(54) Title: METHOD AND APPARATUS FOR FAST HANDOVER EVALUATION

FIG. 1
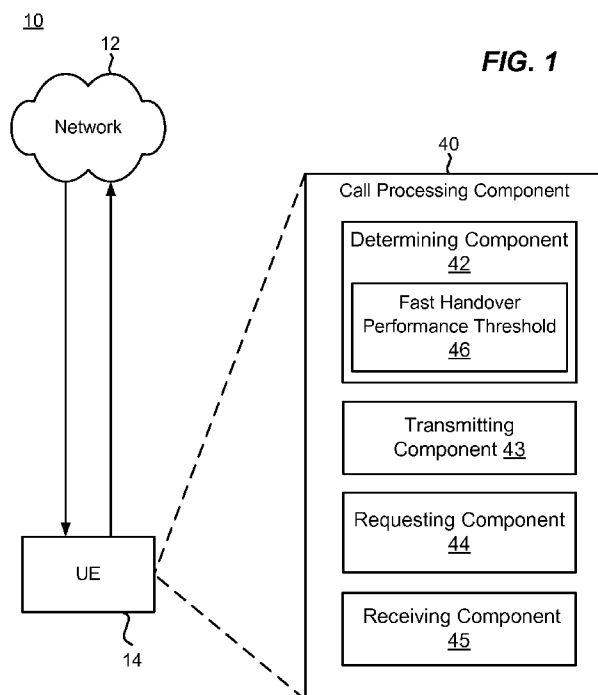
(57) Abstract: The present invention discloses a method of wireless communication, comprising: determining the quality of a serving cell relative to a fast handover performance threshold; transmitting a measurement report to a network entity when the fast handover performance threshold is breached; requesting a handover to a different cell when the fast handover performance threshold is breached; and receiving a handover trigger by a network entity based on the measurement report and the request for handover.

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SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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METHOD AND APPARATUS FOR FAST HANDOVER EVALUATION

BACKGROUND

Field

[0001]   Aspects of the present disclosure relate generally to wireless communication systems, and more particularly, to an apparatus and method for improving handover between a network and a user equipment (UE).

Background

[0002]   Wireless communication networks are widely deployed to provide various communication services such as telephony, video, data, messaging, broadcasts, and so on.   Such networks, which are usually multiple access networks, support communications for multiple users by sharing the available network resources.   One example of such a network is the UMTS Terrestrial Radio Access Network (UTRAN). The UTRAN is the radio access network (RAN) defined as a part of the Universal Mobile Telecommunications System (UMTS), a third generation (3G) mobile phone technology supported by the 3rd Generation Partnership Project (3GPP).   The UMTS, which is the successor to Global System for Mobile Communications (GSM) technologies, currently supports various air interface standards, such as Wideband-Code Division Multiple Access (W-CDMA), Time Division–Code Division Multiple Access (TD-CDMA), and Time Division–Synchronous Code Division Multiple Access (TD-SCDMA).   The UMTS also supports enhanced 3G data communications protocols, such as High Speed Packet Access (HSPA), which provides higher data transfer speeds and capacity to associated UMTS networks.

[0003]   In current TD-SCDMA system, handover (HO) can be initiated by network based on the measurement report message sent from a UE.   The network can then initiate a HO to the target cell based on the measurement report.   However, the UE will only generate the event and report the measurement report to network when, for example, the target cell receive power is higher than receive power serving cell plus the hysteresis and after a time duration.   These requirements may cause UE to drop the current call.

[0004]   Thus, aspects of this apparatus and method include improving handover between a network and a UE when a measurement report is received.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIG. 1 is a schematic diagram illustrating exemplary aspect of call processing in a wireless communication system;

[0006] FIG. 2 is a flow diagram illustrating an exemplary method for call processing in a wireless communication system;

[0007] FIG. 3 is a block diagram illustrating an example of a hardware implementation for an apparatus employing a processing system to perform the functions described herein;

[0008] FIG. 4 is a block diagram conceptually illustrating an example of a telecommunications system including a UE configured to perform the functions described herein;

[0009] FIG. 5 is a conceptual diagram illustrating an example of an access network for use with a UE configured to perform the functions described herein;

[0010] FIG. 6 is a conceptual diagram illustrating an example of a radio protocol architecture for the user and control planes for a base station and/or a UE configured to perform the functions described herein;

[0011] FIG. 7 is a block diagram conceptually illustrating an example of a Node B in communication with a UE in a telecommunications system configured to perform the functions described herein.

[0012] Appendix A is also attached hereto, and includes additional description of aspects of the present apparatus and methods.

DETAILED DESCRIPTION

[0013] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations and is not intended to represent the only configurations in which the concepts described herein may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring such concepts.

[0014]   As discussed above, in current TD-SCDMA systems, HO can be initiated by network based on the measurement report message sent from a UE. The UE measures the quality of a servicing cell and/or a target cell and evaluates if an event report criterion is met. If the criterion is met, the UE will send the measurement report message including the event to network. The network can then initiate a HO to the target cell based on the measurement report.

[0015]   To mitigate a ping-pong effect, e.g. multiple handovers going back and forth between cells, a hysteresis and a timer with value, where the value may be referred to as a "time to trigger" and the timer may be referred to as a "time to trigger timer," are used when the UE evaluates if a measurement event will be generated. The UE will only generate the event, e.g. an event that causes the UE to report a measurement report to network, when, for example, the target cell received power is higher than a sum of the received power of the serving cell plus a hysteresis value for a time duration. In this case, the value of the time duration is the "time to trigger."

[0016]   However, in some scenarios, the serving cell power drops too quickly and the connection may drop before the "time to trigger" timer expires and thus before the UE reports the measurement report to the network. Those scenarios can be, for example, when the UE goes into a building from outdoor coverage, or goes into a lift or elevator where there is only 2G coverage, or when the UE is on a high speed train.

[0017]   An operator can decrease the value of the hysteresis or the "time to trigger" to make the UE report the measurement report more quickly to mitigate the possibility of the call drop in those scenarios, but those parameters are cell level parameters that can be tuned only at a cell level.

[0018]   Consequently for UEs in the same cell, a high amount of ping-pong HO may happen. The ping-pong HO will then cause unnecessary HOs that increase the possibility of a call drop. However, as provided by the apparatus and methods described herein, if a UE can handover immediately to another cell (with different time slot/frequency allocation), the call can be saved.

[0019]   Referring to Fig. 1, in one aspect of the present apparatus and method, a wireless communication system 10 is configured to include wireless communications between network 12 and UE 14. The wireless communications system 10 may be configured to support communications between a number of users. Fig. 1 illustrates a manner in which network 12 communicates with UE 14. The wireless communication system 10 can be configured for downlink message transmission or uplink message transmission,

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as represented by the up/down arrows between network 12 and UE 14. Please note that communication between the UE 14 and network 12 may occur on a primary carrier 16 and a secondary carrier 18.

[0020]   In an aspect, within the UE 14 resides a call processing component 40. The call processing component 40 may be configured, among other things, to include a determining component 42 capable of determining the quality of a serving cell relative to a fast handover performance threshold 46. For example, the fast handover performance threshold 46 may be based on abrupt call quality variations during a time to trigger (TTT) period. For instance, the fast handover performance threshold 46 may include, but is not limited to, one or more of a threshold related to a signal quality metric, a path loss based metric, an interference based metric, a transmission power based metric, or a signal-to-interference ratio based metric. Additionally, the call processing component 40 includes a transmitting component 43 configured for transmitting a measurement report, e.g., including information relating to the measured quality of the serving cell and/or one or more target cells, to a network entity when the fast handover performance threshold 46 is breached, e.g., such that the TTT period is skipped.

[0021]   The call processing component 40 also includes a requesting component 44 capable of requesting a handover to a different cell, e.g., a target cell, when the fast handover performance threshold 46 is breached. Still further the call processing component 40 is configured to include a receiving component 45 operable to receive a handover trigger by a network entity based on the measurement report and the request for handover, e.g., wherein the handover trigger instructs the UE 14 to perform a handover of the call to a target cell.

[0022]   In an aspect, to tackle the serving cell receiver power fast drop problem without impacting other UEs in the same cell, the present apparatus and methods may include a new extra performance offset value on top of the hysteresis value to be added by the call processing component 40. For example, within a time duration, e.g. the TTT, if the value of the quality of a target cell minus the quality of the serving cell increases from a hysteresis value to a hysteresis value plus the performance offset value, e.g. one aspect of the fast handover performance threshold 46 as used herein, the UE will trigger a measurement event, e.g. reporting the measurement report to the network, immediately even if the "time to trigger" timer has not expired. In other words, if the quality of the target cell is better than quality of the serving cell and the quality of target cell increases

fast or the quality of serving cell drops fast, then the measurement event will be triggered immediately.

[0023]   For example, an aspect of a result of operation of the present apparatus and methods, the faster the serving cell quality drops (or the target cell quality increases), the faster the measurement event report will be triggered. This will decrease the probability of a call drop in the fast serving cell quality drop scenario. Nonetheless, the likelihood of ping-pong handover can be mitigated by a proper performance offset value, where the quality of target cell minus the quality of serving cell should not reach the hysteresis value plus the performance offset value, e.g., one aspect of the fast handover performance threshold 46 as used herein, within the time to trigger duration, in normal scenarios.

[0024]   For the interference scenarios, the present apparatus and methods may add other triggers for the fast HO event triggering, for instance, a trigger relating to a signal-to-interference ratio target (SIRtarget), which may be used for controlling transmitter power allocated to the receiver. For example, if there is interference the UE cannot handle, then the downlink block error rate (BLER) will increase and the outer loop power control will increase the SIRtarget. If the SIRtarget of the outer loop power control reaches a threshold, e.g., one aspect of the fast handover performance threshold 46 as used herein, then the present apparatus and methods can trigger the fast HO event.

[0025]   Another example for improved HO involves received power from other cells in the time slot the UE is allocated. If the time slot received power from the other cells is much higher than the time slot receive power of the serving cell, e.g. greater than a threshold in one aspect of the fast handover performance threshold 46 as used herein, then the present apparatus and methods can trigger the fast HO event.

[0026]   Another example for improved HO involves uplink transmit power. If the uplink transmit power is higher than a threshold, e.g., one aspect of the fast handover performance threshold 46 as used herein, it can be interpreted that the network has interference from other UEs in uplink or the path loss is too high. In this case, the present apparatus and methods can trigger the fast HO event. Further, to prevent ping-pong HO in the fast HO scenario, the present apparatus and methods may add a new timer. This new timer may be called an anti-ping-pong HO timer.

[0027]   In addition the call processing component 40 may also be to prevent the handover based on a false breach of the fast handover performance threshold 46. For example, in an aspect of the present apparatus and methods, the new anti-ping-pong HO

timer will be started when the UE performs the handover into a new cell, so that the fast HO event should not be triggered before the new anti-ping-pong HO timer expires. As such, the anti-ping-pong HO timer can keep a UE in a new cell for at least a timer duration of the anti-ping-pong HO timer. The value of the timer duration of the anti-ping-pong HO timer can be referred to as a "time to trigger."

[0028]   Please note that the call processing component 40 and components 42-46, residing therein, may be configured to be operable on the UE 14 and on the network 12.

[0029]   Fig. 2 is a flow diagram illustrating an exemplary method 50. At 52, the UE determines the quality of a serving cell relative to a fast handover performance threshold 46. Transmitting a measurement report to a network entity when the fast handover performance threshold 46 is breached occurs at 53.

[0030]   At 54, the UE requests a handover to a different cell when the fast handover performance threshold 46 is breached. Last, receiving a handover trigger by a network entity based on the measurement report and the request for handover occurs at 55.

[0031]   In an aspect, for example, the executing method 50 may be UE 14 or network 12 (Fig. 1) executing the call processing component 40 (Fig. 1), or respective components thereof.

[0032]   Thus, aspects of this apparatus and method include improving handover between a network and a UE.

[0033]   Fig. 3 is a block diagram illustrating an example of a hardware implementation for an apparatus 100 employing a processing system 114. Apparatus 100 may be configured to include, for example, wireless device 10 (Fig. 1) and/or cell monitoring component 12 (Fig. 1) as described above. In this example, the processing system 114 may be implemented with a bus architecture, represented generally by the bus 102. The bus 102 may include any number of interconnecting buses and bridges depending on the specific application of the processing system 114 and the overall design constraints. The bus 102 links together various circuits including one or more processors, represented generally by the processor 104, and computer-readable media, represented generally by the computer-readable medium 106. The bus 102 may also link various other circuits such as timing sources, peripherals, voltage regulators, and power management circuits, which are well known in the art, and therefore, will not be described any further. A bus interface 108 provides an interface between the bus 102 and a transceiver 110. The transceiver 110 provides a means for communicating with

various other apparatus over a transmission medium. Depending upon the nature of the apparatus, a user interface 112 (e.g., keypad, display, speaker, microphone, joystick) may also be provided.

[0034]   The processor 104 is responsible for managing the bus 102 and general processing, including the execution of software stored on the computer-readable medium 106. The software, when executed by the processor 104, causes the processing system 114 to perform the various functions described infra for any particular apparatus. The computer-readable medium 106 may also be used for storing data that is manipulated by the processor 104 when executing software.

[0035]   In an aspect, processor 104, computer-readable medium 106, or a combination of both may be configured or otherwise specially programmed to perform the functionality of the call processing component 40 (Fig. 1) as described herein.

[0036]   The various concepts presented throughout this disclosure may be implemented across a broad variety of telecommunication systems, network architectures, and communication standards.

[0037]   Referring to Fig. 4, by way of example and without limitation, the aspects of the present disclosure are presented with reference to a UMTS system 200 employing a W-CDMA air interface. A UMTS network includes three interacting domains: a Core Network (CN) 204, a UMTS Terrestrial Radio Access Network (UTRAN) 202, and User Equipment (UE) 210. UE 210 may be configured to include, for example, the call processing component 40 (Fig. 1) as described above. In this example, the UTRAN 202 provides various wireless services including telephony, video, data, messaging, broadcasts, and/or other services. The UTRAN 202 may include a plurality of Radio Network Subsystems (RNSs) such as an RNS 207, each controlled by a respective Radio Network Controller (RNC) such as an RNC 206. Here, the UTRAN 202 may include any number of RNCs 206 and RNSs 207 in addition to the RNCs 206 and RNSs 207 illustrated herein. The RNC 206 is an apparatus responsible for, among other things, assigning, reconfiguring and releasing radio resources within the RNS 207. The RNC 206 may be interconnected to other RNCs (not shown) in the UTRAN 202 through various types of interfaces such as a direct physical connection, a virtual network, or the like, using any suitable transport network.

[0038]   Communication between a UE 210 and a Node B 208 may be considered as including a physical (PHY) layer and a medium access control (MAC) layer. Further, communication between a UE 210 and an RNC 206 by way of a respective Node B 208

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may be considered as including a radio resource control (RRC) layer. In the instant specification, the PHY layer may be considered layer 1; the MAC layer may be considered layer 2; and the RRC layer may be considered layer 3. Information hereinbelow utilizes terminology introduced in the RRC Protocol Specification, 3GPP TS 25.331, incorporated herein by reference.

[0039]   The geographic region covered by the RNS 207 may be divided into a number of cells, with a radio transceiver apparatus serving each cell. A radio transceiver apparatus is commonly referred to as a Node B in UMTS applications, but may also be referred to by those skilled in the art as a base station (BS), a base transceiver station (BTS), a radio base station, a radio transceiver, a transceiver function, a basic service set (BSS), an extended service set (ESS), an access point (AP), or some other suitable terminology. For clarity, three Node Bs 208 are shown in each RNS 207; however, the RNSs 207 may include any number of wireless Node Bs. The Node Bs 208 provide wireless access points to a CN 204 for any number of mobile apparatuses. Examples of a mobile apparatus include a cellular phone, a smart phone, a session initiation protocol (SIP) phone, a laptop, a notebook, a netbook, a smartbook, a personal digital assistant (PDA), a satellite radio, a global positioning system (GPS) device, a multimedia device, a video device, a digital audio player (e.g., MP3 player), a camera, a game console, or any other similar functioning device. The mobile apparatus 221 is commonly referred to as a UE in UMTS applications, but may also be referred to by those skilled in the art as a mobile station, a subscriber station, a mobile unit, a subscriber unit, a wireless unit, a remote unit, a mobile device, a wireless device, a wireless communications device, a remote device, a mobile subscriber station, an access terminal, a mobile terminal, a wireless terminal, a remote terminal, a handset, a terminal, a user agent, a mobile client, a client, or some other suitable terminology. In a UMTS system, the UE 210 may further include a universal subscriber identity module (USIM) 211, which contains a user's subscription information to a network. For illustrative purposes, one UE 210 is shown in communication with a number of the Node Bs 208. The DL, also called the forward link, refers to the communication link from a Node B 208 to a UE 210, and the UL, also called the reverse link, refers to the communication link from a UE 210 to a Node B 208.

[0040]   The CN 204 interfaces with one or more access networks, such as the UTRAN 202. As shown, the CN 204 is a GSM core network. However, as those skilled in the art will recognize, the various concepts presented throughout this disclosure may be

implemented in a RAN, or other suitable access network, to provide UEs with access to types of CNs other than GSM networks.

[0041]   The CN 204 includes a circuit-switched (CS) domain and a packet-switched (PS) domain. Some of the circuit-switched elements are a Mobile services Switching Centre (MSC), a Visitor location register (VLR) and a Gateway MSC. Packet-switched elements include a Serving GPRS Support Node (SGSN) and a Gateway GPRS Support Node (GGSN). Some network elements, like EIR, HLR, VLR and AuC may be shared by both of the circuit-switched and packet-switched domains. In the illustrated example, the CN 204 supports circuit-switched services with a MSC 212 and a GMSC 214. In some applications, the GMSC 214 may be referred to as a media gateway (MGW). One or more RNCs, such as the RNC 206, may be connected to the MSC 212. The MSC 212 is an apparatus that controls call setup, call routing, and UE mobility functions. The MSC 212 also includes a VLR that contains subscriber-related information for the duration that a UE is in the coverage area of the MSC 212. The GMSC 214 provides a gateway through the MSC 212 for the UE to access a circuit-switched network 216. The GMSC 214 includes a home location register (HLR) 215 containing subscriber data, such as the data reflecting the details of the services to which a particular user has subscribed. The HLR is also associated with an authentication center (AuC) that contains subscriber-specific authentication data. When a call is received for a particular UE, the GMSC 214 queries the HLR 215 to determine the UE's location and forwards the call to the particular MSC serving that location.

[0042]   The CN 204 also supports packet-data services with a serving GPRS support node (SGSN) 218 and a gateway GPRS support node (GGSN) 220. GPRS, which stands for General Packet Radio Service, is designed to provide packet-data services at speeds higher than those available with standard circuit-switched data services. The GGSN 220 provides a connection for the UTRAN 202 to a packet-based network 222. The packet-based network 222 may be the Internet, a private data network, or some other suitable packet-based network. The primary function of the GGSN 220 is to provide the UEs 210 with packet-based network connectivity. Data packets may be transferred between the GGSN 220 and the UEs 210 through the SGSN 218, which performs primarily the same functions in the packet-based domain as the MSC 212 performs in the circuit-switched domain.

[0043]   An air interface for UMTS may utilize a spread spectrum Direct-Sequence Code Division Multiple Access (DS-CDMA) system. The spread spectrum DS-CDMA

spreads user data through multiplication by a sequence of pseudorandom bits called chips. The "wideband" W-CDMA air interface for UMTS is based on such direct sequence spread spectrum technology and additionally calls for a frequency division duplexing (FDD). FDD uses a different carrier frequency for the UL and DL between a Node B 208 and a UE 210. Another air interface for UMTS that utilizes DS-CDMA, and uses time division duplexing (TDD), is the TD-SCDMA air interface. Those skilled in the art will recognize that although various examples described herein may refer to a W-CDMA air interface, the underlying principles may be equally applicable to a TD-SCDMA air interface.

[0044]   An HSPA air interface includes a series of enhancements to the 3G/W-CDMA air interface, facilitating greater throughput and reduced latency. Among other modifications over prior releases, HSPA utilizes hybrid automatic repeat request (HARQ), shared channel transmission, and adaptive modulation and coding. The standards that define HSPA include HSDPA (high speed downlink packet access) and HSUPA (high speed uplink packet access, also referred to as enhanced uplink, or EUL).

[0045]   HSDPA utilizes as its transport channel the high-speed downlink shared channel (HS-DSCH). The HS-DSCH is implemented by three physical channels: the high-speed physical downlink shared channel (HS-PDSCH), the high-speed shared control channel (HS-SCCH), and the high-speed dedicated physical control channel (HS-DPCCH).

[0046]   Among these physical channels, the HS-DPCCH carries the HARQ ACK/NACK signaling on the uplink to indicate whether a corresponding packet transmission was decoded successfully. That is, with respect to the downlink, the UE 210 provides feedback to the node B 208 over the HS-DPCCH to indicate whether it correctly decoded a packet on the downlink.

[0047]   HS-DPCCH further includes feedback signaling from the UE 210 to assist the node B 208 in taking the right decision in terms of modulation and coding scheme and precoding weight selection, this feedback signaling including the CQI and PCI.

[0048]   "HSPA Evolved" or HSPA+ is an evolution of the HSPA standard that includes MIMO and 64-QAM, enabling increased throughput and higher performance. That is, in an aspect of the disclosure, the node B 208 and/or the UE 210 may have multiple antennas supporting MIMO technology. The use of MIMO technology enables the node B 208 to exploit the spatial domain to support spatial multiplexing, beamforming, and transmit diversity.

[0049]   Multiple Input Multiple Output (MIMO) is a term generally used to refer to multi-antenna technology, that is, multiple transmit antennas (multiple inputs to the channel) and multiple receive antennas (multiple outputs from the channel). MIMO systems generally enhance data transmission performance, enabling diversity gains to reduce multipath fading and increase transmission quality, and spatial multiplexing gains to increase data throughput.

[0050]   Spatial multiplexing may be used to transmit different streams of data simultaneously on the same frequency. The data steams may be transmitted to a single UE 210 to increase the data rate, or to multiple UEs 210 to increase the overall system capacity. This is achieved by spatially precoding each data stream and then transmitting each spatially precoded stream through a different transmit antenna on the downlink. The spatially precoded data streams arrive at the UE(s) 210 with different spatial signatures, which enables each of the UE(s) 210 to recover the one or more the data streams destined for that UE 210. On the uplink, each UE 210 may transmit one or more spatially precoded data streams, which enables the node B 208 to identify the source of each spatially precoded data stream.

[0051]   Spatial multiplexing may be used when channel conditions are good. When channel conditions are less favorable, beamforming may be used to focus the transmission energy in one or more directions, or to improve transmission based on characteristics of the channel. This may be achieved by spatially precoding a data stream for transmission through multiple antennas. To achieve good coverage at the edges of the cell, a single stream beamforming transmission may be used in combination with transmit diversity.

[0052]   Generally, for MIMO systems utilizing n transmit antennas, n transport blocks may be transmitted simultaneously over the same carrier utilizing the same channelization code. Note that the different transport blocks sent over the n transmit antennas may have the same or different modulation and coding schemes from one another.

[0053]   On the other hand, Single Input Multiple Output (SIMO) generally refers to a system utilizing a single transmit antenna (a single input to the channel) and multiple receive antennas (multiple outputs from the channel). Thus, in a SIMO system, a single transport block is sent over the respective carrier.

[0054]   Referring to Fig. 5, an access network 300 in a UTRAN architecture is illustrated. The multiple access wireless communication system includes multiple

cellular regions (cells), including cells 302, 304, and 306, each of which may include one or more sectors. The multiple sectors can be formed by groups of antennas with each antenna responsible for communication with UEs in a portion of the cell. For example, in cell 302, antenna groups 312, 314, and 316 may each correspond to a different sector. In cell 304, antenna groups 318, 320, and 322 each correspond to a different sector. In cell 306, antenna groups 324, 326, and 328 each correspond to a different sector. The cells 302, 304 and 306 may include several wireless communication devices, e.g., User Equipment or UEs, which may be in communication with one or more sectors of each cell 302, 304 or 306. For example, UEs 330 and 332 may be in communication with Node B 342, UEs 334 and 336 may be in communication with Node B 344, and UEs 338 and 340 can be in communication with Node B 346. Here, each Node B 342, 344, 346 is configured to provide an access point to a CN 204 (see Fig. 4) for all the UEs 330, 332, 334, 336, 338, 340 in the respective cells 302, 304, and 306. Node Bs 342, 344, 346 and UEs 330, 332, 334, 336, 338, 340 respectively may be configured to include, for example, the call processing component 40 (Fig. 1) as described above.

[0055]   As the UE 334 moves from the illustrated location in cell 304 into cell 306, a serving cell change (SCC) or handover may occur in which communication with the UE 334 transitions from the cell 304, which may be referred to as the source cell, to cell 306, which may be referred to as the target cell. Management of the handover procedure may take place at the UE 334, at the Node Bs corresponding to the respective cells, at a radio network controller 206 (see Fig. 4), or at another suitable node in the wireless network. For example, during a call with the source cell 304, or at any other time, the UE 334 may monitor various parameters of the source cell 304 as well as various parameters of neighboring cells such as cells 306 and 302. Further, depending on the quality of these parameters, the UE 334 may maintain communication with one or more of the neighboring cells. During this time, the UE 334 may maintain an Active Set, that is, a list of cells that the UE 334 is simultaneously connected to (i.e., the UTRA cells that are currently assigning a downlink dedicated physical channel DPCH or fractional downlink dedicated physical channel F-DPCH to the UE 334 may constitute the Active Set).

[0056]   The modulation and multiple access scheme employed by the access network 300 may vary depending on the particular telecommunications standard being deployed. By way of example, the standard may include Evolution-Data Optimized (EV-DO) or

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Ultra Mobile Broadband (UMB). EV-DO and UMB are air interface standards promulgated by the 3rd Generation Partnership Project 2 (3GPP2) as part of the CDMA2000 family of standards and employs CDMA to provide broadband Internet access to mobile stations. The standard may alternately be Universal Terrestrial Radio Access (UTRA) employing Wideband-CDMA (W-CDMA) and other variants of CDMA, such as TD-SCDMA; Global System for Mobile Communications (GSM) employing TDMA; and Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, and Flash-OFDM employing OFDMA. UTRA, E-UTRA, UMTS, LTE, LTE Advanced, and GSM are described in documents from the 3GPP organization CDMA2000 and UMB are described in documents from the 3GPP2 organization. The actual wireless communication standard and the multiple access technology employed will depend on the specific application and the overall design constraints imposed on the system.

[0057]   The radio protocol architecture may take on various forms depending on the particular application. An example for an HSPA system will now be presented with reference to Fig. 6.

[0058]   Fig. 6 is a conceptual diagram illustrating an example of the radio protocol architecture 400 for the user plane 402 and the control plane 404 of a user equipment (UE) or node B/base station. For example, architecture 400 may be included in a network entity and/or UE such as an entity within wireless network 12 and/or UE14 (Fig. 1). The radio protocol architecture 400 for the UE and node B is shown with three layers: Layer 1 406, Layer 2 408, and Layer 3 410. Layer 1 406 is the lowest lower and implements various physical layer signal processing functions. As such, Layer 1 406 includes the physical layer 407. Layer 2 (L2 layer) 408 is above the physical layer 407 and is responsible for the link between the UE and node B over the physical layer 407. Layer 3 (L3 layer) 410 includes a radio resource control (RRC) sublayer 415. The RRC sublayer 415 handles the control plane signaling of Layer 3 between the UE and the UTRAN.

[0059]   In the user plane, the L2 layer 408 includes a media access control (MAC) sublayer 409, a radio link control (RLC) sublayer 411, and a packet data convergence protocol (PDCP) 413 sublayer, which are terminated at the node B on the network side. Although not shown, the UE may have several upper layers above the L2 layer 408 including a network layer (e.g., IP layer) that is terminated at a PDN gateway on the

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network side, and an application layer that is terminated at the other end of the connection (e.g., far end UE, server, etc.).

[0060]   The PDCP sublayer 413 provides multiplexing between different radio bearers and logical channels. The PDCP sublayer 413 also provides header compression for upper layer data packets to reduce radio transmission overhead, security by ciphering the data packets, and handover support for UEs between node Bs. The RLC sublayer 411 provides segmentation and reassembly of upper layer data packets, retransmission of lost data packets, and reordering of data packets to compensate for out-of-order reception due to hybrid automatic repeat request (HARQ). The MAC sublayer 409 provides multiplexing between logical and transport channels. The MAC sublayer 409 is also responsible for allocating the various radio resources (e.g., resource blocks) in one cell among the UEs. The MAC sublayer 409 is also responsible for HARQ operations.

[0061]   Fig. 7 is a block diagram of a communication system 500 including a Node B 510 in communication with a UE 550, where Node B 510 may be an entity within wireless network 12 and the UE 550 may be UE 14 according to the aspect described in Fig. 1. In the downlink communication, a transmit processor 520 may receive data from a data source 512 and control signals from a controller/processor 540. The transmit processor 520 provides various signal processing functions for the data and control signals, as well as reference signals (e.g., pilot signals). For example, the transmit processor 520 may provide cyclic redundancy check (CRC) codes for error detection, coding and interleaving to facilitate forward error correction (FEC), mapping to signal constellations based on various modulation schemes (e.g., binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), M-phase-shift keying (M-PSK), M-quadrature amplitude modulation (M-QAM), and the like), spreading with orthogonal variable spreading factors (OVSF), and multiplying with scrambling codes to produce a series of symbols. Channel estimates from a channel processor 544 may be used by a controller/processor 540 to determine the coding, modulation, spreading, and/or scrambling schemes for the transmit processor 520. These channel estimates may be derived from a reference signal transmitted by the UE 550 or from feedback from the UE 550. The symbols generated by the transmit processor 520 are provided to a transmit frame processor 530 to create a frame structure. The transmit frame processor 530 creates this frame structure by multiplexing the symbols with information from the controller/processor 540, resulting in a series of frames. The frames are then provided

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to a transmitter 532, which provides various signal conditioning functions including amplifying, filtering, and modulating the frames onto a carrier for downlink transmission over the wireless medium through antenna 534. The antenna 534 may include one or more antennas, for example, including beam steering bidirectional adaptive antenna arrays or other similar beam technologies.

[0062]   At the UE 550, a receiver 554 receives the downlink transmission through an antenna 552 and processes the transmission to recover the information modulated onto the carrier. The information recovered by the receiver 554 is provided to a receive frame processor 560, which parses each frame, and provides information from the frames to a channel processor 594 and the data, control, and reference signals to a receive processor 570. The receive processor 570 then performs the inverse of the processing performed by the transmit processor 520 in the Node B 510. More specifically, the receive processor 570 descrambles and despreads the symbols, and then determines the most likely signal constellation points transmitted by the Node B 510 based on the modulation scheme. These soft decisions may be based on channel estimates computed by the channel processor 594. The soft decisions are then decoded and deinterleaved to recover the data, control, and reference signals. The CRC codes are then checked to determine whether the frames were successfully decoded. The data carried by the successfully decoded frames will then be provided to a data sink 572, which represents applications running in the UE 550 and/or various user interfaces (e.g., display). Control signals carried by successfully decoded frames will be provided to a controller/processor 590. When frames are unsuccessfully decoded by the receiver processor 570, the controller/processor 590 may also use an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support retransmission requests for those frames.

[0063]   In the uplink, data from a data source 578 and control signals from the controller/processor 590 are provided to a transmit processor 580. The data source 578 may represent applications running in the UE 550 and various user interfaces (e.g., keyboard). Similar to the functionality described in connection with the downlink transmission by the Node B 510, the transmit processor 580 provides various signal processing functions including CRC codes, coding and interleaving to facilitate FEC, mapping to signal constellations, spreading with OVSFs, and scrambling to produce a series of symbols. Channel estimates, derived by the channel processor 594 from a reference signal transmitted by the Node B 510 or from feedback contained in the

midamble transmitted by the Node B 510, may be used to select the appropriate coding, modulation, spreading, and/or scrambling schemes. The symbols produced by the transmit processor 580 will be provided to a transmit frame processor 582 to create a frame structure. The transmit frame processor 582 creates this frame structure by multiplexing the symbols with information from the controller/processor 590, resulting in a series of frames. The frames are then provided to a transmitter 556, which provides various signal conditioning functions including amplification, filtering, and modulating the frames onto a carrier for uplink transmission over the wireless medium through the antenna 552.

[0064]   The uplink transmission is processed at the Node B 510 in a manner similar to that described in connection with the receiver function at the UE 550. A receiver 535 receives the uplink transmission through the antenna 534 and processes the transmission to recover the information modulated onto the carrier. The information recovered by the receiver 535 is provided to a receive frame processor 536, which parses each frame, and provides information from the frames to the channel processor 544 and the data, control, and reference signals to a receive processor 538. The receive processor 538 performs the inverse of the processing performed by the transmit processor 580 in the UE 550. The data and control signals carried by the successfully decoded frames may then be provided to a data sink 539 and the controller/processor, respectively. If some of the frames were unsuccessfully decoded by the receive processor, the controller/processor 540 may also use an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support retransmission requests for those frames.

[0065]   The controller/processors 540 and 590 may be used to direct the operation at the Node B 510 and the UE 550, respectively. For example, the controller/processors 540 and 590 may provide various functions including timing, peripheral interfaces, voltage regulation, power management, and other control functions. The computer readable media of memories 542 and 592 may store data and software for the Node B 510 and the UE 550, respectively. A scheduler/processor 546 at the Node B 510 may be used to allocate resources to the UEs and schedule downlink and/or uplink transmissions for the UEs.

[0066]   Several aspects of a telecommunications system have been presented with reference to a W-CDMA system. As those skilled in the art will readily appreciate, various aspects described throughout this disclosure may be extended to other telecommunication systems, network architectures and communication standards.

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[0067]   By way of example, various aspects may be extended to other UMTS systems such as TD-SCDMA, High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), High Speed Packet Access Plus (HSPA+) and TD-CDMA. Various aspects may also be extended to systems employing Long Term Evolution (LTE) (in FDD, TDD, or both modes), LTE-Advanced (LTE-A) (in FDD, TDD, or both modes), CDMA2000, Evolution-Data Optimized (EV-DO), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Ultra-Wideband (UWB), Bluetooth, and/or other suitable systems. The actual telecommunication standard, network architecture, and/or communication standard employed will depend on the specific application and the overall design constraints imposed on the system.

[0068]   In accordance with various aspects of the disclosure, an element, or any portion of an element, or any combination of elements may be implemented with a "processing system" or processor (Fig. 3) that includes one or more processors. Examples of processors include microprocessors, microcontrollers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), state machines, gated logic, discrete hardware circuits, and other suitable hardware configured to perform the various functionality described throughout this disclosure. One or more processors in the processing system may execute software. Software shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. The software may reside on a computer-readable medium 106 (Fig. 3). The computer-readable medium 106 (Fig. 3) may be a non-transitory computer-readable medium. A non-transitory computer-readable medium includes, by way of example, a magnetic storage device (e.g., hard disk, floppy disk, magnetic strip), an optical disk (e.g., compact disk (CD), digital versatile disk (DVD)), a smart card, a flash memory device (e.g., card, stick, key drive), random access memory (RAM), read only memory (ROM), programmable ROM (PROM), erasable PROM (EPROM), electrically erasable PROM (EEPROM), a register, a removable disk, and any other suitable medium for storing software and/or instructions that may be accessed and read by a computer. The computer-readable medium may also include, by way of example, a carrier wave, a

transmission line, and any other suitable medium for transmitting software and/or instructions that may be accessed and read by a computer. The computer-readable medium may be resident in the processing system, external to the processing system, or distributed across multiple entities including the processing system. The computer-readable medium may be embodied in a computer-program product. By way of example, a computer-program product may include a computer-readable medium in packaging materials. Those skilled in the art will recognize how best to implement the described functionality presented throughout this disclosure depending on the particular application and the overall design constraints imposed on the overall system.

[0069]   It is to be understood that the specific order or hierarchy of steps in the methods disclosed is an illustration of exemplary processes. Based upon design preferences, it is understood that the specific order or hierarchy of steps in the methods may be rearranged. The accompanying method claims present elements of the various steps in a sample order, and are not meant to be limited to the specific order or hierarchy presented unless specifically recited therein.

[0070]   The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects. Thus, the claims are not intended to be limited to the aspects shown herein, but is to be accorded the full scope consistent with the language of the claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. A phrase referring to "at least one of" a list of items refers to any combination of those items, including single members. As an example, "at least one of: a, b, or c" is intended to cover: a; b; c; a and b; a and c; b and c; and a, b and c. All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. §112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited using the phrase "step for."

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CLAIMS

What is claimed is:

1.   A method of wireless communication, comprising:

determining the quality of a serving cell relative to a fast handover performance threshold;

transmitting a measurement report to a network entity when the fast handover performance threshold is breached;

requesting a handover to a different cell when the fast handover performance threshold is breached; and

receiving a handover trigger by a network entity based on the measurement report and the request for handover.

2.   The method of claim 1, further comprising:

preventing handover based on false breach of the fast handover performance threshold.

3.   The method of claim 1, wherein the fast handover performance threshold is a path loss based metric.

4.   The method of claim 1, wherein the fast handover performance threshold is an interference based metric.

5.   The method of claim 1, wherein the fast handover performance threshold is a transmission power based metric.

6.   The method of claim 1, wherein the fast handover performance threshold is based on abrupt call quality variations during the time to trigger (TTT) period such that the TTT is skipped.

7.   The method of claim 1, wherein after the handover trigger, a source cell is exempt from the fast handover performance threshold until the next handover trigger.

8.   An apparatus of wireless communication in a wireless communication network, comprising:

        means for determining the quality of a serving cell relative to a fast handover performance threshold;

        means for transmitting a measurement report to a network entity when the fast handover performance threshold is breached;

        means for requesting a handover to a different cell when the fast handover performance threshold is breached;

        means for receiving a handover trigger by a network entity based on the measurement report and the request for handover.

9.   The apparatus of claim 8, further comprising means for performing the functions of any of claims 2 or 3 or 4 or 5 or 6 or 7.

10.   A computer program product, comprising:

        a non-transitory computer readable medium comprising code for:

        determining the quality of a serving cell relative to a fast handover performance threshold;

        transmitting a measurement report to a network entity when the fast handover performance threshold is breached;

        requesting a handover to a different cell when the fast handover performance threshold is breached;

        receiving a handover trigger by a network entity based on the measurement report and the request for handover.

11.   The computer program product of claim 10, further comprising code for performing the functions of any of claims 2 or 3 or 4 or 5 or 6 or 7.

12.   An apparatus of wireless communication in a wireless communication network, comprising:

at least one processor; and

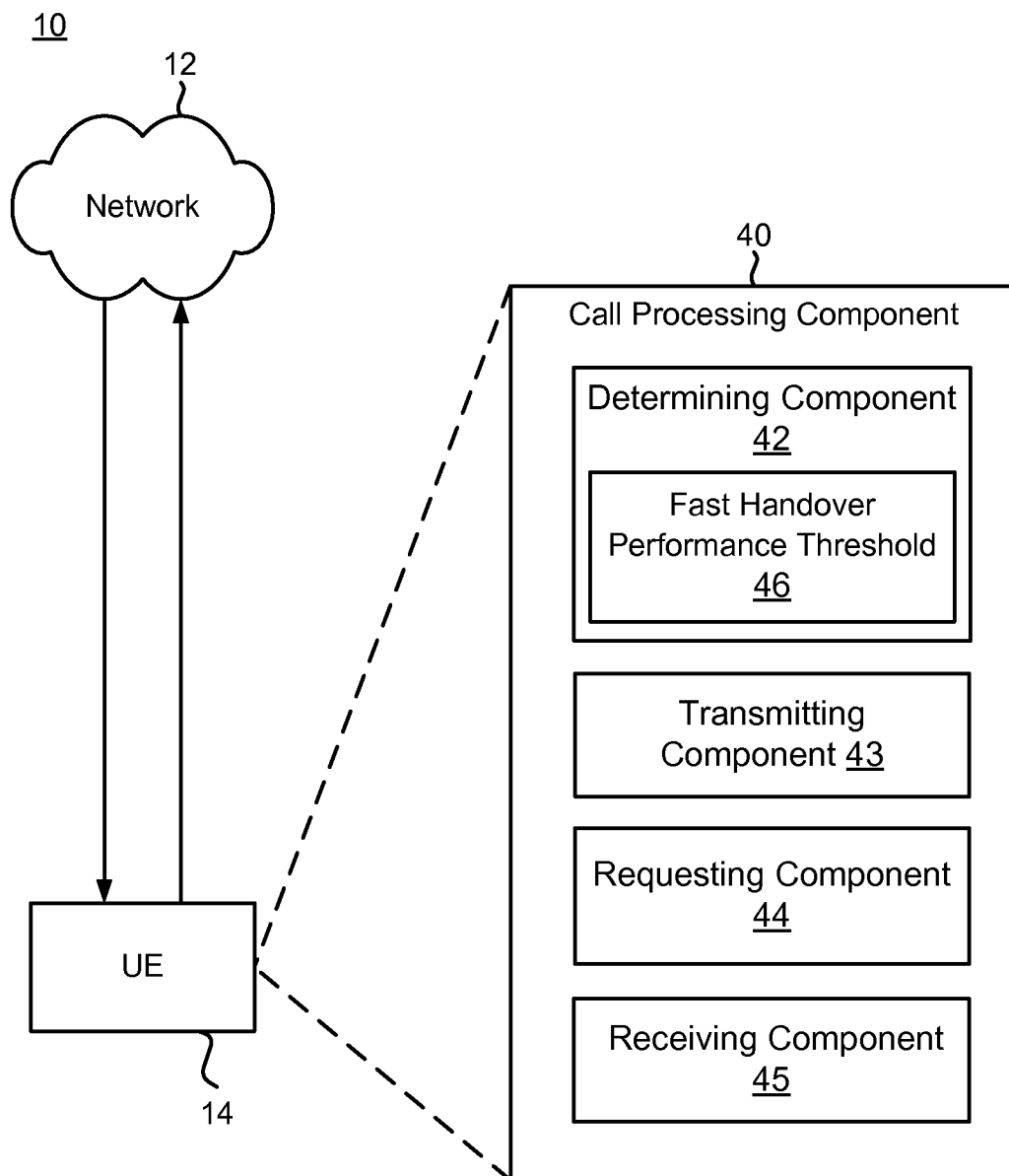a memory coupled to the least one processor, wherein the at least one processor is configured to:

determine the quality of a serving cell relative to a fast handover performance threshold;

transmit a measurement report to a network entity when the fast handover performance threshold is breached;
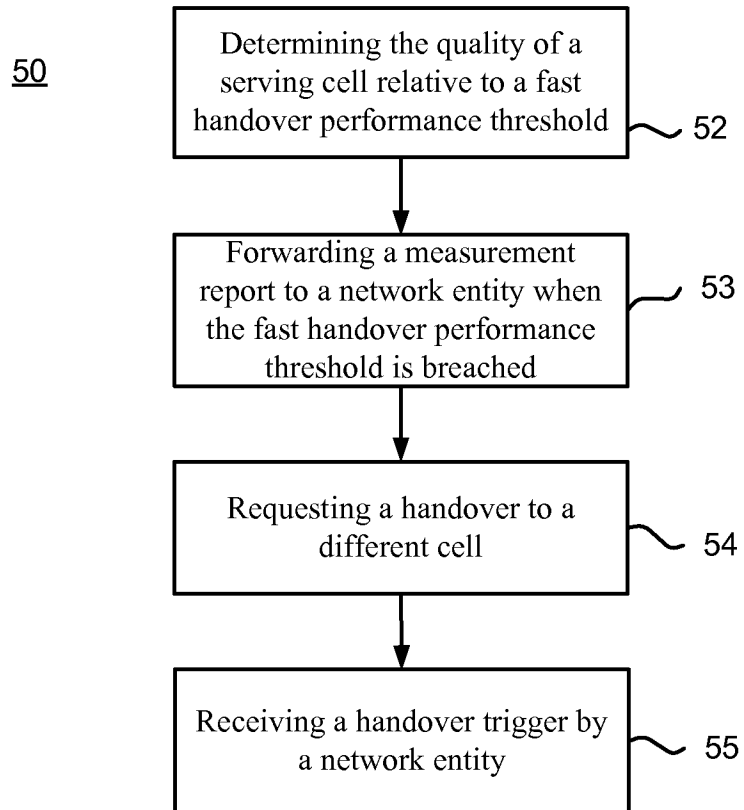
request a handover to a different cell when the fast handover performance threshold is breached;

receive a handover trigger by a network entity based on the measurement report and the request for handover.

13.   The apparatus of claim 12, further configured to perform the functions of claims 2 or 3 or 4 or 5 or 6 or 7.

FIG. 1

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Determining the quality of a
serving cell relative to a fast
handover performance threshold ～ 52

Forwarding a measurement
report to a network entity when
the fast handover performance
threshold is breached ～ 53

Requesting a handover to a
different cell ～ 54

Receiving a handover trigger by
a network entity ～ 55

Fig. 2

FIG. 3

FIG. 4

FIG. 5

400

404
Control-plane

402
User-plane

410 — L3

415
RRC

Radio Bearers
PDCP — 413

408 — L2

RLC — 411

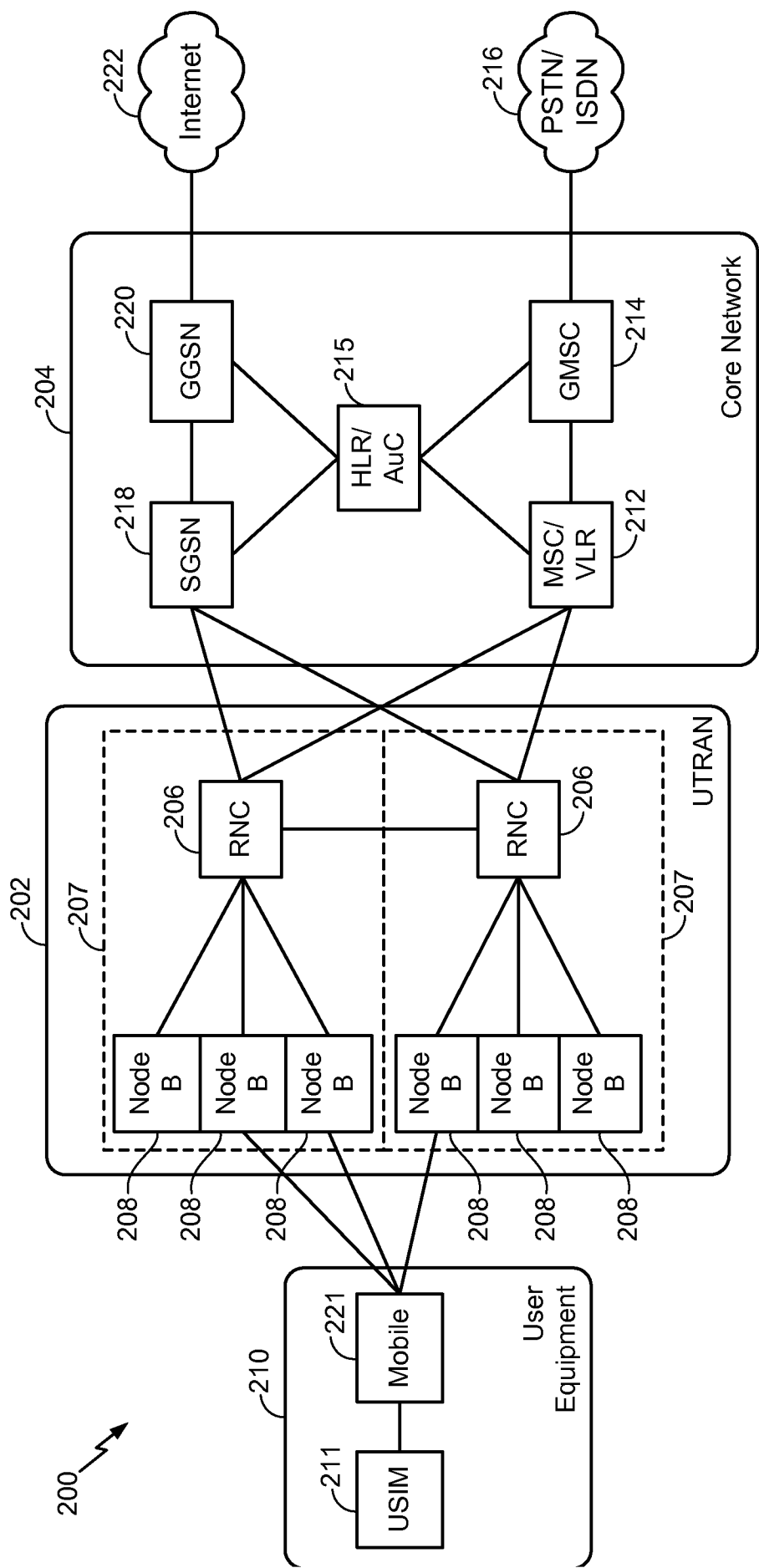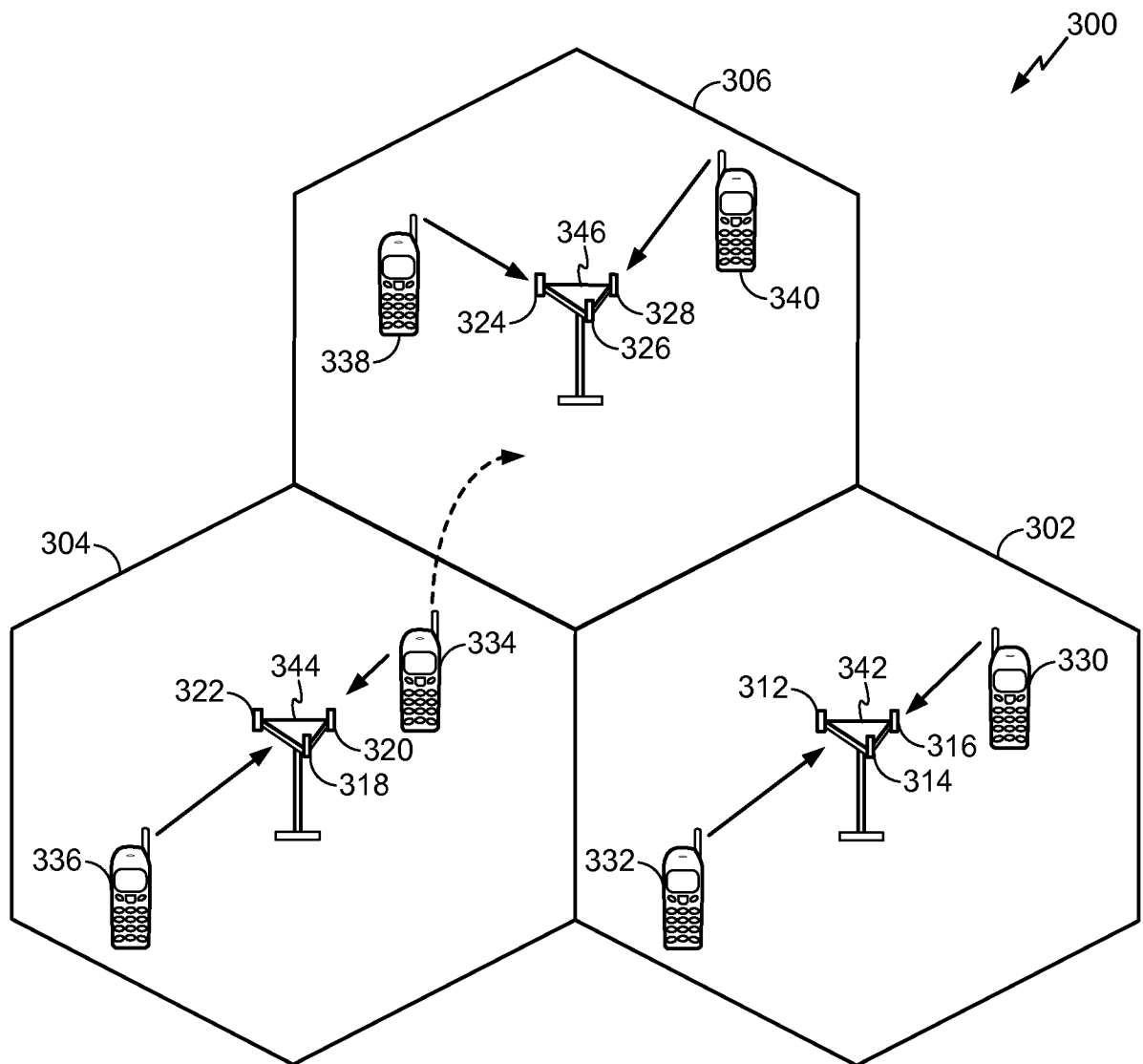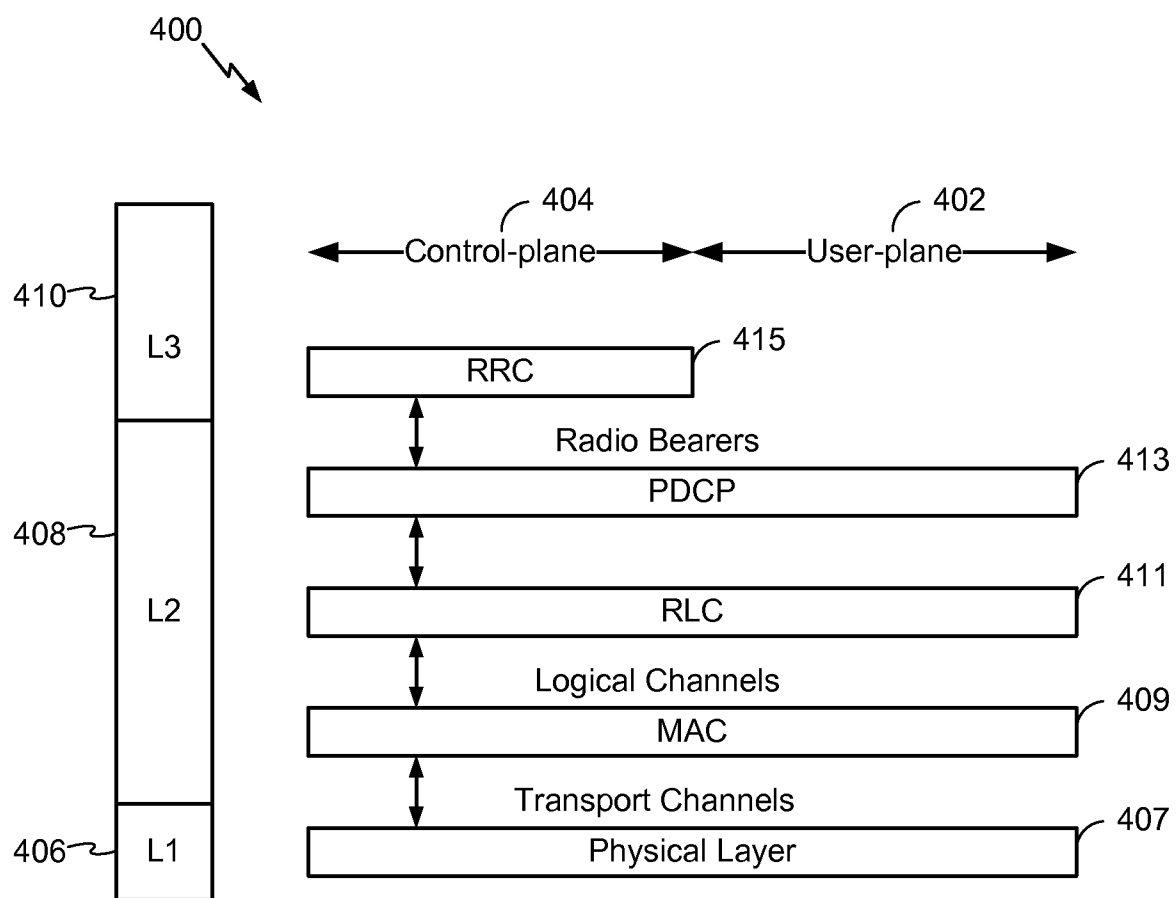Logical Channels
MAC — 409

406 — L1

Transport Channels
Physical Layer — 407

FIG. 6

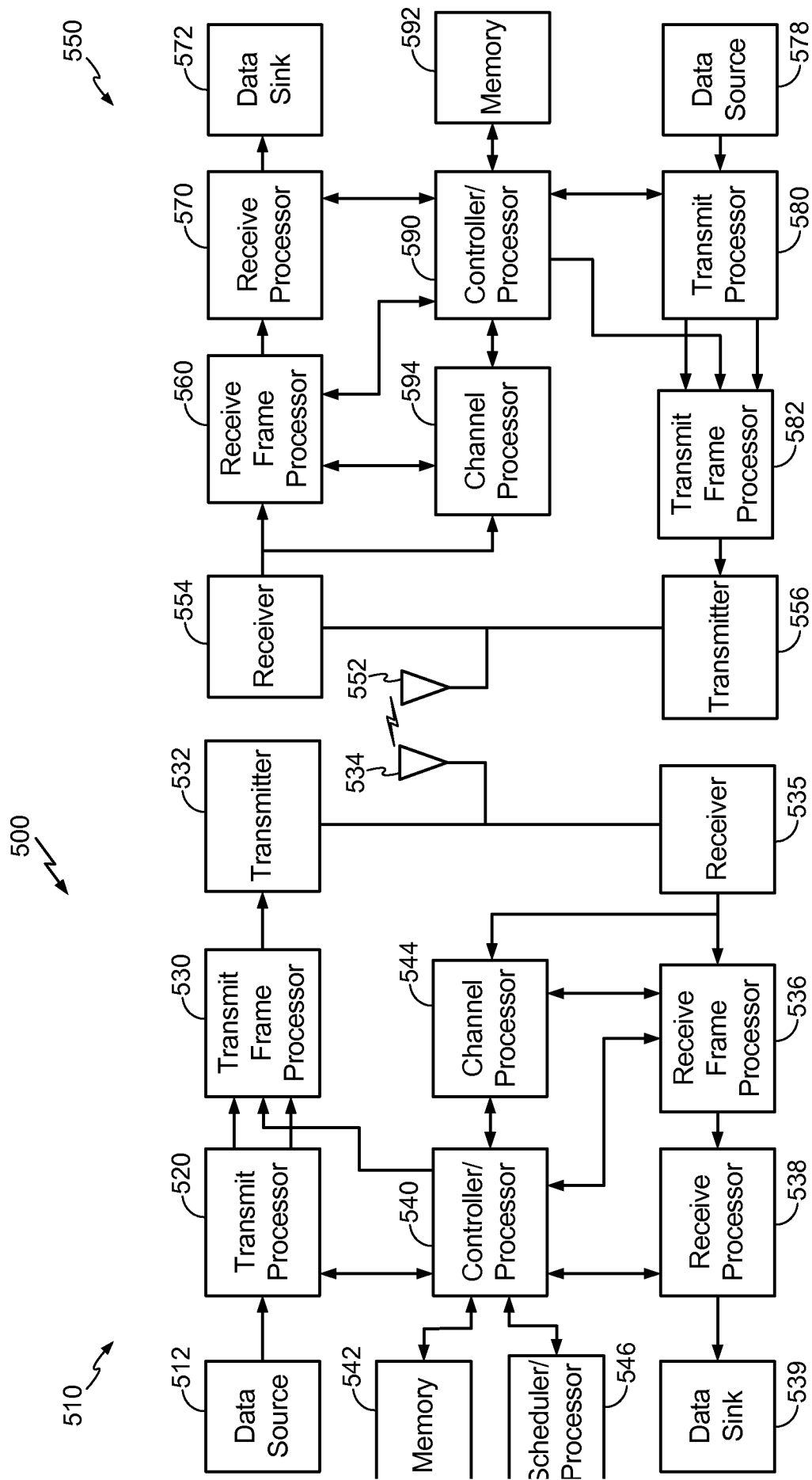*FIG. 7*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2013/070371

A. CLASSIFICATION OF SUBJECT MATTER

H04W 36/30 (2009.01) i

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)

IPC: H04W;H04Q

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)

WPI, EPODOC, CNPAT, CNKI, IEEE: quality, serv+, handover, handoff, HO, threshold, breach+, measure+, report, trigger, cell

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102378192 A (ZTE CORP.) 14 March 2012 (14.03.2012) see description, paragraphs [0123] to [0143], [0152] to [0161] and figures 10, 12	1-13
A	CN 101867966 A (ZTE CORP.) 20 October 2010 (20.10.2012) the whole document	1-13
A	CN 1909735 A (HUAWEI TECHNOLOGIES CO., LTD.) 07 February 2007 (07.02.2007) the whole document	1-13
A	CN 101553014 A (HUAWEI TECHNOLOGIES CO., LTD.) 07 October 2009 (07.10.2009) the whole document	1-13
A	WO 2010/104446 A1 (TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)) 16 September 2010 (16.09.2010) the whole document	1-13

☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

*	Special categories of cited documents:	"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
"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	"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
"L"	document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	"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
"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	"&"	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 June 2013 (11.06.2013)	**04 Jul. 2013 (04.07.2013)**

Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer LI,Changlin Telephone No. (86-10) 62413334

Form PCT/ISA /210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2013/070371

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN 102378192 A	14.03.2012	None	
CN 101867966 A	20.10.2012	None	
CN 1909735 A	07.02.2007	None	
CN 101553014 A	07.10.2009	None	
WO 2010/104446 A1	16.09.2010	US 2010/0234014 A1	16.09.2010
		EP 2406986 A1	18.01.2012