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(54) Title: PRIORITY-BASED SELECTION OF BASE TRANSCEIVER STATIONS IN A TD-SCDMA WIRELESS COMMUNICATION SYSTEM

(57) Abstract: Selection of base transceiver stations or Node Bs for handoff in a time division synchronous code division multiple access (TD-SCDMA) wireless communication system is provided by a user equipment (UE) selecting a neighboring Node B based on a priority level, while communicating with a serving Node B, and measuring a signal transmitted by the selected Node B.

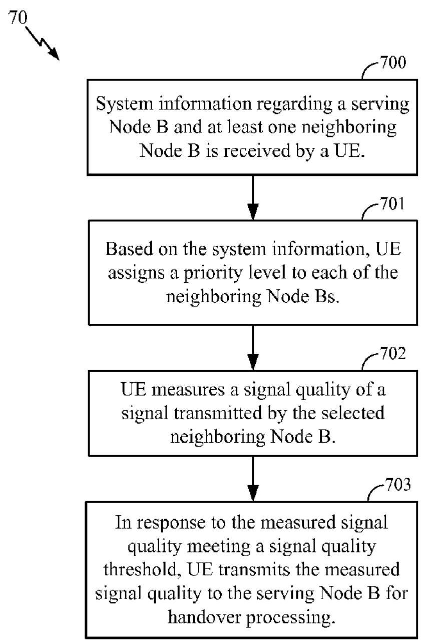

FIG. 7

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PRIORITY-BASED SELECTION OF BASE TRANSCEIVER STATIONS IN A TD-SCDMA WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/295,544, entitled "PRIORITY-BASED SELECTION OF BASE TRANSCEIVER STATIONS IN A TD-SCDMA WIRELESS COMMUNICATION SYSTEM," and filed on January 15, 2010, which is expressly incorporated by reference herein in its entirety.

BACKGROUND

Field

[0002] Aspects of the present disclosure relate generally to wireless communication systems, and more particularly, to priority-based selection of base transceiver stations in a Time Division–Synchronous Code Division Multiple Access (TD-SCDMA) wireless communication system.

Background

[0003] 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 Universal 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). For example, China is pursuing TD-SCDMA as the underlying air interface in the UTRAN architecture with its existing GSM infrastructure as the core network. The UMTS also supports enhanced 3G data communications protocols, such as High

Speed Downlink Packet Data (HSDPA), which provides higher data transfer speeds and capacity to associated UMTS networks.

[0004] As the demand for mobile broadband access continues to increase, research and development continue to advance the UMTS technologies not only to meet the growing demand for mobile broadband access, but to advance and enhance the user experience with mobile communications.

SUMMARY

[0005] In an aspect of the disclosure, selection of base transceiver stations or Node Bs for handoff in a Time Division–Synchronous Code Division Multiple Access (TD-SCDMA) wireless communication system is provided. In such systems, a user equipment (UE) selects a neighboring Node B based on a priority level, while communicating with a serving Node B, and measures a signal transmitted by the selected Node B.

[0006] In an aspect of the disclosure, system information regarding a serving Node B and at least one neighboring Node B is received by a UE. Based on the system information, the UE assigns a priority level to each of the neighboring Node Bs. The UE measures a signal quality of a signal transmitted by the selected neighboring Node B. In response to the measured signal quality meeting a signal quality threshold, the UE transmits the measured signal quality to the serving Node B for handover processing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a block diagram conceptually illustrating an example of a telecommunications system.

[0008] FIG. 2 is a block diagram conceptually illustrating an example of a frame structure in a telecommunications system.

[0009] FIG. 3 is a block diagram conceptually illustrating an example of a Node B in communication with a UE in a telecommunications system.

[0010] FIG. 4 is a functional block diagram illustrating example blocks executed in conducting wireless communication according to one aspect of the present disclosure.

[0011] FIG. 5 is a block diagram conceptually illustrating a TD-SCDMA wireless communication system configured according to one aspect of the present teachings.

[0012] FIG. 6 is a block diagram conceptually illustrating a multi-carrier TD-SCDMA wireless system configured according to one aspect of the present teachings.

[0013] FIG. 7 is a block diagram is shown conceptually illustrating example blocks executed to implement one aspect of the present teachings.

DETAILED DESCRIPTION

[0014] 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 the 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.

[0015] Turning now to FIG. 1, a block diagram is shown illustrating an example of a telecommunications system 100. The various concepts presented throughout this disclosure may be implemented across a broad variety of telecommunication systems, network architectures, and communication standards. By way of example and without limitation, the aspects of the present disclosure illustrated in FIG. 1 are presented with reference to a UMTS system employing a TD-SCDMA standard. In this example, the UMTS system includes a (radio access network) RAN 102 (e.g., UTRAN) that provides various wireless services including telephony, video, data, messaging, broadcasts, and/or other services. The RAN 102 may be divided into a number of Radio Network Subsystems (RNSs) such as an RNS 107, each controlled by a Radio Network Controller (RNC) such as an RNC 106. For clarity, only the RNC 106 and the RNS 107 are shown; however, the RAN 102 may include any number of RNCs and RNSs in addition to the RNC 106 and RNS 107. The RNC 106 is an apparatus responsible for, among other things, assigning, reconfiguring and releasing radio resources within the RNS 107. The RNC 106 may be interconnected to other RNCs (not shown) in the RAN 102 through various types of interfaces such as a direct physical connection, a virtual network, or the like, using any suitable transport network.

[0016] The geographic region covered by the RNS 107 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, two Node Bs 108 are shown; however, the RNS 107 may include any number of wireless Node Bs. The Node Bs 108 provide wireless access points to a core network 104 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 is commonly referred to as user equipment (UE) in UMTS applications, but may also be referred to by those skilled in the art as a mobile station (MS), 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 (AT), 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. For illustrative purposes, three UEs 110 are shown in communication with the Node Bs 108. The downlink (DL), also called the forward link, refers to the communication link from a Node B to a UE, and the uplink (UL), also called the reverse link, refers to the communication link from a UE to a Node B.

[0017] The core network 104, as shown, includes 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 core networks other than GSM networks.

[0018] In this example, the core network 104 supports circuit-switched services with a mobile switching center (MSC) 112 and a gateway MSC (GMSC) 114. One or more RNCs, such as the RNC 106, may be connected to the MSC 112. The MSC 112 is an apparatus that controls call setup, call routing, and UE mobility functions. The MSC 112 also includes a visitor location register (VLR) (not shown) that contains subscriber-related information for the duration that a UE is in the coverage area of the MSC 112. The GMSC 114 provides a gateway through the MSC 112 for the UE to access a circuit-switched network 116. The GMSC 114 includes a home location register (HLR) (not shown) 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 114 queries the HLR to determine the UE's location and forwards the call to the particular MSC serving that location.

[0019] The core network 104 also supports packet-data services with a serving GPRS support node (SGSN) 118 and a gateway GPRS support node (GGSN) 120. GPRS, which stands for General Packet Radio Service, is designed to provide packet-data services at speeds higher than those available with standard GSM circuit-switched data services. The GGSN 120 provides a connection for the RAN 102 to a packet-based network 122. The packet-based network 122 may be the Internet, a private data network, or some other suitable packet-based network. The primary function of the GGSN 120 is to provide the UEs 110 with packet-based network connectivity. Data packets are transferred between the GGSN 120 and the UEs 110 through the SGSN 118, which performs primarily the same functions in the packet-based domain as the MSC 112 performs in the circuit-switched domain.

[0020] The UMTS air interface is a spread spectrum Direct-Sequence Code Division Multiple Access (DS-CDMA) system. The spread spectrum DS-CDMA spreads user data over a much wider bandwidth through multiplication by a sequence of pseudorandom bits called chips. The TD-SCDMA standard is based on such direct sequence spread spectrum technology and additionally calls for a time division duplexing (TDD), rather than a frequency division duplexing (FDD) as used in many FDD mode UMTS/W-CDMA systems. TDD uses the same carrier frequency for both the uplink (UL) and downlink (DL) between a Node B 108 and a UE 110, but divides uplink and downlink transmissions into different time slots in the carrier.

[0021] FIG. 2 shows a frame structure 200 for a TD-SCDMA carrier. The TD-SCDMA carrier, as illustrated, has a frame 202 that is 10 ms in length. The frame 202 has two 5 ms subframes 204, and each of the subframes 204 includes seven time slots, TS0 through TS6. The first time slot, TS0, is usually allocated for downlink communication, while the second time slot, TS1, is usually allocated for uplink communication. The remaining time slots, TS2 through TS6, may be used for either uplink or downlink, which allows for greater flexibility during times of higher data transmission times in either the uplink or downlink directions. A downlink pilot time slot (DwPTS) 206, a guard period (GP) 208, and an uplink pilot time slot (UpPTS) 210 (also known as the uplink pilot channel (UpPCH)) are located between TS0 and TS1. Each time slot, TS0-TS6, may allow data transmission multiplexed on a maximum of 16 code channels. Data transmission on a code channel includes two data portions 212 separated by a midamble 214 and followed by a guard period (GP) 216. The midamble 214 may be used for features, such as channel estimation, while the GP 216 may be used to avoid inter-burst interference.

[0022] FIG. 3 is a block diagram of a Node B 310 in communication with a UE 350 in a RAN 300, where the RAN 300 may be the RAN 102 in FIG. 1, the Node B 310 may be the Node B 108 in FIG. 1, and the UE 350 may be the UE 110 in FIG. 1. In the downlink communication, a transmit processor 320 may receive data from a data source 312 and control signals from a controller/processor 340. The transmit processor 320 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 320 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 344 may be used by a controller/processor 340 to determine the coding, modulation, spreading, and/or scrambling schemes for the transmit processor 320. These channel estimates may be derived from a reference signal transmitted by the UE 350 or from feedback contained in the midamble 214 (FIG. 2) from the UE 350. The symbols generated by the transmit processor 320 are provided to a transmit frame processor 330 to create a frame structure. The transmit frame processor 330 creates this frame structure by multiplexing the symbols with a midamble 214 (FIG. 2) from the controller/processor 340, resulting in a series of frames. The frames are then provided to a transmitter 332, which provides various signal conditioning functions including amplifying, filtering, and modulating the frames onto a carrier for downlink transmission over the wireless medium through smart antennas

334. The smart antennas 334 may be implemented with beam steering bidirectional adaptive antenna arrays or other similar beam technologies.

[0023] At the UE 350, a receiver 354 receives the downlink transmission through an antenna 352 and processes the transmission to recover the information modulated onto the carrier. The information recovered by the receiver 354 is provided to a receive frame processor 360, which parses each frame, and provides the midamble 214 (FIG. 2) to a channel processor 394 and the data, control, and reference signals to a receive processor 370. The receive processor 370 then performs the inverse of the processing performed by the transmit processor 320 in the Node B 310. More specifically, the receive processor 370 descrambles and despreads the symbols, and then determines the most likely signal constellation points transmitted by the Node B 310 based on the modulation scheme. These soft decisions may be based on channel estimates computed by the channel processor 394. 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 372, which represents applications running in the UE 350 and/or various user interfaces (e.g., display). Control signals carried by successfully decoded frames will be provided to a controller/processor 390. When frames are unsuccessfully decoded by the receiver processor 370, the controller/processor 390 may also use an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support retransmission requests for those frames.

[0024] In the uplink, data from a data source 378 and control signals from the controller/processor 390 are provided to a transmit processor 380. The data source 378 may represent applications running in the UE 350 and various user interfaces (e.g., keyboard). Similar to the functionality described in connection with the downlink transmission by the Node B 310, the transmit processor 380 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 394 from a reference signal transmitted by the Node B 310 or from feedback contained in the midamble transmitted by the Node B 310, may be used to select the appropriate coding, modulation, spreading, and/or scrambling schemes. The symbols produced by the transmit processor 380 will be provided to a transmit frame processor 382 to create a frame structure. The transmit frame processor 382 creates this frame structure by multiplexing the symbols with a midamble 214 (FIG. 2) from the controller/processor 390, resulting in a series of frames. The frames are then provided to a transmitter 356, 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 352.

[0025] The uplink transmission is processed at the Node B 310 in a manner similar to that described in connection with the receiver function at the UE 350. A receiver 335 receives the uplink transmission through the antenna 334 and processes the transmission to recover the information modulated onto the carrier. The information recovered by the receiver 335 is provided to a receive frame processor 336, which parses each frame, and provides the midamble 214 (FIG. 2) to the channel processor 344 and the data, control, and reference signals to a receive processor 338. The receive processor 338 performs the inverse of the processing performed by the transmit processor 380 in the UE 350. The data and control signals carried by the successfully decoded frames may then be provided to a data sink 339 and the controller/processor, respectively. If some of the frames were unsuccessfully decoded by the receive processor, the controller/processor 340 may also use an acknowledgement (ACK) and/or negative acknowledgement (NACK) protocol to support retransmission requests for those frames.

[0026] The controller/processors 340 and 390 may be used to direct the operation at the Node B 310 and the UE 350, respectively. For example, the controller/processors 340 and 390 may provide various functions including timing, peripheral interfaces, voltage regulation, power management, and other control functions. The computer readable media of memories 342 and 392 may store data and software for the Node B 310 and the UE 350, respectively. A scheduler/processor 346 at the Node B 310 may be used to allocate resources to the UEs and schedule downlink and/or uplink transmissions for the UEs.

[0027] As various UEs move through a particular cell, there will be a point at which the UE will be handed over from the current serving Node B to a neighboring Node B. In TD-SCDMA systems, the handover process starts from measurement of neighboring cells. One of the common measurement metrics for this handover procedure is measurement of the receive signal code power (RSCP) of the primary common control physical channel (P-CCPCH). The common control channels, such as the P-CCPCH, are typically allocated to the time slot TS0. In fact, the P-CCPCH is often assigned to the first two code channels of the 16 possible code channels in the TS0 time slot.

[0028] In preparing for handover or handoff, the serving Node B may send a radio resource control (RRC) message to configure the UE to measure a few specific neighbor cells. For example, the Node B may broadcast a system information message, such as System Information Block Type 11 messages, with "Measurement control system information" to indicate intra-frequency and inter-frequency measurement system information for multi-carrier systems. The Node B may also include information such as the "Cell parameters identifier (ID)" (scrambling code/midamble code index) and "Frequency information" (universal terrestrial radio access (UTRA) absolute radio frequency channel number (together "UARFCN")) of the neighbor cell to be measured.

[0029] In another example, the Node B may also send a point-to-point measurement control message, which commands the UE to perform intra-frequency measurement or inter-frequency measurement, in multi-carrier systems, with "Intra-frequency cell info list" and "Inter-frequency cell info list", respectively. However, with each of these current processes, there is likely several neighboring cells to measured, and, because the UE is directed to measure all of these neighboring cells before reporting results to the serving Node B, the handover process latency can be quite large.

[0030] FIG. 4 is a functional block diagram 40 illustrating example blocks executed in conducting wireless communication according to one aspect of the present disclosure. In block 400, a UE selects a neighboring Node B based on a priority level while communicating with a serving Node B. The UE then measures a signal, in block 401, transmitted by the selected Node B for handover purposes. Therefore, by prioritizing the selection of neighboring Node Bs to measure, the handover latency process is reduced.

[0031] Different criteria may be used for assigning a priority level to the various neighboring Node Bs. FIG. 5 is a block diagram conceptually illustrating a TD-SCDMA wireless communication system 50 configured according to one aspect of the present teachings. A serving Node B 500 provides a cell 502 of coverage within the TD-SCDMA wireless communication system 50. UEs 501 and 508 are located within the cell 502 of the Node B 500 and are currently involved in calls through the Node B 500. FIG. 5

illustrates only six Node Bs, i.e., the serving Node B 500 and the neighboring Node Bs 503-507, and two UEs, i.e., the UEs 501 and 508, of the TD-SCDMA wireless communication system 50. It should be noted that, in fact, the TD-SCDMA wireless communication system 50 may comprise various numbers of additional Node Bs and additional UEs other than the illustrated UEs 501 and 508. These representative elements have been selected solely for the sake of clarity.

[0032] In the handover preparation process, the UE 501 is configured to assign a priority level to each one of the neighboring Node Bs 503-507 based on a position of the neighboring Node B. Higher priority levels are assigned to the ones of the neighboring Node Bs 503-507 that are closer to the UE 501. In order to obtain its own position, the UE 501 uses its internal position location (e.g., global positioning satellite (GPS)) receiver and corresponding positioning functionality. Moreover, in TD-SCDMA systems, such as TD-SCDMA wireless communication system 50, Node Bs, such as the serving Node B 500 and the neighboring Node Bs 503-507, broadcast substantial system information, including the Node B's own position as well as neighboring cell information that includes the position information of the associated Node Bs. The broadcasting Node Bs send this type of information in system information messages, such as system information block type 15 (SIB-15). Therefore, the UE 501 is able to generally obtain its own position (even without a position location receiver) and also know the position of the Node Bs of the neighboring cells.

[0033] Depending on the specific aspect of the wireless system, these system information messages may include information elements, such as observed time difference of arrival (OTDOA) assistance data for UEs, which mainly provide the information of the serving Node B and neighbor Node Bs. This information would allow the UE 501 to determine the position of both the serving Node B 500 and the neighboring Node Bs 503-507, as well as the corresponding cell parameters identifier (ID) and frequency channel information. Additionally, information elements, such as the ellipsoid, the degree of latitude, the degree of longitude, the relative north, and the relative east of the neighboring Node Bs 503-507 may also be included in such system information messages.

[0034] The UE 501 calculates the distances between itself and the neighboring Node Bs 503-507 using various well known distance calculation algorithms. The UE 501 then assigns a priority level to each one of the neighboring Node Bs 503-507. The highest priority is assigned to the neighboring Node B 504, as it is the closest to the UE 501. The UE 501 then begins signal measurement of the Node B 504 receive signal code power of the primary common control physical channel. In order to be available for handover, the value of the receive signal code power for the Node B 504 primary common control physical channel should exceed a certain signal quality threshold. When the UE 501 obtains the measurement of the Node B 504 receive signal code power, and that measurement exceeds the signal quality threshold, the UE 501 transmits the measurement results to the serving Node B 500. Unlike existing systems, in which the UE 501 would have to measure the receive signal code power of each of the neighboring Node Bs 503-507 before transmitting the results to the serving Node B 500, the UE 501, configured according to one aspect of the present teachings, transmits the signal measurement results of the highest priority neighboring cell, of the Node B 504, to the serving Node B 500. The Node B 500 would then be able to facilitate the handover of the UE 501 to the neighboring Node B 504 much more quickly.

[0035] It should be noted that, as the UE 501 continues its call, it will continue to measure the receive signal code power for the primary common control physical channel for the lower priority ones of the neighboring Node Bs 503 and 505-507. If any of these subsequent measurements exceeds the signal quality threshold, the UE 501 will transmit that result to its then current serving Node B.

[0036] It should further be noted that, if the UE 501 did not have position locating capability, the position of the UE 501 may be determined through additional available methods. For example, by knowing the position information for several of either the serving Node B 500 or the neighboring Node Bs 503-507 and knowing the OTDOA of signals between the UE 501 and those other Node Bs, the UE 501 may estimate its relative position with respect to the known positions of the other Node Bs. Additionally, positioning information received from other wireless transmitters may allow the UE 501 to determine an estimate of its position. The various aspects of the present teachings are not limited to any particular ways for the UE 501 to determine its own position.

[0037] The UE 508, which is also maintaining a call within the cell 502, does not have position locating capability. However, instead of using additional means to determines its position, the UE 508 selects to use the position of the serving Node B 500 as its approximate location. Thus, the UE 508 knows the position information of the serving Node B 500 as well as the position information for the neighboring Node Bs 503-507 through the system information messages broadcast by the Node B 500, as referred to above. Using the well-known algorithms for calculating distances between two known locations, the UE 508 calculates the relative distances between itself and each of the neighboring Node Bs 503-507.

[0038] In using the location of the serving Node B 500 as the approximate location of the UE 508, the prioritization may sometimes be less accurate than when a UE, such as the UE 501, is able to obtain its own position information accurately. After calculating the relative distances, the UE 508 assigns the highest priority level to the neighboring Node B 507. The UE 508 then measures the receive signal code power of the primary common control physical channel of the neighboring Node B 507 and transmits those results to the serving Node B 500. With the value of the receive signal code power of the neighboring Node B 507 exceeding the signal quality threshold, the serving Node B 500 may trigger the handover process for the UE 508. However, the actual distance between the UE 508 and the neighboring Node B 507 is greater than the actual distance between the UE 508 and the neighboring Node B 506. As the UE 508 continues to measure the receive signal code power of the primary common control physical channel for the lower priority neighboring Node Bs 503-506, it next measures the receive signal code power for the neighboring Node B 506. Because this measurement also exceeds the signal quality threshold, the UE 508 transmits this measurement result to the serving Node B 500. For purposes of this example, the UE 508 measures and transmits the measurement of the neighboring Node B 506 prior to handover or handoff taking place from the serving Node B 500 to the neighboring Node B 507. Therefore, on receipt of the new receive signal code power measurement, the serving Node B 500 determines that the higher quality signal is available from the neighboring Node B 506 and issues the command to the UE 508 to instead begin handover procedures with the neighboring Node B 506.

[0039] FIG. 6 is a block diagram conceptually illustrating a multi-carrier TD-SCDMA wireless system 60 configured according to one aspect of the present teachings. The multi-carrier TD-SCDMA wireless system 60 includes a serving Node B 600 that provides a cell 601 of wireless communication coverage. As illustrated for the sake of clarity, the multi-carrier TD-SCDMA wireless system 60 is also shown having neighboring Node Bs 603-605. A UE 602 is located within the cell 601 and is maintaining a call through the serving Node B 600. As a multi-carrier system, the TD-SCDMA wireless system 60 includes Node Bs that transmit over different carrier signals than other of the Node Bs in the system. For example, the serving Node B 600 and the neighboring Node Bs 603 and 605 each transmit over a first carrier frequency. The neighboring Node B 604, however, transmits over a second carrier frequency.

[0040] When preparing for a handover, the UE 602 is configured to assign a priority level to each of the neighboring Node Bs 603-605 based on carrier frequency. In order to measure the signal of a neighboring Node B transmitting at a different carrier frequency, the UE would tune its radio receiver away from the current carrier frequency in order to receive and measure the new signal. This tuning process adds to the latency of the handover procedure. In the aspect depicted in FIG. 6, however, the UE 602 is configured to assign higher priority levels to the neighboring Node Bs 603 and 605 that transmit in the same carrier frequency as the serving Node B 600. Therefore, the UE 602 measures the signal quality being transmitted from the neighboring Node Bs 603 and 605.

[0041] The neighboring Node B 603 is much further away from the UE 602 than the neighboring Node B 605. In analyzing the measurement results, the UE 602 determines that, while the signal quality from the neighboring Node B 605 meets or exceeds the signal quality threshold, the signal quality from the neighboring Node B 603 does not. As a result, the UE 602 only transmits the measurement results for the neighboring Node B 605 to the serving Node B 600 for handover processing.

[0042] Compared to systems that do not practice such prioritization, the UE 602, configured according to one aspect of the present disclosure, reduces the latency period for handover processing by (1) reducing the total number of signal measurements of neighboring Node Bs and (2) reducing the potential tuning time by providing for initial measurements of signals within the carrier frequency that the UE 602 is already tuned.

[0043] After transmitting the priority measurements to the serving Node B 600, the UE 602 continues to measure the signal quality transmitted by the lower priority Node Bs, such as the neighboring Node B 604. The resulting signal measurement for signals transmitted by the neighboring Node B 604 meets or exceeds the signal quality threshold. Therefore, the UE 602 transmits the signal measurement to the serving Node B 600, if the UE 602 is still conducting its call through the serving Node B 600, or to the neighboring Node B 605, if handover from the serving Node B 600 to the neighboring Node B 605 has already taken place.

[0044] It should be noted that in alternative aspects of the present teachings, the UE 602 may be configured to assign priority levels based on both carrier frequency and position of the neighboring Node Bs 603-605. In such an alternative aspect, the UE 602 first prioritizes to measure from the Node Bs transmitting on the same carrier frequency, i.e., the neighboring Node Bs 603 and 605. The UE 602 then prioritizes the frequency group by the position of the Node B. Therefore, the UE 602 would have assigned the highest priority level to the neighboring Node B 605, and, as soon as it measured the signal quality of the neighboring Node B 605, the UE 602 would have transmitted the signal measurement to the serving Node B 600 for handover processing.

[0045] It should further be noted that, in further alternative aspects of the present teachings, the UE 602 may be configured to assign priority levels based on position first and then frequency. In such aspects, the UE 602 would first prioritize the neighboring Node Bs 604 and 603 as the closest Node Bs to the UE 602, and then assign the second priority level to the neighboring Node B 605 as the one of the location priority Node Bs having the same transmitting carrier frequency as the serving Node B 600.

[0046] Turning now to FIG. 7, a block diagram 70 is shown conceptually illustrating example blocks executed to implement one aspect of the present teachings. In block 700, system information regarding a serving Node B and at least one neighboring Node B is received by a UE. Based on the system information, the UE assigns a priority level, in block 701, to each of the neighboring Node Bs. The UE measures a signal quality, in block 702, of a signal transmitted by the selected neighboring Node B. In response to the measured signal quality meeting a signal quality threshold, in block 703, the UE transmits the measured signal quality report to the serving Node B for handover processing.

[0047] Turning back to FIG. 3, in order to implement aspects of the present disclosure, the UE 350 includes software modules stored in the memory 392, including a prioritization module 393. When executed by the controller/processor 390, the executing prioritization module 393 configures the UE 350 to select a neighboring Node B based on a priority level while communicating with a serving Node B, such as Node B 310. The executing prioritization module 393 further configures the UE 350 to measure the signal transmitted by the selected neighboring Node B. The executing prioritization module 393 may perform prioritization based on various criteria, such as distance, frequency, or both, as described with respect to FIGS. 5 and 6.

[0048] In one configuration, the UE 350 includes means for selecting a neighboring Node B based on a priority level, while communicating with a serving Node B, means for measuring a signal transmitted by the selected Node B. In one aspect, the aforementioned means may be the controller/processor 390, the memory 392 with the prioritization module 393 stored thereon, the smart antennas 352, the receiver 354 and the transmitter 356, the receive frame processor 360 and the transmit frame processor 382, the receive processor 370 and the transmit processor 380, and the channel processor 394 for measuring signal quality, such elements together configured to perform the functions recited by the aforementioned means. In another aspect, the aforementioned means may be a module or any apparatus configured to perform the functions recited by the aforementioned means.

[0049] Several aspects of a telecommunications system has been presented with reference to a TD-SCDMA 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. By way of example, various aspects may be extended to other UMTS systems such as W-CDMA, 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.

[0050] Several processors have been described in connection with various apparatuses and methods. These processors may be implemented using electronic hardware, computer software, or any combination thereof. Whether such processors are implemented as hardware or software will depend upon the particular application and overall design constraints imposed on the system. By way of example, a processor, any portion of a processor, or any combination of processors presented in this disclosure may be implemented with a microprocessor, microcontroller, digital signal processor (DSP), a field-programmable gate array (FPGA), a programmable logic device (PLD), a state machine, gated logic, discrete hardware circuits, and other suitable processing components configured to perform the various functions described throughout this disclosure. The functionality of a processor, any portion of a processor, or any combination of processors presented in this disclosure may be implemented with software being executed by a microprocessor, microcontroller, DSP, or other suitable platform.

[0051] 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. A computer-readable medium may include, by way of example, memory such as a magnetic storage device (e.g., hard disk, floppy disk, magnetic strip), an optical disk (e.g., compact disc (CD), digital versatile disc (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, or a removable disk. Although memory is shown separate from the processors in the various aspects presented throughout this disclosure, the memory may be internal to the processors (e.g., cache or register).

[0052] Computer-readable media 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.

[0053] 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.

[0054] 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."

[0055] WHAT IS CLAIMED IS:

CLAIMS

1. A method of wireless communication in a TD-SCDMA system, comprising:

selecting a neighboring Node B based on a priority level, while communicating with a serving Node B; and

measuring a signal transmitted by the selected neighboring Node B.

2. The method of claim 1 further comprising:

transmitting results of the measuring to the serving Node B.

3. The method of claim 1 further comprising:

transmitting a result of the measuring to the serving Node B without first measuring any additional neighboring Node Bs.

4. The method of claim 1 further comprising:

in response to a result of the measuring meeting a signal quality threshold, transmitting the result to the serving Node B.

5. The method of claim 1 further comprising:

transmitting results of the measuring to the serving Node B; and

after the transmitting, measuring another signal transmitted by at least one additional neighboring Node B based on a priority level of the at least one additional neighboring Node B being lower than the priority level of the selected Node B.

6. The method of claim 1 wherein the priority level is assigned based on one of:

a carrier frequency; and

a distance between a position of a UE and the neighboring Node B.

7. The method of claim 6 wherein the position of the UE is determined by one of:

a current position of the UE; and

a location of the serving Node B.

8. The method of claim 1 wherein the priority level is assigned based on a carrier frequency and a distance between a position of a UE and the neighboring Node B.

9. A user equipment (UE) in a time division-synchronous code division multiple access (TD-SCDMA) system, said UE comprising:

at least one processor configured to:

select a neighboring Node B based on a priority level, while communicating with a serving Node B; and

measure a signal transmitted by said selected neighboring Node B.

10. The UE of claim 9 wherein said at least one processor is further configured to:

transmit a result of said measurement to said serving Node B in response to said result meeting a signal quality threshold.

11. The UE of claim 9 wherein said priority level is assigned based on one of:

a carrier frequency; and

a distance between a position of a UE and said neighboring Node B.

12. The UE of claim 11 wherein said position is determined by one of:

a current position of said UE; and

a location of said serving Node B.

13. A computer readable medium having program code recorded thereon, said program code comprising:

program code to select a neighboring Node B in a time division-synchronous code division multiple access (TD-SCDMA) system based on a priority level, while communicating with a serving Node B; and

program code to measure a signal transmitted by said selected neighboring Node B.

14. The computer readable medium of claim 13 further comprising:

program code, executable in response to a result of said measuring meeting a signal quality threshold, to transmit said result to said serving Node B.

15. The computer readable medium of claim 13 wherein said priority level is assigned based on one of:

a carrier frequency; and

a distance between a position of a UE and said neighboring Node B.

16. The computer readable medium of claim 15 wherein said position is determined by one of:

a current position of said UE; and

a location of said serving Node B.

17. An apparatus for wireless communication in a TD-SCDMA system, said apparatus comprising:

means for selecting a neighboring Node B based on a priority level, while communicating with a serving Node B; and

means for measuring a signal transmitted by said selected neighboring Node B.

18. The apparatus of claim 17 further comprising:

means, executable in response to a result of said measuring meeting a signal quality threshold, for transmitting said result to said serving Node B.

19. The apparatus of claim 17 wherein said priority level is assigned based on one of:

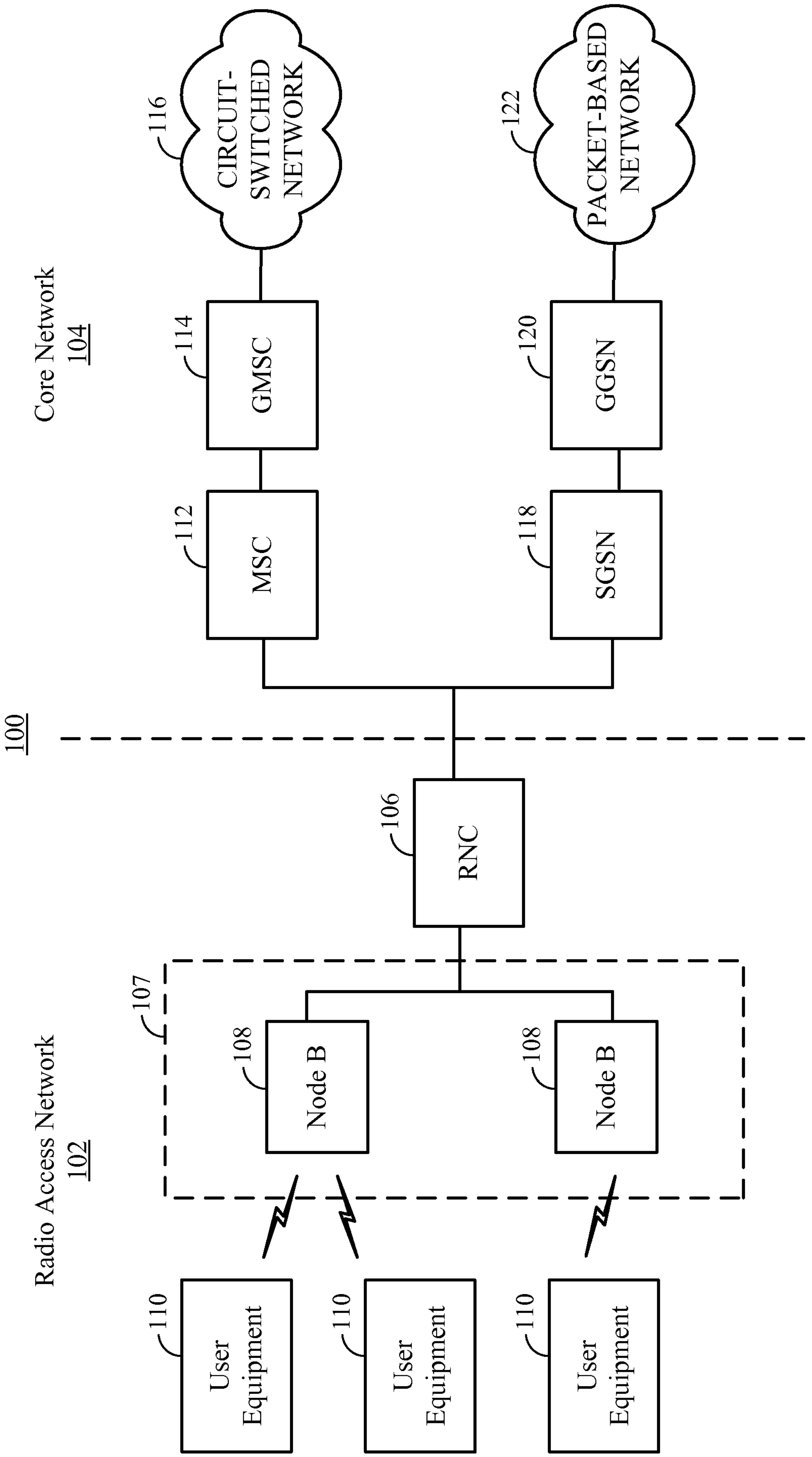
a carrier frequency; and

a distance between a position of a UE and said neighboring Node B.

20. The apparatus of claim 19 wherein said position is determined by one of:

a current position of said UE; and

a location of said serving Node B.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Core Network
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Radio Access Network
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CIRCUIT-SWITCHED NETWORK
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PACKET-BASED NETWORK
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GMSC
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GGSN
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MSC
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SGSN
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RNC
106
107
Node B
108
Node B
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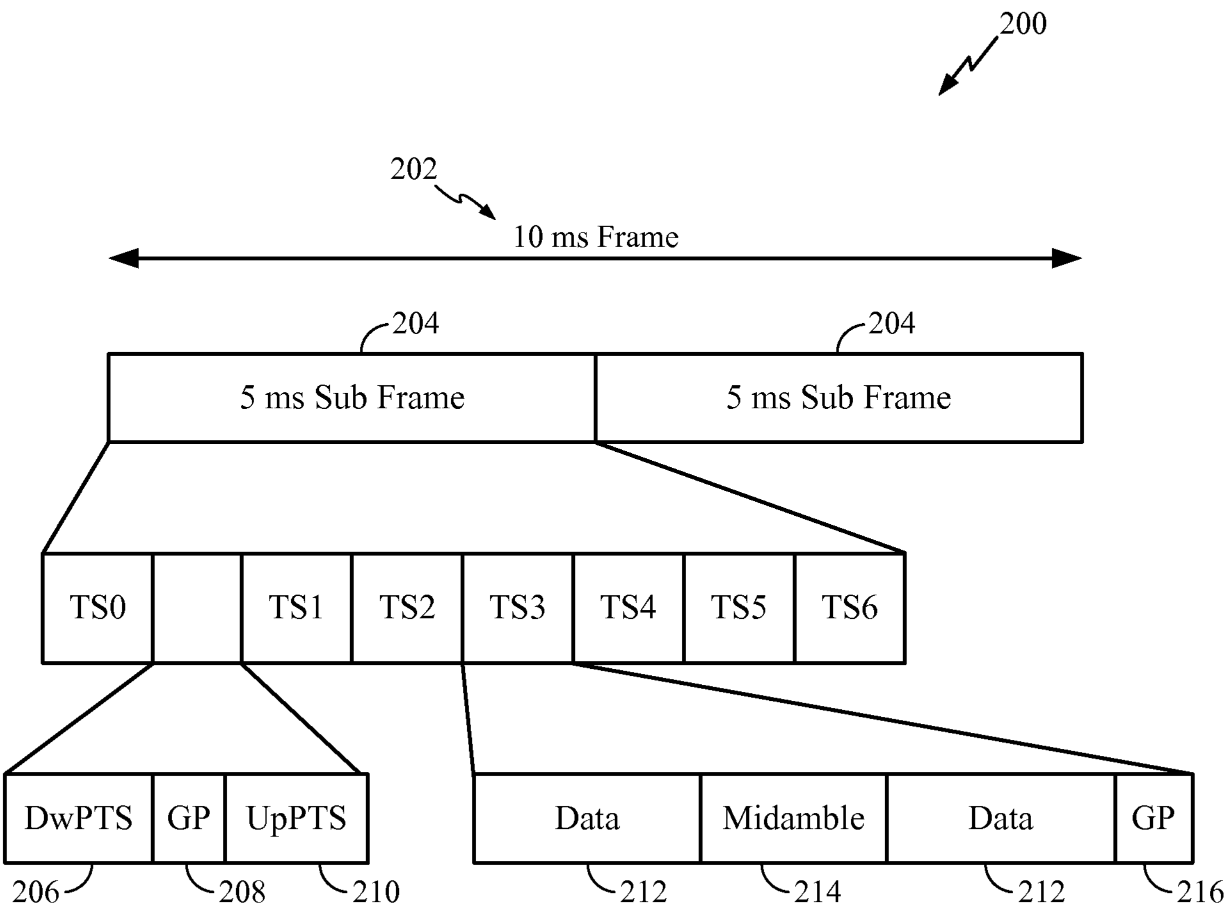
User Equipment
110
User Equipment
110
User Equipment
110

FIG. 1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202
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204
204
5 ms Sub Frame
5 ms Sub Frame
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TS1
TS2
TS3
TS4
TS5
TS6
DwPTS
GP
UpPTS
Data
Midamble
Data
GP
206
208
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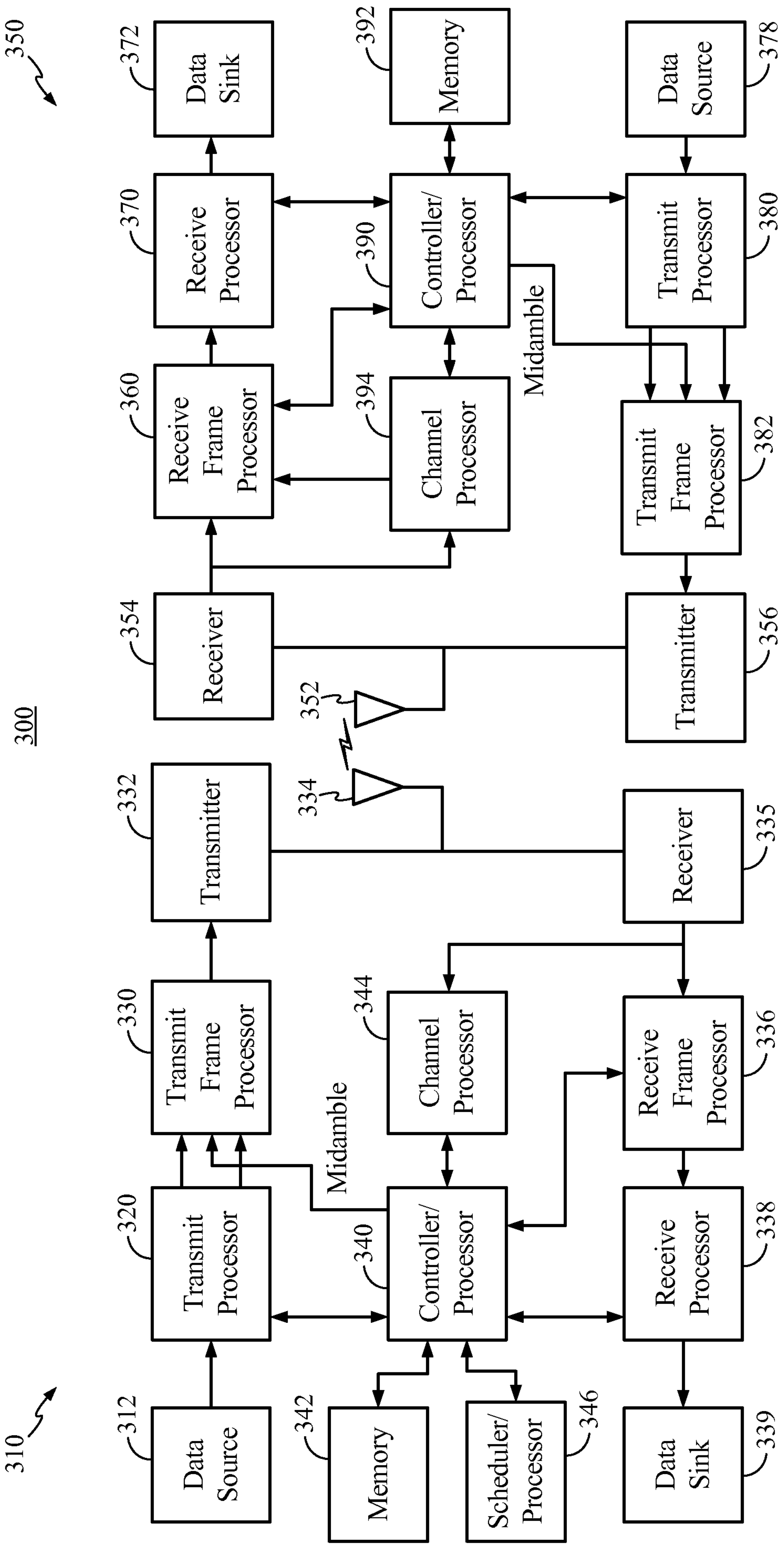
216

FIG. 2

3/5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310
350
Data Source
312
Transmit Processor
320
Transmit Frame Processor
330
Transmitter
332
334
Memory
342
Scheduler/ Processor
346
Controller/ Processor
340
Midamble
Channel Processor
344
Receive Frame Processor
336
Receive Processor
338
Data Sink
339
Receiver
335
352
Receiver
354
Transmitter
356
Receive Frame Processor
360
Channel Processor
394
Receive Processor
370
Data Sink
372
Controller/ Processor
390
Memory
392
Midamble
Transmit Frame Processor
382
Transmit Processor
380
Data Source
378

FIG. 3

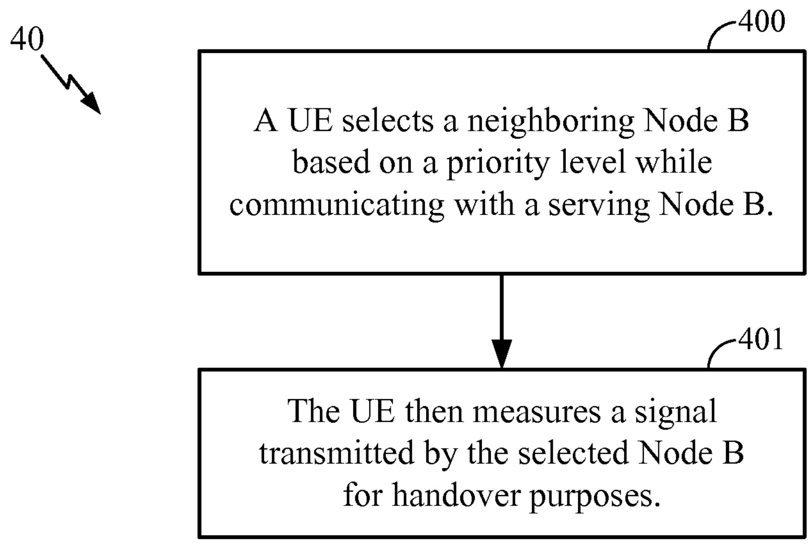
40
400
A UE selects a neighboring Node B based on a priority level while communicating with a serving Node B.
401
The UE then measures a signal transmitted by the selected Node B for handover purposes.

FIG. 4

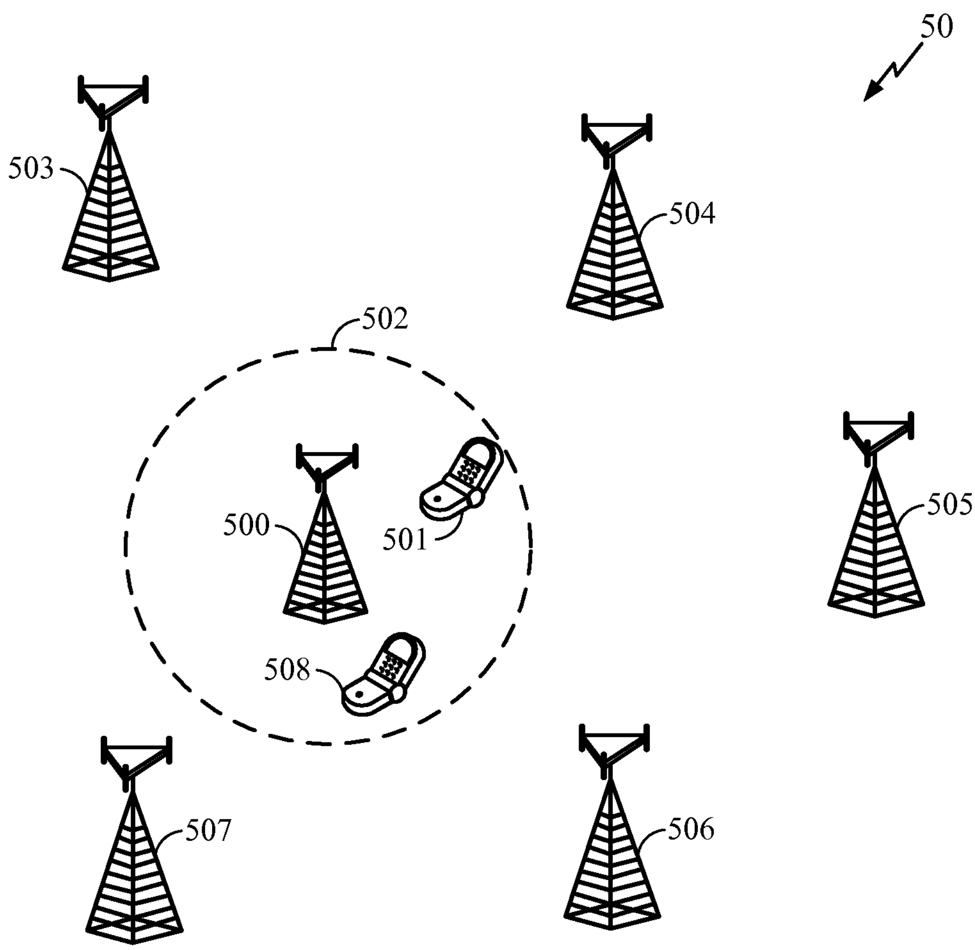
50
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FIG. 5

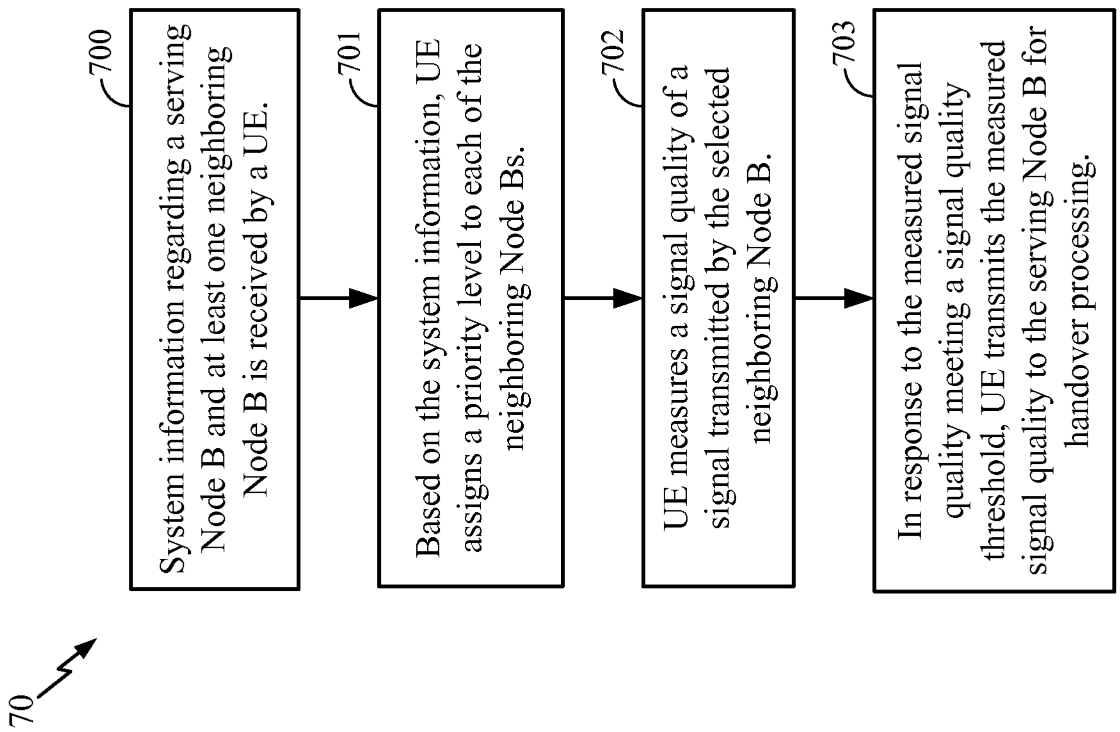
70
700
System information regarding a serving Node B and at least one neighboring Node B is received by a UE.
701
Based on the system information, UE assigns a priority level to each of the neighboring Node Bs.
702
UE measures a signal quality of a signal transmitted by the selected neighboring Node B.
703
In response to the measured signal quality meeting a signal quality threshold, UE transmits the measured signal quality to the serving Node B for handover processing.

FIG. 7

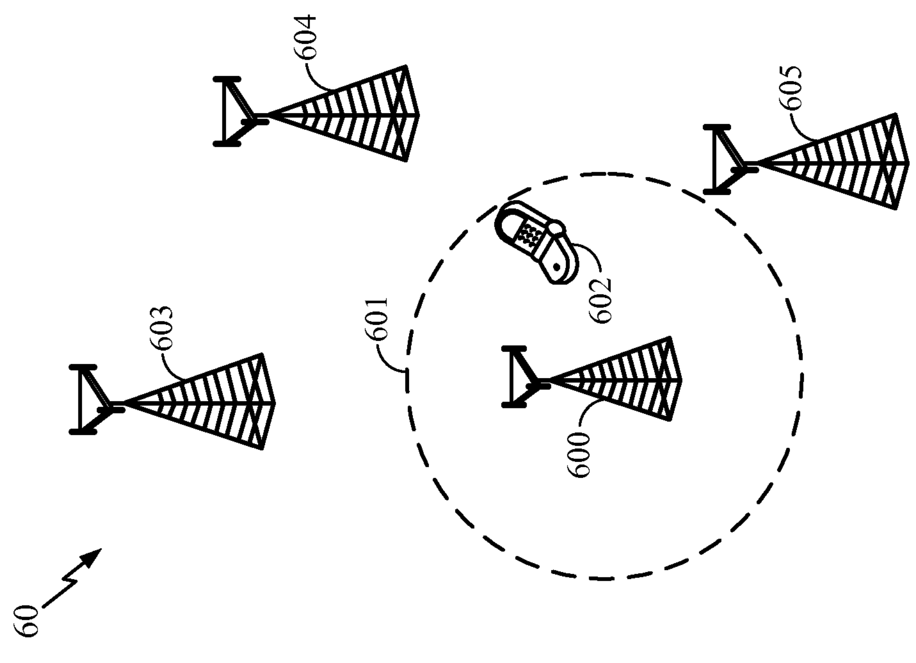
60
603
604
601
602
600
605

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/028619

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

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

B. FIELDS SEARCHED

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

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/124258 A1 (JEON PAUL BAROM [KR]) 14 May 2009 (2009-05-14)	1-5,7,9, 10, 12-14, 16-18,20
Y	* abstract paragraphs [23;32] - [63;78]; figure 4	6,8,11, 15,19
X	US 2008/146233 A1 (TSAI KUN-CHAN [TW] ET AL) 19 June 2008 (2008-06-19) * abstract paragraphs [0022] - [0036]; figure 2;4	1-5,7,9, 10, 12-14, 16-18,20
A	US 2004/152480 A1 (WILLARS PER HANS AKE [SE] ET AL WILLARS PER HANS DOT OVER AKE [SE] ET) 5 August 2004 (2004-08-05) paragraphs [0029] - [0038]	1-20
	-/--	

[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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September 2010	04/10/2010

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	Wolf, William

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2010/028619

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/232098 A1 (MAKABE TAKESHI [JP]) 17 September 2009 (2009-09-17) paragraph [16;20]	6,8,11, 15,19
E	WO 2010/056958 A1 (QUALCOMM INC [US]; CHENG STEVEN D [US]; LEE KUO-CHUN [US]; CHIN TOM [U) 20 May 2010 (2010-05-20) * abstract paragraphs [0047] - [0060]; claims 1-22	1-20

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2010/028619

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US 2009232098 A1	17-09-2009	CN 101518130 A	26-08-2009
		WO 2008013026 A1	31-01-2008
WO 2010056958 A1	20-05-2010	US 2010124924 A1	20-05-2010