNB can then initiate neighbor relation setup by communicating to the target eNB, and prepare for traffic steering.

There are two challenges for the UE to report S-LTE-U mobility target candidates. Firstly, S-LTE-U cells have the same profiles and attributes as LTE cells, and thus the S-LTE-U measurement cannot be directly incorporated into a WLAN measurement report. Secondly, due to the fact that cell coverage is usually small in unlicensed bands, compared to licensed carriers like LTE, and in addition the carrier frequency of S-LTE-U cell may be selected dynamically to adapt to the interference situation, the number of S-LTE-U cells may be large, leading to collisions in carrier frequency and cell identities. As a consequence, the source eNB may not be able to derive the mobility target only by looking at the combination of the carrier frequency and the cell identity.

The source eNB could request the UE to report the ECGI of the target S-LTE-U cell with a standard procedure, but this introduces signalling overhead, and usually takes much longer time and has to take place after the S-LTE-U measurement reporting using the WLAN format. The risk for mobility failure increases accordingly in that situation.

Next, embodiments as illustrated in Figures 6, 7 and 8 will be described.

Figure 6 is a flow chart, illustrating a method that can be performed in a radio access network node, such as an eNodeB or eNB.

Figures 7 and 8 are flow charts, illustrating methods that can be performed in a wireless device, which in this example is a UE.

As shown at step 200 in Figure 6, the source eNB configures the UE to discover nearby S-LTE-U networks, and hence to measure on S-LTE-U cells. This can be achieved via WLAN measurement configuration where for example the Basic Service Set Identification (BSSID) can be set to FF:FF:FF:FF:FF:FF which is an out-of-range value to indicate the mobility target is S-LTE-U. More generally, where a field of the message is provided for the purpose of indicating one or more network identifiers or identifiers for one or more nodes in a network that are in the form of Media Access Control (MAC) addresses, the predefined range of values may relate to the format of the MAC addresses that can be used, and thus, for example, any out-of-range value that cannot be used as a network identifier or as an identifier for a node can be used for this purpose. The value FF:FF:FF:FF:FF:FF is just one example of such a value.

This configuration may be sent either via broadcast or unicast messages to the UE.

In some embodiments, the UE may be provided with separate radio transceiver circuitry, so that it is capable of decoding S-LTE-U signals using the separate radio without impacting the reception of signals from the source cell. In such cases, the UE performs the process shown in Figure 7. Specifically, the UE receives the configuration message requesting it to make S-LTE-

U measurements at step 260. The UE can then search for S-LTE-U cells and receive system information broadcast messages in order to read an identifier that uniquely identifies the or each cell globally, for example the E-UTRAN Cell Global Identifier (ECGI) thereof.

- 5 The UE can also obtain a measurement relating to a signal quality of signals received from the or each cell. For example, the signal quality may be a Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ) or Signal-to-Interference-plus-Noise Ratio (SINR).
- 10 In step 262 of Figure 6, the UE sends a report to the eNB, containing the ECGI and the signal quality measurement. In some embodiments, the UE may use the WLAN measurement report message to report discovered S-LTE-U cells. An example for the UE to report the cell identity is to use the HESSID field in a WLAN measurement report message.
- 15 As an example, the Public Land Mobile Network (PLMN) identity field in ECGI can be coded from 24 bits to 20 bits by using binary numbering instead of directly storing digits. For example, a PLMN identity 123.456 (which, with 4 bits for each digit, would require 24 bits in total) as stored as in the ECGI can be coded as 1EDC8 (which requires 20 bits). Together with the 28 bits long Cell Identity (CI) field in ECGI, the ECGI is thus represented by $20+28 = 48$ bits which
- 20 can be carried in the Homogenous Extended Service Set Identification (HESSID) field.

The UE can include the S-LTE-U cell signal quality measurement, e.g. the Reference Signal Received Power (RSRP), in the rssiWLAN field in the Wireless Local Area Network (WLAN) measurement report. The rssiWLAN is used to carry the WLAN Received Signal Strength

25 Indication (RSSI) that represents WLAN signal quality. The S-LTE-U RSRP can be used by the LTE source eNB to decide whether it is suitable to steer the UE to the S-LTE-U cell.

In some other embodiments, the UE may be provided with only one radio transceiver, or alternatively the UE may have a separate radio that can be used for S-LTE-U cell signal quality

30 measurement, but without the capability of receiving S-LTE-U system broadcast information.

In such cases, the UE performs the process shown in Figure 8. Specifically, the UE receives the configuration message requesting it to make S-LTE-U measurements at step 280. The UE can then search for S-LTE-U cells and can discover the S-LTE-U carrier frequency (for example

35 identified by a EUTRA Absolute radio-frequency channel number, EARFCN) and a physical cell identity (PCI) of one or more cell. The PCI does not uniquely identify the S-LTE-U cell.

At step 282 of Figure 8, the UE reports discovered S-LTE-U cells. In some embodiments, the UE may use the WLAN measurement report message to report discovered S-LTE-U cells. An

40 example for the UE to report the cell identity is to use the HESSID field in a WLAN

measurement report message. Thus, the UE can then concatenate the carrier frequency and PCI using HESSID field, and report it via the WLAN measurement report message to inform the LTE source eNB that a S-LTE-U cell has been discovered.

- 5 The report sent at step 282 also includes a measurement relating to a signal quality of signals received from the or each detected cell. For example, the signal quality may be a Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ) or Signal-to-Interference-plus-Noise Ratio (SINR). The UE can include the S-LTE-U cell signal quality measurement, e.g. the Reference Signal Received Power (RSRP), in the rssiWLAN field in the
10 WLAN measurement report. The rssiWLAN is used to carry the WLAN Received Signal Strength Indication (RSSI) that represents WLAN signal quality. The S-LTE-U RSRP can be used by the LTE source eNB to decide whether it is suitable to steer the UE to the S-LTE-U cell.

- At step 202 as shown in Figure 6, the eNB receives a S-LTE-U measurement report from the
15 UE. As discussed above, this report may be the report sent at step 262 of Figure 7 or at step 282 of Figure 8.

- At step 204 of Figure 6, the eNB determines whether the S-LTE-U measurement report, received from the UE, contains an ECGI, that is, whether the report is the report sent at step
20 262 of Figure 7.

- If the eNB determines that it has received the ECGI of the target candidate in the report received from the UE, the process passes to step 206, in which the LTE eNB can decide whether there is an existing neighbor relationship with that S-LTE-U eNB. If the neighbor
25 relationship exists, the process passes to step 208, in which the LTE eNB proceeds with the mobility procedures. Thus, if the relevant mobility criteria are met, for example based on the received signal quality measurement, the eNB can send a steering command or handover command to the UE, instructing it to perform mobility to the S-LTE-U eNB.

- 30 If the LTE eNB determines at step 206 that there is no existing neighbor relationship with that S-LTE-U eNB, the process passes to step 210, in which the LTE eNB decides whether it is possible to setup a neighbor relation with the discovered mobility target candidate, and, if it is possible, the LTE eNB initiates the procedures to setup the neighbor relation. Thereafter, as before, the process passes to step 208, in which the LTE eNB proceeds with the mobility
35 procedures. Thus, if the relevant mobility criteria are met, for example based on the received signal quality measurement, the eNB can send a steering command or handover command to the UE, instructing it to perform mobility to the S-LTE-U eNB.

- As shown at step 264 in Figure 7, the UE receives the steering command, and performs the
40 relevant mobility procedure, such as performing a handover to the target S-LTE-U cell.

Thus, if the UE is able to report the ECGL and the signal quality, the eNB can initiate a handover (provided that the signal quality criterion is met) more quickly and with a lower signalling overhead.

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If the eNB determines at step 204 that it has not received the ECGL of the target candidate in the report received from the UE, the process passes to step 212, in which the LTE eNB determines whether there is a PCI collision, or whether the carrier frequency and PCI that were reported by the UE in step 282, can uniquely identify the S-LTE-U cell. If the eNB determines
10 that there is an existing neighbor relationship with an S-LTE-U eNB having the reported PCI and carrier frequency, the process passes to step 208 as before. Thus, in this situation, although the eNB cannot know for certain that there is no other cell that has that combination of PCI and carrier frequency, the eNB may assume that it is the cell with the existing neighbor relation that the UE is reporting. In unusual cases in which this is not true, any handover will fail, and the
15 eNB will learn over time that there might be a different cell with the same combination of PCI and carrier frequency.

Again as before, in step 208, the LTE eNB proceeds with the mobility procedures. Thus, if the relevant mobility criteria are met, the eNB can send a steering command or handover command
20 to the UE, instructing it to perform mobility to the S-LTE-U eNB.

If the eNB determines at step 212 that there is a PCI collision, and the carrier frequency and PCI that were reported by the UE in step 282 cannot uniquely identify the S-LTE-U cell, the LTE eNB cannot derive deterministically whether the neighbor relationship exists. In that case, the
25 process passes to step 214.

Thus, if the neighbor relationship is not present or cannot be determined, in step 214, the LTE eNB configures the UE to measure and report the ECGL by configuring the UE with a Discontinuous Reception (DRX) cycle that is long enough that the UE has sufficient idle time to
30 receive system broadcast information of the previously discovered S-LTE-U cell.

Thus, in step 284 of Figure 8, the UE receives the DRX configuration and the ECGL report configuration, and detects the ECGL of the or each candidate target cell. In step 286, the UE reports the ECGL of the or each detected cell to the LTE source cell.
35

Returning to Figure 6, at step 216 the LTE eNB receives the report sent by the UE at step 286, containing the ECGL of the or each candidate target cell.

The process then passes to step 218, in which the LTE eNB can decide whether there is an
40 existing neighbor relationship with the or each S-LTE-U eNB, based on the ECGL that uniquely

identifies the S-LTE-U eNB. If the neighbor relationship exists, the process passes to step 208, in which the LTE eNB proceeds with the mobility procedures. Thus, if the relevant mobility criteria are met, for example based on the received signal quality measurement, the eNB can send a steering command or handover command to the UE, instructing it to perform mobility to the S-LTE-U eNB.

If the LTE eNB determines at step 218 that there is no existing neighbor relationship with that S-LTE-U eNB, the process passes to step 220, in which the LTE eNB decides whether it is possible to setup a neighbor relation with the discovered mobility target candidate, and, if it is possible, the LTE eNB initiates the procedures to setup the neighbor relation. Thereafter, as before, the process passes to step 208, in which the LTE eNB proceeds with the mobility procedures. Thus, if the relevant mobility criteria are met, for example based on the received signal quality measurement, the eNB can send a steering command or handover command to the UE, instructing it to perform mobility to the S-LTE-U eNB.

As shown at step 288 in Figure 8, the UE receives the steering command, and performs the relevant mobility procedure, such as performing a handover to the target S-LTE-U cell.

Thus, the techniques described herein provide methods for enabling mobility between LTE network nodes and S-LTE-U network nodes such as MulteFire network nodes.

Modifications and other variants of the described embodiment(s) will come to mind to one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the embodiment(s) is/are not to be limited to the specific examples disclosed and that modifications and other variants are intended to be included within the scope of this disclosure. Although specific terms may be employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

Figure 9 illustrates a wireless network comprising a more detailed view of network node 900 and wireless device (WD) 910, in accordance with a particular embodiment. For simplicity, Figure 2 only depicts network 920, network nodes 900 and 900a, and WD 910. Network node 900 comprises processor 202, storage 903, interface 901, and antenna 901a. Similarly, WD 910 comprises processor 912, storage 913, interface 911 and antenna 911a. These components may work together in order to provide network node and/or wireless device functionality, such as providing wireless connections in a wireless network. In different embodiments, the wireless network may comprise any number of wired or wireless networks, network nodes, base stations, controllers, wireless devices, relay stations, and/or any other components that may facilitate or participate in the communication of data and/or signals whether via wired or wireless connections.

Network 920 may comprise one or more IP networks, public switched telephone networks (PSTNs), packet data networks, optical networks, wide area networks (WANs), local area networks (LANs), wireless local area networks (WLANs), wired networks, wireless networks, metropolitan area networks, and other networks to enable communication between devices.

Network node 900 comprises processor 902, storage 903, interface 901, and antenna 901a. These components are depicted as single boxes located within a single larger box. In practice however, a network node may comprises multiple different physical components that make up a single illustrated component (e.g., interface 901 may comprise terminals for coupling wires for a wired connection and a radio transceiver for a wireless connection). As another example, network node 900 may be a virtual network node in which multiple different physically separate components interact to provide the functionality of network node 900 (e.g., processor 902 may comprise three separate processors located in three separate enclosures, where each processor is responsible for a different function for a particular instance of network node 900). Similarly, network node 900 may be composed of multiple physically separate components (e.g., a NodeB component and a RNC component, a BTS component and a BSC component, etc.), which may each have their own respective processor, storage, and interface components. In certain scenarios in which network node 900 comprises multiple separate components (e.g., BTS and BSC components), one or more of the separate components may be shared among several network nodes. For example, a single RNC may control multiple NodeB's. In such a scenario, each unique NodeB and BSC pair, may be a separate network node. In some embodiments, network node 900 may be configured to support multiple radio access technologies (RATs). In such embodiments, some components may be duplicated (e.g., separate storage 903 for the different RATs) and some components may be reused (e.g., the same antenna 901a may be shared by the RATs).

Processor 902 may be a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application specific integrated circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software and/or encoded logic operable to provide, either alone or in conjunction with other network node 900 components, such as storage 903, network node 900 functionality. For example, processor 902 may execute instructions stored in storage 903. Such functionality may include providing various wireless features discussed herein to a wireless devices, such as WD 910, including any of the features or benefits disclosed herein.

Storage 903 may comprise any form of volatile or non-volatile computer readable memory including, without limitation, persistent storage, solid state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), removable media, or any other suitable local or remote memory component. Storage 903 may

store any suitable instructions, data or information, including software and encoded logic, utilized by network node 900. Storage 903 may be used to store any calculations made by processor 902 and/or any data received via interface 901.

5 Network node 900 also comprises interface 901 which may be used in the wired or wireless communication of signalling and/or data between network node 900, network 920, and/or WD 910. For example, interface 901 may perform any formatting, coding, or translating that may be needed to allow network node 900 to send and receive data from network 920 over a wired connection. Interface 901 may also include a radio transmitter and/or receiver that may be
10 coupled to or a part of antenna 901a. The radio may receive digital data that is to be sent out to other network nodes or WDs via a wireless connection. The radio may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters. The radio signal may then be transmitted via antenna 901a to the appropriate recipient (e.g., WD 910).

15 Antenna 901a may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In some embodiments, antenna 901a may comprise one or more omni-directional, sector or panel antennas operable to transmit/receive radio signals between, for example, 2 GHz and 66 GHz. An omni-directional antenna may be used to transmit/receive radio signals in any direction, a sector antenna may be used to transmit/receive radio signals
20 from devices within a particular area, and a panel antenna may be a line of sight antenna used to transmit/receive radio signals in a relatively straight line.

WD 910 may be any type of wireless endpoint, mobile station, mobile phone, wireless local loop phone, smartphone, user equipment, desktop computer, PDA, cell phone, tablet, laptop, VoIP
25 phone or handset, which is able to wirelessly send and receive data and/or signals to and from a network node, such as network node 900 and/or other WDs. WD 910 comprises processor 912, storage 913, interface 911, and antenna 911a. Like network node 900, the components of WD 910 are depicted as single boxes located within a single larger box, however in practice a wireless device may comprises multiple different physical components that make up a single
30 illustrated component (e.g., storage 913 may comprise multiple discrete microchips, each microchip representing a portion of the total storage capacity).

Processor 912 may be a combination of one or more of a microprocessor, controller, microcontroller, central processing unit, digital signal processor, application specific integrated
35 circuit, field programmable gate array, or any other suitable computing device, resource, or combination of hardware, software and/or encoded logic operable to provide, either alone or in combination with other WD 910 components, such as storage 913, WD 910 functionality. Such functionality may include providing various wireless features discussed herein, including any of the features or benefits disclosed herein.

Storage 913 may be any form of volatile or non-volatile memory including, without limitation, persistent storage, solid state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), removable media, or any other suitable local or remote memory component. Storage 913 may store any suitable data, instructions, or information, including software and encoded logic, utilized by WD 910. Storage 913 may be used to store any calculations made by processor 912 and/or any data received via interface 911.

Interface 911 may be used in the wireless communication of signalling and/or data between WD 910 and network node 900. For example, interface 911 may perform any formatting, coding, or translating that may be needed to allow WD 910 to send and receive data from network node 900 over a wireless connection. Interface 911 may also include a radio transmitter and/or receiver that may be coupled to or a part of antenna 911a. The radio may receive digital data that is to be sent out to network node 900 via a wireless connection. The radio may convert the digital data into a radio signal having the appropriate channel and bandwidth parameters. The radio signal may then be transmitted via antenna 911a to network node 900.

Antenna 911a may be any type of antenna capable of transmitting and receiving data and/or signals wirelessly. In some embodiments, antenna 911a may comprise one or more omnidirectional, sector or panel antennas operable to transmit/receive radio signals between 2 GHz and 66 GHz. For simplicity, antenna 911a may be considered a part of interface 911 to the extent that a wireless signal is being used.

Any steps described herein are merely illustrative of certain embodiments. It is not required that all embodiments incorporate all the steps disclosed nor that the steps be performed in the exact order depicted or described herein. Furthermore, some embodiments may include steps not illustrated or described herein, including steps inherent to one or more of the steps disclosed herein.

Any appropriate steps, methods, or functions may be performed through a computer program product that may, for example, be executed by the components and equipment illustrated in the figure above. For example, storage 903 may comprise computer readable means on which a computer program can be stored. The computer program may include instructions which cause processor 202 (and any operatively coupled entities and devices, such as interface 901 and storage 903) to execute methods according to embodiments described herein. The computer program and/or computer program product may thus provide means for performing any steps herein disclosed.

Any appropriate steps, methods, or functions may be performed through one or more functional modules. Each functional module may comprise software, computer programs, sub-routines,

libraries, source code, or any other form of executable instructions that are executed by, for example, a processor. In some embodiments, each functional module may be implemented in hardware and/or in software. For example, one or more or all functional modules may be implemented by processors 912 and/or 202, possibly in cooperation with storage 913 and/or 903. Processors 912 and/or 202 and storage 913 and/or 903 may thus be arranged to allow processors 912 and/or 202 to fetch instructions from storage 913 and/or 903 and execute the fetched instructions to allow the respective functional module to perform any steps or functions disclosed herein.

Certain aspects of the disclosure have mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, embodiments other than the ones disclosed above are equally possible and within the scope of the disclosure. Similarly, while a number of different combinations have been discussed, all possible combinations have not been disclosed. One skilled in the art would appreciate that other combinations exist and are within the scope of the disclosure. Moreover, as is understood by the skilled person, the herein disclosed embodiments are as such applicable also to other standards and communication systems and any feature from a particular figure disclosed in connection with other features may be applicable to any other figure and or combined with different features.

CLAIMS

1. A method of operation of a radio access network node, the method comprising:
transmitting (200) a measurement configuration command to a wireless device;
receiving a measurement report (202) from the wireless device relating to a target cell;
5 determining whether the target cell can be uniquely identified by information contained in
the measurement report; and
if the target cell cannot be uniquely identified by information contained in the
measurement report, sending (214) a discontinuous reception, DRX, configuration command to
the wireless device.
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2. The method as in claim 1, wherein determining whether the target cell can be uniquely
identified by information contained in the measurement report comprises determining (204)
whether the measurement report contains a unique cell identity of the target cell.
- 15 3. The method as in claim 2, wherein the unique cell identity is an E-UTRAN cell global
identifier, ECGI.
4. The method as in claim 2 or 3, wherein, if the measurement report does not contain a
unique cell identity of the target cell, determining whether the target cell can be uniquely
20 identified by information contained in the measurement report comprises:
determining (214) whether the target cell can be uniquely identified by a non-unique cell
identity and a carrier frequency of the target cell, contained in the measurement report.
5. The method as in claim 1, further comprising receiving (216) an additional report
25 containing a unique cell identity of the target cell.
6. The method as in claim 5, wherein the unique cell identity is an E-UTRAN cell global
identifier, ECGI.
- 30 7. The method as in one of claims 1 – 6, further comprising, on receiving information from
which the one target cell can be uniquely identified:
determining (206, 218) whether the target cell has an existing neighbour relationship with
said radio access network node.
- 35 8. The method as in claim 7, further comprising, if the target cell does not have an existing
neighbour relationship with said radio access network node:
initiating (210, 220) a procedure to establish a neighbour relationship with the target cell.
9. The method as in claim 7 or 8, further comprising, if the target cell has an existing
40 neighbour relationship with said radio access network node, and if a mobility criterion is met:

initiating (208) a mobility procedure to steer the wireless device to the target cell.

10. The method as in one of claim 1 – 9, wherein the measurement report is a Wireless local area network, WLAN, measurement report.

5

11. The method as in one of claims 1 – 10, wherein the radio access network node is an eNodeB.

12. The method as in one of claims 1 – 11, wherein the measurement configuration command is a standalone LTE unlicensed, S-LTE-U, cell measurement configuration command and the target cell is a S-LTE-U cell.

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13. A radio access network node, being configured to operate according to any one of claims 1 to 12.

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14. A radio access network node (40; 42) for use in a communications network, the radio access network node comprising a processor (50) and a memory (56), the memory containing instructions executable by the processor, such that the radio access network node is operable to:

20

transmit a measurement configuration command to a wireless device;

receive a measurement report from the wireless device relating to a target cell;

determine whether the target cell can be uniquely identified by information contained in the measurement report; and

25

if the target cell cannot be uniquely identified by information contained in the measurement report, send a discontinuous reception, DRX, configuration command to the wireless device.

15. A radio access network node for use in a communications network comprising:

30

a transmitting module for transmitting a measurement configuration command to a

wireless device;

a receiving module for receiving a measurement report from the wireless device relating to a target cell;

a determining module for determining whether the target cell can be uniquely identified by information contained in the measurement report; and

35

a sending module for, if the target cell cannot be uniquely identified by information contained in the measurement report, sending a DRX configuration command to the wireless device.

40

16. A computer program configured, when run on a computer, to carry out the method according to any one of claims 1 to 12.

17. A computer program product comprising a computer readable medium and a computer program according to claim 16.

18. A method of operation of a wireless device, the method comprising:

receiving (260) a measurement configuration command from a radio access network node; and

if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node:

reading a cell identity from system broadcast information from at least one target cell;

measuring a signal quality of the at least one target cell; and

reporting (262) the cell identity and the measured signal quality of the at least one target cell to the radio access network node.

19. The method as in claim 18, wherein the cell identity is a unique cell identity.

20. The method as in claim 18, wherein the unique cell identity is an E-UTRAN cell global identifier, ECGI.

21. The method as in claim 18, 19 or 20, wherein the signal quality is a reference signal received power, RSRP, or reference signal received quality, RSRQ, or signal-to-interference and noise ratio, SINR.

22. The method as in one of claims 18 – 21, comprising reporting the cell identity and the measured signal quality of the at least one target cell to the radio access network node in a Wireless local area network, WLAN, measurement report.

23. The method as in one of claims 18 – 22, wherein the radio access network node is an eNodeB.

24. The method as in one of claims 18 – 23, wherein the target cell is a standalone LTE unlicensed, S-LTE-U, cell, for example a MulteFire cell, and the measurement configuration command is a S-LTE-U cell measurement configuration command.

25. The method as in one of claims 18 – 24, wherein the wireless device has a dual radio receiver.

26. A wireless device for use in a communications network, the device being configured to operate according to any one of claims 18 to 25.

27. A wireless device (44) for use in a communications network, the device comprising a processor (60) and a memory (66), the memory containing instructions executable by the processor, such that the wireless device is operable to:

receive a measurement configuration command from a radio access network node; and

if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node:

read a cell identity from system broadcast information from at least one target cell;

measure a signal quality of the at least one target cell; and

report the cell identity and the measured signal quality of the at least one target cell to the radio access network node.

28. A wireless device for use in a communications network comprising:

a receiving module for receiving a measurement configuration command from a radio access network node;

a reading module for, if the wireless device is capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node, reading a cell identity from system broadcast information from at least one target cell;

a measuring module for measuring a signal quality of the at least one target cell; and

a reporting module for reporting the cell identity and the measured signal quality of the at least one target cell to the radio access network node.

29. A computer program configured, when run on a computer, to carry out the method according to any one of claims 18 to 26.

30. A computer program product comprising a computer readable medium and a computer program according to claim 29.

31. A method of operation of a wireless device, the method comprising:

receiving (280) a measurement configuration command from a radio access network node; and

if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node:

reading a non-unique cell identity of at least one target cell;

measuring a signal quality of the at least one target cell; and

reporting (282) the non-unique cell identity, a carrier frequency, and the measured signal quality of the at least one target cell to the radio access network node.

32. The method as in claim 31, wherein the non-unique cell identity is a PCI.

33. The method as in claim 31 or 32, wherein the signal quality is a RSRP, RSRQ or SINR.

34. The method as in one of claims 31 – 33, comprising reporting the non-unique cell identity and the carrier frequency of the at least one target cell to the radio access network node in a WLAN measurement report.

35. The method as in one of claims 31 – 34, wherein the radio access network node is an eNodeB.

36. The method as in one of claims 31 – 35, wherein the target cell is a S-LTE-U cell, and the measurement configuration command is a S-LTE-U cell measurement configuration command.

37. The method as in one of claims 31 – 36, further comprising:

receiving (284) a DRX configuration command;

entering DRX mode;

reading a unique cell identity from system broadcast information from the at least one target cell; and

reporting (286) the unique cell identity of the at least one target cell to the radio access network node.

38. The method as in claim 37, wherein the unique cell identity is an ECGL.

39. The method as in one of 31 – 38, wherein the wireless device has a single radio receiver.

40. The method as in one of 31 – 38, wherein the wireless device has a dual radio receiver that is capable of making signal quality measurements but is not capable of reading system broadcast information from target cells.

41. A wireless device for use in a communications network, the device being configured to operate according to any one of claims 31 to 40.

42. A wireless device (44) for use in a communications network, the device comprising a processor (60) and a memory (66), the memory containing instructions executable by the processor, such that the wireless device is operable to:

receive a measurement configuration command from a radio access network node; and

if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node:

read a non-unique cell identity of at least one target cell;

measure a signal quality of the at least one target cell; and

report the non-unique cell identity, a carrier frequency, and the measured signal quality of the at least one target cell to the radio access network node.

43. The wireless device according to claim 42, wherein the memory further contains

instructions executable by the processor, such that the wireless device is operable to:

receive a discontinuous reception, DRX, configuration command;

enter DRX mode;

read a unique cell identity from system broadcast information from the at least one target cell; and

report the unique cell identity of the at least one target cell to the radio access network node.

44. The wireless device according to claim 42 or 43, wherein the wireless device has a single radio receiver.

45. The wireless device according to claim 42 or 43, wherein the wireless device has a dual radio receiver that is capable of making signal quality measurements but is not capable of reading system broadcast information from target cells.

46. A wireless device for use in a communications network comprising:

a receiving module for receiving a measurement configuration command from a radio access network node;

a reading module for, if the wireless device is not capable of reading system broadcast information from target cells without interrupting reception of signals from the radio access network node, reading a non-unique cell identity of at least one target cell;

a measuring module for measuring a signal quality of the at least one target cell; and

a reporting module for reporting the non-unique cell identity, a carrier frequency, and the measured signal quality of the at least one target cell to the radio access network node.

47. A computer program configured, when run on a computer, to carry out the method according to any one of claims 31 to 40.

48. A computer program product comprising a computer readable medium and a computer program according to claim 47.

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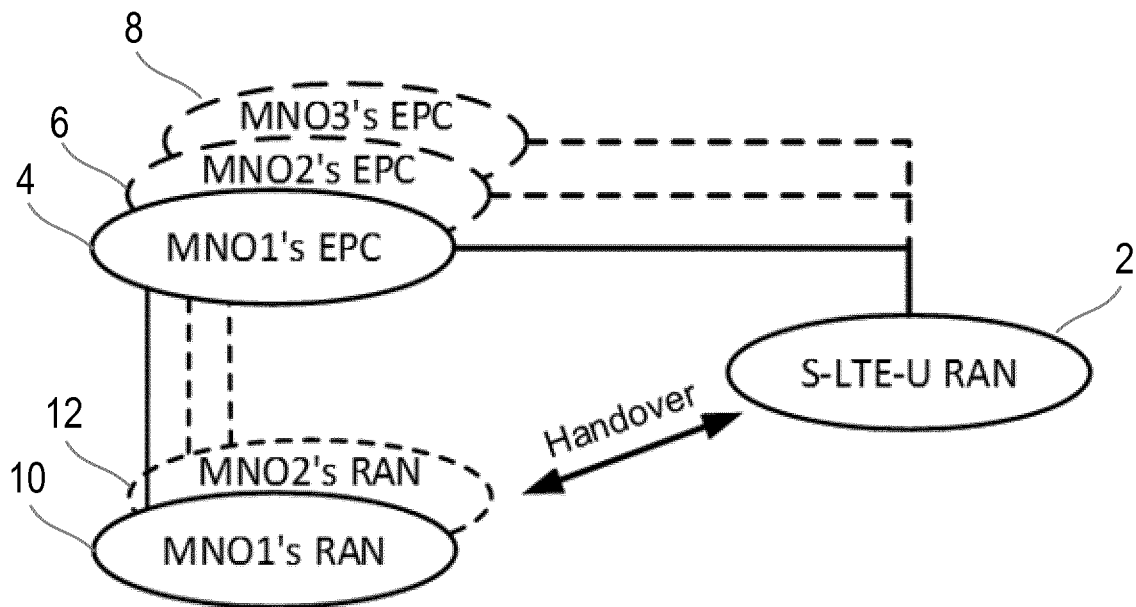


Figure 1

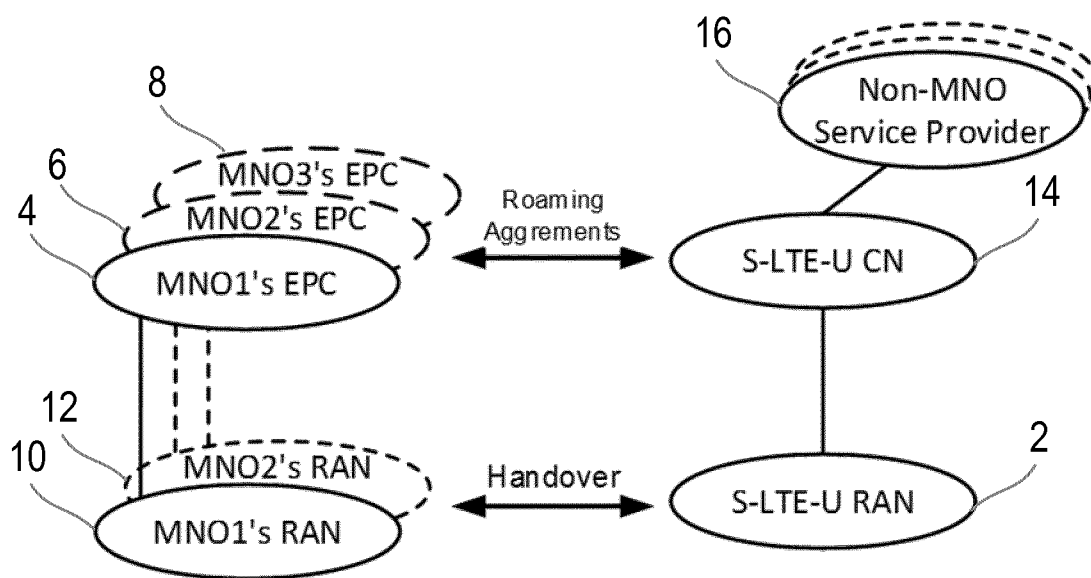


Figure 2

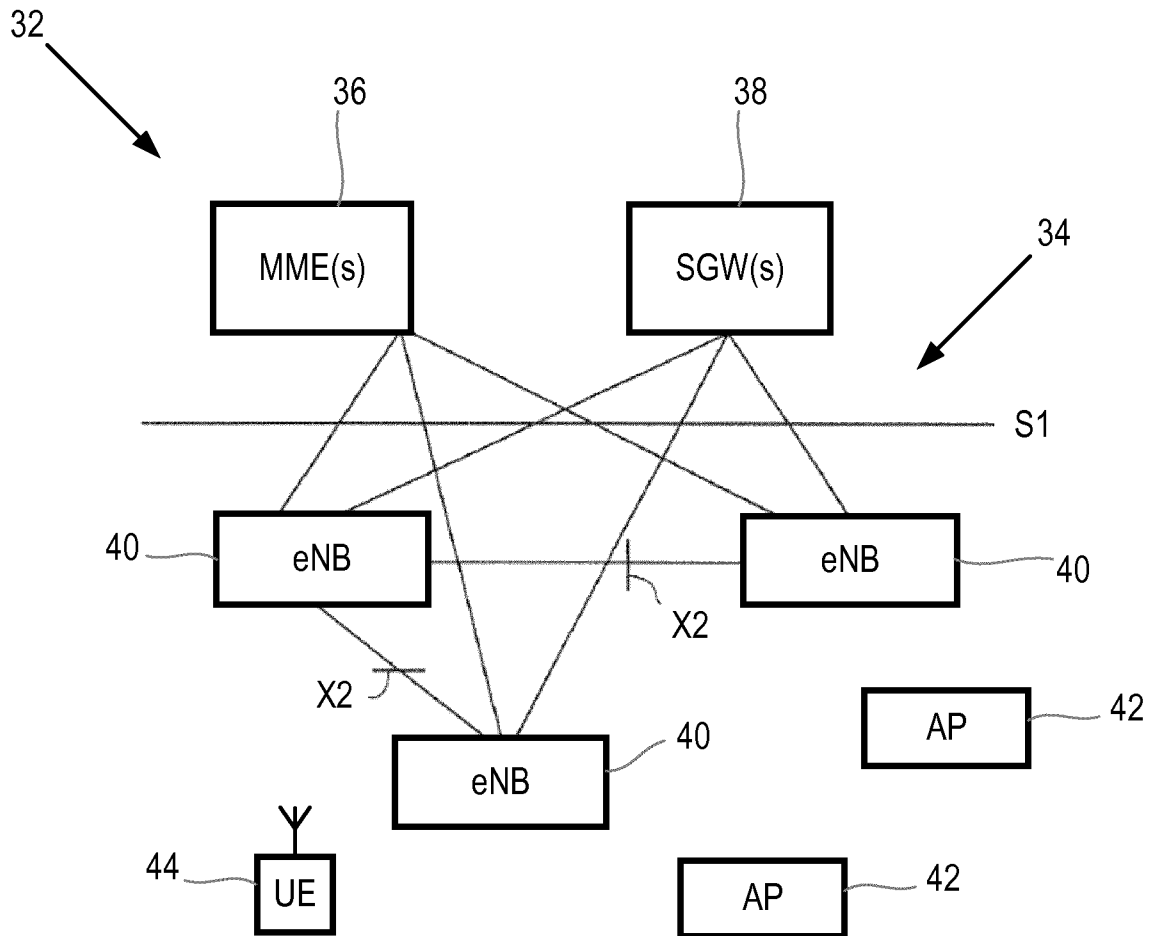


Figure 3

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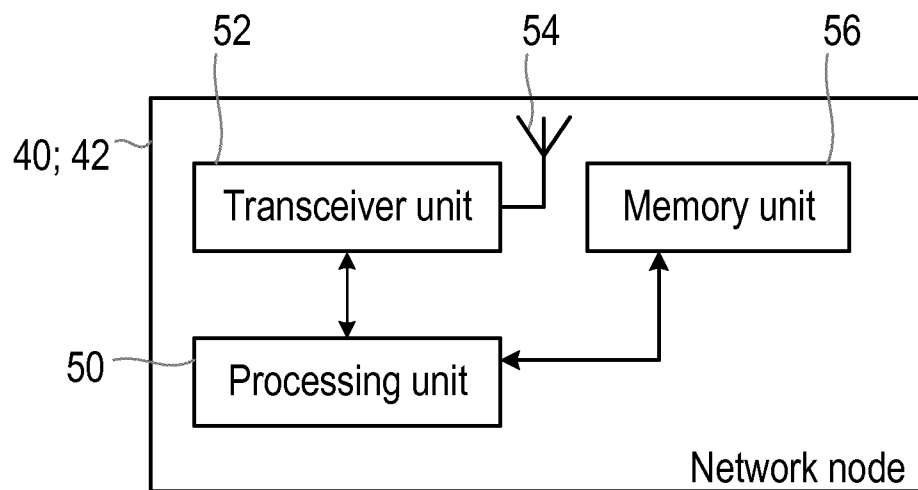


Figure 4

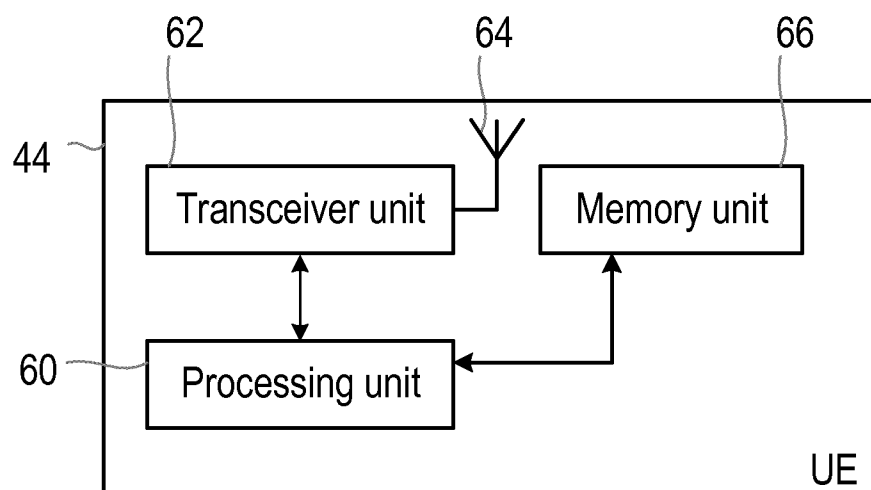


Figure 5

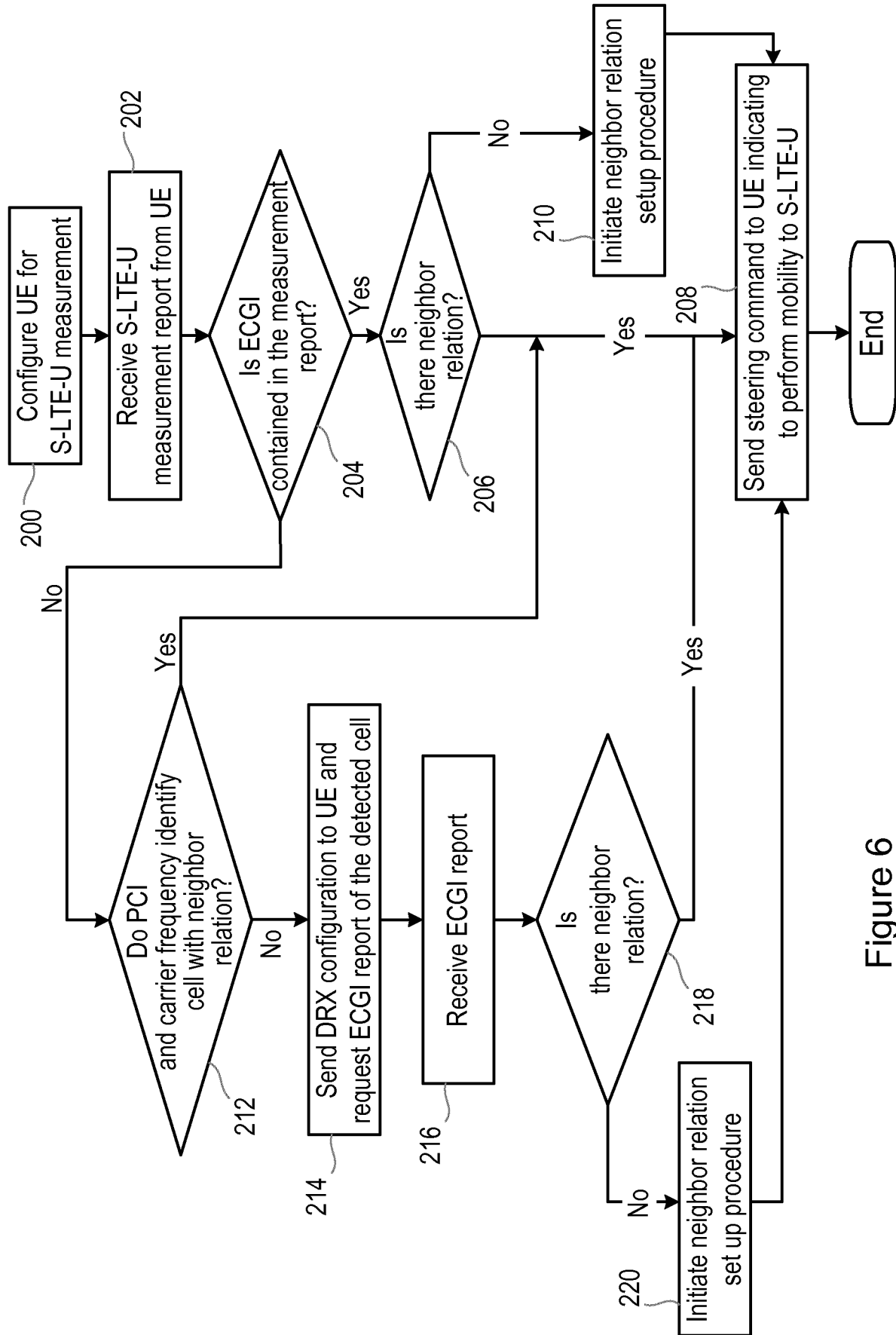


Figure 6

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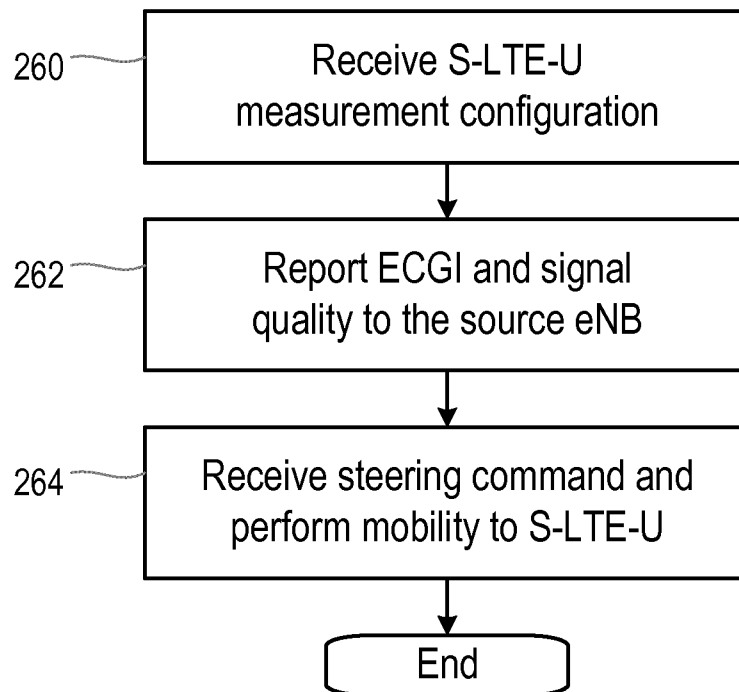


Figure 7

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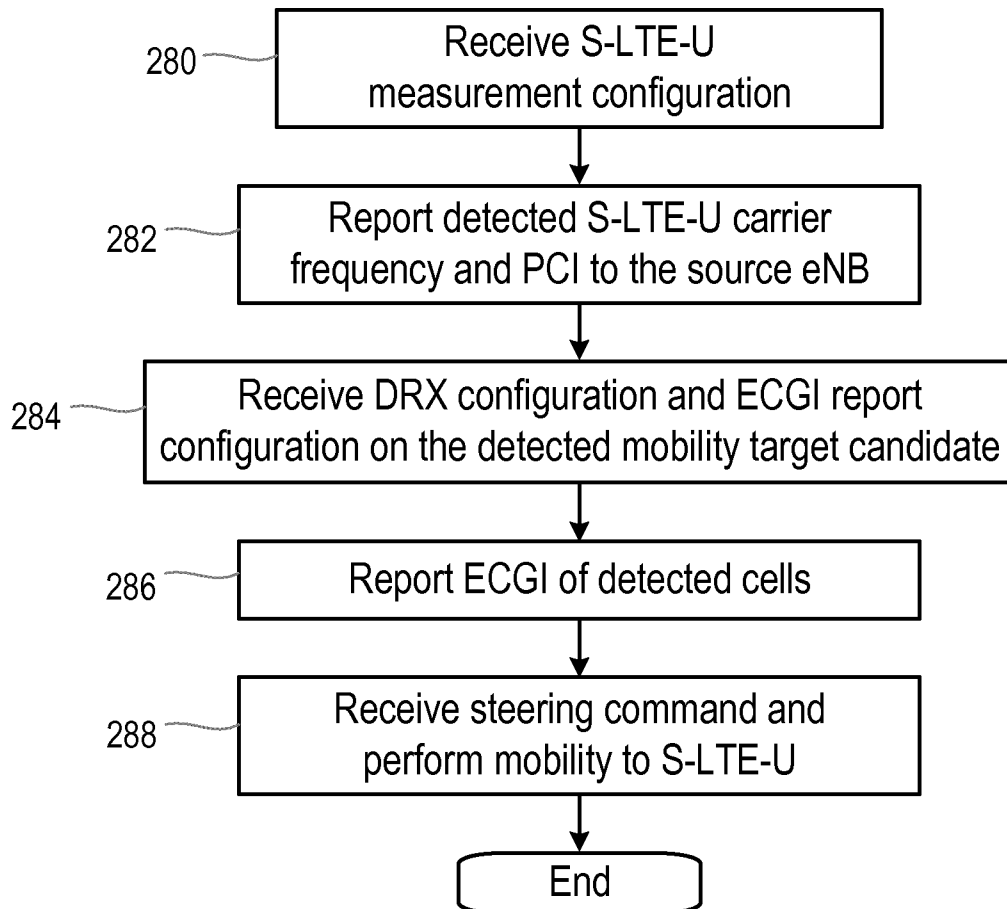


Figure 8

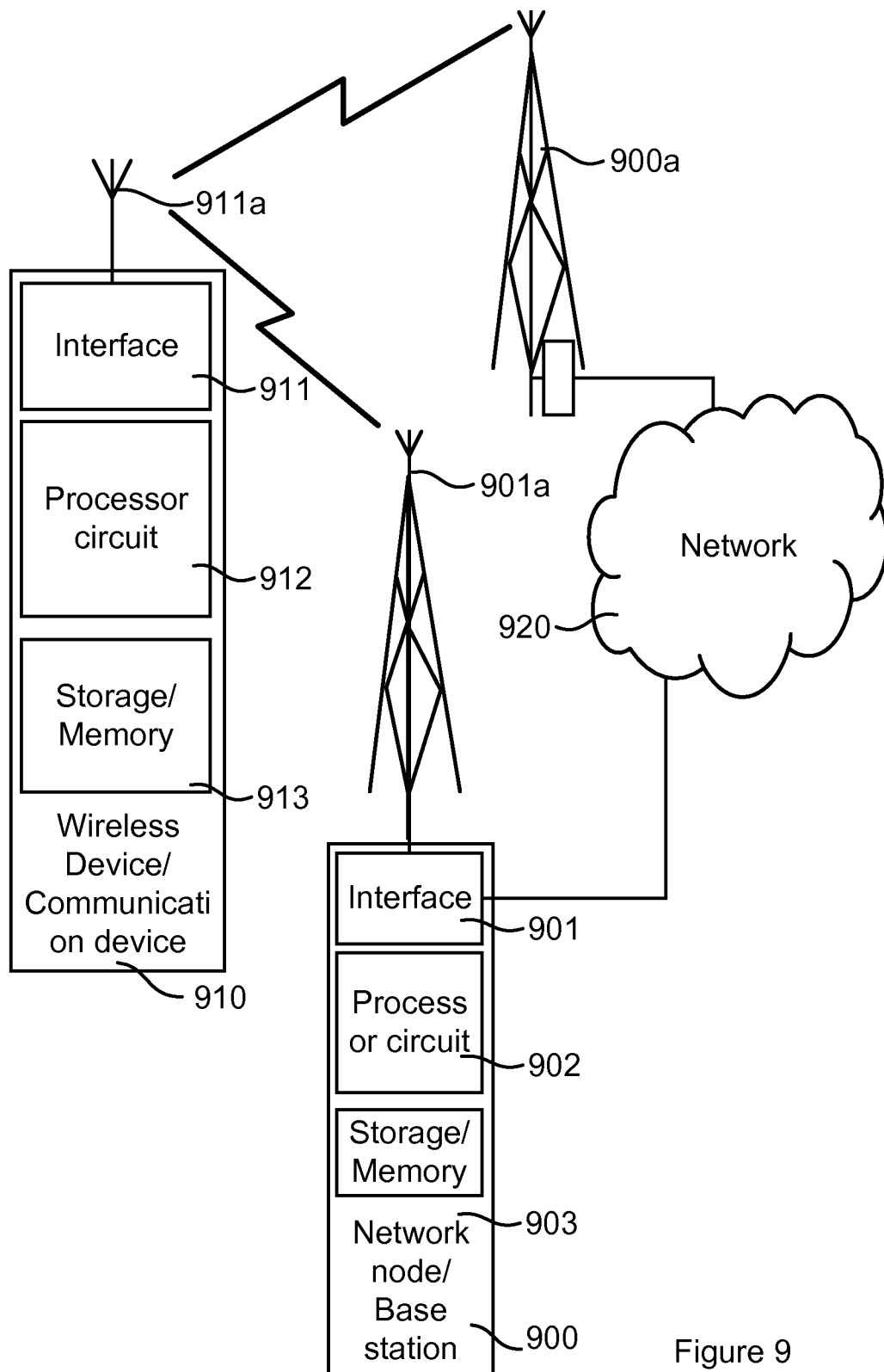


Figure 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/059249

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04W36/00

ADD. H04W16/14 H04W36/04

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2013/169006 A1 (LG ELECTRONICS INC [KR]) 14 November 2013 (2013-11-14) paragraph [0080] paragraphs [0086] - [0090] figure 6	1,13-16
X	WO 2015/065257 A1 (ERICSSON TELEFON AB L M [SE]) 7 May 2015 (2015-05-07)	1-3,5,6, 11,13-17
Y	page 1, lines 22-26 page 2, lines 20-25 page 3, lines 12-14 page 10, lines 1-12	4,7-10, 12
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

29 August 2017

Date of mailing of the international search report

16/10/2017

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INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2017/059249

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/323631 A1 (MARTIN BRIAN [GB] ET AL) 23 December 2010 (2010-12-23)	1,13-16, 31-33, 35, 37-39, 41-44, 46-48
Y	paragraphs [0096] - [0097] paragraphs [0103], [0105] - [0107], [0109] paragraphs [0114], [0116] paragraphs [0126] - [0127] figure 2 paragraph [0013] -----	4,34,36, 40,45
Y	"3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 13)", 3GPP STANDARD; 3GPP TS 36.300, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG2, no. V13.3.0, 1 April 2016 (2016-04-01), pages 1-295, XP051088532, [retrieved on 2016-04-01] paragraph [22.3.3] figures 22.3.3-1 -----	7-9
Y	WO 2016/047730 A1 (NTT DOCOMO INC [JP]) 31 March 2016 (2016-03-31) paragraph [0026] paragraphs [0076] - [0082] -----	10,12, 24,34,36
X	WO 2015/105813 A2 (QUALCOMM INC [US]) 16 July 2015 (2015-07-16)	18-23, 25-30
Y	paragraphs [0054] - [0055] paragraphs [0058] - [0060] paragraphs [0062] - [0068] figures 7-9 -----	24
Y	WO 2012/177203 A1 (ERICSSON TELEFON AB L M [SE]; AXMON JOAKIM [SE]; KAZMI MUHAMMAD [SE];) 27 December 2012 (2012-12-27) paragraphs [0089], [0099] -----	40,45

INTERNATIONAL SEARCH REPORT

International application No.
PCT/EP2017/059249

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-17

Method, radio access network node, another radio access network node, further radio access network node and computer program for determining whether to force a wireless device in DRX mode.

2. claims: 18-48

Method, wireless device, another wireless device, a further wireless device, a computer program, and alternative method, corresponding wireless device, another corresponding wireless device, a further corresponding wireless device, and a corresponding computer program for determining how to read and report the cell identity of a target cell.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/059249

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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