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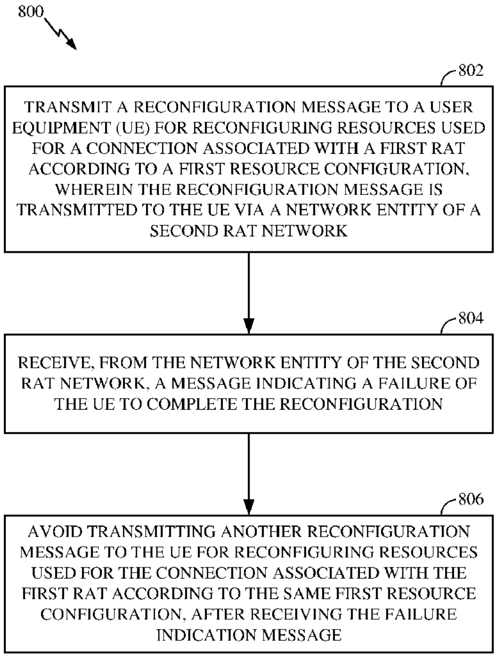

FIG. 8

(57) Abstract: Methods and apparatus for improving user experience for devices capable of dual connectivity are provided. A method includes: receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration; establishing a second connection associated with a second RAT; initiating a reconfiguration of the resources; detecting a number of failures of the reconfiguration of the resources; determining that the detected number of failures equals to or exceeds a threshold number of failures; and transmitting, based at least in part on the determination, a message to indicate a failure of the reconfiguration of the resources.

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METHOD AND APPARATUS FOR METHOD TO IMPROVE USER EXPERIENCE FOR DUAL CONNECTIVITY DEVICES

Field

[0001] The present disclosure relates generally to communication systems, and more particularly, to methods and apparatus for improving user experience for devices capable of dual connectivity.

Background

[0002] Wireless communication systems are widely deployed to provide various telecommunication services such as telephony, video, data, messaging, and broadcasts. Typical wireless communication systems may employ multiple-access technologies capable of supporting communication with multiple users by sharing available system resources (e.g., bandwidth, transmit power). Examples of such multiple-access technologies include Long Term Evolution (LTE) systems, code division multiple access (CDMA) systems, time division multiple access (TDMA) systems, frequency division multiple access (FDMA) systems, orthogonal frequency division multiple access (OFDMA) systems, single-carrier frequency division multiple access (SC-FDMA) systems, and time division synchronous code division multiple access (TD-SCDMA) systems.

[0003] In some examples, a wireless multiple-access communication system may include a number of base stations, each simultaneously supporting communication for multiple communication devices, otherwise known as user equipment (UEs). In LTE or LTE-A network, a set of one or more base stations may define an eNodeB (eNB). In other examples (e.g., in a next generation or 5G network), a wireless multiple access communication system may include a number of distributed units (DUs) (e.g., edge units (EUs), edge nodes (ENs), radio heads (RHs), smart radio heads (SRHs), transmission reception points (TRPs), etc.) in communication with a number of central units (CUs) (e.g., central nodes (CNs), access node controllers (ANCs), etc.), where a set of one or more distributed units, in communication with a central unit, may define an access node (e.g., a new radio base station (NR BS), a new radio node-B (NR NB), a network node, 5G NB, eNB, Next Generation Node B (gNB), etc.). A base station or DU may communicate with a set of UEs on downlink channels (e.g., for transmissions from a base station or to a UE) and uplink channels (e.g., for transmissions from a UE to a base station or distributed unit).

[0004] These multiple access technologies have been adopted in various telecommunication standards to provide a common protocol that enables different wireless devices to communicate on a municipal, national, regional, and even global level. An example of an emerging telecommunication standard is new radio (NR), for example, 5G radio access. NR is a set of enhancements to the LTE mobile standard promulgated by Third Generation Partnership Project (3GPP). It is designed to better support mobile broadband Internet access by improving spectral efficiency, lowering costs, improving services, making use of new spectrum, and better integrating with other open standards using OFDMA with a cyclic prefix (CP) on the downlink (DL) and on the uplink (UL) as well as support beamforming, multiple-input multiple-output (MIMO) antenna technology, and carrier aggregation.

[0005] However, as the demand for mobile broadband access continues to increase, there exists a desire for further improvements in NR technology. Preferably, these improvements should be applicable to other multi-access technologies and the telecommunication standards that employ these technologies.

BRIEF SUMMARY

[0006] The systems, methods, and devices of the disclosure each have several aspects, no single one of which is solely responsible for its desirable attributes. Without limiting the scope of this disclosure as expressed by the claims which follow, some features will now be discussed briefly. After considering this discussion, and particularly after reading the section entitled “Detailed Description” one will understand how the features of this disclosure provide advantages that include improved communications between access points and stations in a wireless network.

[0007] Certain aspects provide a method for wireless communications (e.g., that may be performed by a user equipment). The method generally includes receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration, establishing a second connection associated with a second RAT, initiating a reconfiguration of the resources used for the first connection associated with the first

RAT, detecting a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT, determining that the detected number of failures equals to or exceeds a threshold number of failures, and transmitting, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

[0008] Certain aspects provide a method for wireless communications (e.g., that may be performed by a network entity, such as a base station). The method generally includes transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network, receiving, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration, and avoiding transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

[0009] Aspects generally include methods, apparatus, systems, computer readable mediums, and processing systems, as substantially described herein with reference to and as illustrated by the accompanying drawings.

[0010] To the accomplishment of the foregoing and related ends, the one or more aspects comprise the features hereinafter fully described and particularly pointed out in the claims. The following description and the annexed drawings set forth in detail certain illustrative features of the one or more aspects. These features are indicative, however, of but a few of the various ways in which the principles of various aspects may be employed, and this description is intended to include all such aspects and their equivalents.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] So that the manner in which the above-recited features of the present disclosure can be understood in detail, a more particular description, briefly summarized above, may be had by reference to aspects, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only certain typical aspects of this disclosure and are therefore not to be considered limiting of its scope, for the description may admit to other equally effective aspects.

[0012] FIG. 1 is a block diagram conceptually illustrating an example telecommunications system, in which aspects of the present disclosure may be performed.

[0013] FIG. 2 is a block diagram illustrating an example logical architecture of a distributed RAN, in accordance with certain aspects of the present disclosure.

[0014] FIG. 3 is a diagram illustrating an example physical architecture of a distributed RAN, in accordance with certain aspects of the present disclosure.

[0015] FIG. 4 is a block diagram conceptually illustrating a design of an example BS and user equipment (UE), in accordance with certain aspects of the present disclosure.

[0016] FIG. 5 is a diagram showing examples for implementing a communication protocol stack, in accordance with certain aspects of the present disclosure.

[0017] FIG. 6 is a call flow diagram illustrating an example of failure scenario that may be addressed in accordance with certain aspects of the present disclosure.

[0018] FIG. 7 illustrates example operations for wireless communications (e.g., by a UE), in accordance with aspects of the present disclosure.

[0019] FIG. 8 illustrates example operations for wireless communications (e.g., by a network entity, such as a base station), in accordance with aspects of the present disclosure.

[0020] FIG. 9 is a call flow diagram illustrating how certain aspects of the present disclosure may address an example failure scenario.

[0021] FIG. 10 illustrates a communications device that may include various components configured to perform operations for the techniques disclosed herein in accordance with aspects of the present disclosure.

[0022] FIG. 11 illustrates a communications device that may include various components configured to perform operations for the techniques disclosed herein in accordance with aspects of the present disclosure.

[0023] To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures. It is contemplated that elements disclosed in one aspect may be beneficially utilized on other aspects without specific recitation.

DETAILED DESCRIPTION

[0024] Aspects of the present disclosure provide apparatus, methods, processing systems, and computer readable mediums for new radio (NR) (new radio access technology or 5G technology).

[0025] NR may support various wireless communication services, such as Enhanced mobile broadband (eMBB) targeting wide bandwidth (e.g. 80 MHz beyond), millimeter wave (mmW) targeting high carrier frequency (e.g. 60 GHz), massive MTC (mMTC) targeting non-backward compatible MTC techniques, and/or mission critical targeting ultra-reliable low latency communications (URLLC). These services may include latency and reliability requirements. These services may also have different transmission time intervals (TTI) to meet respective quality of service (QoS) requirements. In addition, these services may co-exist in the same subframe.

[0026] The following description provides examples, and is not limiting of the scope, applicability, or examples set forth in the claims. Changes may be made in the function and arrangement of elements discussed without departing from the scope of the disclosure. Various examples may omit, substitute, or add various procedures or components as appropriate. For instance, the methods described may be performed in an order different from that described, and various steps may be added, omitted, or combined. Also, features described with respect to some examples may be combined in some other examples. For example, an apparatus may be implemented or a method may be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method which is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the disclosure set forth herein. It should be understood that any aspect of the disclosure disclosed herein may be embodied by one or more elements of a claim. The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any aspect described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other aspects.

[0027] The techniques described herein may be used for various wireless communication networks such as LTE, CDMA, TDMA, FDMA, OFDMA, SC-FDMA and other networks. The terms “network” and “system” are often used interchangeably. A CDMA network may implement a radio technology such as Universal Terrestrial Radio Access (UTRA), cdma2000, etc. UTRA includes Wideband CDMA (WCDMA) and other variants of CDMA. cdma2000 covers IS-2000, IS-95 and IS-856 standards. A TDMA network may implement a radio technology such as Global System for Mobile Communications (GSM). An OFDMA network may implement a radio technology such as NR (e.g. 5G RA), Evolved UTRA (E-UTRA), Ultra Mobile Broadband (UMB), IEEE 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, Flash-OFDMA, etc. UTRA and E-UTRA are part of Universal Mobile Telecommunication System (UMTS). NR is an emerging wireless communications technology under development in conjunction with the 5G Technology Forum (5GTF). 3GPP Long Term Evolution (LTE) and LTE-Advanced (LTE-A) are releases of UMTS that use E-UTRA. UTRA, E-UTRA, UMTS, LTE, LTE-A and GSM are described in documents from an organization named “3rd Generation Partnership Project” (3GPP). cdma2000 and UMB are described in documents from an organization named “3rd Generation Partnership Project 2” (3GPP2). “LTE” refers generally to LTE, LTE-Advanced (LTE-A), LTE in an unlicensed spectrum (LTE-whitespace), etc. The techniques described herein may be used for the wireless networks and radio technologies mentioned above as well as other wireless networks and radio technologies. For clarity, while aspects may be described herein using terminology commonly associated with 3G and/or 4G wireless technologies, aspects of the present disclosure can be applied in other generation-based communication systems, such as 5G and later, including NR technologies.

[0028] FIG. 1 illustrates an example wireless network 100, such as a new radio (NR) or 5G network, in which aspects of the present disclosure may be performed. For example, a UE 120 may monitor a number of network failure events (e.g., triggered by failure to support a specified resource configuration) network entity and send a reconfiguration-triggered failure message 150 to the network. As will be described in greater detail below, such a failure message may help break a "dead-loop" in which the UE repeatedly experiences a failure (which may negatively impact user experience).

[0029] As illustrated in FIG. 1, the wireless network 100 may include a number of BSs 110 and other network entities. A BS may be a station that communicates with UEs. Each BS 110 may provide communication coverage for a particular geographic area. In 3GPP, the term "cell" can refer to a coverage area of a Node B and/or a Node B subsystem serving this coverage area, depending on the context in which the term is used. In NR systems, the term "cell" and eNB, Node B, 5G NB, AP, NR BS, NR BS, gNB, or TRP may be interchangeable. In some examples, a cell may not necessarily be stationary, and the geographic area of the cell may move according to the location of a mobile base station. In some examples, the base stations may be interconnected to one another and/or to one or more other base stations or network nodes (not shown) in the wireless network 100 through various types of backhaul interfaces such as a direct physical connection, a virtual network, or the like using any suitable transport network.

[0030] In general, any number of wireless networks may be deployed in a given geographic area. Each wireless network may support a particular radio access technology (RAT) and may operate on one or more frequencies. A RAT may also be referred to as a radio technology, an air interface, etc. A frequency may also be referred to as a carrier, a frequency channel, etc. Each frequency may support a single RAT in a given geographic area in order to avoid interference between wireless networks of different RATs. In some cases, NR or 5G RAT networks may be deployed.

[0031] A BS may provide communication coverage for a macro cell, a pico cell, a femto cell, and/or other types of cell. A macro cell may cover a relatively large geographic area (e.g., several kilometers in radius) and may allow unrestricted access by UEs with service subscription. A pico cell may cover a relatively small geographic area and may allow unrestricted access by UEs with service subscription. A femto cell may cover a relatively small geographic area (e.g., a home) and may allow restricted access by UEs having association with the femto cell (e.g., UEs in a Closed Subscriber Group (CSG), UEs for users in the home, etc.). A BS for a macro cell may be referred to as a macro BS. A BS for a pico cell may be referred to as a pico BS. A BS for a femto cell may be referred to as a femto BS or a home BS. In the example shown in FIG. 1, the

BSs 110a, 110b and 110c may be macro BSs for the macro cells 102a, 102b and 102c, respectively. The BS 110x may be a pico BS for a pico cell 102x. The BSs 110y and 110z may be femto BS for the femto cells 102y and 102z, respectively. A BS may support one or multiple (e.g., three) cells.

[0032] The wireless network 100 may also include relay stations. A relay station is a station that receives a transmission of data and/or other information from an upstream station (e.g., a BS or a UE) and sends a transmission of the data and/or other information to a downstream station (e.g., a UE or a BS). A relay station may also be a UE that relays transmissions for other UEs. In the example shown in FIG. 1, a relay station 110r may communicate with the BS 110a and a UE 120r in order to facilitate communication between the BS 110a and the UE 120r. A relay station may also be referred to as a relay BS, a relay, etc.

[0033] The wireless network 100 may be a heterogeneous network that includes BSs of different types, e.g., macro BS, pico BS, femto BS, relays, etc. These different types of BSs may have different transmit power levels, different coverage areas, and different impact on interference in the wireless network 100. For example, macro BS may have a high transmit power level (e.g., 20 Watts) whereas pico BS, femto BS, and relays may have a lower transmit power level (e.g., 1 Watt).

[0034] The wireless network 100 may support synchronous or asynchronous operation. For synchronous operation, the BSs may have similar frame timing, and transmissions from different BSs may be approximately aligned in time. For asynchronous operation, the BSs may have different frame timing, and transmissions from different BSs may not be aligned in time. The techniques described herein may be used for both synchronous and asynchronous operation.

[0035] A network controller 130 may be coupled to a set of BSs and provide coordination and control for these BSs. The network controller 130 may communicate with the BSs 110 via a backhaul. The BSs 110 may also communicate with one another, e.g., directly or indirectly via wireless or wireline backhaul.

[0036] The UEs 120 (e.g., 120x, 120y, etc.) may be dispersed throughout the wireless network 100, and each UE may be stationary or mobile. A UE may also be referred to as a mobile station, a terminal, an access terminal, a subscriber unit, a station, a

Customer Premises Equipment (CPE), a cellular phone, a smart phone, a personal digital assistant (PDA), a wireless modem, a wireless communication device, a handheld device, a laptop computer, a cordless phone, a wireless local loop (WLL) station, a tablet, a camera, a gaming device, a netbook, a smartbook, an ultrabook, a medical device or medical equipment, a healthcare device, a biometric sensor/device, a wearable device such as a smart watch, smart clothing, smart glasses, virtual reality goggles, a smart wrist band, smart jewelry (e.g., a smart ring, a smart bracelet, etc.), an entertainment device (e.g., a music device, a video device, a satellite radio, etc.), a vehicular component or sensor, a smart meter/sensor, a robot, a drone, industrial manufacturing equipment, a positioning device (e.g., GPS, Beidou, terrestrial), or any other suitable device that is configured to communicate via a wireless or wired medium. Some UEs may be considered machine-type communication (MTC) devices or evolved MTC (eMTC) devices, which may include remote devices that may communicate with a base station, another remote device, or some other entity. Machine type communications (MTC) may refer to communication involving at least one remote device on at least one end of the communication and may include forms of data communication which involve one or more entities that do not necessarily need human interaction. MTC UEs may include UEs that are capable of MTC communications with MTC servers and/or other MTC devices through Public Land Mobile Networks (PLMN), for example. MTC and eMTC UEs include, for example, robots, drones, remote devices, sensors, meters, monitors, cameras, location tags, etc., that may communicate with a BS, another device (e.g., remote device), or some other entity. A wireless node may provide, for example, connectivity for or to a network (e.g., a wide area network such as Internet or a cellular network) via a wired or wireless communication link. MTC UEs, as well as other UEs, may be implemented as Internet-of-Things (IoT) devices, e.g., narrowband IoT (NB-IoT) devices.

[0037] In FIG. 1, a solid line with double arrows indicates desired transmissions between a UE and a serving BS, which is a BS designated to serve the UE on the downlink and/or uplink. A dashed line with double arrows indicates interfering transmissions between a UE and a BS.

[0038] Certain wireless networks (e.g., LTE) utilize orthogonal frequency division multiplexing (OFDM) on the downlink and single-carrier frequency division multiplexing (SC-FDM) on the uplink. OFDM and SC-FDM partition the system bandwidth into multiple (K) orthogonal subcarriers, which are also commonly referred to as tones, bins, etc. Each subcarrier may be modulated with data. In general, modulation symbols are sent in the frequency domain with OFDM and in the time domain with SC-FDM. The spacing between adjacent subcarriers may be fixed, and the total number of subcarriers (K) may be dependent on the system bandwidth. For example, the spacing of the subcarriers may be 15 kHz and the minimum resource allocation (called a 'resource block') may be 12 subcarriers (or 180 kHz). Consequently, the nominal FFT size may be equal to 128, 256, 512, 1024 or 2048 for system bandwidth of 1.25, 2.5, 5, 10 or 20 megahertz (MHz), respectively. The system bandwidth may also be partitioned into subbands. For example, a subband may cover 1.08 MHz (e.g., 6 resource blocks), and there may be 1, 2, 4, 8 or 16 subbands for system bandwidth of 1.25, 2.5, 5, 10 or 20 MHz, respectively.

[0039] While aspects of the examples described herein may be associated with LTE technologies, aspects of the present disclosure may be applicable with other wireless communications systems, such as NR. NR may utilize OFDM with a CP on the uplink and downlink and include support for half-duplex operation using time division duplex (TDD). A single component carrier bandwidth of 100 MHz may be supported. NR resource blocks may span 12 sub-carriers with a sub-carrier bandwidth of 75 kHz over a 0.1 ms duration. Each radio frame may consist of 50 subframes with a length (period) of 10 ms. Consequently, each subframe may have a length of 0.2 ms. In some cases, subframes may have a length (duration) of 1ms and each subframe may be further divided into two slots of .5ms each (e.g., with each slot containing 6 or 7 OFDM symbols depending on cyclic prefix (CP) length. A slot may be further divided into mini-slots, each mini-slot having a smaller duration (e.g., containing fewer symbols than a full slot). Each subframe may indicate a link direction (e.g., DL or UL) for data transmission and the link direction for each subframe may be dynamically switched. Each subframe may include DL/UL data as well as DL/UL control data. Beamforming may be supported and beam direction may be dynamically configured. MIMO transmissions with precoding may also be supported. MIMO configurations in the DL may support up to 8 transmit antennas with multi-layer DL transmissions up to 8 streams and up to 2 streams per UE. Multi-layer transmissions with up to 2 streams per UE may be supported. Aggregation of multiple cells may be supported with up to 8 serving cells. Alternatively, NR may support a different air interface, other than an OFDM-based. NR networks may include entities such CUs and/or DUs.

[0040] In some examples, access to the air interface may be scheduled, wherein a scheduling entity (e.g., a base station) allocates resources for communication among some or all devices and equipment within its service area or cell. Within the present disclosure, as discussed further below, the scheduling entity may be responsible for scheduling, assigning, reconfiguring, and releasing resources for one or more subordinate entities. That is, for scheduled communication, subordinate entities utilize resources allocated by the scheduling entity. Base stations are not the only entities that may function as a scheduling entity. That is, in some examples, a UE may function as a scheduling entity, scheduling resources for one or more subordinate entities (e.g., one or more other UEs). In this example, the UE is functioning as a scheduling entity, and other UEs utilize resources scheduled by the UE for wireless communication. A UE may function as a scheduling entity in a peer-to-peer (P2P) network, and/or in a mesh network. In a mesh network example, UEs may optionally communicate directly with one another in addition to communicating with the scheduling entity.

[0041] Thus, in a wireless communication network with a scheduled access to time–frequency resources and having a cellular configuration, a P2P configuration, and a mesh configuration, a scheduling entity and one or more subordinate entities may communicate utilizing the scheduled resources.

[0042] As noted above, a RAN may include a CU and DUs. A NR BS (e.g., eNB, 5G Node B, Node B, transmission reception point (TRP), access point (AP)) may correspond to one or multiple BSs. NR cells can be configured as access cell (ACells) or data only cells (DCells). For example, the RAN (e.g., a central unit or distributed unit) can configure the cells. DCells may be cells used for carrier aggregation or dual connectivity, but not used for initial access, cell selection/reselection, or handover. In some cases DCells may not transmit synchronization signals—in some case cases DCells may transmit SS. NR BSs may transmit downlink signals to UEs indicating the cell type. Based on the cell type indication, the UE may communicate with the NR BS. For example, the UE may determine NR BSs to consider for cell selection, access, handover, and/or measurement based on the indicated cell type.

[0043] FIG. 2 illustrates an example logical architecture of a distributed radio access network (RAN) 200, which may be implemented in the wireless communication system illustrated in FIG. 1. A 5G access node 206 may include an access node controller (ANC) 202. The ANC may be a central unit (CU) of the distributed RAN 200. The backhaul interface to the next generation core network (NG-CN) 204 may terminate at the ANC. The backhaul interface to neighboring next generation access nodes (NG-ANs) may terminate at the ANC. The ANC may include one or more TRPs 208 (which may also be referred to as BSs, NR BSs, Node Bs, 5G NBs, APs, gNBs, or some other term). As described above, a TRP may be used interchangeably with "cell."

[0044] The TRPs 208 may be a DU. The TRPs may be connected to one ANC (ANC 202) or more than one ANC (not illustrated). For example, for RAN sharing, radio as a service (RaaS), and service specific AND deployments, the TRP may be connected to more than one ANC. A TRP may include one or more antenna ports. The TRPs may be configured to individually (e.g., dynamic selection) or jointly (e.g., joint transmission) serve traffic to a UE.

[0045] The local architecture 200 may be used to illustrate fronthaul definition. The architecture may be defined that support fronthauling solutions across different deployment types. For example, the architecture may be based on transmit network capabilities (e.g., bandwidth, latency, and/or jitter).

[0046] The architecture may share features and/or components with LTE. According to aspects, the next generation AN (NG-AN) 210 may support dual connectivity with NR. The NG-AN may share a common fronthaul for LTE and NR.

[0047] The architecture may enable cooperation between and among TRPs 208. For example, cooperation may be preset within a TRP and/or across TRPs via the ANC 202. According to aspects, no inter-TRP interface may be needed/present.

[0048] According to aspects, a dynamic configuration of split logical functions may be present within the architecture 200. As will be described in more detail with reference to FIG. 5, the Radio Resource Control (RRC) layer, Packet Data Convergence Protocol (PDCP) layer, Radio Link Control (RLC) layer, Medium Access Control (MAC) layer, and a Physical (PHY) layers may be adaptably placed at the DU or CU (e.g., TRP or ANC, respectively). According to certain aspects, a BS may include a central unit (CU) (e.g., ANC 202) and/or one or more distributed units (e.g., one or more TRPs 208).

[0049] FIG. 3 illustrates an example physical architecture of a distributed RAN 300, according to aspects of the present disclosure. A centralized core network unit (C-CU) 302 may host core network functions. The C-CU may be centrally deployed. C-CU functionality may be offloaded (e.g., to advanced wireless services (AWS)), in an effort to handle peak capacity.

[0050] A centralized RAN unit (C-RU) 304 may host one or more ANC functions. Optionally, the C-RU may host core network functions locally. The C-RU may have distributed deployment. The C-RU may be closer to the network edge.

[0051] A DU 306 may host one or more TRPs (edge node (EN), an edge unit (EU), a radio head (RH), a smart radio head (SRH), or the like). The DU may be located at edges of the network with radio frequency (RF) functionality.

[0052] FIG. 4 illustrates example components of the BS 110 and UE 120 illustrated in FIG. 1, which may be used to implement aspects of the present disclosure. As described above, the BS may include a TRP. One or more components of the BS 110 and UE 120 may be used to practice aspects of the present disclosure. For example, antennas 452, processors 466, 458, 464, and/or controller/processor 480 (used to implement transceiver or separate receiver and transmitter chain functions) of the UE 120 and/or antennas 434, processors 430, 420, 438, and/or controller/processor 440 of the BS 110 may be used to perform the operations described herein and illustrated with reference to FIGs. 7 and 8.

[0053] FIG. 4 shows a block diagram of a design of a BS 110 and a UE 120, which may be one of the BSs and one of the UEs in FIG. 1. For a restricted association scenario, the base station 110 may be the macro BS 110c in FIG. 1, and the UE 120 may be the UE 120y. The base station 110 may also be a base station of some other type. The base station 110 may be equipped with antennas 434a through 434t, and the UE 120 may be equipped with antennas 452a through 452r.

[0054] At the base station 110, a transmit processor 420 may receive data from a data source 412 and control information from a controller/processor 440. The control information may be for the Physical Broadcast Channel (PBCH), Physical Control Format Indicator Channel (PCFICH), Physical Hybrid ARQ Indicator Channel (PHICH), Physical Downlink Control Channel (PDCCH), etc. The data may be for the Physical Downlink Shared Channel (PDSCH), etc. The processor 420 may process (e.g., encode and symbol map) the data and control information to obtain data symbols and control symbols, respectively. The processor 420 may also generate reference symbols, e.g., for the PSS, SSS, and cell-specific reference signal. A transmit (TX) multiple-input multiple-output (MIMO) processor 430 may perform spatial processing (e.g., precoding) on the data symbols, the control symbols, and/or the reference symbols, if applicable, and may provide output symbol streams to the modulators (MODs) 432a through 432t. For example, the TX MIMO processor 430 may perform certain aspects described herein for RS multiplexing. Each modulator 432 may process a respective output symbol stream (e.g., for OFDM, etc.) to obtain an output sample stream. Each modulator 432 may further process (e.g., convert to analog, amplify, filter, and upconvert) the output sample stream to obtain a downlink signal. Downlink signals from modulators 432a through 432t may be transmitted via the antennas 434a through 434t, respectively.

[0055] At the UE 120, the antennas 452a through 452r may receive the downlink signals from the base station 110 and may provide received signals to the demodulators (DEMODs) 454a through 454r, respectively. Each demodulator 454 may condition (e.g., filter, amplify, downconvert, and digitize) a respective received signal to obtain input samples. Each demodulator 454 may further process the input samples (e.g., for OFDM, etc.) to obtain received symbols. A MIMO detector 456 may obtain received symbols from all the demodulators 454a through 454r, perform MIMO detection on the received symbols if applicable, and provide detected symbols. For example, MIMO detector 456 may provide detected RS transmitted using techniques described herein. A receive processor 458 may process (e.g., demodulate, deinterleave, and decode) the detected symbols, provide decoded data for the UE 120 to a data sink 460, and provide decoded control information to a controller/processor 480. According to one or more cases, CoMP aspects can include providing the antennas, as well as some Tx/Rx functionalities, such that they reside in distributed units. For example, some Tx/Rx processings can be done in the central unit, while other processing can be done at the distributed units. For example, in accordance with one or more aspects as shown in the diagram, the BS mod/demod 432 may be in the distributed units.

[0056] On the uplink, at the UE 120, a transmit processor 464 may receive and process data (e.g., for the Physical Uplink Shared Channel (PUSCH)) from a data source 462 and control information (e.g., for the Physical Uplink Control Channel (PUCCH) from the controller/processor 480. The transmit processor 464 may also generate reference symbols for a reference signal. The symbols from the transmit processor 464 may be precoded by a TX MIMO processor 466 if applicable, further processed by the demodulators 454a through 454r (e.g., for SC-FDM, etc.), and transmitted to the base station 110. At the BS 110, the uplink signals from the UE 120 may be received by the antennas 434, processed by the modulators 432, detected by a MIMO detector 436 if applicable, and further processed by a receive processor 438 to obtain decoded data and control information sent by the UE 120. The receive processor 438 may provide the decoded data to a data sink 439 and the decoded control information to the controller/processor 440.

[0057] The controllers/processors 440 and 480 may direct the operation at the base station 110 and the UE 120, respectively. The processor 440 and/or other processors and modules at the base station 110 may perform or direct the processes for the techniques described herein. The processor 480 and/or other processors and modules at the UE 120 may also perform or direct processes for the techniques described herein. The memories 442 and 482 may store data and program codes for the BS 110 and the UE 120, respectively. A scheduler 444 may schedule UEs for data transmission on the downlink and/or uplink.

[0058] FIG. 5 illustrates a diagram 500 showing examples for implementing a communications protocol stack, according to aspects of the present disclosure. The illustrated communications protocol stacks may be implemented by devices operating in a in a 5G system (e.g., a system that supports uplink-based mobility). Diagram 500 illustrates a communications protocol stack including a Radio Resource Control (RRC) layer 510, a Packet Data Convergence Protocol (PDCP) layer 515, a Radio Link Control (RLC) layer 520, a Medium Access Control (MAC) layer 525, and a Physical (PHY) layer 530. In various examples the layers of a protocol stack may be implemented as separate modules of software, portions of a processor or ASIC, portions of non-collocated devices connected by a communications link, or various combinations thereof. Collocated and non-collocated implementations may be used, for example, in a protocol stack for a network access device (e.g., ANs, CUs, and/or DUs) or a UE.

[0059] A first option 505-a shows a split implementation of a protocol stack, in which implementation of the protocol stack is split between a centralized network access device (e.g., an ANC 202 in FIG. 2) and distributed network access device (e.g., DU 208 in FIG. 2). In the first option 505-a, an RRC layer 510 and a PDCP layer 515 may be implemented by the central unit, and an RLC layer 520, a MAC layer 525, and a PHY layer 530 may be implemented by the DU. In various examples the CU and the DU may be collocated or non-collocated. The first option 505-a may be useful in a macro cell, micro cell, or pico cell deployment.

[0060] A second option 505-b shows a unified implementation of a protocol stack, in which the protocol stack is implemented in a single network access device (e.g., access node (AN), new radio base station (NR BS), a new radio Node-B (NR NB), a network node (NN), or the like.). In the second option, the RRC layer 510, the PDCP layer 515, the RLC layer 520, the MAC layer 525, and the PHY layer 530 may each be implemented by the AN. The second option 505-b may be useful in a femto cell deployment.

[0061] Regardless of whether a network access device implements part or all of a protocol stack, a UE may implement an entire protocol stack (e.g., the RRC layer 510, the PDCP layer 515, the RLC layer 520, the MAC layer 525, and the PHY layer 530).

[0062] In some cases, to achieve the objectives of NR described above, a UE may be configured support dual connectivity, for 4G and NR/5G for the illustrated examples. This type of dual connectivity (DC) is generally referred to as E-UTRA/NR DC (ENDC). For ENDC devices, a UE should support simultaneous connection to 4G and 5GNR together.

[0063] For ENDC devices, there are certain scenarios that may prompt a series of failures that can negatively impact user experience. For example, a UE with ongoing packet-switched (PS) services on an LTE network, may receive an RRC connection reconfiguration (RRCConnectionReconfiguration) from the NR network to configure NR resources. For various reasons, the UE may not be able to successfully perform the reconfiguration and further attempts at this procedure may lead to repeat radio link failures (RLFs) and repeated connection reestablishment (RRCConnectionReestablishment) procedure attempts. This will result in suspension of the LTE side data service and result in a greatly diminished user experience.

[0064] FIG. 6 is a call flow diagram illustrating an example of the failure scenario described above. As illustrated, a UE may be participating in ongoing PS service via the LTE RAT. At 610, the NR network (via the gNB) may request a resource modification, relayed by the LTE network (via the eNB) via an RRCConnectionReconfiguration to (re-)configure the NR resources.

[0065] As illustrated, after the UE starts to perform the reconfiguration procedure, this reconfiguration could fail for many reasons (e.g., because of an invalid configuration or some feature not supported by the UE). For all such reasons, the UE side would trigger a radio link failure (RLF) and the UE begins to perform a connection reestablishment (RRCConnectionReestablishment) procedure.

[0066] As part of this procedure, at 620, the UE may send an RRCConnectionReestablishmentRequest message to the network side. The network side may accept the reestablishment request and send an RRCConnectionReestablishment message to the UE, at 625. At 630, the UE sends a connection reestablishment complete (RRCConnectionReestablishmentComplete) message to the network.

[0067] Unfortunately, after the reestablishment procedure is complete, the network may send same (NR) RRCConnectionReconfiguration message, at 610. Thus, steps 615 through 630 may be repeated (again and again), which may lead, for example, to a disruption of the PS service (e.g., an end to a VoLTE call, termination of a streamed video, or the like) even if the LTE side radio condition is sufficiently good to support the PS service. This scenario may continue to repeat, in a condition referred to as a "dead loop."

[0068] While standard specification documents describe reconfiguration procedures, they fail to address the dead loop scenario described above. For example, 3GPP Technical Specification (TS) 36.331, Section 5.3.5.5 addresses a Reconfiguration failure but only specifies that if the UE is unable to comply with (part of) the configuration included in the RRCConnectionReconfiguration message, the UE is to continue using the configuration used prior to the reception of RRCConnectionReconfiguration message. This section also specifies that if security has not been activated, the UE is to perform the actions upon leaving RRC_CONNECTED (as specified in Section 5.3.12 of TS 36.331), with the release cause "other" or, if security has not been activated, the UE is to initiate the connection re-establishment procedure (as specified in Section 5.3.7 of TS 36.331), upon which the connection reconfiguration procedure ends.

[0069] In some cases, the UE may also be configured to apply the above-described failure handling also in case the RRCConnectionReconfiguration message causes a protocol error for which the generic error handling (as defined in Section 5.7 of TS 36.331) specifies that the UE is to ignore the message. Unfortunately, even if the UE is unable to comply with part of the configuration specified in the reconfiguration message, per the standard specification, the UE is not to apply any part of the configuration (i.e. there is no partial success/ failure). This compliance may also cover the NR configuration carried within the reconfiguration message (e.g., via octet strings e.g. field nr-SecondaryCellGroupConfig), such that the failure behavior described above also applies in case the UE cannot comply with the NR configuration or with the combination of (parts of) the LTE and NR configurations.

[0070] Further, 3GPP TS 38.331, Section 5.3.5.8.2 addresses a UE's inability to comply with an RRCReconfiguration message. For example, this section specifies that, if the UE is operating in EN-DC mode and is unable to comply with (part of) the configuration included in the RRCReconfiguration message the UE received (over signaling radio bearer 3-SRB3), the UE is to continue using the configuration used prior to the reception of RRCReconfiguration message, initiate the secondary cell group (SCG) failure information procedure (as specified in subclause 5.7.3) to report an SCG reconfiguration error, upon which the connection reconfiguration procedure ends. If the UE is unable to comply with (part of) the configuration included in the RRCReconfiguration message received over the master cell group (MCG) SRB 1, the UE is to continue using the configuration used prior to the reception of RRCReconfiguration message and initiate the connection re-establishment procedure (as specified in TS 36.331 Section 10, 5.3.7), upon which the connection reconfiguration procedure ends.

[0071] Aspects of the present disclosure, however, provide a solution that may help a UE avoid (or break) the dead loop condition described above. In some cases, the UE may monitor (e.g., via the RRC layer), a count of the number of times the reconfiguration failure described above occurs. If the number of failures exceeds a threshold value (e.g., within a certain time period), the UE may trigger a failure procedure.

[0072] FIG. 7 illustrates example operations 700 for wireless communications, in accordance with aspects of the present disclosure. For example, operations 700 may be performed by a UE operation in ENDC mode, such as the UE shown in FIG. 9, to avoid or break the dead loop scenario described above.

[0073] Operations 700 begin, at 702, by receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration. At 704, the UE establishes a second connection associated with a second RAT.

[0074] For example, an ENDC UE with LTE and NR connections may receive a reconfiguration message to reconfigure NR resources.

[0075] At 706, the UE initiates a reconfiguration of the resources used for the first connection associated with the first RAT. At 708, the UE detects a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT. At 710, the UE determines that the detected number of failures equals to or exceeds a threshold number of failures. At 712, the UE transmits, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

[0076] For example, the UE may send a failure message to the LTE eNB, to be forwarded to the NR gNB. The failure message may include a failure type (e.g., unsupported configuration) that the NR gNB may use to determine it should avoid re-sending a reconfiguration message with the same (unsupported) configuration.

[0077] FIG. 8 illustrates example operations 800 for wireless communications that may be considered complementary to operations 700. For example, operations 800 may be performed by a network entity of a first RAT (e.g., an NR gNB or LTE eNB) in communication with an ENDC UE performing operations 700.

[0078] Operations 800 begin, at 802, by transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network. For example, an NR gNB may send a reconfiguration message to a UE, via an LTE eNB.

[0079] At 804, the network entity of the first RAT receives, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration. At 806, the network entity of the first RAT avoids transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

[0080] FIG. 9 is a call flow diagram illustrating how certain aspects of the present disclosure may address the dead loop scenario described above. In the illustrated example, the UE may perform operations 700 of FIG. 7, while NR gNB performs operations 800 of FIG. 8.

[0081] As with the example shown in FIG. 6, the gNB may send a resource modification message 610 specifying a first configuration (Config #1), relayed to the UE as a resource reconfiguration message 615. As described above, for some reason, the reconfiguration may result in a failure, prompting steps 620-630 to reestablish the connection.

[0082] As illustrated in FIG. 9, the UE may monitor the number of such failures, for example, by initiating a counter. The counter may be incremented every time a failure is detected by the UE. In some cases, a timer may also be used. For example, the counter may be reset after a given time period, so a failure message is only triggered if the threshold number of failures is reached within the given time period.

[0083] As illustrated, detection of a sufficient number of failures, such that the counter exceeds a threshold value, may trigger the UE to send a failure message, at 940. For example, the failure type may indicate the UE does not support Config #1. The failure message may be part of a scgFailureInformationNR procedure with a failure type (e.g., scg-reconfigFailure) to inform the gNB about the nature of the failure. In such cases, a format of the failure message may be defined in a standard.

[0084] As illustrated in FIG. 9, the eNB may forward the failure message to the gNB, at 945 (e.g., via an X2 interface). Based on failure message (and the indicated failure type), the gNB may avoid sending a reconfiguration (resource modification) request to the UE for the same configuration (Config #1). In other words, the failure type may indicate some information to the gNB such that the gNB can modify the requested resource configuration accordingly, to avoid the endless dead loop scenario.

[0085] For example, at 950, the gNB sends a resource modification request specifying a different resource configuration (e.g., Config #2). As illustrated, at 955, the resource modification request may be forwarded to the UE via eNB, as a connection reconfiguration request (indicating a reconfiguration of NR resources according to Config #2).

[0086] The UE may repeat the operations described above, while attempting to perform according to the new reconfiguration request. In other words, the UE may either successfully reconfigure or detect a failure, re-initiate the failure counter, and continue to monitor/count the failures as described above. Even in the event of a subsequent failure (e.g., if the UE is not able to support Config #2), the dead loop shown in FIG. 6 is broken and at least the gNB can continue to try different configurations-or decide to stop attempting to reconfigure the UE.

[0087] Exactly how the UE sets the counter (and/or timer) and determines the particular threshold value that triggers sending the failure message may depend on the particular implementation. In some cases, the UE may decide the threshold value (e.g., based on a particular application or desired a user experience) or the UE may be configured by the network (or pre-configured according to a standard).

[0088] FIG. 10 illustrates a wireless communications device 1000 (e.g., UE 120, such as the UE shown in FIG. 9) that may include various components (e.g., corresponding to means-plus-function components) configured to perform operations for the techniques disclosed herein, such as the operations illustrated in FIG. 7. The communications device 1000 includes a processing system 1002 coupled to a transceiver 1008. The transceiver 1008 is configured to transmit and receive signals for the communications device 1000 via an antenna 1010, such as the various signals as described herein. The processing system 1002 may be configured to perform processing functions for the communications device 1000, including processing signals received and/or to be transmitted by the communications device 1000.

[0089] The wireless communications device 1000 includes a processor 1004 coupled to a computer-readable medium/memory 1012 via a bus 1006. In certain aspects, the computer-readable medium/memory 1012 is configured to store instructions (e.g., computer-executable code) that when executed by the processor 1004, cause the processor 1004 to perform the operations illustrated in FIG. 7, or other operations for performing the various techniques discussed herein. In certain aspects, computer-readable medium/memory 1012 may store code for establishing 1014 (e.g., for establishing a second connection associated with a second RAT), code for initiating 1016 (e.g., for initiating a reconfiguration of the resources used for the first connection associated with the first RAT), code for detecting 1018 (e.g., for detecting a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT), code for determining 1020 (e.g., for determining that the detected number of failures equals to or exceeds a threshold number of failures), and/or code for transmitting/receiving 1022 (e.g., for receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first RAT according to a first resource configuration and/or transmitting, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT). In certain aspects, the processor 1004 has circuitry configured to implement the code stored in the computer-readable medium/memory 1012. The processor 1004 may include circuitry for establishing 1030 (e.g., for establishing a second connection associated with a second RAT), circuitry for initiating 1032 (e.g., for initiating a reconfiguration of the resources used for the first connection associated with the first RAT), circuitry for detecting 1034 (e.g., for detecting a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT), circuitry for determining 1036 (e.g., for determining that the detected number of failures equals to or exceeds a threshold number of failures), and/or circuitry for transmitting/receiving 1038 (e.g., for receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first RAT according to a first resource configuration and/or transmitting, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT).

[0090] FIG. 11 illustrates a wireless communications device 1100 (e.g., a base station 110 such as the eNB or gNB shown in FIG. 9) that may include various components (e.g., corresponding to means-plus-function components) configured to perform operations for the techniques disclosed herein, such as the operations illustrated in FIG. 8. The communications device 1100 includes a processing system 1102 coupled to a transceiver 1108. The transceiver 1108 is configured to transmit and receive signals for the communications device 1100 via an antenna 1110, such as the various signals as described herein. The processing system 1102 may be configured to perform processing functions for the communications device 1100, including processing signals received and/or to be transmitted by the communications device 1100.

[0091] The wireless communications device 1100 includes a processor 1104 coupled to a computer-readable medium/memory 1112 via a bus 1106. In certain aspects, the computer-readable medium/memory 1112 is configured to store instructions (e.g., computer-executable code) that when executed by the processor 1104, cause the processor 1104 to perform the operations illustrated in FIG. 8, or other operations for performing the various techniques discussed herein. In certain aspects, computer-readable medium/memory 1112 may store code for transmitting/receiving 1122 (e.g., for transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network and/or receiving, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration), and/or code for avoiding 1124 (e.g., for avoiding transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message). In certain aspects, the processor 1104 has circuitry configured to implement the code stored in the computer-readable medium/memory 1112. The processor 1104 may include circuitry for transmitting/receiving 1138 (e.g., for for transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network and/or receiving, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration), and/or circuitry for avoiding 1140 (e.g., for avoiding transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message).

[0092] The methods disclosed herein comprise one or more steps or actions for achieving the described method. The method steps and/or actions may be interchanged with one another without departing from the scope of the claims. In other words, unless a specific order of steps or actions is specified, the order and/or use of specific steps and/or actions may be modified without departing from the scope of the claims.

[0093] As used herein, 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-b, a-c, b-c, and a-b-c, as well as any combination with multiples of the same element (e.g., a-a, a-a-a, a-a-b, a-a-c, a-b-b, a-c-c, b-b, b-b-b, b-b-c, c-c, and c-c-c or any other ordering of a, b, and c). As used herein, including in the claims, the term "and/or," when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination.

[0094] As used herein, the term "determining" encompasses a wide variety of actions. For example, "determining" may include calculating, computing, processing, deriving, investigating, looking up (e.g., looking up in a table, a database or another data structure), ascertaining and the like. Also, "determining" may include receiving (e.g., receiving information), accessing (e.g., accessing data in a memory) and the like.

Also, "determining" may include resolving, selecting, choosing, establishing and the like.

[0095] 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 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." For example, the articles "a" and "an" as used in this application and the appended claims should generally be construed to mean "one or more" unless specified otherwise or clear from the context to be directed to a singular form. Unless specifically stated otherwise, the term "some" refers to one or more. Moreover, the term "or" is intended to mean an inclusive "or" rather than an exclusive "or." That is, unless specified otherwise, or clear from the context, the phrase, for example, "X employs A or B" is intended to mean any of the natural inclusive permutations. That is, for example the phrase "X employs A or B" is satisfied by any of the following instances: X employs A; X employs B; or X employs both A and B. 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."

[0096] The various operations of methods described above may be performed by any suitable means capable of performing the corresponding functions. The means may include various hardware and/or software component(s) and/or module(s), including, but not limited to a circuit, an application specific integrated circuit (ASIC), or processor. For example, operations 700 and 800 of FIGs. 7 and 8 may be performed by various processors shown in FIG. 4. Generally, where there are operations illustrated in figures, those operations may have corresponding counterpart means-plus-function.

[0097] The various illustrative logical blocks, modules and circuits described in connection with the present disclosure may be implemented or performed with a general purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device (PLD), 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 commercially available 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.

[0098] If implemented in hardware, an example hardware configuration may comprise a processing system in a wireless node. The processing system may be implemented with a bus architecture. The bus may include any number of interconnecting buses and bridges depending on the specific application of the processing system and the overall design constraints. The bus may link together various circuits including a processor, machine-readable media, and a bus interface. The bus interface may be used to connect a network adapter, among other things, to the processing system via the bus. The network adapter may be used to implement the signal processing functions of the PHY layer. In the case of a user terminal 120 (see FIG. 1), a user interface (e.g., keypad, display, mouse, joystick, etc.) may also be connected to the bus. The bus may also link various other circuits such as timing sources, peripherals, voltage regulators, power management circuits, and the like, which are well known in the art, and therefore, will not be described any further. The processor may be implemented with one or more general-purpose and/or special-purpose processors. Examples include microprocessors, microcontrollers, DSP processors, and other circuitry that can execute software. Those skilled in the art will recognize how best to implement the described functionality for the processing system depending on the particular application and the overall design constraints imposed on the overall system.

[0099] If implemented in software, the functions may be stored or transmitted over as one or more instructions or code on a computer readable medium. Software shall be construed broadly to mean instructions, data, or any combination thereof, whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. Computer-readable media include both computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. The processor may be responsible for managing the bus and general processing, including the execution of software modules stored on the machine-readable storage media. A computer-readable storage medium may be coupled to a 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. By way of example, the machine-readable media may include a transmission line, a carrier wave modulated by data, and/or a computer readable storage medium with instructions stored thereon separate from the wireless node, all of which may be accessed by the processor through the bus interface. Alternatively, or in addition, the machine-readable media, or any portion thereof, may be integrated into the processor, such as the case may be with cache and/or general register files. Examples of machine-readable storage media may include, by way of example, RAM (Random Access Memory), flash memory, phase change memory, ROM (Read Only Memory), PROM (Programmable Read-Only Memory), EPROM (Erasable Programmable Read-Only Memory), EEPROM (Electrically Erasable Programmable Read-Only Memory), registers, magnetic disks, optical disks, hard drives, or any other suitable storage medium, or any combination thereof. The machine-readable media may be embodied in a computer-program product.

[0100] A software module may comprise a single instruction, or many instructions, and may be distributed over several different code segments, among different programs, and across multiple storage media. The computer-readable media may comprise a number of software modules. The software modules include instructions that, when executed by an apparatus such as a processor, cause the processing system to perform various functions. The software modules may include a transmission module and a receiving module. Each software module may reside in a single storage device or be distributed across multiple storage devices. By way of example, a software module may be loaded into RAM from a hard drive when a triggering event occurs. During execution of the software module, the processor may load some of the instructions into cache to increase access speed. One or more cache lines may then be loaded into a general register file for execution by the processor. When referring to the functionality of a software module below, it will be understood that such functionality is implemented by the processor when executing instructions from that software module.

[0101] 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 (IR), 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, include 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. Thus, in some aspects computer-readable media may comprise non-transitory computer-readable media (e.g., tangible media). The phrase computer readable medium does not refer to a transitory propagating signal. In addition, for other aspects computer-readable media may comprise transitory computer- readable media (e.g., a signal). Combinations of the above should also be included within the scope of computer-readable media.

[0102] Thus, certain aspects may comprise a computer program product for performing the operations presented herein. For example, such a computer program product may comprise a computer-readable medium having instructions stored (and/or encoded) thereon, the instructions being executable by one or more processors to perform the operations described herein. For example, instructions for performing the operations described herein and illustrated in the appended figures.

[0103] Further, it should be appreciated that modules and/or other appropriate means for performing the methods and techniques described herein can be downloaded and/or otherwise obtained by a user terminal and/or base station as applicable. For example, such a device can be coupled to a server to facilitate the transfer of means for performing the methods described herein. Alternatively, various methods described herein can be provided via storage means (e.g., RAM, ROM, a physical storage medium such as a compact disc (CD) or floppy disk, etc.), such that a user terminal and/or base station can obtain the various methods upon coupling or providing the storage means to the device. Moreover, any other suitable technique for providing the methods and techniques described herein to a device can be utilized.

[0104] It is to be understood that the claims are not limited to the precise configuration and components illustrated above. Various modifications, changes and variations may be made in the arrangement, operation and details of the methods and apparatus described above without departing from the scope of the claims.

CLAIMS

WHAT IS CLAIMED IS:

1. A method for wireless communications, comprising:

receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration;

establishing a second connection associated with a second RAT;

initiating a reconfiguration of the resources used for the first connection associated with the first RAT;

detecting a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT;

determining that the detected number of failures equals to or exceeds a threshold number of failures; and

transmitting, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

2. The method of claim 1, wherein:

the reconfiguration message is received from a base station of the second RAT; and

the failure indication message is transmitted to the base station of the second RAT.

3. The method of claim 1, wherein the failure indication message includes a failure type.

4. The method of claim 3, wherein the failure type indicates a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration.

5. The method of claim 3, wherein the failure type indicates a UE is unable to comply with the first resource configuration specified in the reconfiguration message.

6. The method of claim 1, wherein the detection comprises starting a timer upon detecting a first failure to complete the reconfiguration procedure and wherein the message is transmitted if a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration prior to expiration of the timer.

7. The method of claim 1, wherein: the first RAT comprises 5G technology and the second RAT comprises Long-Term Evolution (LTE) technology.

8. A method for wireless communications, comprising:

transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network;

receiving, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration; and

avoiding transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

9. The method of claim 8, further comprising transmitting a second reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to a second resource configuration different from the first resource configuration.

10. The method of claim 9, further comprising:

determining the second resource configuration based, at least in part, on a failure type indicated in the failure indication message.

11. The method of claim 10, wherein the failure type indicates the UE detected a number of detected failures equals to or exceeds a threshold number of failures to complete the reconfiguration.

12. The method of claim 10, wherein the failure type indicates the UE is unable to comply with the reconfiguration specified in the reconfiguration message.

13. The method of claim 8, wherein: the first RAT comprises 5G, the second RAT network comprises an LTE network, and the UE comprises an E-UTRAN New Radio – Dual Connectivity (ENDC) UE.

14. An apparatus for wireless communications, comprising:

means for receiving a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration;

means for establishing a second connection associated with a second RAT;

means for initiating a reconfiguration of the resources used for the first connection associated with the first RAT;

means for detecting a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT;

means for determining that the detected number of failures equals to or exceeds a threshold number of failures; and

means for transmitting, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

15. The apparatus of claim 14, wherein:

the reconfiguration message is received from a base station of the second RAT; and

the failure indication message is transmitted to the base station of the second RAT.

16. The apparatus of claim 14, wherein the failure indication message includes a failure type.

17. The apparatus of claim 16, wherein the failure type indicates a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration.

18. The apparatus of claim 16, wherein the failure type indicates a UE is unable to comply with the first resource configuration specified in the reconfiguration message.

19. The apparatus of claim 14, wherein the detection means comprises means for starting a timer upon detecting a first failure to complete the reconfiguration procedure and wherein the message is transmitted if a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration prior to expiration of the timer.

20. The apparatus of claim 14, wherein: the first RAT comprises 5G technology and the second RAT comprises Long-Term Evolution (LTE) technology.

21. An apparatus for wireless communications, comprising:

means for transmitting a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network;

means for receiving, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration; and

means for avoiding transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

22. The apparatus of claim 21, wherein the transmitting means is further configured to transmit a second reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to a second resource configuration different from the first resource configuration.

23. The apparatus of claim 22, further comprising:

means for determining the second resource configuration based, at least in part, on a failure type indicated in the failure indication message.

24. The apparatus of claim 23, wherein the failure type indicates the UE detected a number of detected failures equals to or exceeds a threshold number of failures to complete the reconfiguration.

25. The apparatus of claim 23, wherein the failure type indicates the UE is unable to comply with the reconfiguration specified in the reconfiguration message.

26. The apparatus of claim 21, wherein: the first RAT comprises 5G, the second RAT network comprises an LTE network, and the UE comprises an E-UTRAN New Radio – Dual Connectivity (ENDC) UE.

27. An apparatus for wireless communications, comprising:

a processing system configured to:

receive a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration;

establish a second connection associated with a second RAT;

initiate a reconfiguration of the resources used for the first connection associated with the first RAT;

detect a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT;

determine that the detected number of failures equals to or exceeds a threshold number of failures; and

transmit, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

28. The apparatus of claim 27, wherein:

the reconfiguration message is received from a base station of the second RAT; and the failure indication message is transmitted to the base station of the second RAT.

29. The apparatus of claim 27, wherein the failure indication message includes a failure type.

30. The apparatus of claim 29, wherein the failure type indicates a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration.

31. The apparatus of claim 29, wherein the failure type indicates a UE is unable to comply with the first resource configuration specified in the reconfiguration message.

32. The apparatus of claim 27, wherein the detection comprises starting a timer upon detecting a first failure to complete the reconfiguration procedure and wherein the message is transmitted if a UE detected the number of detected failures equals to or exceeds the threshold number of failures to complete the reconfiguration prior to expiration of the timer.

33. The apparatus of claim 27, wherein: the first RAT comprises 5G technology and the second RAT comprises Long-Term Evolution (LTE) technology.

34. An apparatus for wireless communications, comprising:

a processing system configured to:

transmit a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network;

receive, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration; and

avoid transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

35. The apparatus of claim 34, wherein the processing system is further configured to transmit a second reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to a second resource configuration different from the first resource configuration.

36. The apparatus of claim 35, wherein the processing system is further configured to determine the second resource configuration based, at least in part, on a failure type indicated in the failure indication message.

37. The apparatus of claim 36, wherein the failure type indicates the UE detected a number of detected failures equals to or exceeds a threshold number of failures to complete the reconfiguration.

38. The apparatus of claim 36, wherein the failure type indicates the UE is unable to comply with the reconfiguration specified in the reconfiguration message.

39. The apparatus of claim 34, wherein: the first RAT comprises 5G, the second RAT network comprises an LTE network, and the UE comprises an E-UTRAN New Radio – Dual Connectivity (ENDC) UE.

40. A computer-readable medium for wireless communications, comprising codes executable to:

receive a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration;

establish a second connection associated with a second RAT;

initiate a reconfiguration of the resources used for the first connection associated with the first RAT;

detect a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT;

determine that the detected number of failures equals to or exceeds a threshold number of failures; and transmit, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

41. A computer-readable medium for wireless communications, comprising codes executable to:

transmit a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network;

receive, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration; and

avoid transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

42. A user equipment, comprising:

at least one antenna; and

a processing system configured to:

receive, via the at least one antenna, a reconfiguration message to reconfigure resources used for a first connection associated with a first radio access technology (RAT) according to a first resource configuration;

establish, via the at least one antenna, a second connection associated with a second RAT;

initiate a reconfiguration of the resources used for the first connection associated with the first RAT;

detect a number of failures of the reconfiguration of the resources used for the first connection associated with the first RAT;

determine that the detected number of failures equals to or exceeds a threshold number of failures; and

transmit, based at least in part on the determination that the number of detected failures equals to or exceeds the threshold number of failures, a message to indicate a failure of the reconfiguration of the resources used for the first connection associated with the first RAT.

43. A base station, comprising:
at least one antenna; and
a processing system configured to:
transmit, via the at least one antenna, a reconfiguration message to a user equipment (UE) for reconfiguring resources used for a connection associated with a first RAT according to a first resource configuration, wherein the reconfiguration message is transmitted to the UE via a network entity of a second RAT network;
receive, via the at least one antenna, from the network entity of the second RAT network, a message indicating a failure of the UE to complete the reconfiguration; and
avoid transmitting another reconfiguration message to the UE for reconfiguring resources used for the connection associated with the first RAT according to the same first resource configuration, after receiving the failure indication message.

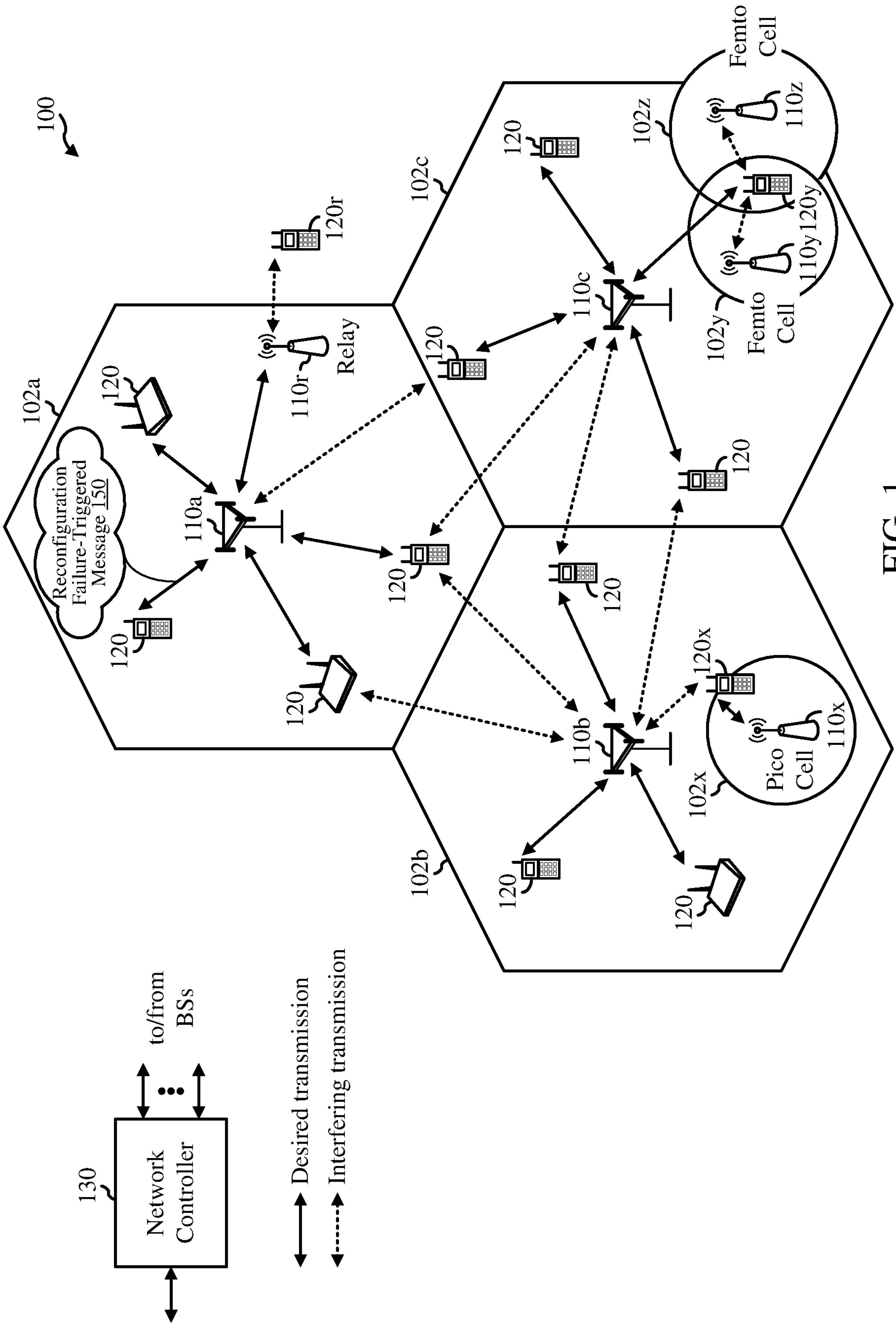
100
102a
Reconfiguration Failure-Triggered Message 150
110a
120
110r
Relay
120r
102c
110c
102z
110z
Femto Cell
120y
110y
102y
Femto Cell
102b
110b
120x
110x
102x
Pico Cell
130
Network Controller
to/from BSs
Desired transmission
Interfering transmission

FIG. 1

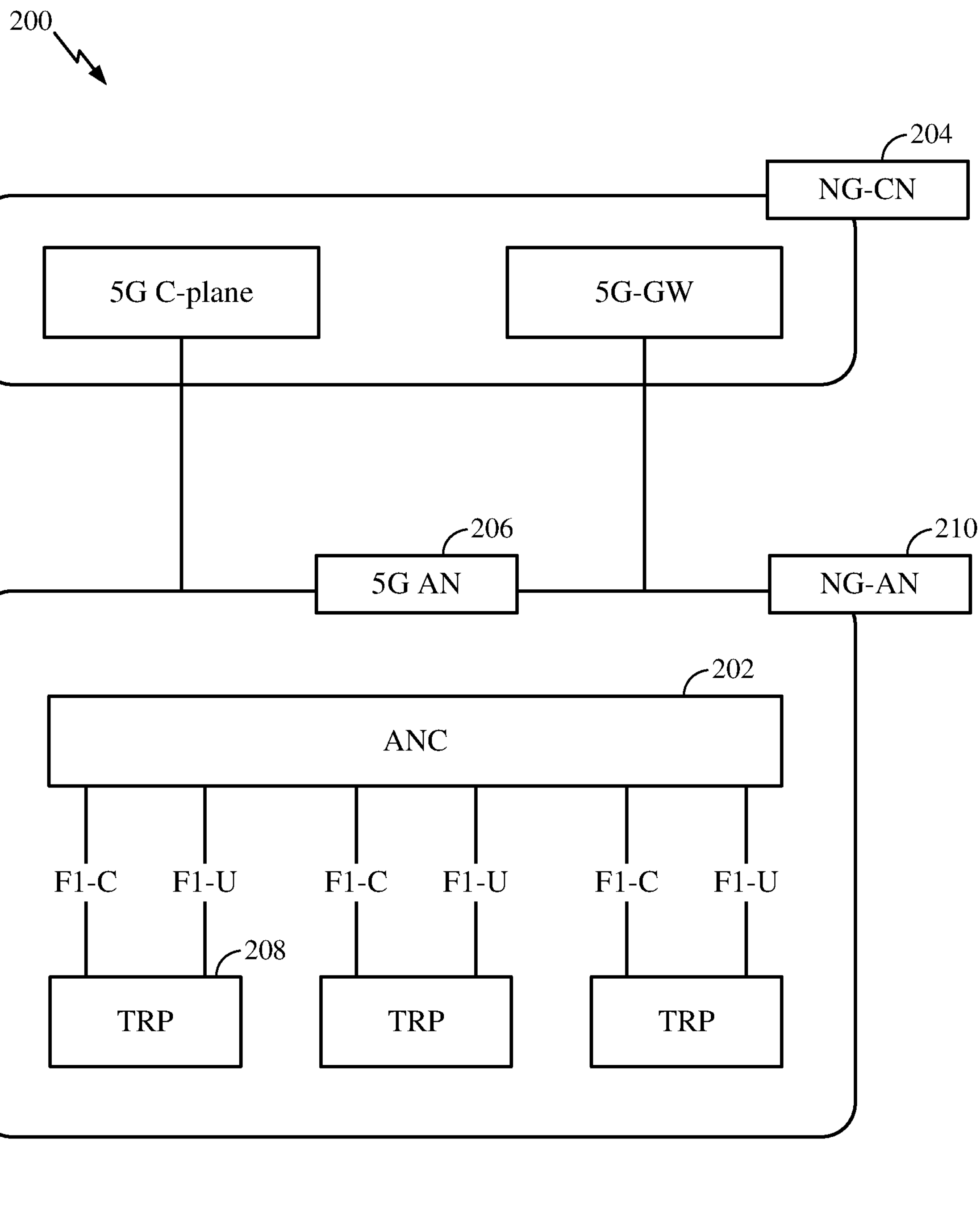
200
204
NG-CN
5G C-plane
5G-GW
206
5G AN
210
NG-AN
202
ANC
F1-C
F1-U
F1-C
F1-U
F1-C
F1-U
208
TRP
TRP
TRP

FIG. 2

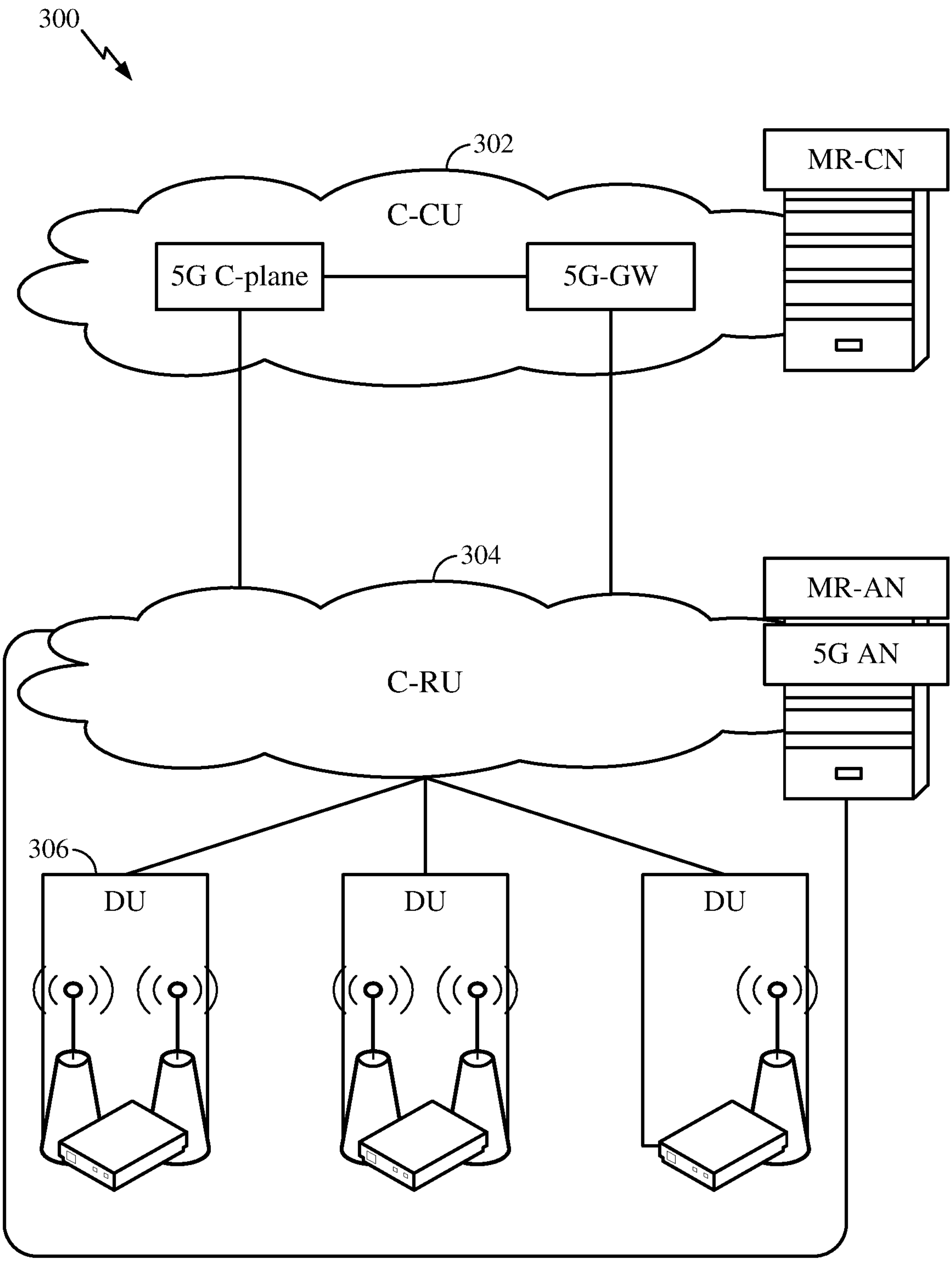

FIG. 3

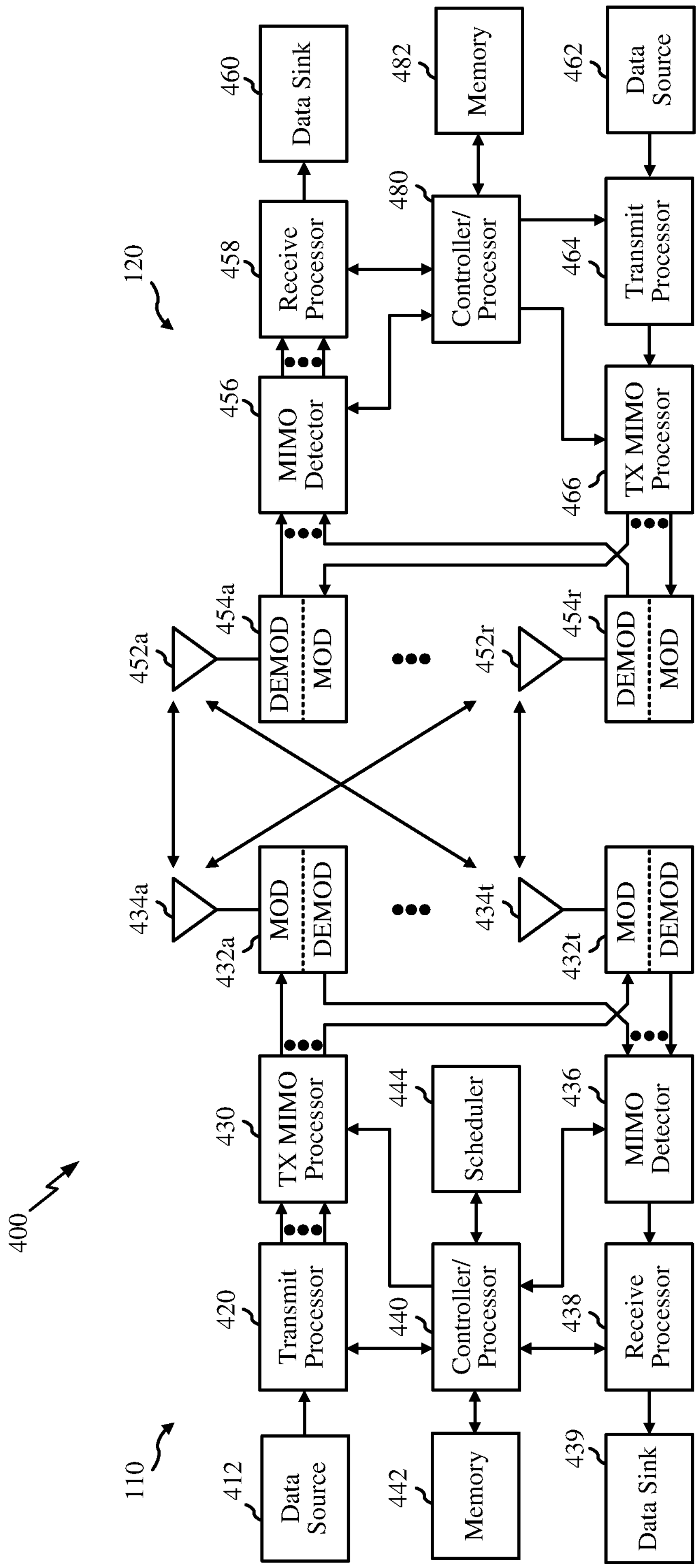
400
110
120
412
Data Source
420
Transmit Processor
430
TX MIMO Processor
432a
MOD
DEMOD
434a
432t
MOD
DEMOD
434t
440
Controller/ Processor
442
Memory
444
Scheduler
436
MIMO Detector
438
Receive Processor
439
Data Sink
452a
454a
DEMOD
MOD
452r
454r
DEMOD
MOD
456
MIMO Detector
458
Receive Processor
460
Data Sink
480
Controller/ Processor
482
Memory
462
Data Source
464
Transmit Processor
466
TX MIMO Processor

FIG. 4

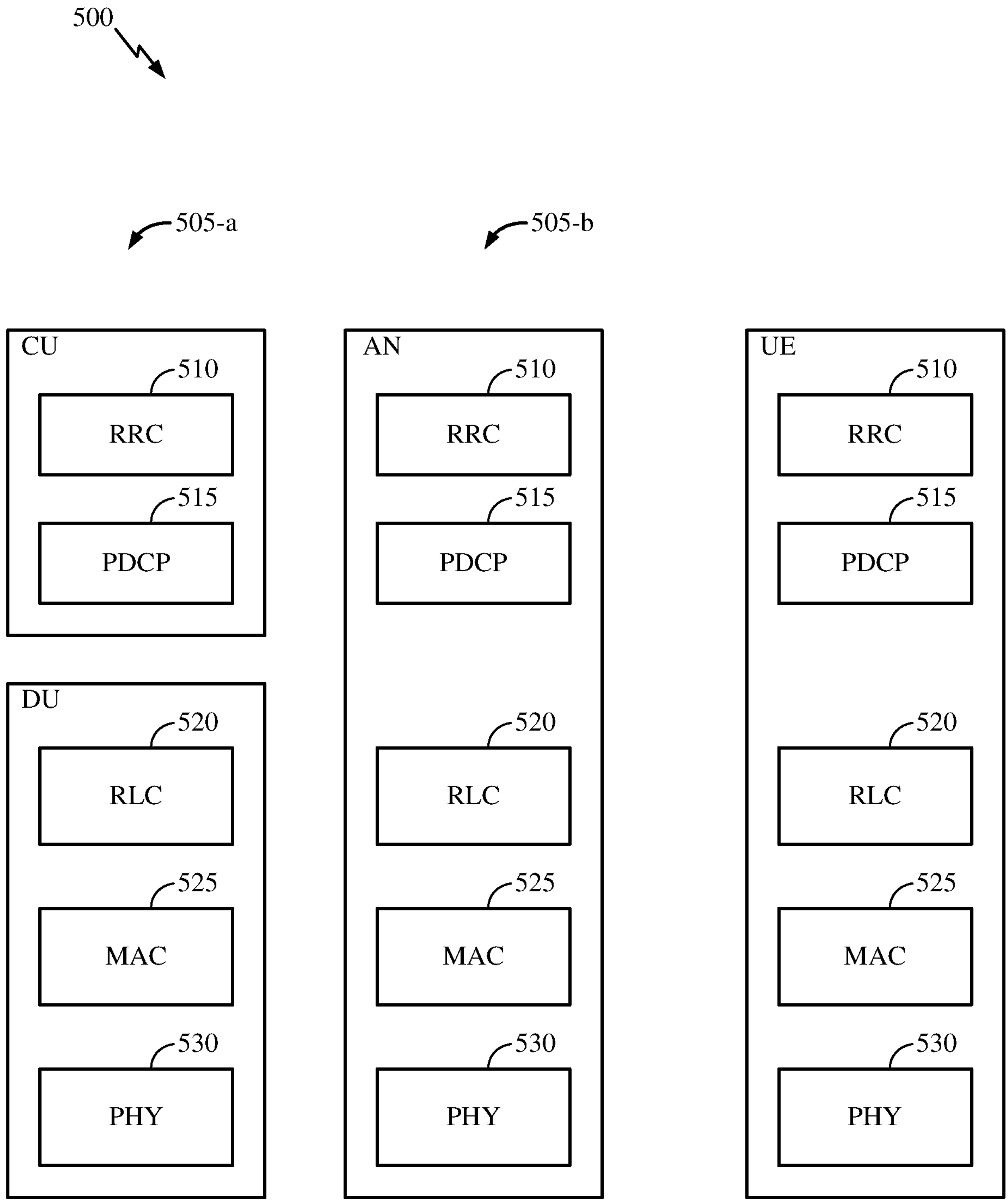
500
505-a
505-b
CU
510
RRC
515
PDCP
DU
520
RLC
525
MAC
530
PHY
AN
510
RRC
515
PDCP
520
RLC
525
MAC
530
PHY
UE
510
RRC
515
PDCP
520
RLC
525
MAC
530
PHY

FIG. 5

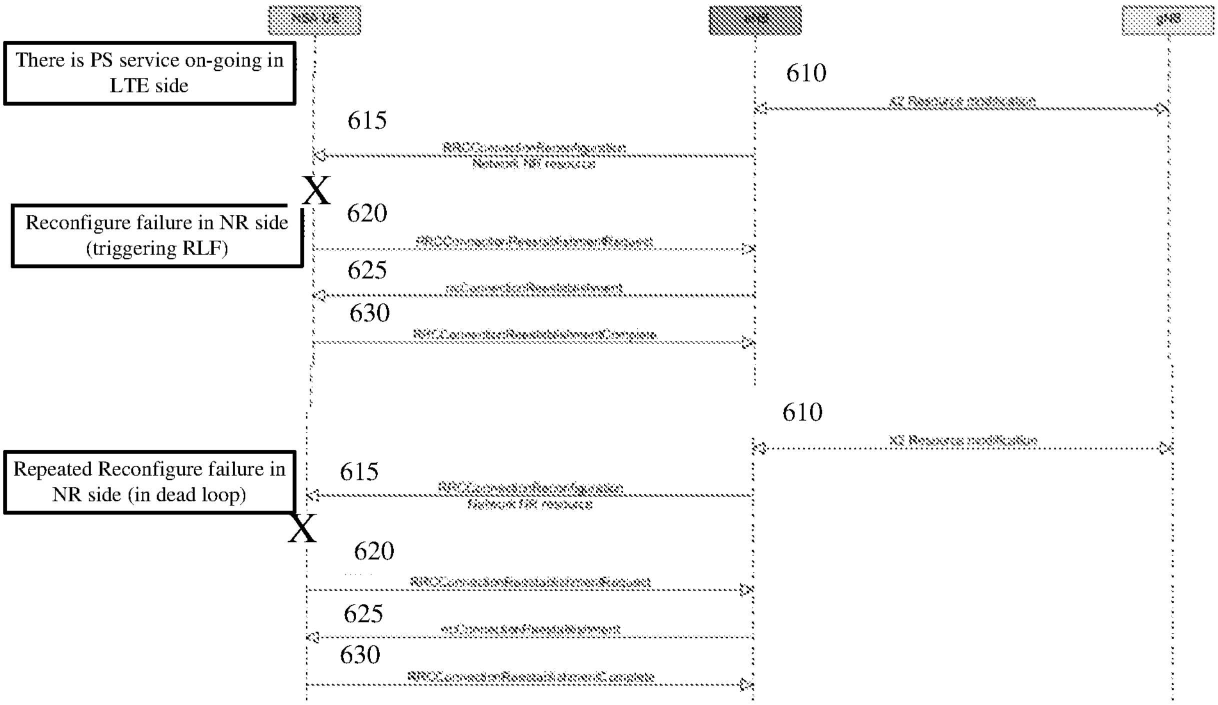
There is PS service on-going in LTE side
610
615
Reconfigure failure in NR side (triggering RLF)
620
625
630
610
Repeated Reconfigure failure in NR side (in dead loop)
615
620
625
630

FIG. 6

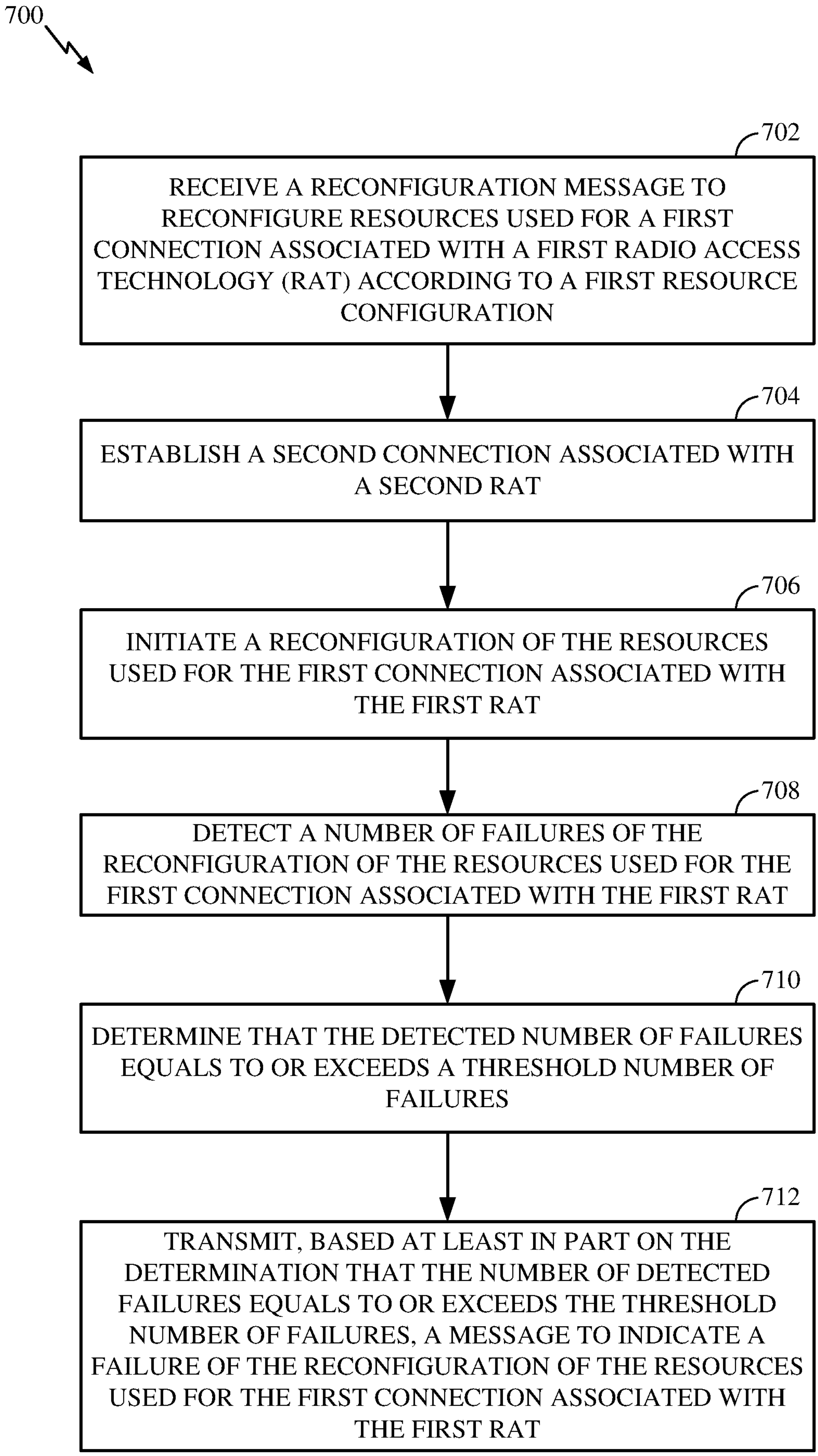
700
702
RECEIVE A RECONFIGURATION MESSAGE TO RECONFIGURE RESOURCES USED FOR A FIRST CONNECTION ASSOCIATED WITH A FIRST RADIO ACCESS TECHNOLOGY (RAT) ACCORDING TO A FIRST RESOURCE CONFIGURATION
704
ESTABLISH A SECOND CONNECTION ASSOCIATED WITH A SECOND RAT
706
INITIATE A RECONFIGURATION OF THE RESOURCES USED FOR THE FIRST CONNECTION ASSOCIATED WITH THE FIRST RAT
708
DETECT A NUMBER OF FAILURES OF THE RECONFIGURATION OF THE RESOURCES USED FOR THE FIRST CONNECTION ASSOCIATED WITH THE FIRST RAT
710
DETERMINE THAT THE DETECTED NUMBER OF FAILURES EQUALS TO OR EXCEEDS A THRESHOLD NUMBER OF FAILURES
712
TRANSMIT, BASED AT LEAST IN PART ON THE DETERMINATION THAT THE NUMBER OF DETECTED FAILURES EQUALS TO OR EXCEEDS THE THRESHOLD NUMBER OF FAILURES, A MESSAGE TO INDICATE A FAILURE OF THE RECONFIGURATION OF THE RESOURCES USED FOR THE FIRST CONNECTION ASSOCIATED WITH THE FIRST RAT

FIG. 7

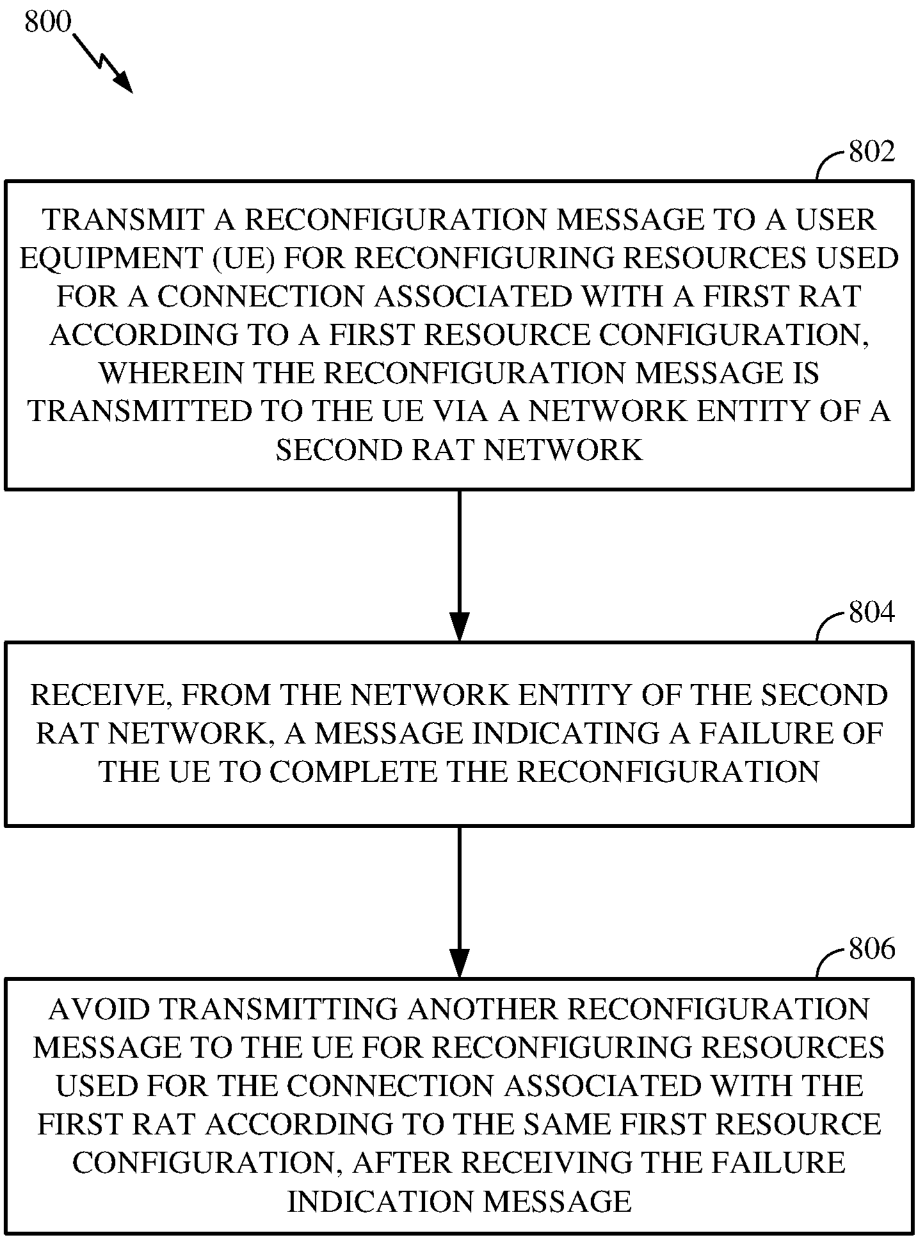
800
802
TRANSMIT A RECONFIGURATION MESSAGE TO A USER EQUIPMENT (UE) FOR RECONFIGURING RESOURCES USED FOR A CONNECTION ASSOCIATED WITH A FIRST RAT ACCORDING TO A FIRST RESOURCE CONFIGURATION, WHEREIN THE RECONFIGURATION MESSAGE IS TRANSMITTED TO THE UE VIA A NETWORK ENTITY OF A SECOND RAT NETWORK
804
RECEIVE, FROM THE NETWORK ENTITY OF THE SECOND RAT NETWORK, A MESSAGE INDICATING A FAILURE OF THE UE TO COMPLETE THE RECONFIGURATION
806
AVOID TRANSMITTING ANOTHER RECONFIGURATION MESSAGE TO THE UE FOR RECONFIGURING RESOURCES USED FOR THE CONNECTION ASSOCIATED WITH THE FIRST RAT ACCORDING TO THE SAME FIRST RESOURCE CONFIGURATION, AFTER RECEIVING THE FAILURE INDICATION MESSAGE

FIG. 8

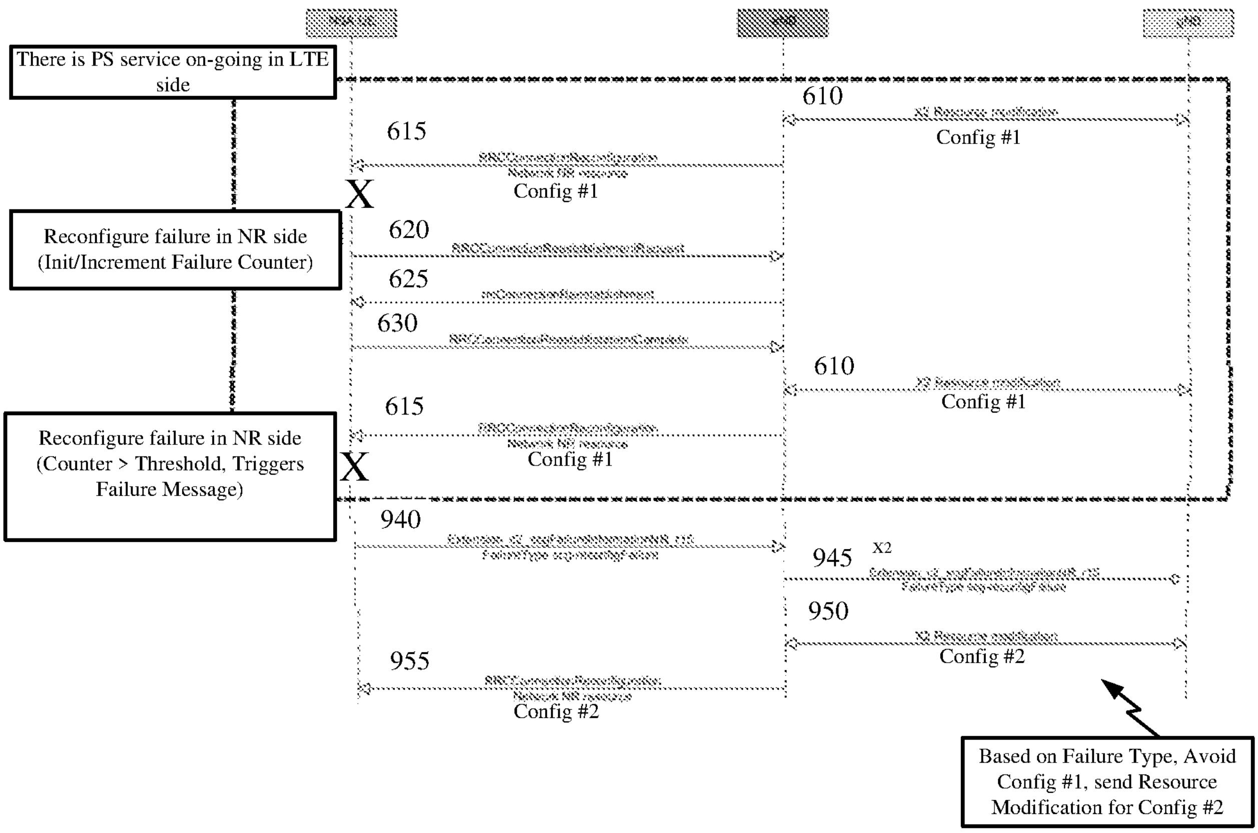
There is PS service on-going in LTE side
610
Config #1
615
Config #1
X
Reconfigure failure in NR side (Init/Increment Failure Counter)
620
625
630
610
Config #1
615
Config #1
Reconfigure failure in NR side (Counter > Threshold, Triggers Failure Message)
X
940
945
X2
950
Config #2
955
Config #2
Based on Failure Type, Avoid Config #1, send Resource Modification for Config #2

FIG. 9

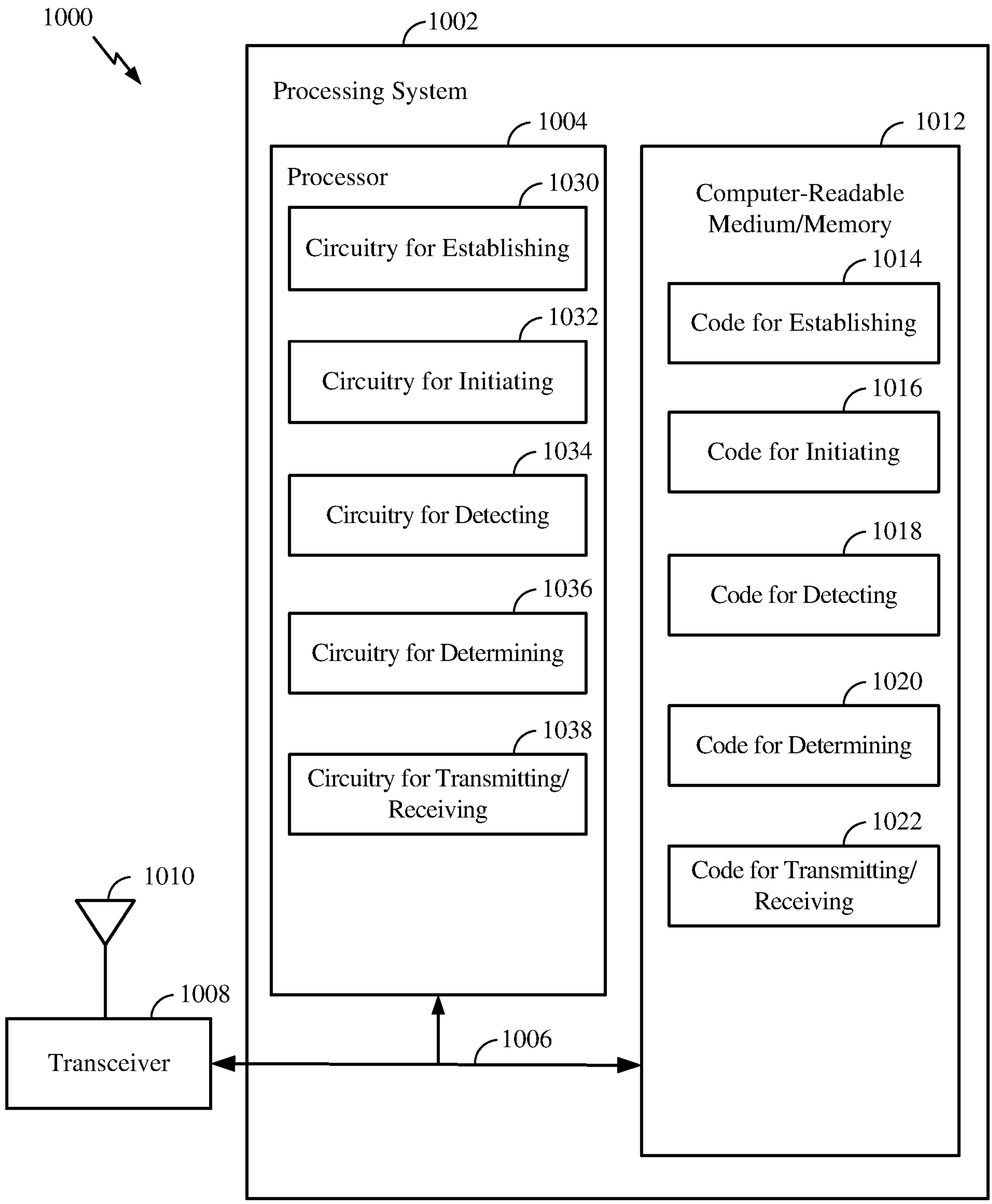
1000
1002
Processing System
1004
Processor
1030
Circuitry for Establishing
1032
Circuitry for Initiating
1034
Circuitry for Detecting
1036
Circuitry for Determining
1038
Circuitry for Transmitting/ Receiving
1012
Computer-Readable Medium/Memory
1014
Code for Establishing
1016
Code for Initiating
1018
Code for Detecting
1020
Code for Determining
1022
Code for Transmitting/ Receiving
1010
1008
Transceiver
1006

FIG. 10

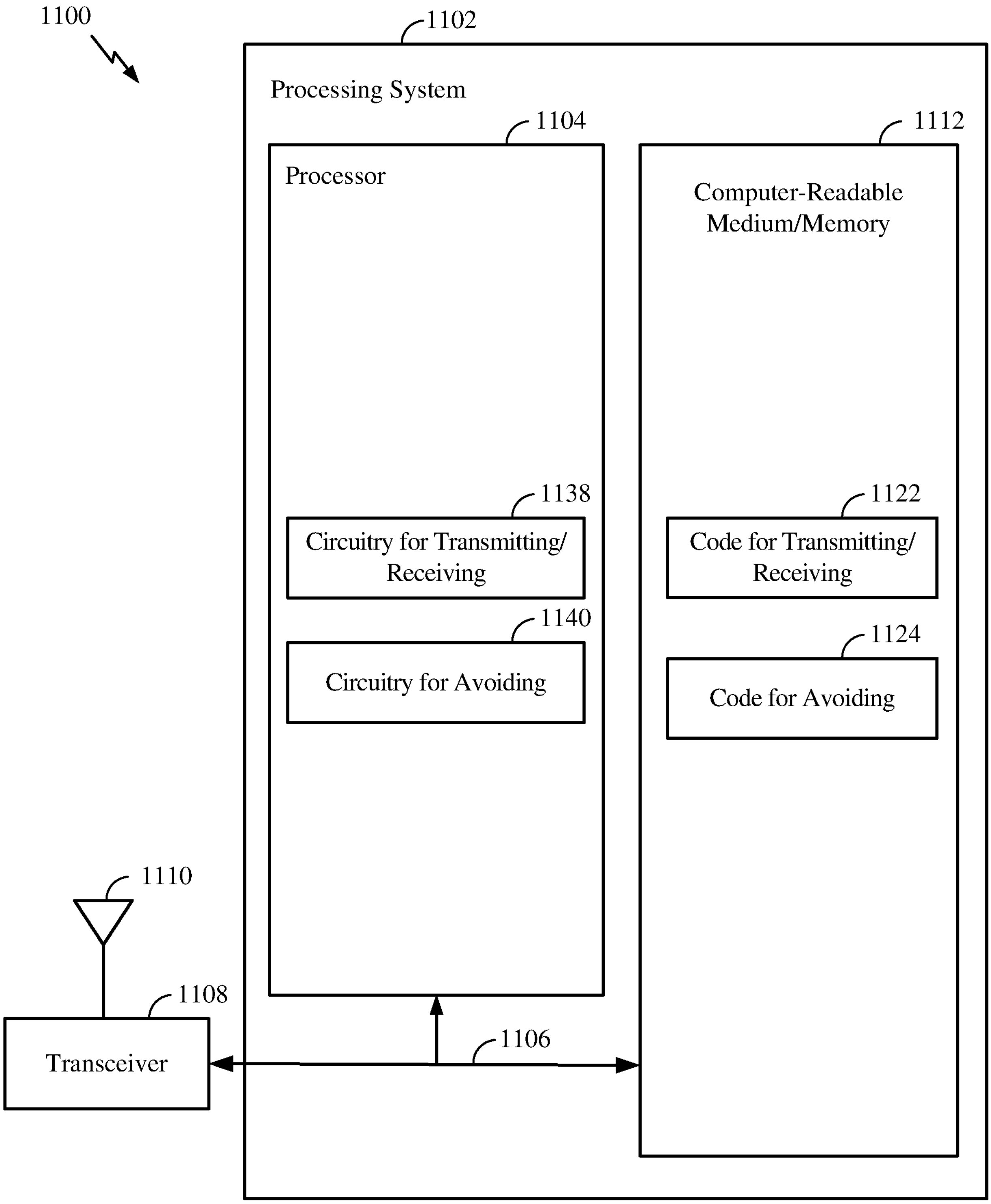
1100
1102
Processing System
1104
Processor
1112
Computer-Readable Medium/Memory
1138
Circuitry for Transmitting/ Receiving
1140
Circuitry for Avoiding
1122
Code for Transmitting/ Receiving
1124
Code for Avoiding
1110
1108
Transceiver
1106

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/090448

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/00(2018.01)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

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

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

WPI, EPODOC, CNPAT, CNKI: NR, LTE, dual connection, resource, reconfiguration, failure, number, type

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 108633018 A (HUAWEI TECHNOLOGIES CO., LTD.) 09 October 2018 (2018-10-09) description, paragraphs 0092-0169, 0243-0244, 0250, 0257, and figures 2a-7, 15-16	1-43
X	WO 2017196095 A2 (KT CORP.) 16 November 2017 (2017-11-16) description, paragraphs 26-131, and figures 1-3	1-43
A	US 2016044565 A1 (LG ELECTRONICS INC.) 11 February 2016 (2016-02-11) the whole document	1-43
A	CN 108632918 A (SPREADTRUM COMMUNICATIONS SHANGHAI CO., LTD.) 09 October 2018 (2018-10-09) the whole document	1-43

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"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 March 2020	**06 March 2020**

Name and mailing address of the ISA/CN	Authorized officer
National Intellectual Property Administration, PRC **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	**WANG,Guogang**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53961755**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/090448

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	108633018	A	09 October 2018	US	2020022209	A1	16 January 2020
				EP	3598823	A1	22 January 2020
				KR	20190131057	A	25 November 2019
				CA	3057209	A1	27 September 2018
				WO	2018171583	A1	27 September 2018
WO	2017196095	A2	16 November 2017	CN	109076383	A	21 December 2018
				KR	20170128758	A	23 November 2017
				US	2019342148	A1	07 November 2019
US	2016044565	A1	11 February 2016	EP	2987364	A1	24 February 2016
				CN	105122887	A	02 December 2015
				WO	2014171715	A1	23 October 2014
				US	9743323	B2	22 August 2017
				WO	2014171716	A1	23 October 2014
				EP	2987356	A4	19 October 2016
				CN	105144795	B	13 November 2018
				CN	105144795	A	09 December 2015
				EP	2987364	B1	06 March 2019
				EP	2987356	A1	24 February 2016
				US	9763150	B2	12 September 2017
				EP	2987364	A4	19 October 2016
				US	2016057668	A1	25 February 2016
				EP	2987356	B1	10 April 2019
				CN	105122887	B	09 November 2018
CN	108632918	A	09 October 2018		None		