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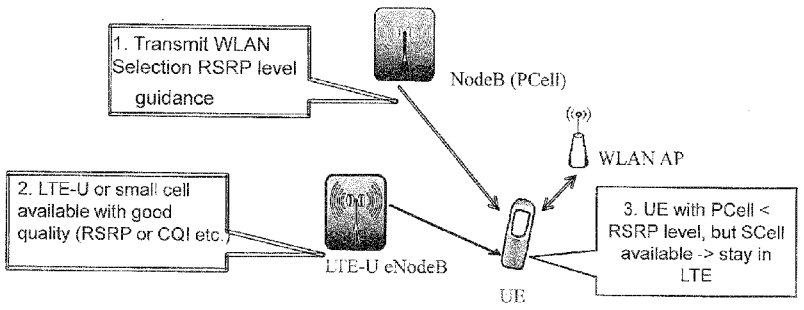

Fig. 1b

(57) Abstract: A is disclosed for defining offloading criteria in a communications system. The method comprises maintaining, in a network apparatus, a first criteria for offloading a user terminal from a mobile network to a local network. A second criteria is defined for refraining from offloading the user terminal from the mobile network to the local network, wherein the offloading of the user terminal from the mobile network to the local network is disabled, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

DESCRIPTION

TITLE

TRAFFIC OFFLOADING WHEN MULTIPLE CARRIERS ARE USED

FIELD OF THE INVENTION

The exemplary and non-limiting embodiments of this invention relate generally to wireless communications networks, and more particularly to service offloading.

BACKGROUND ART

The following description of background art may include insights, discoveries, understandings or disclosures, or associations together with dis-closures 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.

Mobile data offloading refers to using of complementary network technologies for delivering data originally targeted to a cellular network. Rules triggering a mobile offloading action may be set by a mobile subscriber or a network operator. The code operating on the rules resides in an end-user device and/or in a server. The end user may do data offloading for controlling data service costs and/or for the availability of a higher bandwidth. The network operator may do data offloading for decreasing congestion of the cellular network. An access network discovery and selection function (ANDSF) may be used for controlling offloading between 3GPP access networks and non-3GPP access networks (such as WLAN). ANDSF assists user devices to discover nearby access networks.

SUMMARY

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an extensive overview of the invention. It is not intended to identify key/critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts of the invention in a simplified form as a prelude to the more detailed description that is presented later.

Various aspects of the invention comprise a method, apparatuses, and a computer program product as defined in the independent claims. Further embodiments of the invention are disclosed in the dependent claims.

An aspect of the invention relates to a method for defining offloading criteria in a communications system, the method comprising maintaining, in a network apparatus, a first criteria for offloading a user terminal from a mobile network to a local network; defining a second criteria for refraining from offloading the user terminal from the mobile network to the local network; disabling the offloading of the user terminal from the mobile network to the local network, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

A further aspect of the invention relates to an apparatus comprising at least one processor; and at least one memory including a computer program code, wherein at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to perform any of the method steps.

A still further aspect of the invention relates to an apparatus comprising at least one processor; and at least one memory including a computer program code, wherein at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to disable offloading of a user terminal from a mobile network to a local network, if a predetermined criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

A still further aspect of the invention relates to a computer program product comprising executable code that when executed, causes execution of functions of the method.

Although the various aspects, embodiments and features of the invention are recited independently, it should be appreciated that all combinations of the various aspects, embodiments and features of the invention are possible and within the scope of the present invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail by means of exemplary embodiments with reference to the attached drawings, in which

Figure 1a illustrates generic WLAN selection with LTE carrier aggregation;

Figure 1b illustrates LTE-U/small cell consideration for WLAN selection;

Figure 2 shows a simplified block diagram illustrating exemplary system architecture;

Figure 3 shows a simplified block diagram illustrating exemplary apparatuses;

Figure 4 shows a messaging diagram illustrating an exemplary messaging event according to an embodiment of the invention.

Figure 5 shows a schematic diagram of a flow chart according to an exemplary embodiment of the invention.

DETAILED DESCRIPTION OF SOME EMBODIMENTS

3GPP is working with WLAN-3GPP radio level interworking. 3GPP is also about to start discussions on LTE in unlicensed band operation (along with the relevant frequency variants). Regarding WLAN radio interworking enhancement work it is considered that from a radio perspective a user terminal (UE) is to be offloaded to a wireless local area network (WLAN) based on serving 3GPP cell (e.g. LTE PCell or an UTRA serving cell) signal strength measurement, such as RSRP measurement, compared to a given RSRP threshold provided by a network. Respectively, similar criteria may be considered for onloading i.e. moving back from WLAN to the 3GPP radio.

The difference between offloading and handover is that in offloading the whole connection is not necessary moved, while it is only using alternative technology and potentially for a part of the services (part of bearers or data flows). In some cases only control plane connection may remain on the 3GPP side. Also UE is expected to make a decision whether offloading conditions are fulfilled and especially whether the conditions actually experienced in WLAN (after offloading) are sufficient and if UE is to return to the 3GPP radio network. The WLAN network is not checked either whether the offloading is acceptable before giving UE parameters to guide the offloading decision. The intention is to reduce the load of the 3GPP network while using a likely less loaded WLAN for the situation when better or at least sufficient service may be obtainable from the WLAN side. The use of different offloading criteria is also to ensure that the user is not provided with a service quality worse than in WLAN, thus aiming to offload users that are not having a good quality on the 3GPP side. The connection with the LTE network may thus also remain in parallel for streams such as voice over LTE (VoLTE) that require seamless handling of mobility inside the 3GPP network. In case of WLAN offloading, the difference compared to handovers is also that in some cases UE may already select WLAN before the actual data offloading decision from 3GPP to WLAN. In this case UE first finds WLAN access points and starts listening to the WLAN access points, meaning that UE selects WLAN, and only in a later phase when the offloading criteria are met, the actual offloading to WLAN takes place and data is routed from the 3GPP radio network to WLAN.

For instance, if a serving cell RSRP level (i.e. the signal strength measured by UE) < the RSRP threshold (provided by the network), UE is offloaded to WLAN.

The above-mentioned simple serving cell signal strength (or signal quality such as RSRQ or CQI) based criteria and related thresholds are unlikely to be an optimum criteria for offloading UE to WLAN when UE may actually receive (or transmit) data using multiple carriers by using carrier aggregation, and especially by using the carrier aggregation with LTE-U (LTE in unlicensed band).

With the carrier aggregation, UE is receiving data not only from a primary cell (PCell) but also from one or more secondary cells (SCell). Thus an aggregated throughput is clearly higher than for a single carrier UE. Especially with a case of inter-site carrier aggregation (dual connectivity) with an on-going small cell work, PCell may be a relatively weak macro cell, while SCell may be a well performing small cell and able to provide high data rate, wherein transferring UE to WLAN based on the macro cell RSRP/RSRQ only is not desirable (and may even lead to a reduced throughput). Also if the aggregated PCell is on a higher frequency or with a smaller bandwidth than SCell, then SCell performance may be clearly better than expected with PCell based considerations. The resulting metric for the selected criteria, taking multiple carriers into account, may be scaled further with a factor reflecting system load or otherwise desire to offload the traffic from the 3GPP system to WLAN, this scaling factor being obtained either from broadcast signalling or direct signaling.

In case of a HSPA operation, respectively receiving more than one HSDPA carrier on the same or different frequencies, causes that the primary cell does not give an impression good enough on expected QoS in HSPA side. Thus CPICH RSCP, CPICH Ec/No, or CQI from the carriers is to be considered across each available carrier.

With the LTE-U operation, the serving cell (PCell) may remain as a LTE licensed spectrum cell, and an LTE cell on an unlicensed spectrum (an LTE-U cell) may be aggregated a secondary cell SCell with a licensed spectrum PCell.

In a situation where also LTE-U cells are deployed on the unlicensed spectrum such as WLAN access points, the PCell or serving cell RSRP level compared to the RSRP threshold does not give enough information for making a decision whether UE is to be offloaded to WLAN or not. Although the PCell (the serving cell) RSRP is below the given RSRP threshold and therefore traffic through the PCell may be somewhat limited, the whole traffic of a given UE may go through LTE-U SCell as this LTE-U Scell may be sufficiently strong and not interference or traffic limited.

An exemplary embodiment discloses using the LTE carrier aggregation and the use of LTE-U in connection with definition of WLAN offloading criteria.

In an exemplary embodiment, with the use of LTE CA, the PCell RSRP is not solely considered as the criteria, but if UE has SCell(s) configured by RRC, then following examples may be considered: When there is a secondary cell SCell configured (and usable from the SCell RSRP threshold) the WLAN off-loading is not used unless each cell meets the criteria of RSRP being small enough. When there is a secondary cell SCell configured and in use, if RSRP is higher than the threshold in SCell, then the WLAN off-loading is not used. If a MAC layer had deactivated SCell, then the off-loading does not take place as it is expected that sufficient data throughput is reached with PCell only and there is no need to use CA by activating SCell.

With the use of LTE CA together with LTE-U (LTE unlicensed band operation) it may be attractive to also define other criteria and rules for these offloading decisions. Examples of 3GPP to WLAN offloading rules and criteria may include:

a) If LTE-U is deployed in the network and indicated e.g. in the broadcast channel of a serving (PCell) licensed spectrum LTE cell, UE supporting LTE-U does not offload to WLAN even if the serving cell RSRP level (measured by UE) < the RSRP threshold (provided by the network).

b) Instead of making the decision whether to offload (steer) UE to WLAN, UE checks whether the serving cell RSRP level is below a given RSRP threshold and whether there is a LTE-U cell available. If the LTE-U cell is indicated e.g. in a broadcast channel of the licensed spectrum LTE PCell, UE supporting LTE-U remains connected to LTE PCell even if PCell RSRP is below the threshold. If no LTE-U cell is indicated by PCell, UE is offloaded to WLAN if the PCell RSRP level is below the RSRP threshold.

c) If even more accurate information on the LTE-U cell is desired before deciding whether to offload UE to WLAN, UE may be requested to search, find and potentially even measure the LTE-U cell before decision making e.g. as follows: If the LTE-U cell is indicated e.g. in the broadcast channel of the licensed spectrum LTE PCell and UE has been able to find (detect) LTE-UE and potentially also measure the RSRP (or RSRQ) level for LTE-U, UE remains connected to LTE PCell even if PCell RSRP is below the threshold. If no LTE-U cell is indicated by the PCell or UE has not been able to find (detect) LTE-UE even if indicated, UE may be offloaded to WLAN if the PCell RSRP level is below the RSRP threshold.

When there is also data flow running, WLAN offloading may also be defined as follows:

d) Even if the LTE PCell RSRP level is below the RSRP threshold, UE is not offloaded to WLAN if the LTE-U cell is configured by RRC even if this LTE-U SCell is not activated (the activation of the LTE-U SCell only happens when there is traffic to be transmitted and received through the LTE-U SCell). If the LTE PCell RSRP level is below the RSRP threshold and no LTE-U cell is configured, UE is offloaded to WLAN.

e) However, even in this case additional criteria may be defined as follows: If LTE PCell RSRP level is below RSRP threshold and no LTE-U cell is configured but UE has been able to find a sufficiently good LTE-U cell and the LTE-U cell is indicated by LTE PCell, UE is not offloaded to WLAN. If the LTE PCell RSRP level is below the RSRP threshold and no LTE-U cell is configured or found by UE, UE is offloaded to WLAN.

Figure 1a shows an illustration of generic WLAN selection with LTE carrier aggregation (regardless of whether SCell is an LTE-U cell or a regular LTE carrier). Figure 1b shows an illustration of an LTE-U/small cell consideration for WLAN selection.

The above examples are based on the use of RSRP which has been considered as the criteria to be broadcasted by LTE eNodeB in the WLAN-3GPP radio interworking studies in 3GPP. Further possible approaches exist to consider additional metrics with the carrier aggregation as well as with LTE-U, as follows:

Consideration of total aggregated bandwidth available (to derive then an offset for the RSRP criteria to be considered for PCell or any other cell). For example, even if the LTE PCell RSRP level is below the RSRP threshold, UE is not offloaded to WLAN if the total aggregated bandwidth available is above a given threshold. If the LTE PCell RSRP level is below the RSRP threshold and if the total aggregated bandwidth is below the given threshold, UE is offloaded to WLAN.

Consideration of CQI values across each carrier and theoretical aggregated data rate availability (as a criteria to offload to WLAN and also a reference value for considering returning from WLAN). For example, even if the LTE PCell RSRP level is below the RSRP threshold, UE is not offloaded to WLAN if the total aggregated data rate derived from the CQI values for the aggregated bandwidths is above a given threshold. If the LTE PCell RSRP level is below the RSRP threshold and if the total aggregated data rate derived from the CQI values for the aggregated bandwidths is below the given threshold, UE is offloaded to WLAN. If UE is offloading each service (bearers and/or data flows) to WLAN, and is thus not reporting to LTE PCell new CQI values anymore, UE may keep the latest CQI value, or N latest values or their average or medians for the carriers UE was using as a reference to consider against the service quality experienced in WLAN. CQI may be used to define an expected data rate across each carrier previously configured for CA

operation and compared if the WLAN service quality is high enough compared to the service quality in the LTE side. And in case the service quality experienced in WLAN is too low compared to the LTE side expected data rate from each carrier, then UE is to return using the 3GPP network (LTE or HSPA), with this referred as onloading.

RSRQ may also be used instead of RSRP in the WLAN offloading criteria (rules).

Above cases may be further adjusted if LTE load information is available, or equivalent metric indicating “network” preference for off-loading, as operators may not be willing to broadcast actual load value of their network.

In an exemplary embodiment, Wi-Fi offloading is performed via access network discovery and selection function (ANDSF) policies without using handover messages inside the 3GPP network.

Exemplary embodiments of the present invention will now be de-scribed more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. 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 embodiment. Single features of different embodiments may also be combined to provide other embodiments. Like reference numerals refer to like elements throughout.

The present invention is applicable to any network apparatus, user terminal, server, corresponding component, and/or to any communication system or any combination of different communication systems that support service offloading. The communication system may be a fixed communication system or a wireless communication system or a communication system utilizing both fixed networks and wireless networks. The protocols used, the specifications of communication systems, 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, the embodiment.

In the following, different embodiments will be described using, as an example of a system architecture whereto the embodiments may be applied, an architecture based on LTE (or LTE-A) (long term evolution (advanced long term evolution)), without restricting the embodiment to such an architecture, however.

A general architecture of a communication system is illustrated in Figure 2. Figure 2 is 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 2 are logical connections; the actual physical connections may be different. It is apparent to a person skilled in the art that the systems also comprise other functions and structures. It should be appreciated that the functions, structures, elements and the protocols used in or for service offloading, are irrelevant to the actual invention. Therefore, they need not to be discussed in more detail here.

The exemplary radio system of Figure 2 comprises a network node 201 of a network operator. The network node 201 may include e.g. an LTE (or LTE-A) base station (eNB), radio network controller (RNC), or any other network element, or a combination of network elements. The network node 201 may be connected to one or more core network (CN) elements (not shown in Figure 2) such as a mobile switching centre (MSC), MSC server (MSS), mobility management entity (MME), gateway GPRS support node (GGSN), serving GPRS support node (SGSN), home location register (HLR), home subscriber server (HSS), visitor location register (VLR). In Figure 2, the radio network node 201 that may also be called eNB (enhanced node-B, evolved node-B) or network apparatus of the radio system, hosts the functions for radio resource management in a public land mobile network. Figure 2 shows one or more user equipment 202 located in the service area of the radio network node 201. The user equipment or UE refers to a portable computing device, and it may also be referred to as a user terminal. Such computing devices include wireless mobile communication devices operating with or without a subscriber identification module (SIM) in hardware or in software, including, but not limited to, the following types of devices: mobile phone, smart-phone, personal digital assistant (PDA), handset, laptop computer. In the example situation of Figure 2, the user equipment 202 is capable of connecting to the radio network node 201 via a connection 203.

Figure 3 is a block diagram of an apparatus according to an embodiment of the invention. Figure 3 shows a user equipment 202 located in the area of a radio network node 201. The user equipment 202 is configured to be in connection with the radio network node 201. The user equipment or UE 202 comprises a controller 301 operationally connected to a memory 302 and a transceiver 303. The controller 301 controls the operation of the user equipment 202. The memory 302 is configured to store software and data. The transceiver 303 is configured to set up and maintain a wireless connection 303 to the radio network node 301. The transceiver 303 is operationally connected to a set of antenna ports 304 connected to an antenna arrangement 305. The antenna arrangement 305 may comprise a set of antennas. The number of antennas may be one to four, for example. The number

of antennas is not limited to any particular number. The user equipment 202 may also comprise various other components, such as a user interface, camera, and media player. They are not displayed in the figure due to simplicity. The radio network node 201, such as an LTE base station (eNode-B, eNB) comprises a controller 306 operationally connected to a memory 307, and a transceiver 308. The controller 306 controls the operation of the radio network node 201. The memory 307 is configured to store software and data. The transceiver 308 is configured to set up and maintain a wireless connection 203 to the user equipment 202 within the service area of the radio network node 201. The transceiver 308 is operationally connected to an antenna arrangement 309. The antenna arrangement 309 may comprise a set of antennas. The number of antennas may be two to four, for example. The number of antennas is not limited to any particular number. The radio network node 201 may be operationally connected (directly or indirectly) to another network element (not shown in Figure 3) of the communication system, such as a radio network controller (RNC), a mobility management entity (MME), an MSC server (MSS), a mobile switching centre (MSC), a radio resource management (RRM) node, a gateway GPRS support node, an operations, administrations and maintenance (OAM) node, a home location register (HLR), a visitor location register (VLR), a serving GPRS support node, a gateway, and/or a server, via an interface. The embodiments are not, however, restricted to the network given above as an example, but a person skilled in the art may apply the solution to other communication networks provided with the necessary properties. For example, the connections between different network elements may be realized with internet protocol (IP) connections.

Although the apparatus 201, 202 has been depicted as one entity, different modules and memory may be implemented in one or more physical or logical entities. The apparatus may also be a user terminal which is a piece of equipment or a device that associates, or is arranged to associate, the user terminal and its user with a subscription and allows a user to interact with a communications system. The user terminal presents information to the user and allows the user to input information. In other words, the user terminal may be any terminal capable of receiving information from and/or transmitting information to the network, connectable to the network wirelessly or via a fixed connection. Examples of the user terminals include a personal computer, a game console, a laptop (a notebook), a personal digital assistant, a mobile station (mobile phone), a smart phone, and a line telephone.

The apparatus 201, 202 may generally include a processor, controller, control unit or the like connected to a memory and to various interfaces of the apparatus. Generally the processor is a central processing unit, but the processor may be an additional operation

processor. The processor may comprise a computer processor, application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), and/or other hardware components that have been programmed in such a way to carry out one or more functions of an embodiment.

The memory 302, 307 may include volatile and/or non-volatile memory and typically stores content, data, or the like. For example, the memory 302, 307 may store computer program code such as software applications (for example for the detector unit and/or for the adjuster unit) or operating systems, information, data, content, or the like for a processor to perform steps associated with operation of the apparatus in accordance with embodiments. The memory may be, for example, random access memory (RAM), a hard drive, or other fixed data memory or storage device. Further, the memory, or part of it, may be removable memory detachably connected to the apparatus.

The techniques described herein may be implemented by various means so that an apparatus implementing one or more functions of a corresponding mobile entity described with an embodiment comprises not only prior art means, but also means for implementing the one or more functions of a corresponding apparatus described with an embodiment and it may comprise separate means for each separate function, or means may be configured to perform two or more functions. For example, these techniques may be implemented in hardware (one or more apparatuses), firmware (one or more apparatuses), software (one or more modules), or combinations thereof. For a firmware or software, implementation can be through modules (e.g. procedures, functions, and so on) that perform the functions described herein. The software codes may be stored in any suitable, processor/computer-readable data storage medium(s) or memory unit(s) or article(s) of manufacture and executed by one or more processors/computers. The data storage medium or the memory unit may be implemented within the processor/computer or external to the processor/computer, in which case it can be communicatively coupled to the processor/computer via various means as is known in the art.

The signalling chart of Figure 4 illustrates the required signalling. In the example of Figure 4, a first network apparatus 201 which may comprise e.g. a network element (network node, e.g. a LTE/LTE-A-capable base station eNode-B, eNB) may maintain 401 a first criteria for offloading a user terminal 202 from a mobile network to a local network. The first network apparatus 201 may define 401 a second criteria for refraining from offloading the user terminal 202 from the mobile network to the local network. In item 402, the first network apparatus 201 may transmit the second criteria to a second network apparatus which may comprise e.g. a network element (network node, e.g. a user terminal, UE). In item 403, the second criteria is received in the user terminal 202. Based on the received

second criteria, an offloading decision is made 402 in the user terminal such that the offloading of the user terminal from the mobile network to the local network is disabled, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation. Alternatively, the offloading decision is made 401 in the base station 201, wherein the base station 201 instructs 402 the user terminal 202 to refrain 403 from offloading the user terminal 202 from the mobile network to the local network.

Figure 5 is a flow chart illustrating an exemplary embodiment. In Figure 5, a first network apparatus 201 which may comprise e.g. a network element (network node, e.g. a LTE/LTE-A-capable base station (eNode-B, eNB)) may maintain 501 a first criteria for offloading a user terminal 202 from a mobile network to a local network. The first network apparatus 201 may define 501 a second criteria for refraining from offloading the user terminal 202 from the mobile network to the local network. In item 502, the first network apparatus 201 may transmit the second criteria to a second network apparatus which may comprise e.g. a network element (network node, e.g. a user terminal, UE). Alternatively, an offloading decision is made 501 in the base station 201, wherein the base station 201 instructs 502 the user terminal 202 to refrain from offloading the user terminal 202 from the mobile network to the local network. The offloading decision may involve that the offloading of the user terminal from the mobile network to the local network is to be disabled, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

Figure 6 is a flow chart illustrating an exemplary embodiment. In Figure 6, a second network apparatus 202 which may comprise e.g. a network element (network node, e.g. a user terminal, UE) may receive 601, from a first network apparatus 201 (which may comprise e.g. a network element (network node, e.g. a LTE/LTE-A-capable base station eNode-B, eNB)), a second criteria for refraining from offloading the user terminal 202 from a mobile network to a local network. Based on the received second criteria and based on possible signal power/quality measurements performed 602 in the user terminal 202, an offloading decision may be made 603 in the user terminal 202 such that the offloading of the user terminal from the mobile network to the local network is disabled, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation. Alternatively, the offloading decision is made in the base station 201, wherein instructions are received 601 in the user terminal 202 from the base station 201, to refrain 603 from offloading the user terminal 202 from the mobile network to the local network.

The steps/points, signalling messages and related functions de-scribed above in Figures 1 to 6 are in no absolute chronological order, and some of the steps/points may be performed simultaneously or in an order differing from the given one. Other functions can also be executed between the steps/points or within the steps/points and other signalling messages sent be-tween 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 or part of the step/point. The apparatus operations illustrate a procedure that may be implemented in one or more physical or logical entities. The signalling messages are only exemplary and may even comprise several separate messages for transmitting the same information. In addition, the messages may also contain other information.

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

List of abbreviations

CQI	channel quality information
MAC	medium access control
RRC	radio resource control
RSRP	reference signal received power
RSSI	received signal strength indicator
RSRQ	reference signal received quality
PCell	primary cell
SCell	secondary cell
LTE-U	LTE in unlicensed band
CA	carrier aggregation
CPICH	common pilot channel
Wi-Fi	wireless fidelity

CLAIMS

1. A method for defining offloading criteria in a communications system, the method comprising

maintaining (401, 501), in a network apparatus (201), a first criteria for offloading a user terminal (202) from a mobile network to a local network;

defining (401, 501) a second criteria for refraining from offloading the user terminal from the mobile network to the local network;

disabling (402, 502) the offloading of the user terminal from the mobile network to the local network, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

2. A method for defining offloading criteria in a communications system, the method comprising

receiving (403, 601), in a user terminal (202) from a network apparatus (201), a second criteria for refraining from offloading the user terminal from a mobile network to a local network, wherein a first criteria for offloading the user terminal from the mobile network to the local network is maintained in the network apparatus;

disabling (403, 603) offloading of the user terminal from the mobile network to the local network, if the second criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

3. A method according to claim 1 or 2, c h a r a c t e r i z e d in that the second criteria is fulfilled if a secondary cell is configured, unless each available cell meets the first criteria.

4. A method according to claim 1, 2 or 3, c h a r a c t e r i z e d in that the second criteria is fulfilled if a secondary cell is configured and in use, and if a reference signal received power is higher than a corresponding threshold in the secondary cell.

5. A method according to any one of claims 1 to 4, c h a r a c t e r i z e d in that the second criteria is fulfilled if a secondary cell is configured and in use, and if channel quality information indicates a higher channel quality than a corresponding threshold in the secondary cell.

6. A method according to any one of claims 1 to 5, c h a r a c t e r i z e d in that the second criteria is fulfilled if a medium access control layer has deactivated a secondary cell.

7. A method as claimed in any one of claims 1 to 6, c h a r a c t e r i z e d in that the second criteria is fulfilled

if an LTE unlicensed band operation LTE-U is deployed in the mobile network and indicated by a serving primary cell licensed spectrum LTE cell, even if a serving cell reference signal received power level measured by the user terminal < a reference signal received power threshold provided by the network.

8. A method as claimed in any one of claims 1 to 7, c h a r a c t e r i z e d in that the second criteria is fulfilled

if a serving cell reference signal received power threshold level is below a given reference signal received power threshold,

if there is an LTE-U cell available, and

if an LTE-U cell is indicated by a licensed spectrum LTE primary cell, even if a primary cell reference signal received power threshold is below the threshold.

9. A method as claimed in any one of claims 1 to 8, c h a r a c t e r i z e d in that the user terminal is requested to search and potentially measure an LTE-U cell before making an offloading decision.

10. A method as claimed in any one of claims 1 to 9, c h a r a c t e r i z e d in that if a LTE-U cell is indicated by a licensed spectrum LTE primary cell and if the user terminal has detected an LTE-U cell and potentially also measured reference signal received power level or reference signal received quality level for the LTE-U cell, the user terminal remains connected to the LTE primary cell even if the primary cell reference signal is below the corresponding threshold.

11. A method as claimed in any one of claims 1 to 10, c h a r a c t e r i z e d in that the second criteria is fulfilled

if there is data flow running, even if an LTE primary cell reference signal received power level is below a reference signal received power threshold, and

if a LTE-U secondary cell is configured, even if the LTE-U secondary cell is not activated.

12. A method as claimed in any one of claims 1 to 11, c h a r a c t e r i z e d in that the second criteria is fulfilled

if there is data flow running, and

if an LTE primary cell reference signal received power level is below a reference signal received power threshold and no LTE-U cell is configured but the user terminal has found a sufficient LTE-U cell and the LTE-U cell is indicated by the LTE primary cell.

13. A method as claimed in any one of claims 1 to 12, c h a r a c t e r i z e d in that the second criteria is fulfilled

if a total aggregated bandwidth available is above a given threshold, even if an LTE primary cell reference signal received power level is below a reference signal received power threshold.

14. A method as claimed in any one of claims 1 to 13, c h a r a c t e r i z e d in that the second criteria is fulfilled

if a total aggregated data rate derived from channel quality information values for aggregated bandwidths is above a given threshold, even if an LTE primary cell reference signal received power level is below a reference signal received power threshold.

15. A method as claimed in any one of claims 1 to 14, c h a r a c t e r i z e d in that the values evaluated for offloading criteria are stored in the user terminal to be used as a benchmark compared to a wireless local area network WLAN quality in order to determine whether the quality provided WLAN is sufficient for keeping the traffic in the wireless local area network WLAN instead of returning back to mobile network.

16. A method as claimed in any one of claims 1 to 15, c h a r a c t e r i z e d in that the local network is a wireless local area network WLAN.

17. A method as claimed in any one of claims 1 to 16, c h a r a c t e r i z e d in that the mobile network is an LTE or LTE-A network

18. A method as claimed in any one of claims 1 to 17, c h a r a c t e r i z e d in that the method comprises enabling offloading if the second criteria is no longer fulfilled.

19. A method as claimed in any one of claims 1 to 18, c h a r a c t e r i z e d in that the first criteria is fulfilled if a serving cell reference signal received power level measured by the user terminal < a reference signal received power threshold provided by the network.

20. A method as claimed in any one of claims 1 to 19, c h a r a c t e r i z e d in that deployment of LTE unlicensed band operation LTE-U is indicated in a broadcast channel of a serving primary cell licensed spectrum LTE cell.

21. An apparatus comprising at least one processor; and at least one memory including a computer program code, c h a r a c t e r i z e d in that the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to perform any of the method steps of claims 1 to 20.

22. An apparatus comprising at least one processor; and at least one memory including a computer program code, c h a r a c t e r i z e d in that the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to

disable offloading of a user terminal from a mobile network to a local network, if a predetermined criteria is fulfilled and if the user terminal is able to receive and/or transmit data using multiple carriers by using carrier aggregation.

23. A computer program product comprising executable code that when executed, causes execution of functions of a method according to any one of claims 1 to 20.

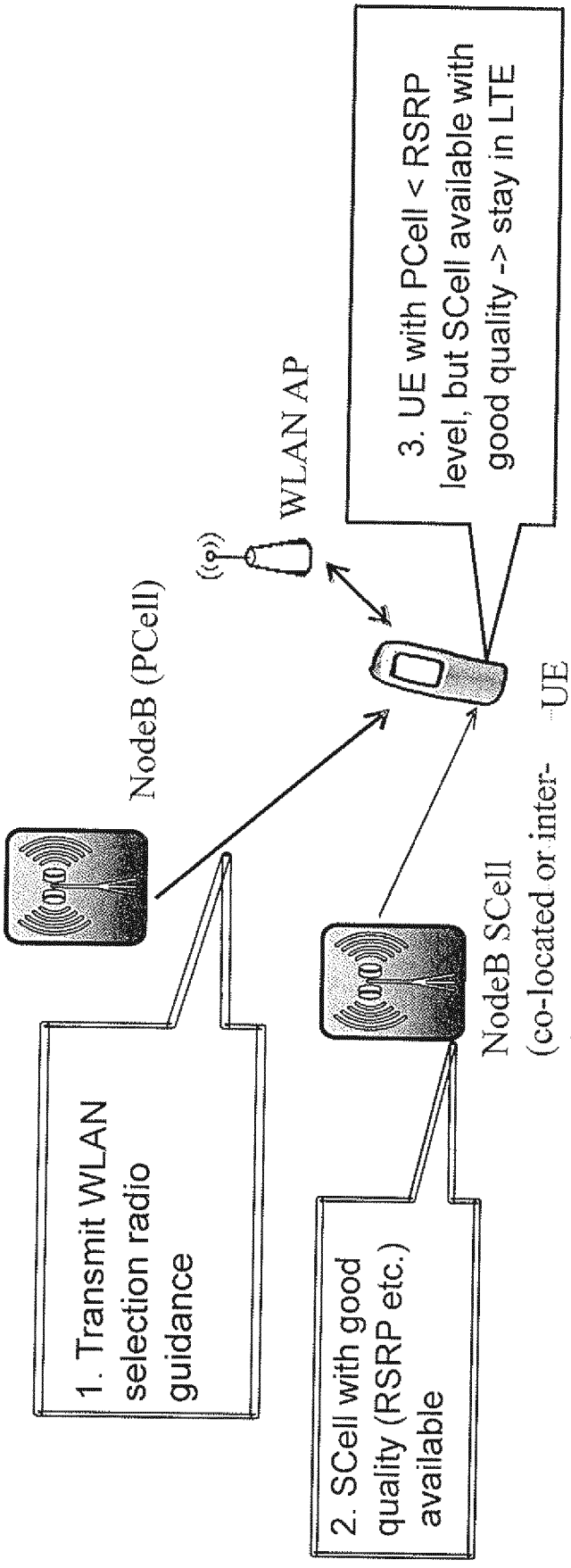
NodeB (PCell)
WLAN AP
3. UE with PCell < RSRP level, but SCell available with good quality -> stay in LTE
UE
NodeB SCell (co-located or inter-site CA)
1. Transmit WLAN selection radio guidance
2. SCell with good quality (RSRP etc.) available

Fig. 1a

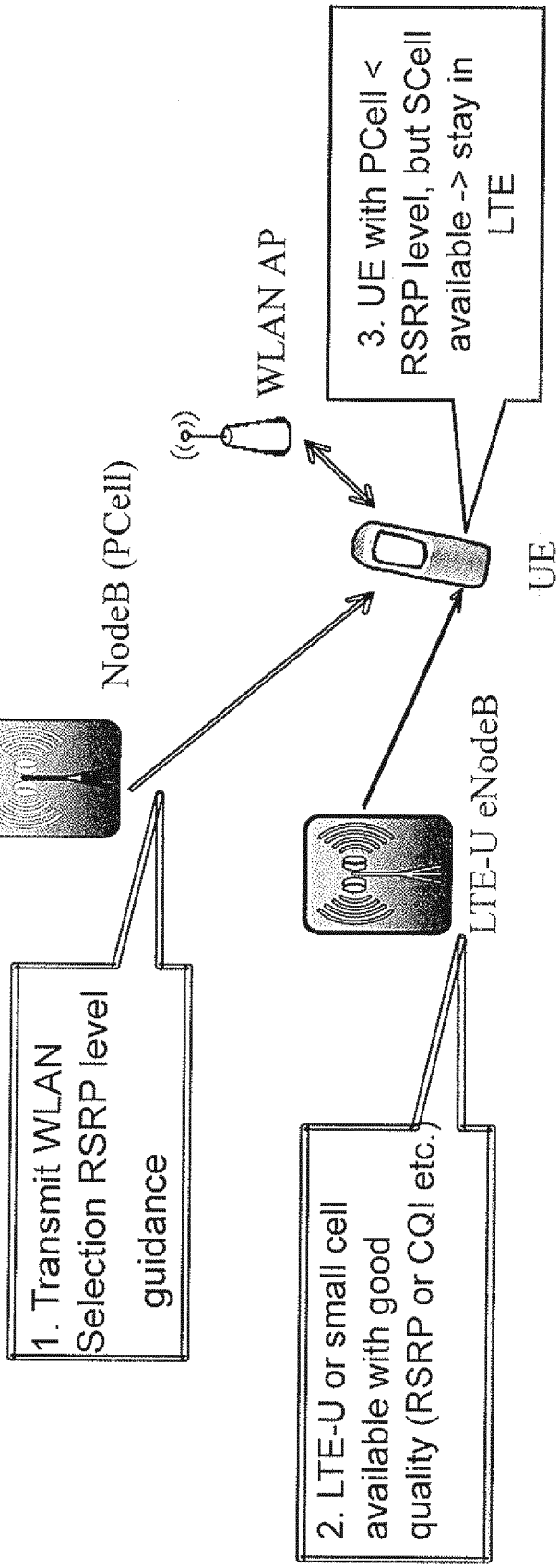
NodeB (PCell)
WLAN AP
UE
LTE-U eNodeB
1. Transmit WLAN Selection RSRP level guidance
2. LTE-U or small cell available with good quality (RSRP or CQI etc.)
3. UE with PCell < RSRP level, but SCell available -> stay in LTE

Fig. 1b

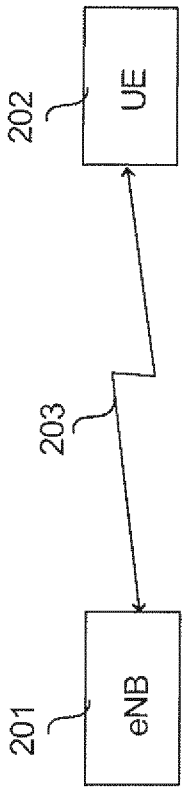
201
eNB
203
202
UE

Fig. 2

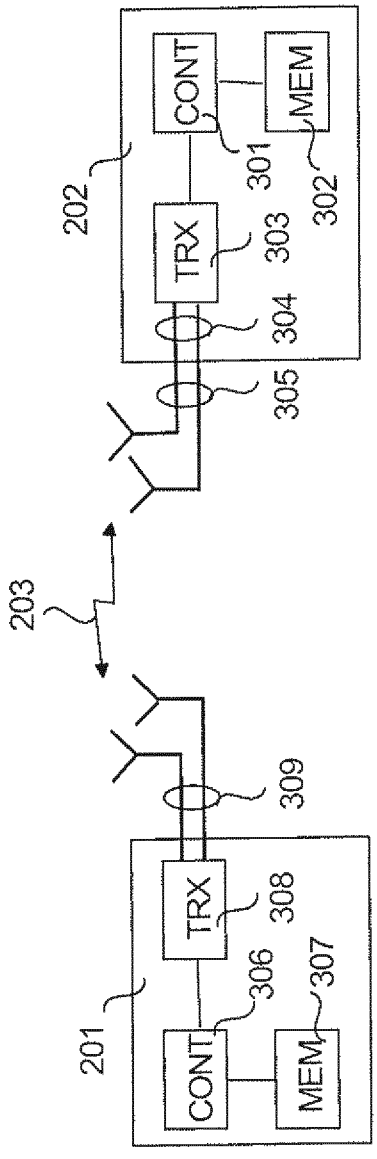
201
CONT
306
TRX
308
MEM
307
309
203
202
CONT
301
MEM
302
TRX
303
304
305

Fig. 3

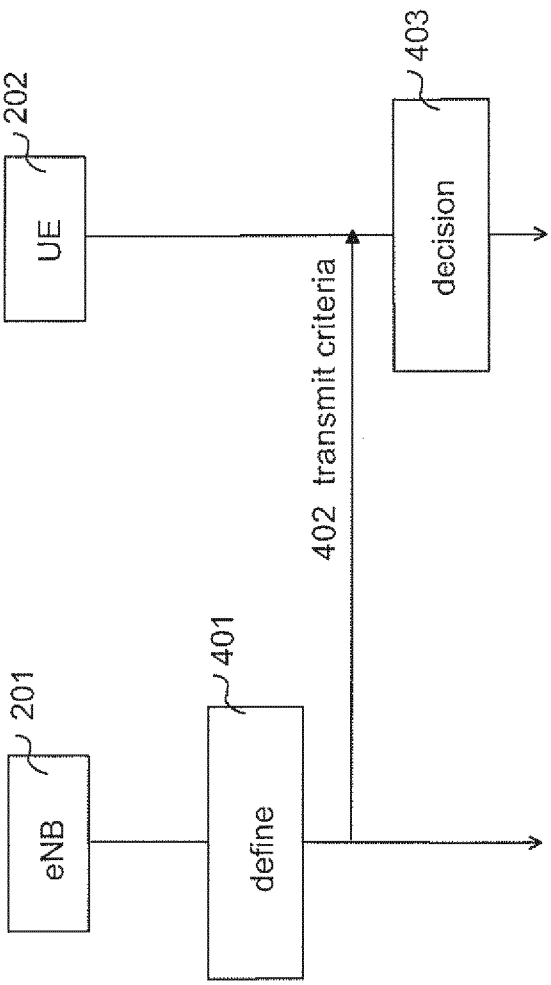
202
UE
403
decision
402 transmit criteria
401
define
201
eNB

Fig. 4

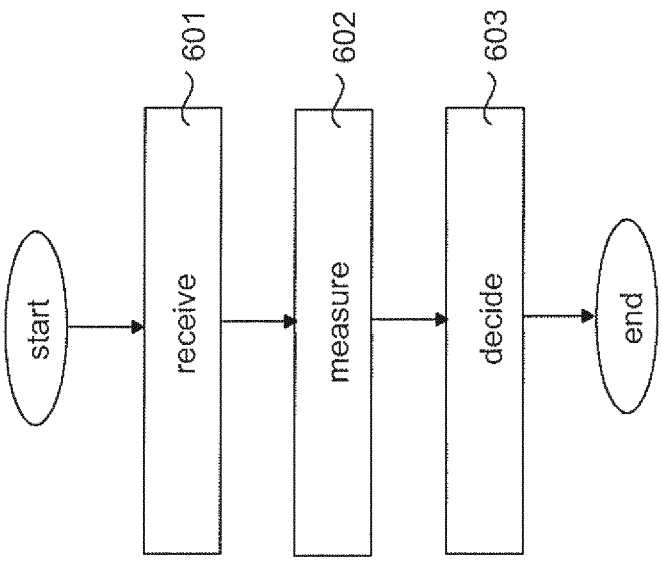
start
receive
601
measure
602
decide
603
end

Fig. 6

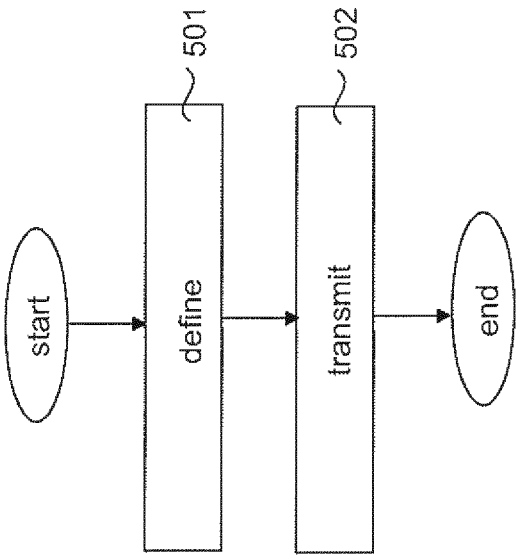
start
define
501
transmit
502
end

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/052478

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04W36/00 H04W36/30
ADD. H04W16/14

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.
Y	WO 2014/017855 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 30 January 2014 (2014-01-30) abstract; figures 5,6 paragraph [0053] - paragraph [0062] paragraph [0129] - paragraph [0137] -----	1-23
Y	WO 2010/088930 A2 (ERICSSON TELEFON AB L M [SE]; LINDOFF BENGT [SE]; KAZMI MUHAMMAD [SE]) 12 August 2010 (2010-08-12) abstract; figure 6 page 10, line 33 - page 14, line 5 ----- -/--	1-6, 13-19, 21-23

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

[X] 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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 October 2014	10/11/2014

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

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CISCO: "On LTE in Unlicensed Spectrum", 3GPP DRAFT; RP-131749-ON LTE IN UNLICENSED SPECTRUM, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. TSG RAN, no. Busan, Korea; 20131203 - 20131206 2 December 2013 (2013-12-02), XP050733900, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN/RAN/Docs/ [retrieved on 2013-12-02] section 2	7-12,20
A	"Introducing LTE in Unlicensed Spectrum", 3GPP DRAFT; RP-131635 LTE IN UNLICENSED SPECTRUM, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , no. Busan, South Korea; 20131203 - 20131207 2 December 2013 (2013-12-02), XP050733706, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN/RAN/Docs/ [retrieved on 2013-12-02] pages 3,4	1-23
A	AT&T: "Drivers, Benefits and Challenges for LTE in Unlicensed Spectrum", 3GPP DRAFT; RP-131701 DBCS FOR LTE-U DRAFT (AT&T - FINAL), 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE , vol. TSG RAN, no. Busan, Korea; 20131203 - 20131206 2 December 2013 (2013-12-02), XP050733827, Retrieved from the Internet: URL:http://www.3gpp.org/ftp/Meetings_3GPP_SYNC/RAN/RAN/Docs/ [retrieved on 2013-12-02] sections 2.2 and 2.3	1-23

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2014/052478

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014017855 A1	30-01-2014	US 2014029420 A1	30-01-2014
		WO 2014017855 A1	30-01-2014
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		WO 2010088930 A2	12-08-2010