



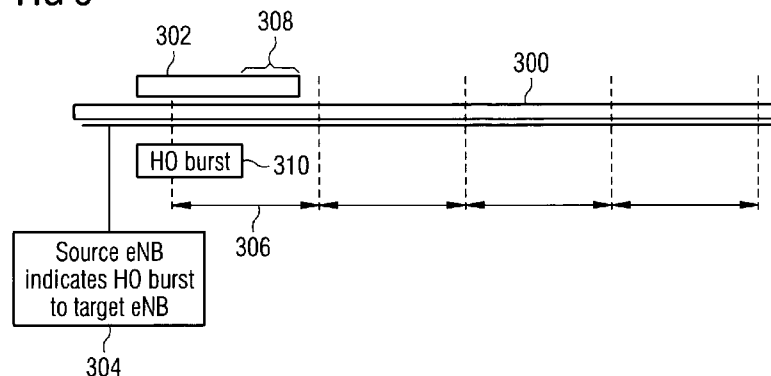
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(54) **Title:** METHODS AND APPARATUSES FOR A HANDOVER USING RESERVED TEMPORAL RESOURCES

FIG 3



(57) **Abstract:** The invention relates to apparatuses, methods and a system for performing a handover. Information about a handover need is obtained. Temporal resources for handovers are reserved based on handover need. Information on the reserved temporal handover resources is conveyed. Handovers are carried out by using the reserved temporal handover resources. The temporal resources may be random access channel resources. The reserved temporal handover resources may correspond to physical resources of a physical uplink shared channel and/or a physical uplink control channel.

METHODS AND APPARATUSES FOR A HANDOVER USING RESERVED TEMPORAL RESOURCES**Field**

The invention relates to apparatuses, methods, computer programs, computer program products and a computer-readable media.

Background

The following description of background art may include insights, discoveries, understandings or disclosures, or associations together with disclosures not known to the relevant art prior to the present invention but provided by the invention. Some such contributions of the invention may be specifically pointed out below, whereas other such contributions of the invention will be apparent from their context.

Recently need for more efficient usage of radio resources has brought out an idea of co-existence or sharing of systems meaning that systems share operational resources, for example spectrum in a given region.

Brief description

According to an aspect of the present invention, there is provided an apparatus comprising: at least one processor and at least one memory including a computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus at least to: obtain information about a handover need; reserve temporal resources for handovers based on the handover need from a physical up-link shared channel; convey information on the reserved temporal handover resources, and carry out handovers by using the reserved temporal handover resources.

According to another aspect of the present invention, there is provided a system, comprising: a handover source node and a handover target node, the handover source node being configured to notify the handover target
5 node about a handover burst, and to obtain information from the handover target node, and the handover target node being configured to obtain a notification of the handover burst, reserve temporal resources for handovers based on the notification, initiate an information trans-
10 fer to the handover source node about the reservation, and carry out handovers by using the reserved temporal handover resources.

According to another aspect of the present invention, there is provided a method comprising: obtaining in-
15 formation about a handover need; reserving temporal resources for handovers based on the handover need from a physical uplink shared channel; conveying information on the reserved temporal handover resources, and carrying out handovers by using the reserved temporal handover re-
20 sources.

According to yet another aspect of the present invention, there is provided an apparatus comprising: apparatus comprising: means for obtaining information about a handover need; means for reserving temporal resources for
25 handovers based on the handover need from a physical uplink shared channel; means for conveying information on the reserved temporal handover resources, and means for carrying out handovers by using the reserved temporal handover resources.

30 According to yet another aspect of the present invention, there is provided a computer program embodied on a computer-readable storage medium, the computer program

comprising program code for controlling a process to execute a process, the process comprising: obtaining information about a handover need; reserving temporal resources for handovers based on the handover need from a physical uplink shared channel; conveying information on the reserved temporal handover resources, and carrying out handovers by using the reserved temporal handover resources.

According to yet another aspect of the present invention, there is provided a computer-readable medium encoded with instructions that, when executed by a computer, perform: obtaining information about a handover need; reserving temporal resources for handovers based on the handover need from a physical uplink shared channel; conveying information on the reserved temporal handover resources, and carrying out handovers by using the reserved temporal handover resources.

List of drawings

Embodiments of the present invention are described below, by way of example only, with reference to the accompanying drawings, in which

- Figure 1 illustrates an example of a system;
- Figure 2 is a flow chart;
- Figure 3 shows an example of resource usage; and
- Figure 4 shows an example of an apparatus.

Description of embodiments

The following embodiments are only examples. Although the specification may refer to "an", "one", or "some" embodiment(s) in several locations, this does not necessarily mean that each such reference is to the same embodiment(s), or that the feature only applies to a single em-

bodiment. Single features of different embodiments may also be combined to provide other embodiments.

Embodiments are applicable to any user device, such as a user terminal, relay node, server, node, corresponding component, and/or to any communication system or any combination of different communication systems that support required functionalities. The communication system may be a wireless communication system or a communication system utilizing both fixed networks and wireless networks. The protocols used, the specifications of communication systems, apparatuses, such as servers and user terminals, especially in wireless communication, develop rapidly. Such development may require extra changes to an embodiment. Therefore, all words and expressions should be interpreted broadly and they are intended to illustrate, not to restrict, embodiments.

In the following, different embodiments will be described using, as an example of an access architecture to which the embodiments may be applied, a radio access architecture based on long term evolution (LTE) Advanced, LTE-A, that is based on orthogonal frequency multiplexed access (OFDMA) in a downlink and a single-carrier frequency-division multiple access (SC-FDMA) in an uplink, without restricting the embodiments to such an architecture, however.

In an orthogonal frequency division multiplexing (OFDM) system, the available spectrum is divided into multiple orthogonal sub-carriers. In OFDM systems, available bandwidth is divided into narrower sub-carriers and data is transmitted in parallel streams. Each OFDM symbol is a linear combination of signals on each of the subcarriers. Further, each OFDM symbol is preceded by a cyclic prefix

(CP), which is used to decrease Inter-Symbol Interference. Unlike in OFDM, SC-FDMA subcarriers are not independently modulated.

Typically, a (e)NodeB needs to know channel quality of each user device and/or the preferred precoding matrices (and/or other multiple input-multiple output (MIMO) specific feedback information, such as channel quantization) over the allocated sub-bands to schedule transmissions to user devices. Required information is usually
10 signalled to the (e)NodeB.

Figure 1 is an example of a simplified system architecture only showing some elements and functional entities, all being logical units whose implementation may differ from what is shown. The connections shown in Figure
15 1 are logical connections; the actual physical connections may be different. It is apparent to a person skilled in the art that the system typically comprises also other functions and structures than those shown in Figure 1.

Figure 1 shows a part of a radio access network of
20 E-UTRA, LTE or LTE-Advanced (LTE-A) or LTE/SAE (SAE = system architecture evolution, SAE is enhancement of packet switched technology to cope with faster data rates and growth of Internet protocol traffic). E-UTRA is an air interface of Release 8 (UTRA= UMTS terrestrial radio access,
25 UMTS= universal mobile telecommunications system). Some advantages obtainable by LTE (or E-UTRA) are a possibility to use plug and play devices, and Frequency Division Duplex (FDD) and Time Division Duplex (TDD) in the same platform.

30 The embodiments are not, however, restricted to the system given as an example but a person skilled in the art may apply the solution to other communication systems provided

with the necessary properties. Some examples of other options for suitable systems are the universal mobile telecommunications system (UMTS) radio access network (UTRAN or E-UTRAN), long term evolution (LTE, the same as E-UTRA), wireless local area network (WLAN or WiFi), worldwide interoperability for microwave access (WiMAX), Bluetooth®, personal communications services (PCS), wideband code division multiple access (WCDMA), code division multiple access (CDMA), groupe spécial mobile or global system for mobile communications (GSM), enhanced data rates for GSM evolution (GSM EDGE or GERAN), systems using ultra-wideband (UWB) technology and different mesh networks. The embodiments are especially suitable for co-existence networks of two or more systems or layers of one or more systems. In the example of Figure 1, a multilayer sharing or resources is expected and the system producing the layer capable to use a spectrum hole is depicted.

Figure 1 shows user devices 100 and 102 configured to be in a wireless connection on one or more communication channels 104, 106 in a cell with a (e)NodeB 108 providing the cell. The physical link from a user device to a (e)NodeB is called uplink or reverse link and the physical link from the NodeB to the user device is called downlink or forward link.

The NodeB, or advanced evolved node B (eNodeB, eNB) in LTE-Advanced, is a computing device configured to control the radio resources of communication system it is coupled to. The (e)NodeB may also be referred to a base station, an access point or any other type of interfacing device including a relay station capable of operating in a wireless environment.

The (e)NodeB includes transceivers, for instance. From the transceivers of the (e)NodeB, a connection is provided to an antenna unit that establishes bi-directional radio links to user devices. The (e)NodeB is
5 further connected to a core network 110 (CN). Depending on the system, the counterpart on the CN side can be a serving system architecture evolution (SAE) gateway (routing and forwarding user data packets), packet data network gateway (PDN GW), for providing connectivity to user de-
10 vices (UEs) to external packet data networks, or mobile management entity (MME), etc.

The communication system is also able to communicate with other networks, such as a public switched telephone network or the Internet.

15 The user device illustrates one type of an apparatus to which resources on the air interface may be allocated and assigned, and thus any feature described herein with a user device may be implemented with a corresponding apparatus. The user device may also be called a subscriber
20 unit, mobile station, remote terminal, access terminal, user terminal or user equipment (UE) just to mention but a few names or apparatuses.

The user device typically refers to a portable computing device that includes wireless mobile communication devices
25 operating with or without a subscriber identification module (SIM), including, but not limited to, the following types of devices: a mobile station (mobile phone), smartphone, personal digital assistant (PDA), handset, laptop computer, game console, notebook, and multimedia device.

30 It should be understood that, in Figure 1, user devices are depicted to include 2 antennas only for the sake of clarity. The number of reception and/or transmis-

sion antennas may naturally vary according to a current implementation.

Further, although the apparatuses have been depicted as single entities, different units, processors
5 and/or memory units (not all shown in Figure 1) may be implemented.

It is obvious for a person skilled in the art that the depicted system is only an example of a part of a radio access system and in practise, the system may comprise a
10 plurality of (e)NodeBs, the user device may have an access to a plurality of radio cells and the system may comprise also other apparatuses, such as physical layer relay nodes or other network elements, etc. At least one of the NodeBs or eNodeBs may be a Home(e)nodeB. Additionally, in a geo-
15 graphical area of a radio communication system a plurality of different kinds of radio cells as well as a plurality of radio cells may be provided. Radio cells may be macro cells (or umbrella cells) which are large cells, usually having a diameter of up to tens of kilometres, or smaller
20 cells such as micro-, femto- or picocells. The (e)NodeB 108 of Figure 1 may provide any kind of these cells. A cellular radio system may be implemented as a multilayer network including several kinds of cells. Typically, in multilayer networks, one node B provides one kind of a
25 cell or cells, and thus a plurality of node Bs are required to provide such a network structure.

In Figure 1, node (e)NodeB 114 may be a Home(e)Node or pico or femto node. It is operably coupled 120 to the (e)NodeB 108 which may provide a macro cell or a primary
30 communication system cell. User device 116 depicts a user device communicating with the (e)NodeB via a radio link

118. The (e)NodeB may be coupled to the core network 110 directly 122 or indirectly via another network node.

Recently for fulfilling the need for improving the deployment and performance of communication systems, concept of

5 "plug-and-play" node (e)Bs has been introduced. Typically, a network which is able to use "plug-and-play" node (e)Bs, includes, in addition to Home node (e)Bs (Home(e)nodeBs), a home node B gateway, or HNB-GW (not shown in Figure 1). A HNB Gateway (HNB-GW), which is typically installed

10 within an operator's network aggregates traffic from a large number of HNBs back to a core network through Iu-cs and Iu-ps interfaces.

With increasing number of personal, local and wireless communication systems operating in a same geographical

15 area, the questions of co-existence and inter-networking are raised. Cognitive and re-configurable radios may be a key for obtaining a heterogeneous communication environment where mitigation techniques and cognitive signalling are used for sharing the spectrum and routing information.

20 Cognitive radios are designed to efficient spectrum use deploying so-called smart wireless devices being capable to sense and detect the environment and adapt to it thus being suitable for opportunistic spectrum usage, in which also the frequency bands not being used by their primary
25 (usually licensed) users may be utilized by secondary users. For this purpose cognitive radios are designed to detect unused spectrum, such as spectrum holes.

The heterogeneous networks may also create new interference challenges due to the deployment of different wire-

30 less nodes such as macro/micro eNBs, pico eNBs, and Home eNBs creating a multi-layer network using the same spectrum resource.

In the following, some embodiments of a method for secondary spectrum use are explained in further detail by means of Figures 2 and 3. The embodiments are especially suitable for enabling system operation for a primary system when one or more secondary systems are allowed to operate on the same physical resources in the situation of co-existence/sharing of systems. Co-existence/spectrum sharing is one of major challenges in open spectrum usage.

Another exemplary use case is network energy saving in which one or more LTE cells (that is to say carriers) may be switched on and off in a way which is advantageous in the energy saving point of view. The LTE cells may be switched off when traffic has decreased to such an amount that a reduced number of carriers may deal with the remaining traffic.

Yet another exemplary use case is a communication service provider having multiple networks using different radio access technologies and, possibly, also multiple carriers or frequency layers with network operation and maintenance, wherein a radio resource management unit or some other corresponding network elements providing control functionalities are used commonly or in a coordinate manner. In such a case, a network element may decide to switch on or off one or more LTE cells.

Typically, in a geographical area, a system which is a licensed user has a primary user status and possible ad-hoc users or opportunistic users which are ready to use spectrum holes or corresponding resources are called secondary users. Secondary users are typically not allowed to cause too much interference to primary users.

If a need for transferring many or even all users from a cell exists, a handover burst is in many cases go-

ing to take place, since especially in urban areas, cells are typically densely occupied. A burst of handovers may take place especially in the case, when a cell is switch on or off. Then a lot of traffic is transferred from currently used resources to new ones. One example of such a situation is when LTE and legacy (in this application for example, GSM) cells coexist in a same, shared frequency layer. On the shared layer, the legacy and LTE cells are not at least completely co-located but separated by a vacant buffer zone. Other layers may be reserved solely for the legacy system and/or LTE. LTE cells on the shared layer are switched on when GSM traffic is low and LTE traffic approaches the capacity of LTE layer or, in the absence of an LTE-specific layer, sufficient amount of LTE-capable user devices are detected. The LTE cells are switched off when more GSM capacity is needed based on a traffic load.

In this example, when an LTE cell is switched on and, in particular, switched off, user devices in the LTE cell currently using the resources to be switched off need to be handed over to other radio cells in that location. If no LTE cells are provided on other frequency layers in that location, a need for inter radio access technology (RAT) handovers exist. If LTE cells on other layers have an overlapping coverage, inter-frequency handovers within LTE system cells may be carried out. Typically, an assumption can be made that a significant number of user devices are handed over to a same target cell.

Switching the LTE cells off will thus cause a burst of handovers with considerable amount of radio resource control signaling both in source and target cells as well as random accesses to the target cell. Further-

more, motivation to minimize signaling delays regarding to these handovers exist.

When a user device performs a handover, its first transmission in a handover target cell takes place at a physical random access channel (PRACH) where random access preambles are transmitted. The user device usually receives parameters for the preamble transmission through a source cell. These parameters may define time and frequency resources of PRACH and the available preamble sequences. Additionally, a dedicated preamble sequence may be given for a non-contention based random access. A dedicated preamble sequence may be in the use of one user device at a time. Thus, the preamble collisions may be avoided and the user device may be identified in the target cell by the preamble sequence that makes a non-contention based random access more reliable and faster than a contention based random access.

In LTE Rel. 8-10, non-contention based and contention based physical random access channel preambles are transmitted on same physical resources. The physical resources are communicated in broadcasted system information. The system information also communicates which one or ones of the totally 64 preambles are reserved for non-contention based use and cannot thus be selected by user devices for contention based access.

A random access channel (RACH) load may become substantially high during a handover burst, and a method of temporarily increasing the RACH capacity is hence needed. One option is to increase physical resources reserved for PRACH and the number of preambles reserved for non-contention based access for the duration of a handover burst. This requires changing or modifying system informa-

tion and notifying user devices in the target cell about this change or modification.

User devices in a handover target cell should receive updated system information before extended amount of preambles for non-contention based access are used for a handover. Otherwise a risk exists that a same preamble is simultaneously used for both a handover related non-contention based random access and for a normal contention based random access. This may lead to erroneous timing measurements as well as losing a contention based random access attempt.

When system information is changed or modified, a system information modification indicator is sent to a user device during a first broadcast control channel (BCCH) modification period and only after that transmission of updated system information is started. Additionally, the start of a BCCH modification period is restricted to particular radio frames ($\text{SFN mod modification period} = 0$). Thus average delay from a (e)NodeB decision of system information change or modification to the start of updated system information transmission depends on configured modification period. Thus the increase of PRACH preambles for non-contention based access via changing or modifying system information may be seen as a slow solution causing delay to handovers. Further, the share of PRACH preambles reserved for non-contention based random access is dimensioned for typical needs in each cell and is thus usually insufficient for burst of handovers.

If a need for transferring many or even all users from a cell exists, a handover burst is in many cases going to take place, since especially in urban areas, cells are typically densely occupied. Embodiments provide an im-

proved method for dealing with a handover burst. A shorter delay time in dealing with a handover burst is provided.

An embodiment starts in block 200 of Figure 2.

5 In block 202, information about a handover need is obtained. Typically, a handover source cell notifies a handover target cell about a handover need, such as a burst of handovers. Notifying may be carried out by transmitting a handover request which then is received by the
10 target cell.

In block 204, temporal resources for handovers are reserved based on the handover need.

In an embodiment, reserved temporal handover resources may correspond to physical resources of a physical
15 uplink shared channel and/or a physical uplink control channel.

For example, the handover target cell reserves from a physical uplink shared channel (PUSCH) temporal PRACH resources solely for the use of user devices to be
20 handed over from the source cell. It should be appreciated that these temporal RACH resources are at least partially different from normal PRACH resources which are signaled as a part of normal system information in a system information block.

25 In block 206, information on the reserved temporal resources for handovers is conveyed. This may be carried out by signaling between a node reserving the resources and the node which needs a handover burst to be carried out. Conveyance may mean preparing a message including
30 this information.

Typically, the target cell informs the source cell about its readiness to receive the offered new users. The

information may for instance be a handover grant message that includes information about temporal PRACH resources and dedicated preambles.

The source cell is typically informed about a temporal RACH resource configuration. Typically, data regarding to a handover burst, such as handover preambles, is conveyed using at least partially different physical resources than for "normal" handover signaling. In the following, a clarifying example for the LTE-system is explained in further detail:

In the LTE-system, a part of a handover command, MobilityControlInfo information element, may be transmitted by a target cell node and is transparently forwarded to a user terminal by a source cell node. The command may contain rach-ConfigDedicated and radioResourceConfigCommon information elements, wherein the rach-ConfigDedicated information element defines at least one subframe and preamble to be used by the user device in a handover, and wherein the radioResourceConfigCommon contains two information elements: rach-ConfigCommon and prach-Config that provide cell-specific PRACH parameters in the target cell. In particular, rach-ConfigCommon information element defines the number of non-dedicated preambles in a subframe used for contention based random access (RA) with numberOfRA-Preambles, and the prach-Config information elements defines subframes containing PRACH with prach-ConfigIndex and the frequency offset of PRACH with prach-FreqOffset.

Further, in the same example, for temporal PRACH resource configuration: prach-ConfigIndex in prach-Config may be set to a different value than prach-ConfigIndex in prach-ConfigSIB, which is broadcasted as target system in-

formation in order that handover PRACH burst is to be transmitted in subframes that are at least partially different from subframes used for a normal PRACH burst according to the broadcasted system information.

5 Correspondingly, prach_FreqOffset may be set to a different value than prach_FreqOffset in prach-ConfigSIB that is broadcasted in target cell system information in order that handover PRACH burst is to be transmitted at a frequency different from a frequency used for normal PRACH
10 burst according to the broadcasted system information.

 Data field numberOfRA-Preambles may be set on temporal PRACH resources into lower value than the numberOfRA-Preambles broadcasted by a target cell. Some preambles on temporal PRACH resources may be reserved for
15 contention-based RA as a need may exists that some user devices making a handover carry out a random access after they have completed their handover, but before they have acquired a broadcasted configuration for the normal PRACH resources in the cell. A different numberOfRA-Preambles
20 value on temporal and normal PRACH resources is possible even in the case of temporal and normal PRACH resources being partially overlapping, since data field rach-ConfigDedicated controls both the preamble and subframe to be used in non-contention based random access (RA).

25 In block 208, handovers are carried out by using the reserved temporal handover resources. The handovers may otherwise be carried out by using a "normal" handover procedure of the current radio protocol, but the resources used for this purpose are at least partly the reserved
30 temporal resources.

 It should be understood that starting from the beginning of a handover burst a target cell may avoid unnec-

essary interference on the temporal PRACH by not scheduling PUSCH resources corresponding to temporal PRACH resources.

Typically, after a handover, temporal PRACH resources are released to their normal use. Thus, temporal RACH resources may be returned to a normal PUSCH use by rescheduling. The user device is required to acquire broadcasted system information, and overwrite any stored system information. Thus, the user device begins to use normal PRACH resources after it has acquired SystemInformationBlockType2-information which carries a radioResourceConfigCommon data field.

Thus, the target cell may re-schedule PUSCH used as temporal PRACH resources after the handovers are completed and sufficient time for devices to acquire SystemInformationBlockType2 information has passed.

An example is illustrated in Figure 3. The example is only used for clarification purposes and is non-limiting of a nature. The example illustrates how a handover burst may be started earlier than using conventional handover methods, as temporal PRACH resources may simply be created by PUSCH scheduling instead of system information change or modification. The delay from the moment when a source cell indicates a need for a handover burst to the beginning of the handover burst is only caused by signaling between a target cell and source cell and radio resource controlling signaling between a source cell and user device. This delay is similar to a "normal" handover signaling even if a large number of handovers is taken care of in the case of a handover burst. Furthermore, the temporal PRACH resources for dedicated preambles may be released earlier as the delay after the handover burst

is caused by system information blocks SIB1 and SIB2 acquisition and application by the user device, not by broadcast control channel (BCCH) modification involving modification periods 306 (arrows with two heads illustrate
5 the periods). The conventional BCCH modification typically causes a delay (i.e. $1\frac{1}{2}$ modification periods with uniform time distribution for (e)NB decision) that as an average ranges from 480 ms to over 30 seconds in other extreme.

In Figure 3, normal PRACH resources are depicted
10 as 300, the temporal PRACH resources as 302 and timing of a handover burst as 310. Block 304 shows when a source cell indicates the need for a handover burst to a target cell. Part of temporal PRACH resources marked as 308 depicts the time needed for user devices carrying out hand-
15 overs to acquire and apply SIB1 and SIB2 via BCCH.

The example described above is also suitable for devices supporting earlier LTE generations back to Release 8 as long as the temporal RACH handover resources are not overlapping in time with normal RACH resources. However,
20 if handover preambles are transmitted by using same subframes, devices supporting these earlier standards may not allow a target cell to send separate responses for handover preambles and for preambles that have been sent on a regular PRACH. A message of preamble responses may be addressed by using an identity that is a so called random
25 access radio network temporary identifier (RA-RNTI) that according to earlier LTE specifications is obtained by a fixed mapping from the PRACH resource index. For instance, if one regular PRACH resource per a subframe of an FDD
30 system is provided, RA-RNTI values from 1 to 10 are in use. Thus, if a user device transmits a preamble in subframe n (n can have a value from 0 to 9), it typically

searches a response addressed with RA-RNTI value $n+1$ irrespective of prach-FreqOffset value. One possibility to enable the separation of responses to handover preambles from responses to "normal" preambles is defining different mappings from PRACH resources to random access radio network temporary identifier (RA-RNTI) for the temporal and/or "normal" RACH resources. The difference may be an offset defined in a standard or given by a handover target cell. Such an offset would even make possible code division multiplexing of temporal and regular PRACH by reusing time and frequency resources and defining a different preamble set for handovers.

A handover burst typically takes place in the situation when at least one cell is going to be switched off as described above. After the handover burst, a source cell may stop transmitting common channels and a common reference signal in the downlink. After that the source cell is considered to be switched off.

Some other signaling may be used as well to enhance camping of idle user devices in a target cell: updating inter-frequency neighbouring cell list on neighbouring cells, changing frequency layer priorities and/or frequency layer-specific reselection parameters for transferring camping idle user devices to other cells, and/or configuring a cell to be barred.

It is also possible to prevent new user devices entering a source cell (that is the cell to be switched off): updating inter-frequency neighbouring cell list on neighboring cells, refusing handover requests, and/or not responding to PRACH after the last handover of the burst is completed.

Embodiments may be used for some other purposes as well. For example for energy saving: handing over a considerable amount of user devices from one cell to another one in a short period of time enable a shorter switch-off
5 time for the cell to be emptied.

The embodiment ends in block 210. The embodiment is repeatable and one option for repetition is shown with arrow 212. Other options are naturally also possible.

It should be appreciated that reception formats
10 typically corresponds to transmission formats.

The steps/points, signaling messages and related functions described above in Figures 2 and 3 are in no absolute chronological order, and some of the steps/points may be performed simultaneously or in an order differing from the
15 given one. Other functions can also be executed between the steps/points or within the steps/points and other signaling messages sent between the illustrated messages. Some of the steps/points or part of the steps/points can also be left out or replaced by a corresponding step/point
20 or part of the step/point.

It should be understood that transmitting and/or receiving may herein mean preparing a transmission and/or reception, preparing a message to be transmitted and/or received, or physical transmission and/or reception itself, etc on a
25 case by case basis. In an embodiment, a server, node or host may convey information on reserved temporal handover resources. This conveyance may or may not include transmission and/or reception.

In the following an example of a system where embodiments
30 may be applied to is explained in further detail by means of Figure 1.

The system includes at least two nodes of which two are depicted.

In this example, (e)NodeB 108 is a source cell node and node 114 is a target cell node. The node 114 may be an
5 (e)NodeB or a base station or any suitable network element generating a radio cell. The rest of the network which the node 114 belongs to, is not shown, since the structure of the network is not relevant in this context. In Figure 1, only one user device 116 having a radio connection 118
10 with the node 114 is shown for the sake of clarity. It is obvious for a skilled person that typically, a plurality of user devices exists in the cell, some of them having a radio resource connection to the serving node and some of them being in an idle mode. The (e)NodeB 108 and the node
15 114 are operably coupled to each other which is depicted by arrow 120.

If a need for transferring many or even all users from a cell exists, a handover burst is in many cases going to take place, since especially in urban areas, cells are
20 typically densely occupied. Then, in an embodiment, a source cell notifies a target cell about a large handover burst. The target cell reserves temporal resources for handovers from a physical uplink shared channel based on the handover burst information and initiates an informa-
25 tion transfer about the reservation to the source cell. The source cell obtains the information and the target cell carries out handovers by using the reserved temporal handover resources. Further details and non-limiting examples of embodiments are described above in relation to
30 Figures 2 and 3.

An embodiment provides an apparatus which may be any node, host, server or any other suitable apparatus able to carry

out processes described above in relation to Figures 2 and 3.

Figure 4 illustrates a simplified block diagram of an apparatus according to an embodiment. It should be appreciated that the apparatus may also include other units or parts than those depicted in Figure 4. Although the apparatus has been depicted as one entity, different modules and memory (one or more) may be implemented in one or more physical or logical entities.

10 The apparatus 400 may in general include at least one processor, controller or a unit designed for carrying out control functions operably coupled to at least one memory unit and to various interfaces. Further, a memory unit may include volatile and/or non-volatile memory. The
15 memory unit may store computer program code and/or operating systems, information, data, content or the like for the processor to perform operations according to embodiments. Each of the memory units may be a random access memory, hard drive, etc. The memory units may be at least
20 partly removable and/or detachably operationally coupled to the apparatus.

 The apparatus may be a software application, or a module, or a unit configured as arithmetic operation, or as a program (including an added or updated software routine), executed by an operation processor. Programs, also
25 called program products or computer programs, including software routines, applets and macros, can be stored in any apparatus-readable data storage medium and they include program instructions to perform particular tasks.
30 Computer programs may be coded by a programming language, which may be a high-level programming language, such as objective-C, C, C++, Java, etc., or a low-level program-

ming language, such as a machine language, or an assembler.

Modifications and configurations required for implementing functionality of an embodiment may be performed
5 as routines, which may be implemented as added or updated software routines, application circuits (ASIC) and/or programmable circuits. Further, software routines may be downloaded into an apparatus. The apparatus, such as a node device, or a corresponding component, may be config-
10 ured as a computer or a microprocessor, such as a single-chip computer element, or as a chipset, including at least a memory for providing storage capacity used for arithmetic operation and an operation processor for executing the arithmetic operation.

15 As an example of an apparatus according to an embodiment, it is shown an apparatus, such as a node device, including facilities in a control unit 404 (including one or more processors, for example) to carry out functions of embodiments according to Figures 2 and 3. This is depicted
20 in Figure 4.

The apparatus may also include at least one processor 404 and at least one memory 402 including a computer program code, the at least one memory and the computer program code configured to, with the at least one proces-
25 sor, cause the apparatus at least to: obtain information about a handover need, reserve temporal resources for handovers based on the handover need from a physical uplink shared channel, convey information on the reserved temporal handover resources and carry out handovers by us-
30 ing the reserved temporal handover resources.

Another example of an apparatus comprises means 404 for obtaining information about a handover need, means

404 for reserving temporal resources for handovers based on the handover need from a physical uplink shared channel, means 404 (406) for conveying information on the reserved temporal handover resources and means 404 for carrying out handovers by using the reserved temporal handover resources.

Yet another example of an apparatus comprises an information unit configured to obtain information about a handover need, a reserving unit configured to reserve temporal resources for handovers based on the handover need from a physical uplink shared channel, a conveyance unit configured to convey information on the reserved temporal handover resources, and a handover unit configured to carry out handovers by using the reserved temporal handover resources.

Embodiments of Figures 2 and 3 may be carried out in processor or control unit 404 possibly with aid of memory 402 as well as a transmitter and/or receiver 406.

It should be appreciated that different units may be implemented as one module, unit, processor, etc, or as a combination of several modules, units, processor, etc.

It should be understood that the apparatuses may include other units or modules etc. used in or for transmission. However, they are irrelevant to the embodiments and therefore they need not to be discussed in more detail herein. Transmitting may herein mean transmitting via antennas to a radio path, carrying out preparations for physical transmissions or transmission control depending on the implementation, etc. The apparatus may utilize a transmitter and/or receiver which are not included in the apparatus itself, such as a processor, but are available

to it, being operably coupled to the apparatus. This is depicted as an option in Figure 4 as a transceiver 406.

Embodiments provide computer programs embodied on a distribution medium, comprising program instructions which, when loaded into electronic apparatuses, constitute the apparatuses as explained above.

Other embodiments provide computer programs embodied on a computer readable medium, configured to control a processor to perform embodiments of the methods described above.

10 The computer program may be in source code form, object code form, or in some intermediate form, and it may be stored in some sort of carrier, distribution medium, or computer readable medium, which may be any entity or device capable of carrying the program. Such carriers include a record medium, computer memory, read-only memory, electrical carrier signal, telecommunications signal, and software distribution package, for example. Depending on the processing power needed, the computer program may be executed in a single electronic digital computer or it may be distributed amongst a number of computers.

The techniques described herein may be implemented by various means. For example, these techniques may be implemented in hardware (one or more devices), firmware (one or more devices), software (one or more modules), or combinations thereof. For a hardware implementation, the apparatus may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described herein, or a

combination thereof. For firmware or software, the implementation can be carried out through modules of at least one chip set (e.g., procedures, functions, and so on) that perform the functions described herein. The software codes
5 may be stored in a memory unit and executed by processors. The memory unit may be implemented within the processor or externally to the processor. In the latter case it can be communicatively coupled to the processor via various means, as is known in the art. Additionally, the compo-
10 nents of systems described herein may be rearranged and/or complimented by additional components in order to facilitate achieving the various aspects, etc., described with regard thereto, and they are not limited to the precise configurations set forth in the given figures, as will be
15 appreciated by one skilled in the art.

It will be obvious to a person skilled in the art that, as technology advances, the inventive concept may be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may
20 vary within the scope of the claims.

Claims

1. An apparatus comprising:
at least one processor and at least one memory including a
computer program code, the at least one memory and the
5 computer program code configured to, with the at least one
processor, cause the apparatus at least to:
obtain information about a handover need;
reserve temporal resources for handovers based on the
handover need;
10 convey information on the reserved temporal handover re-
sources, and
carry out handovers by using the reserved temporal hand-
over resources.
- 15 2. The apparatus of claim 1, wherein the temporal re-
sources are random access channel resources.
3. The apparatus of any of preceding claim, wherein the
reserved temporal handover resources correspond to physi-
20 cal resources of at least one of the following uplink
channel: a physical uplink shared channel and physical up-
link control channel.
- 25 4. The apparatus of any preceding claim, wherein the
temporal resources are physical random access resources
and information element prach-ConfigIndex in prach-Config
is set to a different value than information element
30 prach-ConfigIndex in prach-ConfigSIB for handover physical
random access data to be conveyed in sub frames that are
at least partially different from sub frames used for nor-
mal physical random access data.

5. The apparatus of any preceding claim, wherein the temporal resources are physical random access resources and information element prach_FreqOffset is set to a different value than information element prach_FreqOffset in prach-ConfigSIB for handover physical random access data to be conveyed at a frequency different from frequency used for normal physical random access data.

6. The apparatus of claims 4 or 5, wherein mappings from a physical random access channel resource to a random access radio network temporary identifier are different for temporal and normal random access resources.

7. The apparatus of any preceding claim, wherein after the handovers, the temporal resources are physical uplink shared channel resources, and they are returned to a normal physical uplink shared channel use by rescheduling.

8. The apparatus of any preceding claim, the apparatus comprising a server, host or node device.

9. A computer program comprising program instructions which, when loaded into the apparatus, constitute the modules of any preceding claim 1 to 7.

25

10. A system, comprising:
a handover source node and a handover target node,
the handover source node being configured to notify the handover target node about a handover burst, and to obtain information from the handover target node, and the handover target node being configured to obtain a notification of the handover burst, reserve temporal resources for handovers based on the notification, initiate an information transfer to the handover source node about

30

the reservation, and carry out handovers by using the reserved temporal handover resources.

11. A method comprising:

- 5 obtaining information about a handover need;
reserving temporal resources for handovers based on the
handover need from a physical uplink shared channel,;;
conveying information on the reserved temporal handover
resources, and
10 carrying out handovers by using the reserved temporal
handover resources.

12. The method of claim 11, wherein the temporal resources are random access channel resources.

15

13. The method of any preceding claim 11 to 12,
wherein the reserved temporal handover resources correspond to physical resources of at least one of the following uplink channel: a physical uplink shared channel and
20 physical uplink control channel.

14. The method of any preceding claim 11 to 13,
wherein the temporal resources are physical resources reserved for a physical random access channel and for preambles reserved for non-contention based access.
25

15. The method of any preceding claim 11 to 14,
wherein the temporal resources are physical random access resources and information element prach-ConfigIndex in
30 prach-Config is set to a different value than information element prach-ConfigIndex in prach-ConfigSIB for handover physical random access data to be conveyed in sub frames that are at least partially different from sub frames used for normal physical random access data.

35

16. The method of any preceding claim 11 to 15, wherein the temporal resources are physical random access resources and information element prach_FreqOffset is set to a different value than information element

5 prach_FreqOffset in prach-ConfigSIB for handover physical random access data to be conveyed at a frequency different from frequency used for normal physical random access data.

10 17. The method of claims 15 or 16, wherein mappings from a physical random access channel resource to a random access radio network temporary identifier are different for temporal and normal random access resources.

15 18. The method of any preceding claim 11 to 17, wherein after the handovers, the temporal resources are physical uplink shared channel resources, and they are returned to a normal physical uplink shared channel use by rescheduling.

20 19. An apparatus comprising:
means for obtaining information about a handover need;
means for reserving temporal resources for handovers based on the handover need from a physical uplink shared chan-
25 nel;
means for conveying information on the reserved temporal handover resources, and
means for carrying out handovers by using the reserved temporal handover resources.

30 20. A computer program embodied on a computer-readable storage medium, the computer program comprising program code for controlling a process to execute a process, the process comprising:

35 obtaining information about a handover need;

reserving temporal resources for handovers based on the handover need from a physical uplink shared channel; conveying information on the reserved temporal handover resources, and

5 carrying out handovers by using the reserved temporal handover resources.

21. The computer program of claim 20, wherein the temporal resources are random access channel resources.

10

22. The computer program of any preceding claim 20 to 21, wherein the reserved temporal handover resources correspond to physical resources of at least one of the following uplink channel: a physical uplink shared channel and physical uplink control channel.

15

23. The computer program of any preceding claim 20 to 22, wherein the temporal resources are physical resources reserved for a physical random access channel and for preambles reserved for non-contention based access.

20

24. The computer program of any preceding claim 20 to 23, wherein the temporal resources are physical random access resources and information element prach-ConfigIndex in prach-Config is set to a different value than information element prach-ConfigIndex in prach-ConfigSIB for handover physical random access data to be conveyed in subframes that are at least partially different from subframes used for normal physical random access data.

30

25. The computer program of any preceding claim 20 to 24, wherein the temporal resources are physical random access resources and information element prach_FreqOffset is set to a different value than information element prach_FreqOffset in prach-ConfigSIB for handover physical

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random access data to be conveyed at a frequency different from frequency used for normal physical random access data.

5 26. The computer program of claims 24 or 25, wherein mappings from a physical random access channel resource to a random access radio network temporary identifier are different for temporal and normal random access resources.

10 27. The computer program of any preceding claim 20 to 26, wherein after the handovers, the temporal resources are physical uplink shared channel resources, and they are returned to a normal physical uplink shared channel use by rescheduling.

15 28. A computer-readable medium encoded with instructions that, when executed by a computer, perform:
obtaining information about a handover need;
reserving temporal resources for handovers based on the
20 handover need from a physical uplink shared channel;
conveying information on the reserved temporal handover resources, and
carrying out handovers by using the reserved temporal handover resources.

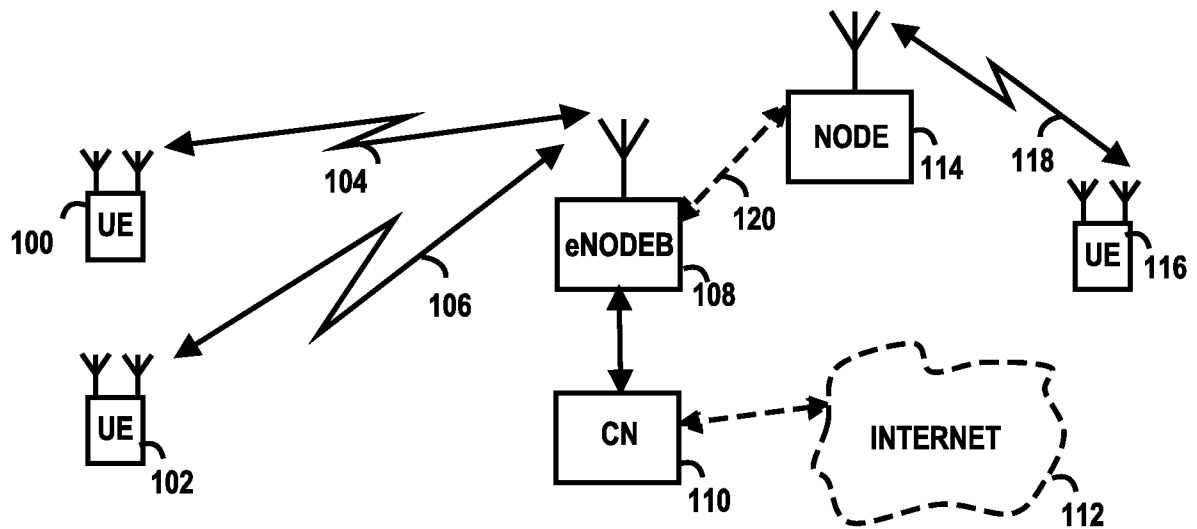


FIG. 1

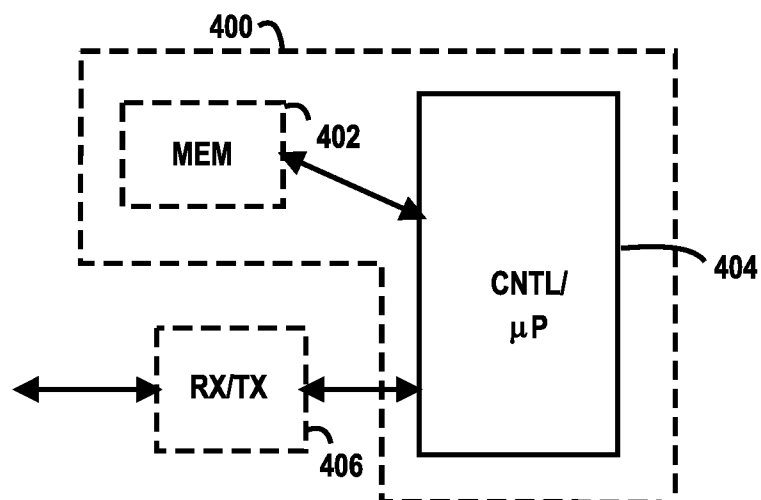


FIG. 4

FIG. 2

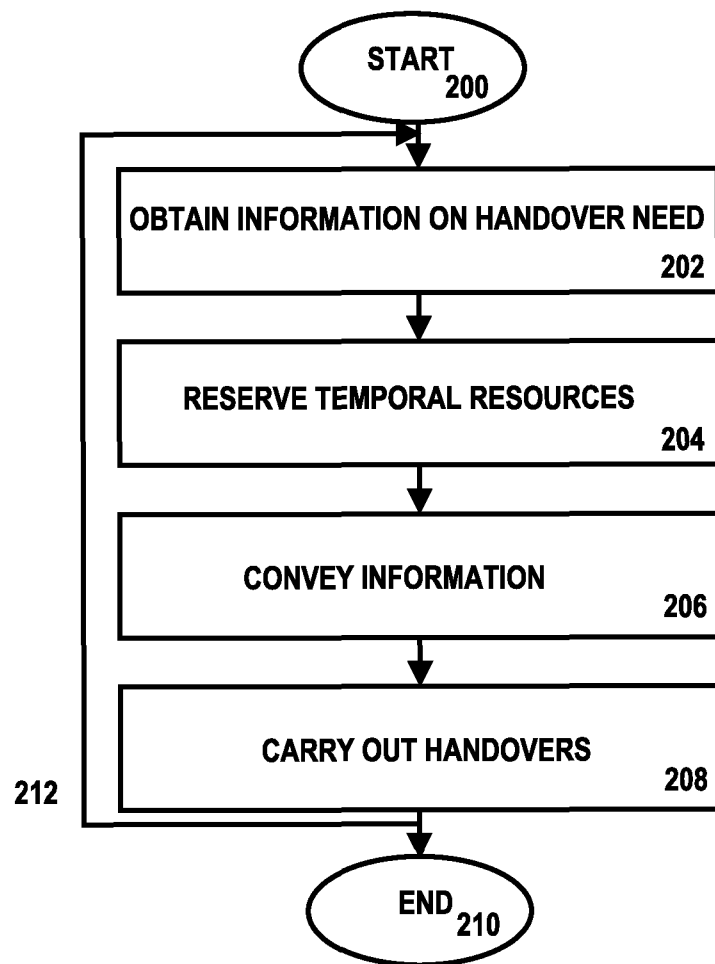
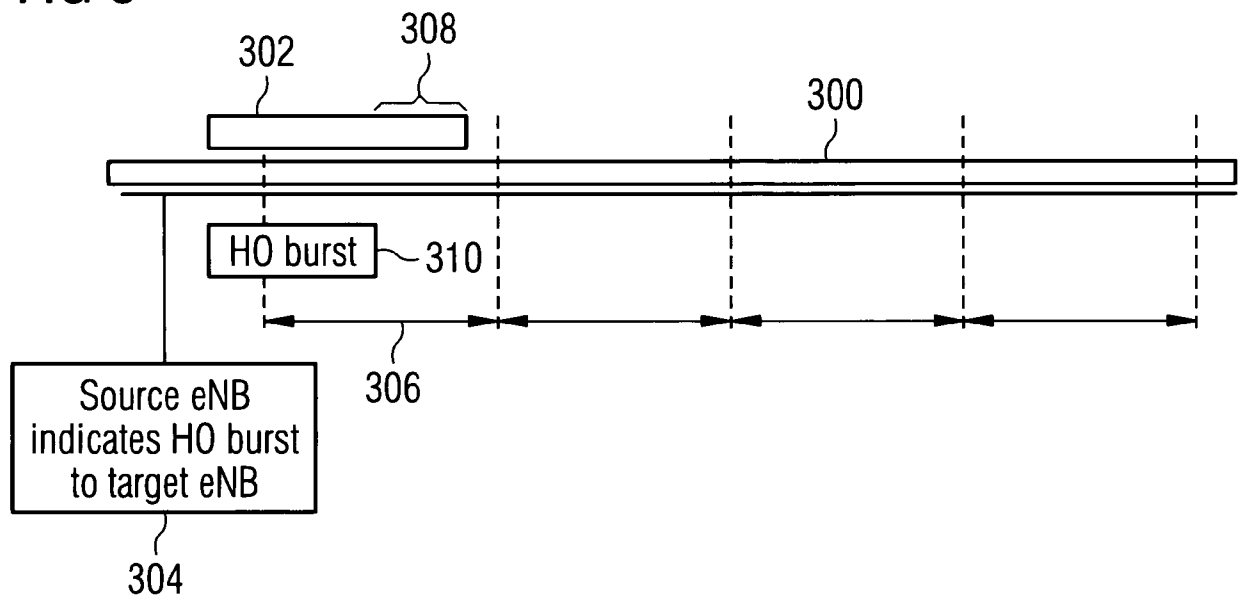


FIG 3



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/068756

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

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W

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

Electronic data base consulted during the international search (name of data base and, where practical, 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	WO 2008/107856 A2 (NOKIA CORP [FI]; NOKIA INC [US]; DALSGAARD LARS [FI]; SEBIRE BENOIST []) 12 September 2008 (2008-09-12) page 9, lines 26-29 page 10, lines 4-7 page 13, lines 19-24 page 14, lines 21-31 page 15, lines 18-21 page 15, line 24 - page 16, line 1 page 16, lines 11-22 page 17, lines 1-4 figures 4, 7, 8 ----- -/--	1-28



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

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"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

14 December 2011

Date of mailing of the international search report

21/12/2011

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2010/068756

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	"LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 version 10.0.0 Release 10)", TECHNICAL SPECIFICATION, EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE (ETSI), 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS ; FRANCE, vol. 3GPP RAN 1, no. V10.0.0, 1 January 2011 (2011-01-01), pages 1-104, XP014062130, Par. 5.7 tables 5.7.1-2 tables 5.7.1-3 tables 5.7.1-4 -----	1-28

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2010/068756

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