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(71) Applicant: **QUALCOMM INCORPORATED** [US/US]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(72) Inventor; and
(71) Applicant *(for US only)*: **ZHANG, Nan** [CN/CN]; 5775 Morehouse Drive, San Diego, California 92121-1714 (US).

(74) Agent: **SHANGHAI PATENT & TRADEMARK LAW OFFICE, LLC**; 435 Guiping Road, Shanghai 200233 (CN).

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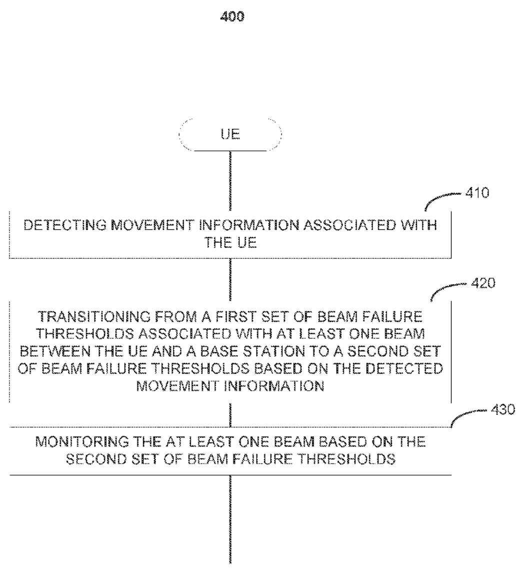

FIG. 4

(57) Abstract: In an embodiment, a UE may detect movement information associated with the UE.The UE may transition from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information. The UE may monitor the at least one beam based on the second set of beam failure thresholds.

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MODIFYING A BEAM FAILURE THRESHOLD BASED UPON USER EQUIPMENT MOVEMENT INFORMATION

BACKGROUND OF THE DISCLOSURE

1. Field of the Disclosure

[0001] Aspects of the disclosure relate generally to wireless communications, and more particularly to modifying a beam failure threshold based upon user equipment (UE) movement information.

2. Description of the Related Art

[0002] Wireless communication systems have developed through various generations, including a first-generation analog wireless phone service (1G), a second-generation (2G) digital wireless phone service (including interim 2.5G networks), a third-generation (3G) high speed data, Internet-capable wireless service and a fourth-generation (4G) service (e.g., LTE or WiMax). There are presently many different types of wireless communication systems in use, including cellular and personal communications service (PCS) systems. Examples of known cellular systems include the cellular analog advanced mobile phone system (AMPS), and digital cellular systems based on code division multiple access (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA), the Global System for Mobile access (GSM) variation of TDMA, etc.

[0003] A fifth generation (5G) wireless standard, referred to as New Radio (NR), enables higher data transfer speeds, greater numbers of connections, and better coverage, among other improvements. The 5G standard, according to the Next Generation Mobile Networks Alliance, is designed to provide data rates of several tens of megabits per second to each of tens of thousands of users, with 1 gigabit per second to tens of workers on an office floor. Several hundreds of thousands of simultaneous connections should be supported in order to support large wireless sensor deployments. Consequently, the spectral efficiency of 5G mobile communications should be significantly enhanced compared to the current 4G standard. Furthermore, signaling efficiencies should be enhanced and latency should be substantially reduced compared to current standards.

SUMMARY

[0004] The following presents a simplified summary relating to one or more aspects disclosed herein. Thus, the following summary should not be considered an extensive overview relating to all contemplated aspects, nor should the following summary be considered to identify key or critical elements relating to all contemplated aspects or to delineate the scope associated with any particular aspect. Accordingly, the following summary has the sole purpose to present certain concepts relating to one or more aspects relating to the mechanisms disclosed herein in a simplified form to precede the detailed description presented below.

[0005] An aspect is directed to a method of operating a user equipment (UE), comprising detecting movement information associated with the UE, transitioning from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information, and monitoring the at least one beam based on the second set of beam failure thresholds.

[0006] Another aspect is directed to a user equipment (UE), comprising means for detecting movement information associated with the UE, means for transitioning from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information, and means for monitoring the at least one beam based on the second set of beam failure thresholds.

[0007] Another aspect is directed to a user equipment (UE), comprising a memory, at least one transceiver, and at least one processor communicatively coupled to the memory and the at least one transceiver, the at least one processor configured to detect movement information associated with the UE, transition from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information, and monitor the at least one beam based on the second set of beam failure thresholds.

[0008] Other objects and advantages associated with the aspects disclosed herein will be apparent to those skilled in the art based on the accompanying drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying drawings are presented to aid in the description of various aspects of the disclosure and are provided solely for illustration of the aspects and not limitation thereof.

[0010] FIG. 1 illustrates an exemplary wireless communications system, according to various aspects.

[0011] FIGS. 2A and 2B illustrate example wireless network structures, according to various aspects.

[0012] FIGS. 3A to 3C are simplified block diagrams of several sample aspects of components that may be employed in wireless communication nodes and configured to support communication as taught herein.

[0013] FIG. 4 illustrates an exemplary process of wireless communications according to an aspect of the disclosure.

[0014] FIG. 5 illustrates an example implementation of the process of FIG. 4 in accordance with an embodiment of the disclosure.

DETAILED DESCRIPTION

[0015] Aspects of the disclosure are provided in the following description and related drawings directed to various examples provided for illustration purposes. Alternate aspects may be devised without departing from the scope of the disclosure. Additionally, well-known elements of the disclosure will not be described in detail or will be omitted so as not to obscure the relevant details of the disclosure.

[0016] The words “exemplary” and/or “example” are used herein to mean “serving as an example, instance, or illustration.” Any aspect described herein as “exemplary” and/or “example” is not necessarily to be construed as preferred or advantageous over other aspects. Likewise, the term “aspects of the disclosure” does not require that all aspects of the disclosure include the discussed feature, advantage or mode of operation.

[0017] Those of skill in the art will appreciate that the information and signals described below may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description below may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof, depending in part on the particular application, in part on the desired design, in part on the corresponding technology, etc.

[0018] Further, many aspects are described in terms of sequences of actions to be performed by, for example, elements of a computing device. It will be recognized that various actions described herein can be performed by specific circuits (e.g., application specific integrated circuits (ASICs)), by program instructions being executed by one or more processors, or by a combination of both. Additionally, the sequence(s) of actions described herein can be considered to be embodied entirely within any form of non-transitory computer-readable storage medium having stored therein a corresponding set of computer instructions that, upon execution, would cause or instruct an associated processor of a device to perform the functionality described herein. Thus, the various aspects of the disclosure may be embodied in a number of different forms, all of which have been contemplated to be within the scope of the claimed subject matter. In addition, for each of the aspects described herein, the corresponding form of any such aspects may be described herein as, for example, "logic configured to" perform the described action.

[0019] As used herein, the terms "user equipment" (UE) and "base station" are not intended to be specific or otherwise limited to any particular radio access technology (RAT), unless otherwise noted. In general, a UE may be any wireless communication device (e.g., a mobile phone, router, tablet computer, laptop computer, tracking device, wearable (e.g., smartwatch, glasses, augmented reality (AR) / virtual reality (VR) headset, etc.), vehicle (e.g., automobile, motorcycle, bicycle, etc.), Internet of Things (IoT) device, etc.) used by a user to communicate over a wireless communications network. A UE may be mobile or may (e.g., at certain times) be stationary, and may communicate with a radio access network (RAN). As used herein, the term "UE" may be referred to interchangeably as an "access terminal" or "AT," a "client device," a "wireless device," a "subscriber device," a "subscriber terminal," a "subscriber station," a "user terminal" or UT, a "mobile terminal," a "mobile station," or variations thereof. Generally, UEs can communicate with a core network via a RAN, and through the core network the UEs can be connected with external networks such as the Internet and with other UEs. Of course, other mechanisms of connecting to the core network and/or the Internet are also possible for the UEs, such as over wired access networks, wireless local area network (WLAN) networks (e.g., based on IEEE 802.11, etc.) and so on.

[0020] A base station may operate according to one of several RATs in communication with UEs depending on the network in which it is deployed, and may be alternatively referred to as an access point (AP), a network node, a NodeB, an evolved NodeB (eNB), a New Radio (NR) Node B (also referred to as a gNB or gNodeB), etc. In addition, in some systems a base station may provide purely edge node signaling functions while in other systems it may provide additional control and/or network management functions. A communication link through which UEs can send signals to a base station is called an uplink (UL) channel (e.g., a reverse traffic channel, a reverse control channel, an access channel, etc.). A communication link through which the base station can send signals to UEs is called a downlink (DL) or forward link channel (e.g., a paging channel, a control channel, a broadcast channel, a forward traffic channel, etc.). As used herein the term traffic channel (TCH) can refer to either an UL / reverse or DL / forward traffic channel.

[0021] The term "base station" may refer to a single physical transmission-reception point (TRP) or to multiple physical TRPs that may or may not be co-located. For example, where the term "base station" refers to a single physical TRP, the physical TRP may be an antenna of the base station corresponding to a cell of the base station. Where the term "base station" refers to multiple co-located physical TRPs, the physical TRPs may be an array of antennas (e.g., as in a multiple-input multiple-output (MIMO) system or where the base station employs beamforming) of the base station. Where the term "base station" refers to multiple non-co-located physical TRPs, the physical TRPs may be a distributed antenna system (DAS) (a network of spatially separated antennas connected to a common source via a transport medium) or a remote radio head (RRH) (a remote base station connected to a serving base station). Alternatively, the non-co-located physical TRPs may be the serving base station receiving the measurement report from the UE and a neighbor base station whose reference RF signals the UE is measuring. Because a TRP is the point from which a base station transmits and receives wireless signals, as used herein, references to transmission from or reception at a base station are to be understood as referring to a particular TRP of the base station.

[0022] An "RF signal" comprises an electromagnetic wave of a given frequency that transports information through the space between a transmitter and a receiver. As used herein, a transmitter may transmit a single "RF signal" or multiple "RF signals" to a receiver. However, the receiver may receive multiple "RF signals" corresponding to each transmitted RF signal due to the propagation characteristics of RF signals through multipath channels. The same transmitted RF signal on different paths between the transmitter and receiver may be referred to as a "multipath" RF signal.

[0023] According to various aspects, **FIG. 1** illustrates an exemplary wireless communications system 100. The wireless communications system 100 (which may also be referred to as a wireless wide area network (WWAN)) may include various base stations 102 and various UEs 104. The base stations 102 may include macro cell base stations (high power cellular base stations) and/or small cell base stations (low power cellular base stations). In an aspect, the macro cell base station may include eNBs where the wireless communications system 100 corresponds to an LTE network, or gNBs where the wireless communications system 100 corresponds to a NR network, or a combination of both, and the small cell base stations may include femtocells, picocells, microcells, etc.

[0024] The base stations 102 may collectively form a RAN and interface with a core network 170 (e.g., an evolved packet core (EPC) or next generation core (NGC)) through backhaul links 122, and through the core network 170 to one or more location servers 172. In addition to other functions, the base stations 102 may perform functions that relate to one or more of transferring user data, radio channel ciphering and deciphering, integrity protection, header compression, mobility control functions (e.g., handover, dual connectivity), inter-cell interference coordination, connection setup and release, load balancing, distribution for non-access stratum (NAS) messages, NAS node selection, synchronization, RAN sharing, multimedia broadcast multicast service (MBMS), subscriber and equipment trace, RAN information management (RIM), paging, positioning, and delivery of warning messages. The base stations 102 may communicate with each other directly or indirectly (e.g., through the EPC / NGC) over backhaul links 134, which may be wired or wireless.

[0025] The base stations 102 may wirelessly communicate with the UEs 104. Each of the base stations 102 may provide communication coverage for a respective geographic coverage area 110. In an aspect, one or more cells may be supported by a base station 102 in each coverage area 110. A "cell" is a logical communication entity used for communication with a base station (e.g., over some frequency resource, referred to as a carrier frequency, component carrier, carrier, band, or the like), and may be associated with an identifier (e.g., a physical cell identifier (PCI), a virtual cell identifier (VCI)) for distinguishing cells operating via the same or a different carrier frequency. In some cases, different cells may be configured according to different protocol types (e.g., machine-type communication (MTC), narrowband IoT (NB-IoT), enhanced mobile broadband (eMBB), or others) that may provide access for different types of UEs. Because a cell is supported by a specific base station, the term "cell" may refer to either or both the logical communication entity and the base station that supports it, depending on the context. In some cases, the term "cell" may also refer to a geographic coverage area of a base station (e.g., a sector), insofar as a carrier frequency can be detected and used for communication within some portion of geographic coverage areas 110.

[0026] While neighboring macro cell base station 102 geographic coverage areas 110 may partially overlap (e.g., in a handover region), some of the geographic coverage areas 110 may be substantially overlapped by a larger geographic coverage area 110. For example, a small cell base station 102' may have a coverage area 110' that substantially overlaps with the coverage area 110 of one or more macro cell base stations 102. A network that includes both small cell and macro cell base stations may be known as a heterogeneous network. A heterogeneous network may also include home eNBs (HeNBs), which may provide service to a restricted group known as a closed subscriber group (CSG).

[0027] The communication links 120 between the base stations 102 and the UEs 104 may include UL (also referred to as reverse link) transmissions from a UE 104 to a base station 102 and/or downlink (DL) (also referred to as forward link) transmissions from a base station 102 to a UE 104. The communication links 120 may use MIMO antenna technology, including spatial multiplexing, beamforming, and/or transmit diversity. The communication links 120 may be through one or more carrier frequencies. Allocation of carriers may be asymmetric with respect to DL and UL (e.g., more or less carriers may be allocated for DL than for UL).

[0028] The wireless communications system 100 may further include a wireless local area network (WLAN) access point (AP) 150 in communication with WLAN stations (STAs) 152 via communication links 154 in an unlicensed frequency spectrum (e.g., 5 GHz). When communicating in an unlicensed frequency spectrum, the WLAN STAs 152 and/or the WLAN AP 150 may perform a clear channel assessment (CCA) or listen before talk (LBT) procedure prior to communicating in order to determine whether the channel is available.

[0029] The small cell base station 102' may operate in a licensed and/or an unlicensed frequency spectrum. When operating in an unlicensed frequency spectrum, the small cell base station 102' may employ LTE or NR technology and use the same 5 GHz unlicensed frequency spectrum as used by the WLAN AP 150. The small cell base station 102', employing LTE / 5G in an unlicensed frequency spectrum, may boost coverage to and/or increase capacity of the access network. NR in unlicensed spectrum may be referred to as NR-U. LTE in an unlicensed spectrum may be referred to as LTE-U, licensed assisted access (LAA), or MulteFire.

[0030] The wireless communications system 100 may further include a millimeter wave (mmW) base station 180 that may operate in mmW frequencies and/or near mmW frequencies in communication with a UE 182. Extremely high frequency (EHF) is part of the RF in the electromagnetic spectrum. EHF has a range of 30 GHz to 300 GHz and a wavelength between 1 millimeter and 10 millimeters. Radio waves in this band may be referred to as a millimeter wave. Near mmW may extend down to a frequency of 3 GHz with a wavelength of 100 millimeters. The super high frequency (SHF) band extends between 3 GHz and 30 GHz, also referred to as centimeter wave. Communications using the mmW/near mmW radio frequency band have high path loss and a relatively short range. The mmW base station 180 and the UE 182 may utilize beamforming (transmit and/or receive) over a mmW communication link 184 to compensate for the extremely high path loss and short range. Further, it will be appreciated that in alternative configurations, one or more base stations 102 may also transmit using mmW or near mmW and beamforming. Accordingly, it will be appreciated that the foregoing illustrations are merely examples and should not be construed to limit the various aspects disclosed herein.

[0031] Transmit beamforming is a technique for focusing an RF signal in a specific direction. Traditionally, when a network node (e.g., a base station) broadcasts an RF signal, it broadcasts the signal in all directions (omni-directionally). With transmit beamforming, the network node determines where a given target device (e.g., a UE) is located (relative to the transmitting network node) and projects a stronger downlink RF signal in that specific direction, thereby providing a faster (in terms of data rate) and stronger RF signal for the receiving device(s). To change the directionality of the RF signal when transmitting, a network node can control the phase and relative amplitude of the RF signal at each of the one or more transmitters that are broadcasting the RF signal. For example, a network node may use an array of antennas (referred to as a "phased array" or an "antenna array") that creates a beam of RF waves that can be "steered" to point in different directions, without actually moving the antennas. Specifically, the RF current from the transmitter is fed to the individual antennas with the correct phase relationship so that the radio waves from the separate antennas add together to increase the radiation in a desired direction, while cancelling to suppress radiation in undesired directions.

[0032] Transmit beams may be quasi-collocated, meaning that they appear to the receiver (e.g., a UE) as having the same parameters, regardless of whether or not the transmitting antennas of the network node themselves are physically collocated. In NR, there are four types of quasi-collocation (QCL) relations. Specifically, a QCL relation of a given type means that certain parameters about a second reference RF signal on a second beam can be derived from information about a source reference RF signal on a source beam. Thus, if the source reference RF signal is QCL Type A, the receiver can use the source reference RF signal to estimate the Doppler shift, Doppler spread, average delay, and delay spread of a second reference RF signal transmitted on the same channel. If the source reference RF signal is QCL Type B, the receiver can use the source reference RF signal to estimate the Doppler shift and Doppler spread of a second reference RF signal transmitted on the same channel. If the source reference RF signal is QCL Type C, the receiver can use the source reference RF signal to estimate the Doppler shift and average delay of a second reference RF signal transmitted on the same channel. If the source reference RF signal is QCL Type D, the receiver can use the source reference RF signal to estimate the spatial receive parameter of a second reference RF signal transmitted on the same channel.

[0033] In receive beamforming, the receiver uses a receive beam to amplify RF signals detected on a given channel. For example, the receiver can increase the gain setting and/or adjust the phase setting of an array of antennas in a particular direction to amplify (e.g., to increase the gain level of) the RF signals received from that direction. Thus, when a receiver is said to beamform in a certain direction, it means the beam gain in that direction is high relative to the beam gain along other directions, or the beam gain in that direction is the highest compared to the beam gain in that direction of all other receive beams available to the receiver. This results in a stronger received signal strength (e.g., reference signal received power (RSRP), reference signal received quality

(RSRQ), signal-to-interference-plus-noise ratio (SINR), etc.) of the RF signals received from that direction.

[0034] Receive beams may be spatially related. A spatial relation means that parameters for a transmit beam for a second reference signal can be derived from information about a receive beam for a first reference signal. For example, a UE may use a particular receive beam to receive a reference downlink reference signal (e.g., synchronization signal block (SSB)) from a base station. The UE can then form a transmit beam for sending an uplink reference signal (e.g., sounding reference signal (SRS)) to that base station based on the parameters of the receive beam.

[0035] Note that a "downlink" beam may be either a transmit beam or a receive beam, depending on the entity forming it. For example, if a base station is forming the downlink beam to transmit a reference signal to a UE, the downlink beam is a transmit beam. If the UE is forming the downlink beam, however, it is a receive beam to receive the downlink reference signal. Similarly, an "uplink" beam may be either a transmit beam or a receive beam, depending on the entity forming it. For example, if a base station is forming the uplink beam, it is an uplink receive beam, and if a UE is forming the uplink beam, it is an uplink transmit beam.

[0036] In 5G, the frequency spectrum in which wireless nodes (e.g., base stations 102/180, UEs 104/182) operate is divided into multiple frequency ranges, FR1 (from 450 to 6000 MHz), FR2 (from 24250 to 52600 MHz), FR3 (above 52600 MHz), and FR4 (between FR1 and FR2). In a multi-carrier system, such as 5G, one of the carrier frequencies is referred to as the "primary carrier" or "anchor carrier" or "primary serving cell" or "PCell," and the remaining carrier frequencies are referred to as "secondary carriers" or "secondary serving cells" or "SCells." In carrier aggregation, the anchor carrier is the carrier operating on the primary frequency (e.g., FR1) utilized by a UE 104/182 and the cell in which the UE 104/182 either performs the initial radio resource control (RRC) connection establishment procedure or initiates the RRC connection re-establishment procedure. The primary carrier carries all common and UE-specific control channels, and may be a carrier in a licensed frequency (however, this is not always the case). A secondary carrier is a carrier operating on a second frequency (e.g., FR2) that may be configured once the RRC connection is established between the UE 104 and the anchor carrier and that may be used to provide additional radio resources. In some cases, the secondary carrier may be a carrier in an unlicensed frequency. The secondary carrier may contain only necessary signaling information and signals, for example, those that are UE-specific may not be present in the secondary carrier, since both primary uplink and downlink carriers are typically UE-specific. This means that different UEs 104/182 in a cell may have different downlink primary carriers. The same is true for the uplink primary carriers. The network is able to change the primary carrier of any UE 104/182 at any time. This is done, for example, to balance the load on different carriers. Because a "serving cell" (whether a PCell or an SCell) corresponds to a carrier frequency / component carrier over which some base station is communicating, the term "cell," "serving cell," "component carrier," "carrier frequency," and the like can be used interchangeably.

[0037] For example, still referring to FIG. 1, one of the frequencies utilized by the macro cell base stations 102 may be an anchor carrier (or "PCell") and other frequencies utilized by the macro cell base stations 102 and/or the mmW base station 180 may be secondary carriers ("SCells"). The simultaneous transmission and/or reception of multiple carriers enables the UE 104/182 to significantly increase its data transmission and/or reception rates. For example, two 20 MHz aggregated carriers in a multi-carrier system would theoretically lead to a two-fold increase in data rate (i.e., 40 MHz), compared to that attained by a single 20 MHz carrier.

[0038] The wireless communications system 100 may further include one or more UEs, such as UE 190, that connects indirectly to one or more communication networks via one or more device-to-device (D2D) peer-to-peer (P2P) links. In the example of FIG. 1, UE 190 has a D2D P2P link 192 with one of the UEs 104 connected to one of the base stations 102 (e.g., through which UE 190 may indirectly obtain cellular connectivity) and a D2D P2P link 194 with WLAN STA 152 connected to the WLAN AP 150 (through which UE 190 may indirectly obtain WLAN-based Internet connectivity). In an example, the D2D P2P links 192 and 194 may be supported with any well-known D2D RAT, such as LTE Direct (LTE-D), WiFi Direct (WiFi-D), Bluetooth®, and so on.

[0039] The wireless communications system 100 may further include a UE 164 that may communicate with a macro cell base station 102 over a communication link 120 and/or the mmW base station 180 over a mmW communication link 184. For example, the macro cell base station 102 may support a PCell and one or more SCells for the UE 164 and the mmW base station 180 may support one or more SCells for the UE 164.

[0040] According to various aspects, **FIG. 2A** illustrates an example wireless network structure 200. For example, an NGC 210 (also referred to as a "5GC") can be viewed functionally as control plane functions 214 (e.g., UE registration, authentication, network access, gateway selection, etc.) and user plane functions 212, (e.g., UE gateway function, access to data networks, IP routing, etc.) which operate cooperatively to form the core network. User plane interface (NG-U) 213 and control plane interface (NG-C) 215 connect the gNB 222 to the NGC 210 and specifically to the control plane functions 214 and user plane functions 212. In an additional configuration, an eNB 224 may also be connected to the NGC 210 via NG-C 215 to the control plane functions 214 and NG-U 213 to user plane functions 212. Further, eNB 224 may directly communicate with gNB 222 via a backhaul connection 223. In some configurations, the New RAN 220 may only have one or more gNBs 222, while other configurations include one or more of both eNBs 224 and gNBs 222. Either gNB 222 or eNB 224 may communicate with UEs 204 (e.g., any of the UEs depicted in FIG. 1). Another optional aspect may include location server 230, which may be in communication with the NGC 210 to provide location assistance for UEs 204. The location server 230 can be implemented as a plurality of separate servers (e.g., physically separate servers, different software modules on a single server, different software modules spread across multiple physical servers, etc.), or alternately may each correspond to a single server. The location server 230 can be configured to support one or more location services for UEs 204 that can connect to the location server 230 via the core network, NGC 210, and/or via the Internet (not illustrated). Further, the location server 230 may be integrated into a component of the core network, or alternatively may be external to the core network.

[0041] According to various aspects, **FIG. 2B** illustrates another example wireless network structure 250. For example, an NGC 260 (also referred to as a "5GC") can be viewed functionally as control plane functions, provided by an access and mobility management function (AMF) / user plane function (UPF) 264, and user plane functions, provided by a session management function (SMF) 262, which operate cooperatively to form the core network (i.e., NGC 260). User plane interface 263 and control plane interface 265 connect the eNB 224 to the NGC 260 and specifically to SMF 262 and AMF/UPF 264, respectively. In an additional configuration, a gNB 222 may also be connected to the NGC 260 via control plane interface 265 to AMF/UPF 264 and user plane interface 263 to SMF 262. Further, eNB 224 may directly communicate with gNB

222 via the backhaul connection 223, with or without gNB direct connectivity to the NGC 260. In some configurations, the New RAN 220 may only have one or more gNBs 222, while other configurations include one or more of both eNBs 224 and gNBs 222. Either gNB 222 or eNB 224 may communicate with UEs 204 (e.g., any of the UEs depicted in FIG. 1). The base stations of the New RAN 220 communicate with the AMF-side of the AMF/UPF 264 over the N2 interface and the UPF-side of the AMF/UPF 264 over the N3 interface.

[0042] The functions of the AMF include registration management, connection management, reachability management, mobility management, lawful interception, transport for session management (SM) messages between the UE 204 and the SMF 262, transparent proxy services for routing SM messages, access authentication and access authorization, transport for short message service (SMS) messages between the UE 204 and the short message service function (SMSF) (not shown), and security anchor functionality (SEAF). The AMF also interacts with the authentication server function (AUSF) (not shown) and the UE 204, and receives the intermediate key that was established as a result of the UE 204 authentication process. In the case of authentication based on a UMTS (universal mobile telecommunications system) subscriber identity module (USIM), the AMF retrieves the security material from the AUSF. The functions of the AMF also include security context management (SCM). The SCM receives a key from the SEAF that it uses to derive access-network specific keys. The functionality of the AMF also includes location services management for regulatory services, transport for location services messages between the UE 204 and the location management function (LMF) 270, as well as between the New RAN 220 and the LMF 270, evolved packet system (EPS) bearer identifier allocation for interworking with the EPS, and UE 204 mobility event notification. In addition, the AMF also supports functionalities for non-3GPP access networks.

[0043] Functions of the UPF include acting as an anchor point for intra-/inter-RAT mobility (when applicable), acting as an external protocol data unit (PDU) session point of interconnect to the data network (not shown), providing packet routing and forwarding, packet inspection, user plane policy rule enforcement (e.g., gating, redirection, traffic steering), lawful interception (user plane collection), traffic usage reporting, quality of service (QoS) handling for the user plane (e.g., UL/DL rate enforcement, reflective QoS marking in the DL), UL traffic verification (service data flow (SDF) to QoS flow mapping), transport level packet marking in the UL and DL, DL packet buffering and DL data notification triggering, and sending and forwarding of one or more "end markers" to the source RAN node.

[0044] The functions of the SMF 262 include session management, UE Internet protocol (IP) address allocation and management, selection and control of user plane functions, configuration of traffic steering at the UPF to route traffic to the proper destination, control of part of policy enforcement and QoS, and downlink data notification. The interface over which the SMF 262 communicates with the AMF-side of the AMF/UPF 264 is referred to as the N11 interface.

[0045] Another optional aspect may include a LMF 270, which may be in communication with the NGC 260 to provide location assistance for UEs 204. The LMF 270 can be implemented as a plurality of separate servers (e.g., physically separate servers, different software modules on a single server, different software modules spread across multiple physical servers, etc.), or alternately may each correspond to a single server. The LMF 270 can be configured to support one or more location services for UEs 204 that can connect to the LMF 270 via the core network, NGC 260, and/or via the Internet (not illustrated).

[0046] **FIGS. 3A, 3B, and 3C** illustrate several sample components (represented by corresponding blocks) that may be incorporated into a UE 302 (which may correspond to any of the UEs described herein), a base station 304 (which may correspond to any of the base stations described herein), and a network entity 306 (which may correspond to or embody any of the network functions described herein, including the location server 230 and the LMF 270) to support the file transmission operations as taught herein. It will be appreciated that these components may be implemented in different types of apparatuses in different implementations (e.g., in an ASIC, in a system-on-chip (SoC), etc.). The illustrated components may also be incorporated into other apparatuses in a communication system. For example, other apparatuses in a system may include components similar to those described to provide similar functionality. Also, a given apparatus may contain one or more of the components. For example, an apparatus may include multiple transceiver components that enable the apparatus to operate on multiple carriers and/or communicate via different technologies.

[0047] The UE 302 and the base station 304 each include wireless wide area network (WWAN) transceiver 310 and 350, respectively, configured to communicate via one or more wireless communication networks (not shown), such as an NR network, an LTE network, a GSM network, and/or the like. The WWAN transceivers 310 and 350 may be connected to one or more antennas 316 and 356, respectively, for communicating with other network nodes, such as other UEs, access points, base stations (e.g., eNBs, gNBs), etc., via at least one designated RAT (e.g., NR, LTE, GSM, etc.) over a wireless communication medium of interest (e.g., some set of time/frequency resources in a particular frequency spectrum). The WWAN transceivers 310 and 350 may be variously configured for transmitting and encoding signals 318 and 358 (e.g., messages, indications, information, and so on), respectively, and, conversely, for receiving and decoding signals 318 and 358 (e.g., messages, indications, information, pilots, and so on), respectively, in accordance with the designated RAT. Specifically, the transceivers 310 and 350 include one or more transmitters 314 and 354, respectively, for transmitting and encoding signals 318 and 358, respectively, and one or more receivers 312 and 352, respectively, for receiving and decoding signals 318 and 358, respectively.

[0048] The UE 302 and the base station 304 also include, at least in some cases, wireless local area network (WLAN) transceivers 320 and 360, respectively. The WLAN transceivers 320 and 360 may be connected to one or more antennas 326 and 366, respectively, for communicating with other network nodes, such as other UEs, access points, base stations, etc., via at least one designated RAT (e.g., WiFi, LTE-D, Bluetooth®, etc.) over a wireless communication medium of interest. The WLAN transceivers 320 and 360 may be variously configured for transmitting and encoding signals 328 and 368 (e.g., messages, indications, information, and so on), respectively, and, conversely, for receiving and decoding signals 328 and 368 (e.g., messages, indications, information, pilots, and so on), respectively, in accordance with the designated RAT. Specifically, the transceivers 320 and 360 include one or more transmitters 324 and 364, respectively, for transmitting and encoding signals 328 and 368, respectively, and one or more receivers 322 and 362, respectively, for receiving and decoding signals 328 and 368, respectively.

[0049] Transceiver circuitry including a transmitter and a receiver may comprise an integrated device (e.g., embodied as a transmitter circuit and a receiver circuit of a single communication device) in some implementations, may comprise a separate transmitter device and a separate receiver device in some implementations, or may be embodied in other ways in other implementations. In an aspect, a transmitter may include or be coupled to a plurality of antennas (e.g., antennas 316, 336, and 376), such as an antenna array, that permits the respective apparatus to perform transmit "beamforming," as described herein. Similarly, a receiver may include or be coupled to a plurality of antennas (e.g., antennas 316, 336, and 376), such as an antenna array, that permits the respective apparatus to perform receive beamforming, as described herein. In an aspect, the transmitter and receiver may share the same plurality of antennas (e.g., antennas 316, 336, and 376), such that the respective apparatus can only receive or transmit at a given time, not both at the same time. A wireless communication device (e.g., one or both of the transceivers 310 and 320 and/or 350 and 360) of the apparatuses 302 and/or 304 may also comprise a network listen module (NLM) or the like for performing various measurements.

[0050] The apparatuses 302 and 304 also include, at least in some cases, satellite positioning systems (SPS) receivers 330 and 370. The SPS receivers 330 and 370 may be connected to one or more antennas 336 and 376, respectively, for receiving SPS signals 338 and 378, respectively, such as global positioning system (GPS) signals, global navigation satellite system (GLONASS) signals, Galileo signals, Beidou signals, Indian Regional Navigation Satellite System (NAVIC), Quasi-Zenith Satellite System (QZSS), etc. The SPS receivers 330 and 370 may comprise any suitable hardware and/or software for receiving and processing SPS signals 338 and 378, respectively. The SPS receivers 330 and 370 request information and operations as appropriate from the other systems, and performs calculations necessary to determine the apparatus' 302 and 304 positions using measurements obtained by any suitable SPS algorithm.

[0051] The base station 304 and the network entity 306 each include at least one network interfaces 380 and 390 for communicating with other network entities. For example, the network interfaces 380 and 390 (e.g., one or more network access ports) may be configured to communicate with one or more network entities via a wire-based or wireless backhaul connection. In some aspects, the network interfaces 380 and 390 may be implemented as transceivers configured to support wire-based or wireless signal communication. This communication may involve, for example, sending and receiving: messages, parameters, or other types of information.

[0052] The apparatuses 302, 304, and 306 also include other components that may be used in conjunction with the operations as disclosed herein. The UE 302 includes processor circuitry implementing a processing system 332 for providing functionality relating to, for example, false base station (FBS) detection as disclosed herein and for providing other processing functionality. The base station 304 includes a processing system 384 for providing functionality relating to, for example, FBS detection as disclosed herein and for providing other processing functionality. The network entity 306 includes a processing system 394 for providing functionality relating to, for example, FBS detection as disclosed herein and for providing other processing functionality. In an aspect, the processing systems 332, 384, and 394 may include, for example, one or more general purpose processors, multi-core processors, ASICs, digital signal processors (DSPs), field programmable gate arrays (FPGA), or other programmable logic devices or processing circuitry.

[0053] The apparatuses 302, 304, and 306 include memory circuitry implementing memory components 340, 386, and 396 (e.g., each including a memory device), respectively, for maintaining information (e.g., information indicative of reserved resources, thresholds, parameters, and so on). In some cases, the apparatus 302 may include beam failure threshold module 342. The beam failure threshold module 342 may comprise a hardware circuit that is part of or coupled to the processing system 332, that, when executed, causes the apparatus 302 to perform the functionality described herein. Alternatively, the beam failure threshold module 342 may be a memory module (as shown in FIGS. 3A) stored in the memory components 340, that, when executed by the processing systems 332, causes the apparatuses 302 to perform the functionality described herein.

[0054] The UE 302 may include one or more sensors 344 coupled to the processing system 332 to provide movement and/or orientation information that is independent of motion data derived from signals received by the WWAN transceiver 310, the WLAN transceiver 320, and/or the GPS receiver 330. By way of example, the sensor(s) 344 may include an accelerometer (e.g., a micro-electrical mechanical systems (MEMS) device), a gyroscope, a geomagnetic sensor (e.g., a compass), an altimeter (e.g., a barometric pressure altimeter), and/or any other type of movement detection sensor. Moreover, the sensor(s) 344 may include a plurality of different types of devices and combine their outputs in order to provide motion information. For example, the sensor(s) 344 may use a combination of a multi-axis accelerometer and orientation sensors to provide the ability to compute positions in 2D and/or 3D coordinate systems.

[0055] In addition, the UE 302 includes a user interface 346 for providing indications (e.g., audible and/or visual indications) to a user and/or for receiving user input (e.g., upon user actuation of a sensing device such a keypad, a touch screen, a microphone, and so on). Although not shown, the apparatuses 304 and 306 may also include user interfaces.

[0056] Referring to the processing system 384 in more detail, in the downlink, IP packets from the network entity 306 may be provided to the processing system 384. The processing system 384 may implement functionality for an RRC layer, a packet data convergence protocol (PDCP) layer, a radio link control (RLC) layer, and a medium access control (MAC) layer. The processing system 384 may provide RRC layer functionality associated with broadcasting of system information (e.g., master information block (MIB), system information blocks (SIBs)), RRC connection control (e.g., RRC connection paging, RRC connection establishment, RRC connection modification, and RRC connection release), inter-RAT mobility, and measurement configuration for UE measurement reporting; PDCP layer functionality associated with header compression/decompression, security (ciphering, deciphering, integrity protection, integrity verification), and handover support functions; RLC layer functionality associated with the transfer of upper layer packet data units (PDUs), error correction through ARQ, concatenation, segmentation, and reassembly of RLC service data units (SDUs), re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, scheduling information reporting, error correction, priority handling, and logical channel prioritization.

[0057] The transmitter 354 and the receiver 352 may implement Layer-1 functionality associated with various signal processing functions. Layer-1, which includes a physical (PHY) layer, may include error detection on the transport channels, forward error correction (FEC) coding/decoding of the transport channels, interleaving, rate matching, mapping onto physical channels, modulation/demodulation of physical channels, and MIMO antenna processing. The transmitter 354 handles 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)). The coded and modulated symbols may then be split into parallel streams. Each stream may then be mapped to an orthogonal frequency division multiplexing (OFDM) subcarrier, multiplexed with a reference signal (e.g., pilot) in the time and/or frequency domain, and then combined together using an Inverse Fast Fourier Transform (IFFT) to produce a physical channel carrying a time domain OFDM symbol stream. The OFDM stream is spatially precoded to produce multiple spatial streams. Channel estimates from a channel estimator may be used to determine the coding and modulation scheme, as well as for spatial processing. The channel estimate may be derived from a reference signal and/or channel condition feedback transmitted by the UE 302. Each spatial stream may then be provided to one or more different antennas 356. The transmitter 354 may modulate an RF carrier with a respective spatial stream for transmission.

[0058] At the UE 302, the receiver 312 receives a signal through its respective antenna(s) 316. The receiver 312 recovers information modulated onto an RF carrier and provides the information to the processing system 332. The transmitter 314 and the receiver 312 implement Layer-1 functionality associated with various signal processing functions. The receiver 312 may perform spatial processing on the information to recover any spatial streams destined for the UE 302. If multiple spatial streams are destined for the UE 302, they may be combined by the receiver 312 into a single OFDM symbol stream. The receiver 312 then converts the OFDM symbol stream from the time-domain to the frequency domain using a fast Fourier transform (FFT). The frequency domain signal comprises a separate OFDM symbol stream for each subcarrier of the OFDM signal. The symbols on each subcarrier, and the reference signal, are recovered and demodulated by determining the most likely signal constellation points transmitted by the base station 304. These soft decisions may be based on channel estimates computed by a channel estimator. The soft decisions are then decoded and de-interleaved to recover the data and control signals that were originally transmitted by the base station 304 on the physical channel. The data and control signals are then provided to the processing system 332, which implements Layer-3 and Layer-2 functionality.

[0059] In the UL, the processing system 332 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, and control signal processing to recover IP packets from the core network. The processing system 332 is also responsible for error detection.

[0060] Similar to the functionality described in connection with the DL transmission by the base station 304, the processing system 332 provides RRC layer functionality associated with system information (e.g., MIB, SIBs) acquisition, RRC connections, and measurement reporting; PDCP layer functionality associated with header compression/decompression, and security (ciphering, deciphering, integrity protection, integrity verification); RLC layer functionality associated with the transfer of upper layer PDUs, error correction through ARQ, concatenation, segmentation, and reassembly of RLC SDUs, re-segmentation of RLC data PDUs, and reordering of RLC data PDUs; and MAC layer functionality associated with mapping between logical channels and transport channels, multiplexing of MAC SDUs onto transport blocks (TBs), demultiplexing of MAC SDUs from TBs, scheduling information reporting, error correction through HARQ, priority handling, and logical channel prioritization.

[0061] Channel estimates derived by the channel estimator from a reference signal or feedback transmitted by the base station 304 may be used by the transmitter 314 to select the appropriate coding and modulation schemes, and to facilitate spatial processing. The spatial streams generated by the transmitter 314 may be provided to different antenna(s) 316. The transmitter 314 may modulate an RF carrier with a respective spatial stream for transmission.

[0062] The UL transmission is processed at the base station 304 in a manner similar to that described in connection with the receiver function at the UE 302. The receiver 352 receives a signal through its respective antenna(s) 356. The receiver 352 recovers information modulated onto an RF carrier and provides the information to the processing system 384.

[0063] In the UL, the processing system 384 provides demultiplexing between transport and logical channels, packet reassembly, deciphering, header decompression, control signal processing to recover IP packets from the UE 302. IP packets from the processing system 384 may be provided to the core network. The processing system 384 is also responsible for error detection.

[0064] For convenience, the apparatuses 302, 304, and/or 306 are shown in FIGS. 3A-C as including various components that may be configured according to the various examples described herein. It will be appreciated, however, that the illustrated blocks may have different functionality in different designs.

[0065] The various components of the apparatuses 302, 304, and 306 may communicate with each other over data buses 334, 382, and 392, respectively. The components of FIGS. 3A-C may be implemented in various ways. In some implementations, the components of FIGS. 3A-C may be implemented in one or more circuits such as, for example, one or more processors and/or one or more ASICs (which may include one or more processors). Here, each circuit may use and/or incorporate at least one memory component for storing information or executable code used by the circuit to provide this functionality. For example, some or all of the functionality represented by blocks 310 to 346 may be implemented by processor and memory component(s) of the UE 302 (e.g., by execution of appropriate code and/or by appropriate configuration of processor components). Similarly, some or all of the functionality represented by blocks 350 to 384 may be implemented by processor and memory component(s) of the base station 304 (e.g., by execution of appropriate code and/or by appropriate configuration of processor components). Also, some or all of the functionality represented by blocks 390 to 396 may be implemented by processor and memory component(s) of the network entity 306 (e.g., by execution of appropriate code and/or by appropriate configuration of processor components). For simplicity, various operations, acts, and/or functions are described herein as being performed “by a UE,” “by a base station,” “by a positioning entity,” etc. However, as will be appreciated, such operations, acts, and/or functions may actually be performed by specific components or combinations of components of the UE, base station, positioning entity, etc., such as the processing systems 332, 384, 394, the transceivers 310, 320, 350, and 360, the memory components 340, 386, and 396, the beam failure threshold module 342, etc.

[0066] In some designs, UEs are either pre-configured (per standard) or dynamically configured (e.g., by the RAN via RRC signaling) with a set of beam failure thresholds. For example, the set of beam failure thresholds may comprise a first beam failure threshold denoted as BeamFailureInstanceMax that indicates a maximum number of beam failure instances, a second beam failure threshold denoted as BeamFailureDetectionTimer that indicates an expiration period after which beam failure is determined if the timer is not reset, and so on. The set of beam failure thresholds is evaluated at the UE with respect to signals (e.g., data traffic or control signaling) transported over one or more beams between the UE and a base station (e.g., UL beam(s), DL beam(s), etc.).

[0067] Various factors may lead to beam failure. One such factor is UE movement. However, UE movement is not factored into beam failure threshold(s) in current systems. For example, as noted above, if the set of beam failure thresholds is pre-configured per standard, the set of beam failure thresholds is fixed and not subject to change based on UE movement. Alternatively, if the set of beam failure thresholds is configured dynamically by the RAN, the RAN does not have access to real-time UE movement information.

[0068] One or more embodiments of the present disclosure are thereby directed to dynamically transitioning beam failure threshold(s) at the UE based upon movement information detected at the UE (e.g., in real-time). In some designs, dynamically transitioning beam failure threshold(s) at the UE based upon movement information detected at the UE provides various technical advantages, such as facilitating faster beam failure detection and beam failure recovery.

[0069] FIG. 4 illustrates an exemplary process 400 of wireless communications according to an aspect of the disclosure. The process 400 of FIG. 4 is performed by a UE, such as UE 302 of FIG. 3A.

[0070] At 402, UE 302 (e.g., one or more of sensors 344, processing system 332, etc.) detects movement information associated with the UE. The movement information can be detected at 402 based on sensors 344 in a variety (e.g., based on GPS position, WiFi-assisted position, gyroscope, accelerometer such as a MEMS, etc.). In some designs, the movement information comprises a speed of the UE, whereas in other designs the movement information may comprise one or more of a velocity of the UE, an acceleration of the UE, etc. In some designs, the movement information comprises instantaneous motion of the UE, whereas in other designs the movement information may comprise time-averaged motion (e.g., average motion over a window of time, etc.).

[0071] At 404, UE 302 (e.g., beam failure threshold module 342, processing system 332, WWAN transceiver 310, etc.) transitions from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information. In an example, the respective first and second sets of beam failure thresholds may comprise different beam failure instance thresholds (e.g., BeamFailureInstanceMax), different beam detection timer expiration thresholds (e.g., BeamFailureDetectionTimer), or a combination thereof.

[0072] At 406, UE 302 (e.g., beam failure threshold module 342, processing system 332, WWAN transceiver 310, etc.) monitors the at least one beam based on the second set of beam failure thresholds.

[0073] Referring to FIG. 4, in an example, UE 302 may determine that the detected movement information indicates that movement of the UE exceeds a movement threshold (e.g., a speed threshold, a velocity threshold, an acceleration threshold, etc.). In this case, in an example where the first set of beam failure thresholds includes a first beam failure instance threshold, the second set of beam failure thresholds may include a second beam failure instance threshold that is less than the first beam failure instance threshold. In this case, fewer instances of beam failure will result in the UE assessing that a respective beam has failed in a scenario where there is relatively high UE movement. In an example where the first set of beam failure thresholds includes a first beam detection timer expiration threshold, the second set of beam failure thresholds may include a second beam detection timer expiration threshold that has a longer duration than the first beam failure instance threshold. In this case, the UE will associate the beam(s) with a beam failure condition more quickly in a scenario where there is relatively high UE movement.

[0074] Referring to FIG. 4, in some designs, the second set of beam failure thresholds can be static in the sense that the degree to which the movement of the UE exceeds the movement threshold does not impact the second set of beam failure thresholds. In other designs, the second set of beam failure thresholds may be based on a degree to which the movement of the UE exceeds the movement threshold. For example, at least one beam failure threshold among the second set of beam failure thresholds can be based on a linear or non-linear function (e.g., the respective at least one beam failure threshold is scaled upwards or downwards either linearly or non-linearly based on the degree of difference). In other designs, a plurality of movement difference ranges can be defined, with each movement difference range being associated with a different value for a respective beam failure threshold. In this case, the UE can identify the respective difference range associated with the detected UE movement, and use the associated value as the respective beam failure threshold.

[0075] Referring to FIG. 4, in an example where UE 302 determines that the detected movement information indicates that movement of the UE exceeds a movement threshold, the first set of beam failure thresholds may be pre-configured or dynamically configured by the base station, and the second set of beam failure thresholds may function to override the first set of beam failure thresholds without coordination with the base station. Alternatively, in a scenario where the second set of beam failure thresholds may be based on a degree to which the movement of the UE exceeds the movement threshold, the first and second sets of beam failure thresholds may each comprise threshold(s) that override other beam failure threshold(s) pre-configured or dynamically configured by the base station (e.g., the first and second sets of beam failure thresholds may correspond to different threshold calculations associated with a linear or non-linear function as noted above, etc.).

[0076] Referring to FIG. 4, in an example, UE 302 may determine that the detected movement information indicates that movement of the UE does not exceed a movement threshold (e.g., a speed threshold, a velocity threshold, an acceleration threshold, etc.). For example, UE 302 may be static or slow-moving. In this case, in an example where the first set of beam failure thresholds includes a first beam failure instance threshold, the second set of beam failure thresholds may include a second beam failure instance threshold that is greater than the first beam failure instance threshold. In this case, more instances of beam failure are required for the UE to assess that a respective beam has failed in a scenario where there is relatively low UE movement. In an example where the first set of beam failure thresholds includes a first beam detection timer expiration threshold, the second set of beam failure thresholds may include a second beam detection timer expiration threshold that has a shorter duration than the first beam failure instance threshold. In this case, the UE will associate the beam(s) with a beam failure condition more slowly in a scenario where there is relatively low UE movement. In an example, the second set of beam failure thresholds in this case may correspond to the beam failure threshold(s) that are pre-configured or dynamically configured by the base station (e.g., via RRC signaling). Alternatively, in a scenario where the second set of beam failure thresholds may be based on a degree to which the movement of the UE exceeds the movement threshold, the first and second sets of beam failure thresholds may each comprise threshold(s) that override other beam failure threshold(s) pre-configured or dynamically configured by the base station (e.g., the first and second sets of beam failure thresholds may correspond to different threshold calculations associated with a linear or non-linear function as noted above, etc.).

[0077] FIG. 5 illustrates an example implementation of the process 400 of FIG. 4 in accordance with an embodiment of the disclosure.

[0078] At 502, BS 304 dynamically configures a first set of beam failure thresholds with UE 302 via RRC signaling. At 504, UE 302 detects movement information that indicates UE 302 is moving at less than a movement threshold. Accordingly, UE 302 determines to use (rather than override) the first set of beam failure thresholds. At 506, data traffic and/or control signaling is transported over one or more beams between UE 302 and BS 304 (e.g., UL beams, DL beams, etc.), and at 508, UE 302 monitors the data traffic and/or control signaling over the respective beam(s) based on the first set of beam failure thresholds.

[0079] At 510, detects movement information that indicates UE 302 is moving at more than a movement threshold. In an example, the movement threshold at 510 may be offset from the movement threshold at 504 to avoid a so-called ping-ponging effect which may occur in a scenario where the UE movement is hovering around the respective movement threshold. At 512, UE 302 determines a second set of beam failure thresholds. In particular, as noted above, the second set of beam failure thresholds is generally configured so as to facilitate a quick assessment that a beam has failure, since beam failure is more likely to occur in scenarios where UE 302 is moving at a higher rate (e.g., higher speed, velocity, acceleration, etc.). At 514, data traffic and/or control signaling is transported over one or more beams between UE 302 and BS 304 (e.g., UL beams, DL beams, etc.), and at 516, UE 302 monitors the data traffic and/or control signaling over the respective beam(s) based on the second set of beam failure thresholds.

[0080] At 518, UE 302 detects movement information that indicates UE 302 is once again moving at less than a movement threshold. In this case, the process returns to 506-508, and UE 302 resumes beam monitoring based on the first set of beam failure thresholds.

[0081] Those of skill in the art will appreciate that information and signals may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the above description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0082] Further, those of skill in the art will appreciate that the various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the aspects disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present disclosure.

[0083] The various illustrative logical blocks, modules, and circuits described in connection with the aspects disclosed herein may be implemented or performed with a general purpose processor, a DSP, an ASIC, an FPGA, or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general purpose processor may be a microprocessor, but in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0084] The methods, sequences and/or algorithms described in connection with the aspects disclosed herein may be embodied directly in hardware, in a software module executed by a processor, or in a combination of the two. A software module may reside in random access memory (RAM), flash memory, read-only memory (ROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), registers, hard disk, a removable disk, a CD-ROM, or any other form of storage medium known in the art. An exemplary storage medium is coupled to the processor such that the processor can read information from, and write information to, the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. The ASIC may reside in a user terminal (e.g., UE). In the alternative, the processor and the storage medium may reside as discrete components in a user terminal.

[0085] In one or more exemplary aspects, the functions described may be implemented in hardware, software, firmware, or any combination thereof. If implemented in software, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Computer-readable media includes both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A storage media may be any available media that can be accessed by a computer. By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Also, any connection is properly termed a computer-readable medium. For example, if the software is transmitted from a website, server, or other remote source using a coaxial cable, fiber optic cable, twisted pair, digital subscriber line (DSL), or wireless technologies such as infrared, radio, and microwave, then the coaxial cable, fiber optic cable, twisted pair, DSL, or wireless technologies such as infrared, radio, and microwave are included in the definition of medium. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media.

[0086] While the foregoing disclosure shows illustrative aspects of the disclosure, it should be noted that various changes and modifications could be made herein without departing from the scope of the disclosure as defined by the appended claims. The functions, steps and/or actions of the method claims in accordance with the aspects of the disclosure described herein need not be performed in any particular order. Furthermore, although elements of the disclosure may be described or claimed in the singular, the plural is contemplated unless limitation to the singular is explicitly stated.

CLAIMS

What is claimed is:

1. A method of operating a user equipment (UE), comprising:

detecting movement information associated with the UE;

transitioning from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information; and

monitoring the at least one beam based on the second set of beam failure thresholds.

2. The method of claim 1, further comprising:

determining that the detected movement information indicates that movement of the UE exceeds a movement threshold.

3. The method of claim 2,

wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is less than the first beam failure instance threshold.

4. The method of claim 2,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a longer duration than the first beam failure instance threshold.

5. The method of claim 4, wherein the second set of beam failure thresholds is based on a degree to which the movement of the UE exceeds the movement threshold.

6. The method of claim 5, wherein the second set of beam failure thresholds is determined or derived based on:

a linear or non-linear function that is based upon the degree to which the movement of the UE exceeds the movement threshold, or

a plurality of movement ranges that are each associated with a different set of beam failure thresholds.

7. The method of claim 2,

wherein the first set of beam failure thresholds is pre-configured or dynamically configured by the base station, and

wherein the second set of beam failure thresholds overrides the first set of beam failure thresholds without coordination with the base station.

8. The method of claim 1, wherein the detected movement information indicates that movement of the UE does not exceed a movement threshold.

9. The method of claim 8,

wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is greater than the first beam failure instance threshold.

10. The method of claim 9,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a shorter duration than the first beam failure instance threshold.

11. A user equipment (UE), comprising:

means for detecting movement information associated with the UE;

means for transitioning from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information; and means for monitoring the at least one beam based on the second set of beam failure thresholds.

12. The UE of claim 11, further comprising:

means for determining that the detected movement information indicates that movement of the UE exceeds a movement threshold.

13. The UE of claim 12,

wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is less than the first beam failure instance threshold.

14. The UE of claim 12,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a longer duration than the first beam failure instance threshold.

15. The UE of claim 14, wherein the second set of beam failure thresholds is based on a degree to which the movement of the UE exceeds the movement threshold.

16. The UE of claim 15, wherein the second set of beam failure thresholds is determined or derived based on:

a linear or non-linear function that is based upon the degree to which the movement of the UE exceeds the movement threshold, or

a plurality of movement ranges that are each associated with a different set of beam failure thresholds.

17. The UE of claim 12,

wherein the first set of beam failure thresholds is pre-configured or dynamically configured by the base station, and wherein the second set of beam failure thresholds overrides the first set of beam failure thresholds without coordination with the base station.

18. The UE of claim 11, wherein the detected movement information indicates that movement of the UE does not exceed a movement threshold.

19. The UE of claim 18,

wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is greater than the first beam failure instance threshold.

20. The UE of claim 19,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a shorter duration than the first beam failure instance threshold.

21. A user equipment (UE), comprising:

a memory;

at least one transceiver; and

at least one processor communicatively coupled to the memory and the at least one transceiver, the at least one processor configured to:

detect movement information associated with the UE;

transition from a first set of beam failure thresholds associated with at least one beam between the UE and a base station to a second set of beam failure thresholds based on the detected movement information; and

monitor the at least one beam based on the second set of beam failure thresholds.

22. The UE of claim 21, wherein the at least one processor is further configured to determine that the detected movement information indicates that movement of the UE exceeds a movement threshold.

23. The UE of claim 22,

wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is less than the first beam failure instance threshold.

24. The UE of claim 22,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a longer duration than the first beam failure instance threshold.

25. The UE of claim 24, wherein the second set of beam failure thresholds is based on a degree to which the movement of the UE exceeds the movement threshold.

26. The UE of claim 25, wherein the second set of beam failure thresholds is determined or derived based on:

a linear or non-linear function that is based upon the degree to which the movement of the UE exceeds the movement threshold, or

a plurality of movement ranges that are each associated with a different set of beam failure thresholds.

27. The UE of claim 22,

wherein the first set of beam failure thresholds is pre-configured or dynamically configured by the base station, and

wherein the second set of beam failure thresholds overrides the first set of beam failure thresholds without coordination with the base station.

28. The UE of claim 21, wherein the detected movement information indicates that movement of the UE does not exceed a movement threshold.

29. The UE of claim 28,

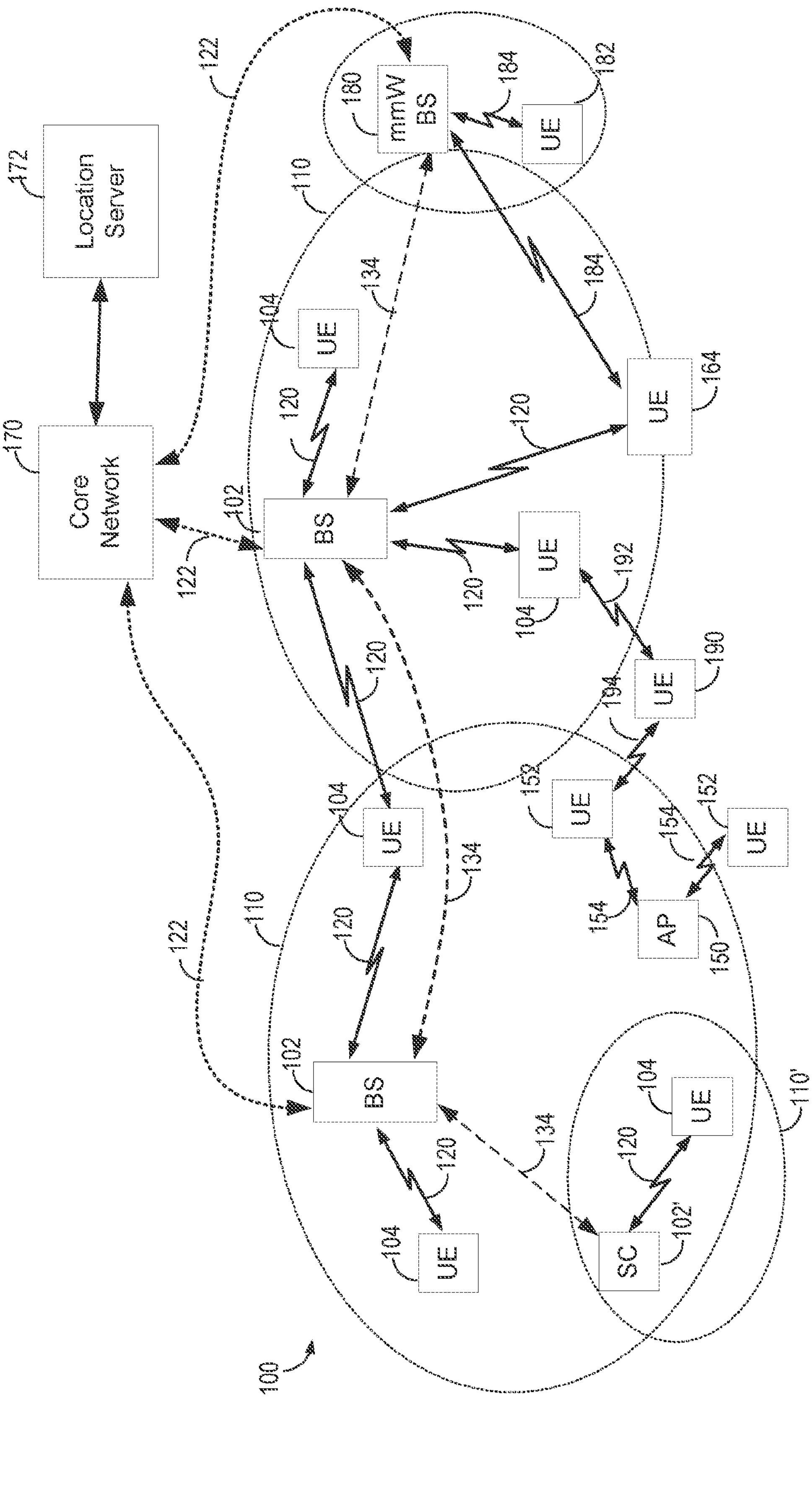
wherein the first set of beam failure thresholds includes a first beam failure instance threshold, and

wherein the second set of beam failure thresholds includes a second beam failure instance threshold that is greater than the first beam failure instance threshold.

30. The UE of claim 29,

wherein the first set of beam failure thresholds includes a first beam detection timer expiration threshold, and

wherein the second set of beam failure thresholds includes a second beam detection timer expiration threshold that has a shorter duration than the first beam failure instance threshold.


Location Server
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Core Network
170
122
mmW BS
180
UE
182
184
110
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104
UE
120
BS
102
UE
164
UE
190
192
194
UE
152
AP
150
154
UE
104
BS
102
SC
102'
110'
100

FIG. 1

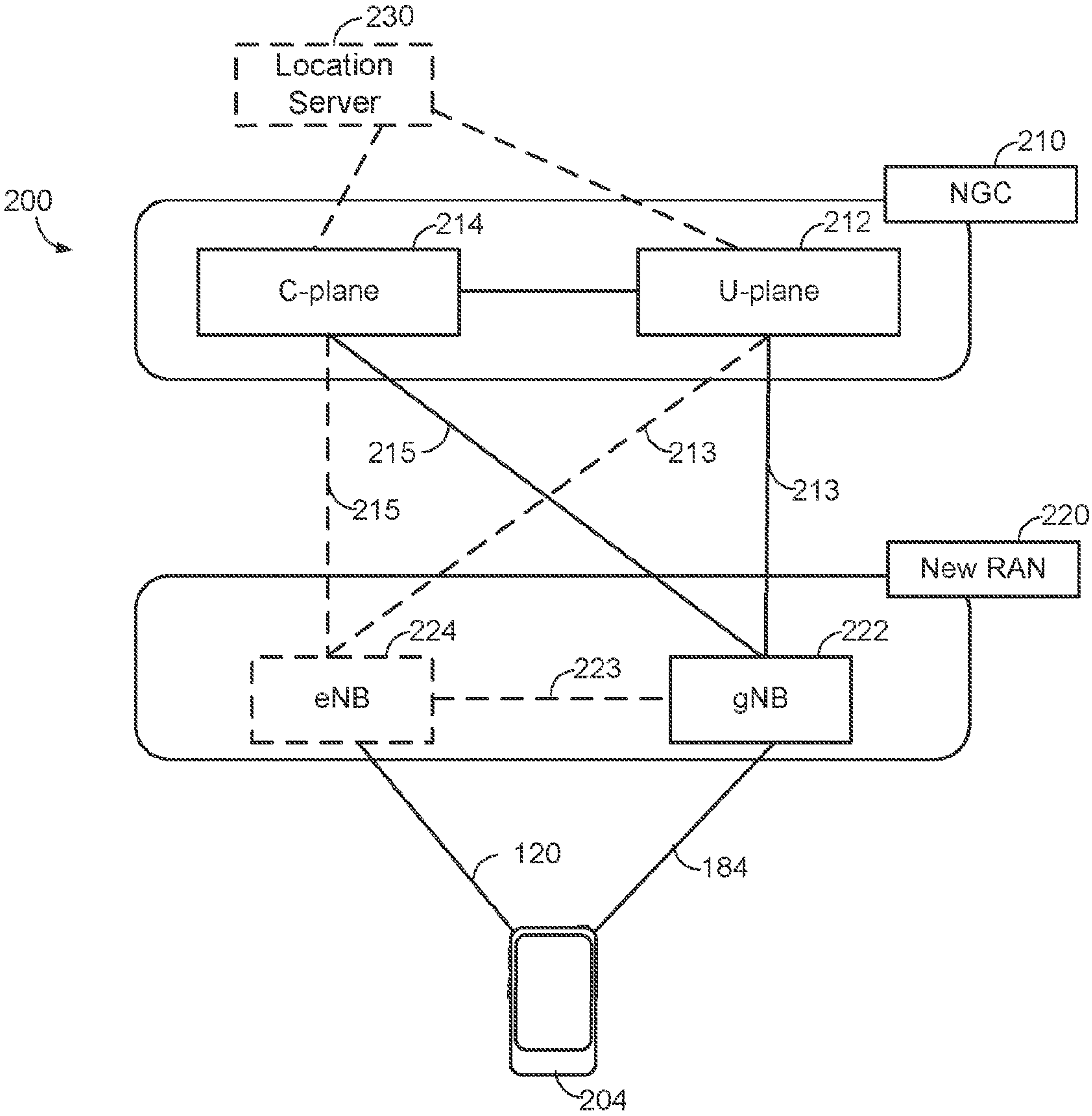
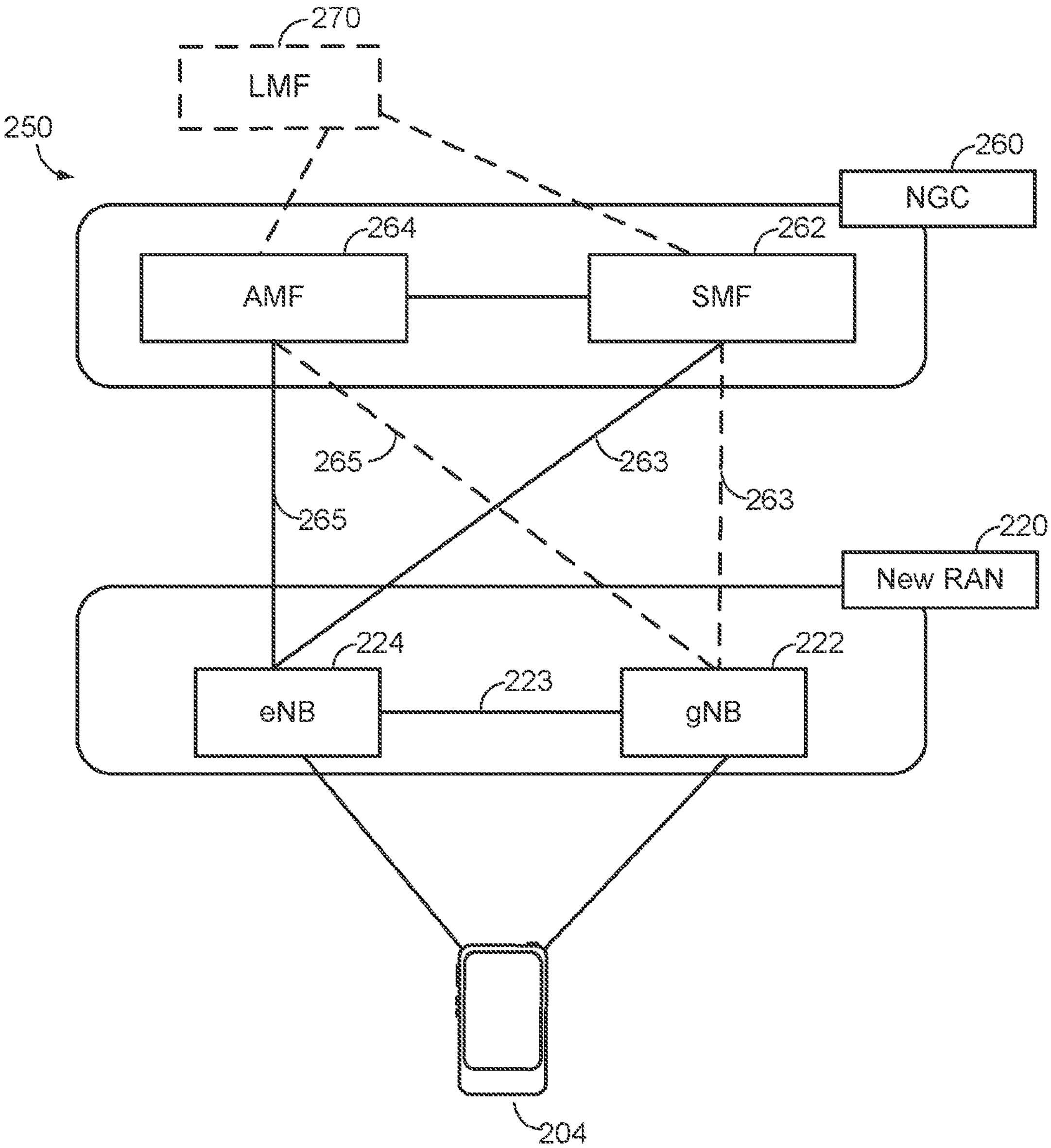

230
Location Server
210
NGC
200
214
212
C-plane
U-plane
215
213
215
213
220
New RAN
224
222
223
eNB
gNB
120
184
204

FIG. 2A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LMF
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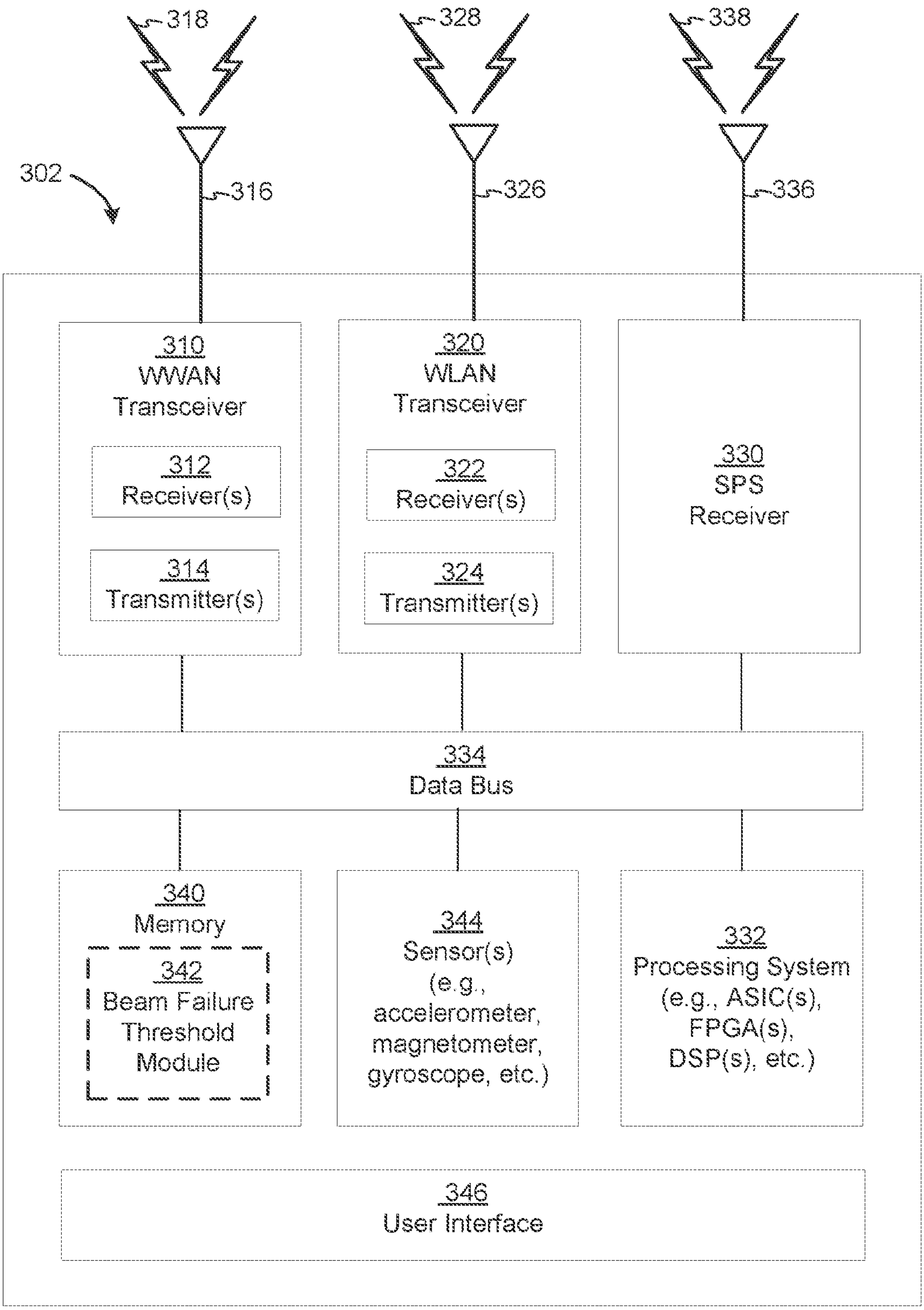
260
NGC
264
262
AMF
SMF
265
263
265
263
220
New RAN
224
222
223
eNB
gNB
204

FIG. 2B



318
328
338
302
316
326
336
310
WWAN
Transceiver
312
Receiver(s)
314
Transmitter(s)
320
WLAN
Transceiver
322
Receiver(s)
324
Transmitter(s)
330
SPS
Receiver
334
Data Bus
340
Memory
342
Beam Failure
Threshold
Module
344
Sensor(s)
(e.g.,
accelerometer,
magnetometer,
gyroscope, etc.)
332
Processing System
(e.g., ASIC(s),
FPGA(s),
DSP(s), etc.)
346
User Interface

FIG. 3A

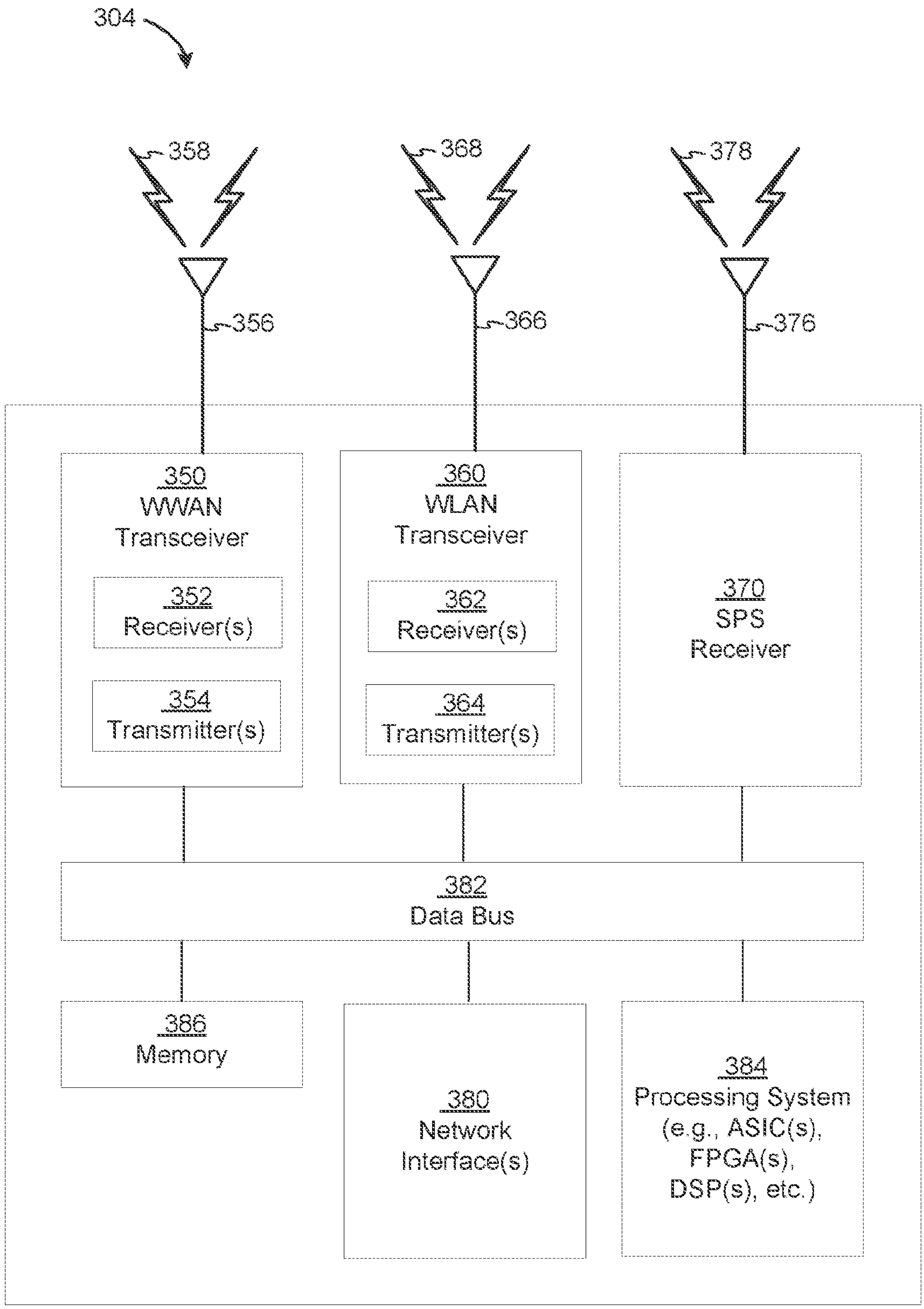

304
358
368
378
356
366
376
350
WWAN
Transceiver
352
Receiver(s)
354
Transmitter(s)
360
WLAN
Transceiver
362
Receiver(s)
364
Transmitter(s)
370
SPS
Receiver
382
Data Bus
386
Memory
380
Network
Interface(s)
384
Processing System
(e.g., ASIC(s),
FPGA(s),
DSP(s), etc.)

FIG. 3B

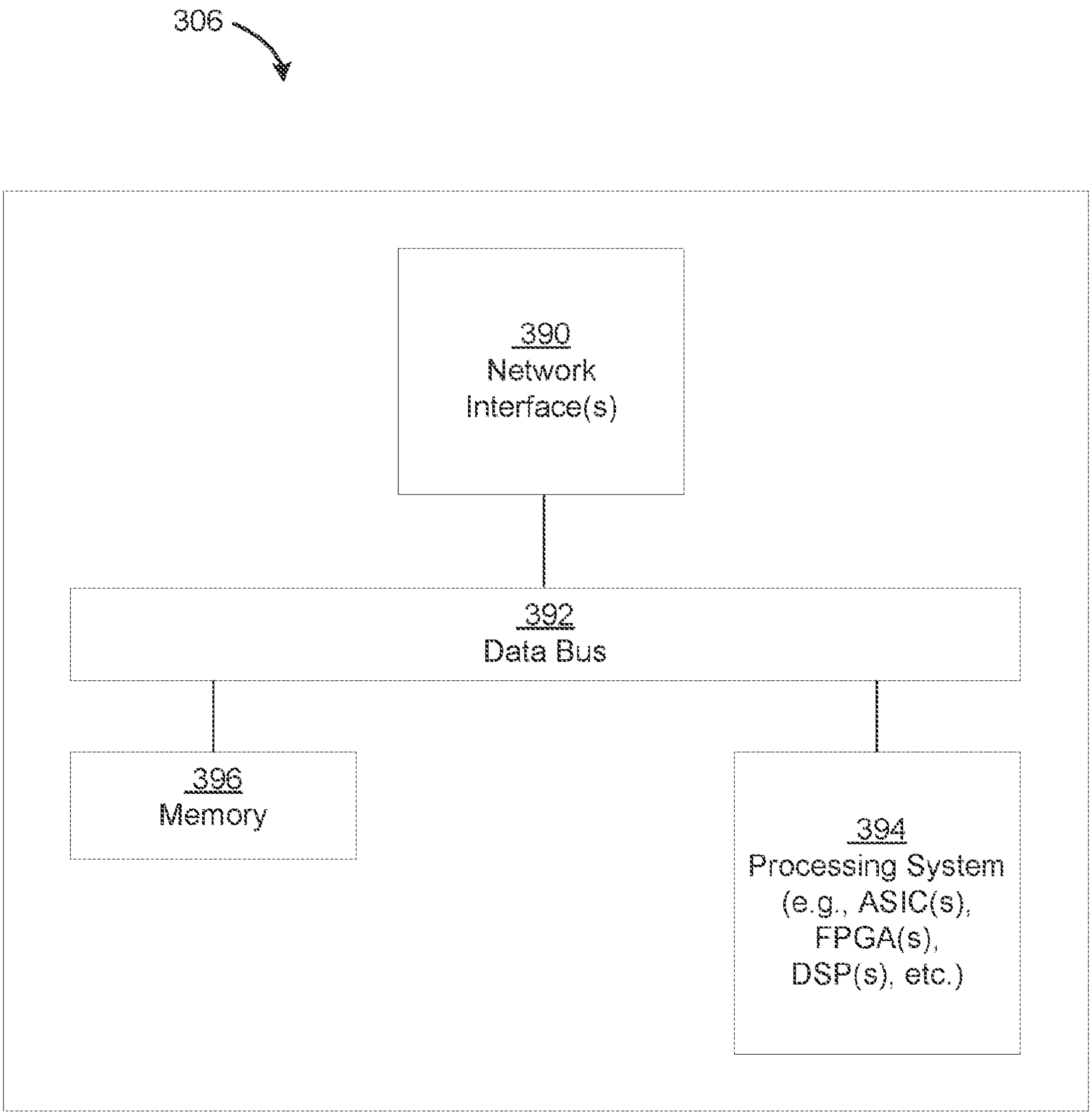

306
390
Network Interface(s)
392
Data Bus
396
Memory
394
Processing System (e.g., ASIC(s), FPGA(s), DSP(s), etc.)

FIG. 3C

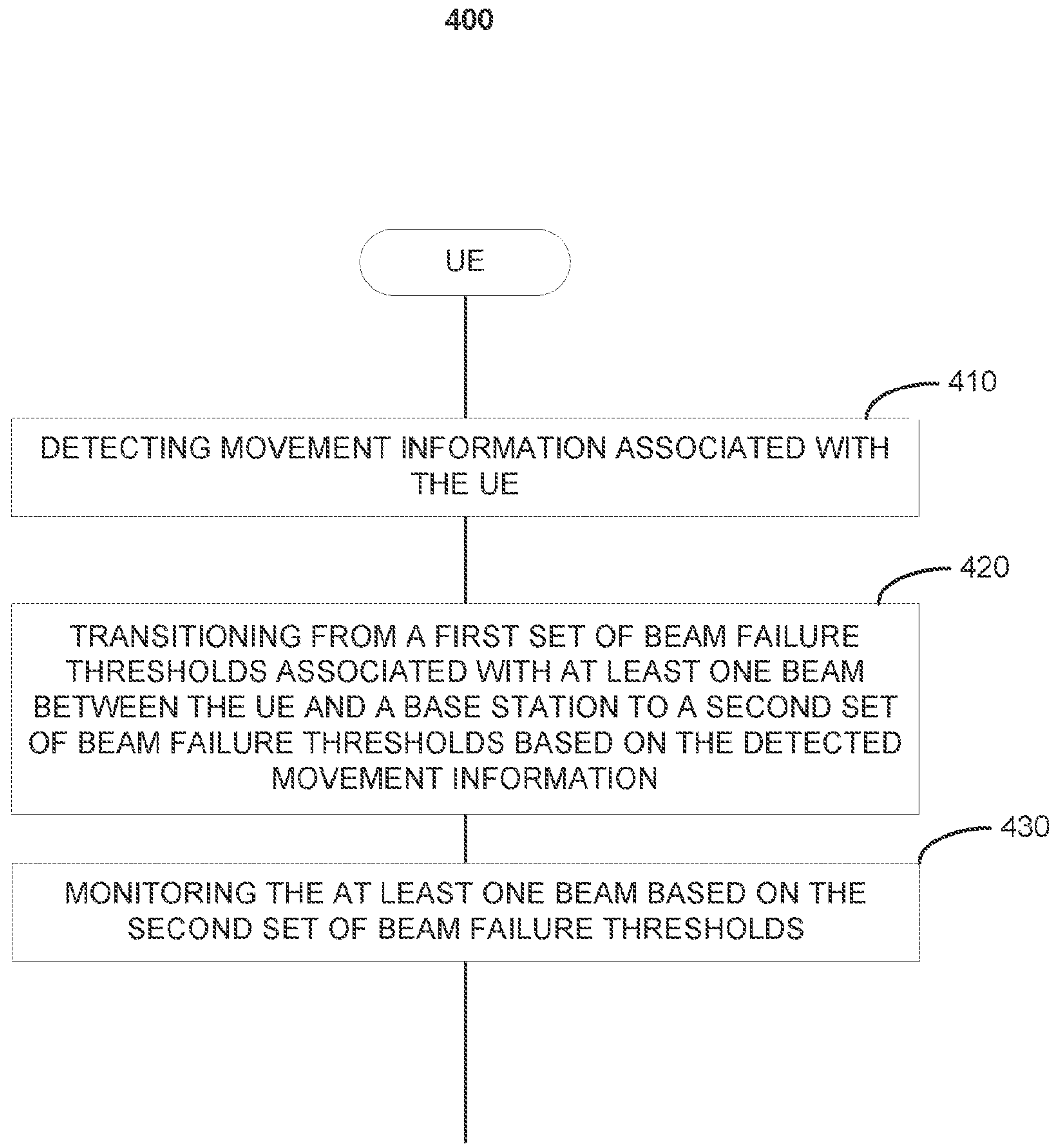

400
UE
410
DETECTING MOVEMENT INFORMATION ASSOCIATED WITH THE UE
420
TRANSITIONING FROM A FIRST SET OF BEAM FAILURE THRESHOLDS ASSOCIATED WITH AT LEAST ONE BEAM BETWEEN THE UE AND A BASE STATION TO A SECOND SET OF BEAM FAILURE THRESHOLDS BASED ON THE DETECTED MOVEMENT INFORMATION
430
MONITORING THE AT LEAST ONE BEAM BASED ON THE SECOND SET OF BEAM FAILURE THRESHOLDS

FIG. 4

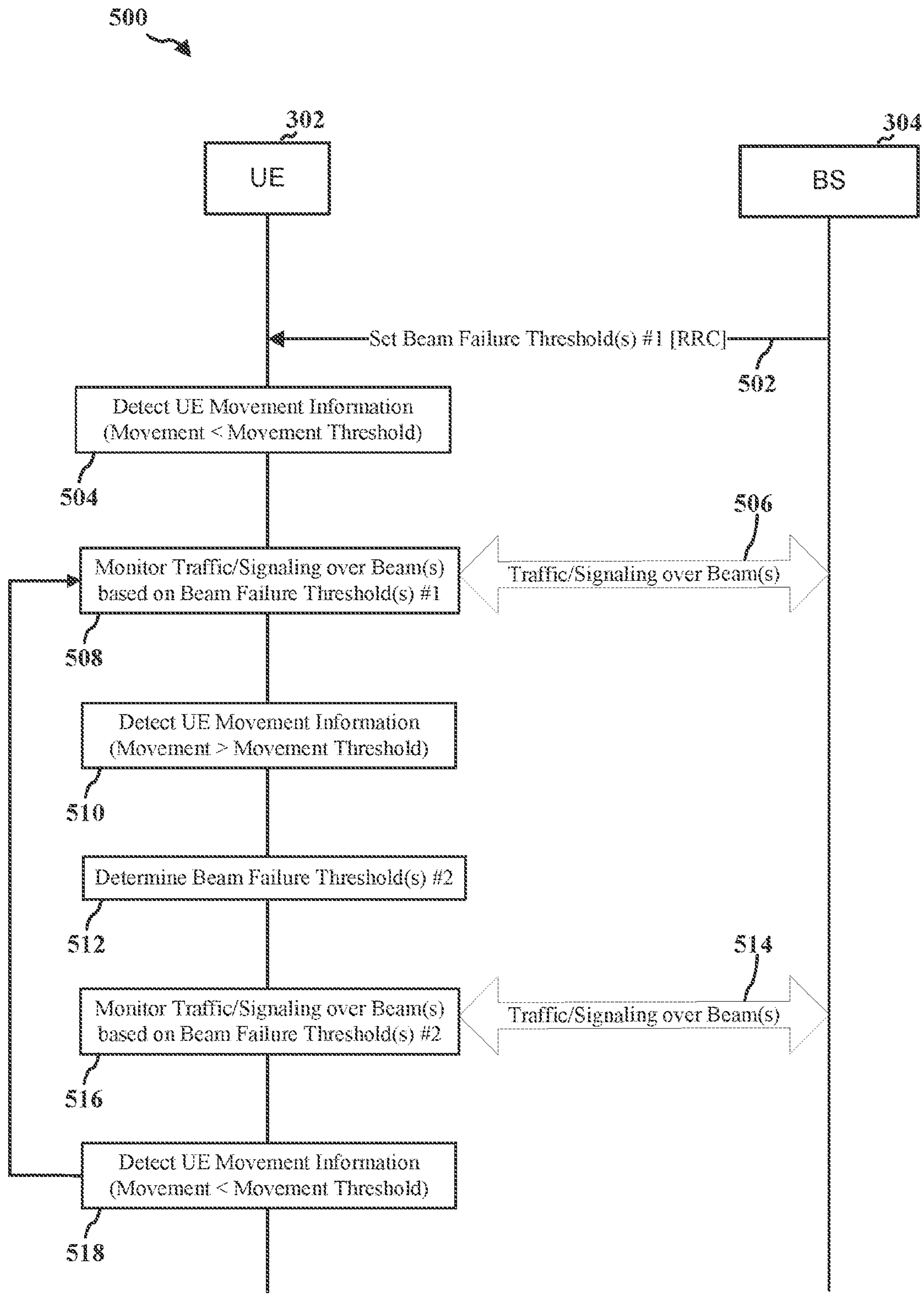

500
302
UE
304
BS
Set Beam Failure Threshold(s) #1 [RRC]
502
Detect UE Movement Information
(Movement < Movement Threshold)
504
506
Monitor Traffic/Signaling over Beam(s)
based on Beam Failure Threshold(s) #1
Traffic/Signaling over Beam(s)
508
Detect UE Movement Information
(Movement > Movement Threshold)
510
Determine Beam Failure Threshold(s) #2
512
514
Monitor Traffic/Signaling over Beam(s)
based on Beam Failure Threshold(s) #2
Traffic/Signaling over Beam(s)
516
Detect UE Movement Information
(Movement < Movement Threshold)
518

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2020/091001

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/08(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)

H04W; H04L; H04B

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)

EPTXT;USTXT;VEN;WOTXT;CNABS;CNTXT;CNKI;3GPP: beam, failure, second, change, adjust, threshold?, UE, sensor, terminal, move, movement, mobility

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2019319833 A1 (QUALCOMM INC.) 17 October 2019 (2019-10-17) claims 12 and 17, description, paragraphs [0022]-[0090]	1-30
Y	WO 2018017840 A1 (CONVIDA WIRELESS LLC) 25 January 2018 (2018-01-25) description, paragraphs [0256]-[0452]	1-30
Y	US 2020068457 A1 (HUAWEI TECHNOLOGIES CO., LTD.) 27 February 2020 (2020-02-27) description, paragraphs [0168]-[0544]	1-30
A	US 2019215863 A1 (SAMSUNG ELECTRONICS CO., LTD.) 11 July 2019 (2019-07-11) the whole document	1-30
A	WO 2019217880 A1 (CONVIDA WIRELESS LLC) 14 November 2019 (2019-11-14) the whole document	1-30

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

* Special categories of cited documents:
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- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
01 February 2021	**10 February 2021**

Name and mailing address of the ISA/CN

National Intellectual Property Administration, PRC
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088
China

Facsimile No. **(86-10)62019451**

Authorized officer

SHEN,Li

Telephone No. **86-(010)-62411421**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2020/091001

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2019319833	A1	17 October 2019	WO	2019199400	A1	17 October 2019
WO	2018017840	A1	25 January 2018	KR	20190032470	A	27 March 2019
				CN	110036677	A	19 July 2019
				JP	2019530266	A	17 October 2019
				US	2019319686	A1	17 October 2019
				US	10804989	B2	13 October 2020
				EP	3488646	A1	29 May 2019
US	2020068457	A1	27 February 2020	CN	108810922	A	13 November 2018
				BR	112019022826	A2	26 May 2020
				EP	3609225	A1	12 February 2020
				EP	3609225	A4	12 February 2020
				WO	2018201990	A1	08 November 2018
US	2019215863	A1	11 July 2019	CN	111602451	A	28 August 2020
				KR	20190085416	A	18 July 2019
				WO	2019139384	A1	18 July 2019
				EP	3721667	A1	14 October 2020
				US	10721767	B2	21 July 2020
WO	2019217880	A1	14 November 2019		None		