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(54) **Title:** HANDLING END-TO-END PC5 CONNECTION IN U2U RELAY

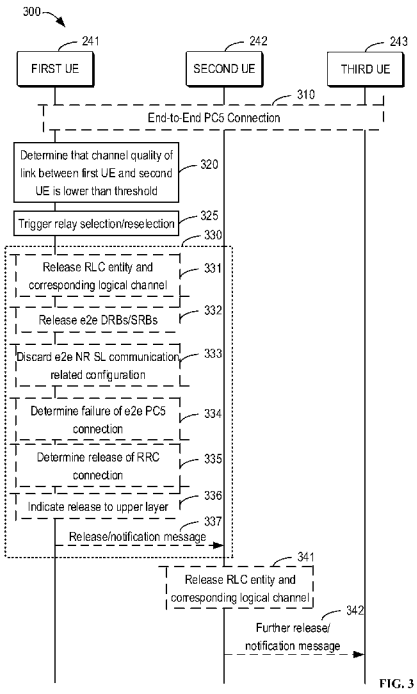

FIG. 3

(57) **Abstract:** Example embodiments of the present disclosure relate to a first UE, a second UE, methods, apparatuses, and computer readable medium for handling end-to-end PC5 connection in U2U relay. In this solution, a first UE, which is a remote UE in U2U relay scenario, may determine a channel quality of a link between the first UE and a second UE (e.g., the relay UE), and may further perform at least one operation associated with the end-to-end connection if the channel quality is lower than a threshold for triggering relay selection or reselection. As such, the threshold may be used as a condition for the at least one operation associated with the end-to-end connection.

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HANDLING END-TO-END PC5 CONNECTION IN U2U RELAY

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to network units, methods, apparatuses, and computer readable medium for handling end-to-end proximity communication 5 (PC5) connection in UE-to-UE (U2U) relay.

BACKGROUND

[0002] A wireless communications system may include one or multiple network communication devices, such as base stations, which may be otherwise known as an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. Each network communication devices, such as a base station may support wireless communications for one or multiple user communication devices, which may be otherwise known as user equipment (UE), or other suitable terminology. The wireless communications system may support wireless communications with one or multiple user communication devices by utilizing resources of the wireless communication system (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers). Additionally, the wireless communications system may support wireless communications across various radio access technologies including third generation (3G) radio access technology, fourth generation (4G) radio access technology, fifth generation (5G) radio access technology, among other suitable radio access technologies beyond 5G (e.g., sixth generation (6G)).

[0003] A scenario of UE-to-UE (U2U) relay has been discussed in the third generation partner project (3GPP). A remote UE (also referred to as a source UE) may communicate with another remote UE (also referred to as a peer remote UE or target UE) via a relay UE. At least one threshold for triggering relay selection or reselection has been configured, however, more aspects of the threshold can be further considered.

SUMMARY

[0004] The present disclosure relates to a first UE, a second UE, methods, apparatuses, and computer readable medium for handling end-to-end PC5 connection in U2U relay. According to the proposed solution, a threshold for triggering relay selection or reselection may be used as a condition for other operations associated with the end-to-end PC5

connection.

[0005] In some implementations, there is provided a first UE. The first UE comprises at least one memory; and at least one processor coupled with the at least one memory and configured to cause the first UE to: determine a channel quality of a link between the first UE and a second UE, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; trigger a relay selection or reselection for the end-to-end PC5 connection based on a determination that the channel quality being lower than a threshold; and perform at least one operation associated with the end-to-end PC5 connection based on a determination that the channel quality being lower than the threshold.

[0006] In some implementations, there is provided a second UE. The second UE comprises at least one memory; and at least one processor coupled with the at least one memory and configured to cause the second UE to: determine that a release condition for a link between the second UE and a third UE is met or a sidelink radio link failure (RLF) occurs, wherein an end-to-end PC5 connection has been established between a first UE with the third UE via the second UE; and transmit, to the first UE, a message being a release message or a notification message.

[0007] In some implementations, there is provided a first UE. The first UE comprises at least one memory; and at least one processor coupled with the at least one memory and configured to cause the first UE to: receive, from a second UE, a message being a release message or a notification message, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; and perform at least one operation associated with the end-to-end PC5 connection based on the message.

[0008] In some implementations, there is provided a method performed by the first UE. The method comprises: determining a channel quality of a link between the first UE and a second UE, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; triggering a relay selection or reselection for the end-to-end PC5 connection based on a determination that the channel quality being lower than a threshold; and performing at least one operation associated with the end-to-end PC5 connection based on a determination that the channel quality being lower than the threshold.

[0009] In some implementations, there is provided a method performed by the second UE. The method comprises: determining that a release condition for a link between the second UE and a third UE is met or a sidelink RLF occurs, wherein an end-to-end PC5 connection

has been established between a first UE with the third UE via the second UE; and transmitting, to the first UE, a message being a release message or a notification message.

[0010] In some implementations, there is provided a method performed by the first UE. The method comprises: receiving, from a second UE, a message being a release message or a notification message, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; and performing at least one operation associated with the end-to-end PC5 connection based on the message.

[0011] In some implementations, there is provided a processor for wireless communication. The processor comprises at least one controller coupled with at least one memory and configured to cause the processor to: determine a channel quality of a link between the first UE and a second UE, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; trigger a relay selection or reselection for the end-to-end PC5 connection based on a determination that the channel quality being lower than a threshold; and perform at least one operation associated with the end-to-end PC5 connection based on a determination that the channel quality being lower than the threshold.

[0012] In some implementations, there is provided a processor for wireless communication. The processor comprises at least one controller coupled with at least one memory and configured to cause the processor to: determine that a release condition for a link between the second UE and a third UE is met or a sidelink RLF occurs, wherein an end-to-end PC5 connection has been established between a first UE with the third UE via the second UE; and transmit, to the first UE, a message being a release message or a notification message.

[0013] In some implementations, there is provided a processor for wireless communication. The processor comprises at least one controller coupled with at least one memory and configured to cause the processor to: receive, from a second UE, a message being a release message or a notification message, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE; and perform at least one operation associated with the end-to-end PC5 connection based on the message.

[0014] In some implementations of the methods, and the first UE described herein, further comprising: maintaining a U2U relay configuration after initiating an RRC connection re-establishment procedure, wherein the U2U relay configuration is received from a serving base station after the end-to-end PC5 connection has been established; and report the UE-to-UE relay configuration to a re-established gNB after completing the re-establishment

procedure.

[0015] In some implementations of the methods, and the first UE described herein, further comprising: release a U2U relay configuration after initiating an RRC connection re-establishment procedure, wherein the U2U configuration is received from a serving base station after the end-to-end PC5 connection has been established; and use a further U2U relay configuration from system information while a timer associated with a cell selection or reselection is running or a further timer associated with a reestablishment request is running.

[0016] In some implementations of the methods, the first UE, and the second UE described herein, the channel quality is determined based on a measurement result of communication data, and wherein the threshold comprises a sidelink reference signal received power (SL-RSRP) threshold.

[0017] In some implementations of the methods, the first UE, and the second UE described herein, the channel quality is determined based on a measurement result of discovery message, and wherein the threshold comprises a sidelink discovery reference signal received power (SD-RSRP) threshold.

[0018] In some implementations of the methods, the first UE, and the second UE described herein, the at least one operation comprises one of: releasing a radio link control (RLC) entity, or releasing a logical channel associated with a RLC channel identity (ID) of a specific destination.

[0019] In some implementations of the methods, the first UE, and the second UE described herein, the at least one operation comprises: transmitting, to the second UE, a release message or a notification message.

[0020] In some implementations of the methods, the first UE, and the second UE described herein, the release condition comprises: an indication, from an upper layer to a radio resource control (RRC) layer, for releasing an RRC connection between the second UE and the third UE.

[0021] In some implementations of the methods, the first UE, and the second UE described herein, the release condition comprises: a reception of a further release message or a further notification message from the third UE.

[0022] In some implementations of the methods, the first UE, and the second UE described herein, the notification message comprises an indication type, and the indication type

indicates a release cause.

[0023] In some implementations of the methods, the first UE, and the second UE described herein, the message indicates a sidelink RLF of a link between the second UE and the third UE.

[0024] In some implementations of the methods, the first UE, and the second UE described herein, the at least one operation comprises one of: determining a failure of the end-to-end PC5 connection, releasing end-to-end data radio bearers (DRB) for the end-to-end PC5 connection, releasing end-to-end signalling radio bearers (SRB) for the end-to-end PC5 connection, or discarding an end-to-end sidelink communication related configuration for the end-to-end PC5 connection.

[0025] In some implementations of the methods, the first UE, and the second UE described herein, the at least one operation comprises one of: determining that an RRC connection is released for the end-to-end PC5 connection, or indicating, from an RRC layer to an upper layer, a release of the RRC connection.

[0026] In some implementations of the methods, the first UE, and the second UE described herein, the release message comprises a proximity communication 5 signalling (PC5-S) layer release message, the notification message comprises an RRC layer notification message.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. 1 illustrates an example of a wireless communications system in which some embodiments of the present disclosure can be implemented;

[0028] FIG. 2A illustrates a schematic diagram of an example communication network in which some embodiments of the present disclosure can be implemented;

[0029] FIG. 2B illustrates an example RRC reconfiguration sidelink procedure;

[0030] FIG. 2C illustrates an example procedure for L2 U2U remote UE connection establishment;

[0031] FIG. 2D illustrates a schematic diagram of an example communication network in which some embodiments of the present disclosure can be implemented;

[0032] FIG. 3 illustrates a signalling chart illustrating communication process in accordance with some example embodiments of the present disclosure;

[0033] FIG. 4 illustrates a signalling chart illustrating communication process in accordance

with some example embodiments of the present disclosure;

[0034] FIG. 5 illustrates an example of a device that is suitable for implementing embodiments of the present disclosure;

[0035] FIG. 6 illustrates an example of a processor that is suitable for implementing some embodiments of the present disclosure;

[0036] FIG. 7 illustrates a flowchart of an example method implemented at a first UE in accordance with aspects of the present disclosure;

[0037] FIG. 8 illustrates a flowchart of an example method implemented at a second UE in accordance with aspects of the present disclosure; and

[0038] FIG. 9 illustrates a flowchart of an example method implemented at a first UE in accordance with aspects of the present disclosure.

[0039] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0040] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below. In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0041] References in the present disclosure to "one embodiment," "an example embodiment," "an embodiment," "some embodiments," and the like indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment(s). Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0042] It shall be understood that although the terms "first" and "second" or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of embodiments. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms. In some examples, values, procedures, or apparatuses are referred to as "best," "lowest," "highest," "minimum," "maximum," or the like. It will be appreciated that such descriptions are intended to indicate that a selection among many used functional alternatives can be made, and such selections need not be better, smaller, higher, or otherwise preferable to other selections.

[0043] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of embodiments. As used herein, the singular forms "a," "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "has," "having," "includes" and/or "including," when used herein, specify the presence of stated features, elements, components and/or the like, but do not preclude the presence or addition of one or more other features, elements, components and/or combinations thereof. For example, the term "includes" and its variants are to be read as open terms that mean "includes, but is not limited to." The term "based on" is to be read as "based at least in part on." The term "one embodiment" and "an embodiment" are to be read as "at least one embodiment." The term "another embodiment" is to be read as "at least one other embodiment." The use of an expression such as "A and/or B" can mean either "only A" or "only B" or "both A and B." Other definitions, explicit and implicit, may be included below.

[0044] FIG. 1 illustrates an example of a wireless communications system 100 in which some embodiments of the present disclosure can be implemented. The wireless communications system 100 may include one or more network entities 102 (also referred to as network equipment (NE)), one or more UEs 104, a core network 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as a long term evolution (LTE) network or an LTE-Advanced (LTE-A) network. In some other implementations, the wireless communications system 100 may be a 5G network, such as a new radio (NR) network. In other implementations, the wireless

communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0045] The one or more network entities 102 may be dispersed throughout a geographic region to form the wireless communications system 100. One or more of the network entities 102 described herein may be or include or may be referred to as a network node, a base station, a network element, a radio access network (RAN), a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0046] A network entity 102 may provide a geographic coverage area 112 for which the network entity 102 may support services (e.g., voice, video, packet data, message, broadcast, etc.) for one or more UEs 104 within the geographic coverage area 112. For example, a network entity 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas 112 may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0047] The one or more UEs 104 may be dispersed throughout a geographic region of the wireless communications system 100. A UE 104 may include or may be referred to as a

mobile device, a wireless device, a remote device, a remote unit, a handheld device, or a subscriber device, or some other suitable terminology. In some implementations, the UE 104 may be referred to as a unit, a station, a terminal, or a client, among other examples. Additionally, or alternatively, the UE 104 may be referred to as an Internet-of-Things (IoT) device, an Internet-of-Everything (IoE) device, or machine-type communication (MTC) device, among other examples. In some implementations, a UE 104 may be stationary in the wireless communications system 100. In some other implementations, a UE 104 may be mobile in the wireless communications system 100.

[0048] The one or more UEs 104 may be devices in different forms or having different capabilities. Some examples of UEs 104 are illustrated in FIG. 1. A UE 104 may be capable of communicating with various types of devices, such as the network entities 102, other UEs 104, or network equipment (e.g., the core network 106, the packet data network 108, a relay device, an integrated access and backhaul (IAB) node, or another network equipment), as shown in FIG. 1. Additionally, or alternatively, a UE 104 may support communication with other network entities 102 or UEs 104, which may act as relays in the wireless communications system 100.

[0049] A UE 104 may also be able to support wireless communication directly with other UEs 104 over a communication link 114. For example, a UE 104 may support wireless communication directly with another UE 104 over a device-to-device (D2D) communication link. In some implementations, such as vehicle-to-vehicle (V2V) deployments, vehicle-to-everything (V2X) deployments, or cellular-V2X deployments, the communication link 114 may be referred to as a sidelink (SL). For example, a UE 104 may support wireless communication directly with another UE 104 over a PC5 interface.

[0050] A network entity 102 may support communications with the core network 106, or with another network entity 102, or both. For example, a network entity 102 may interface with the core network 106 through one or more backhaul links 116 (e.g., via an S1, N2, N3, or another network interface). The network entities 102 may communicate with each other over the backhaul links 116 (e.g., via an X2, Xn, or another network interface). In some implementations, the network entities 102 may communicate with each other directly (e.g., between the network entities 102). In some other implementations, the network entities 102 may communicate with each other or indirectly (e.g., via the core network 106). In some implementations, one or more network entities 102 may include subcomponents, such as an access network entity, which may be an example of an access node controller (ANC). An

ANC may communicate with the one or more UEs 104 through one or more other access network transmission entities, which may be referred to as a radio heads, smart radio heads, or transmission-reception points (TRPs).

[0051] In some implementations, a network entity 102 may be configured in a disaggregated architecture, which may be configured to utilize a protocol stack physically or logically distributed among two or more network entities 102, such as an integrated access backhaul (IAB) network, an open RAN (O-RAN) (e.g., a network configuration sponsored by the O-RAN Alliance), or a virtualized RAN (vRAN) (e.g., a cloud RAN (C-RAN)). For example, a network entity 102 may include one or more of a central unit (CU), a distributed unit (DU), a radio unit (RU), a RAN Intelligent Controller (RIC) (e.g., a Near-Real Time RIC (Near-RT RIC), a Non-Real Time RIC (Non-RT RIC)), a Service Management and Orchestration (SMO) system, or any combination thereof.

[0052] An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0053] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., Radio Resource Control (RRC), service data adaption protocol (SDAP), Packet Data Convergence Protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU.

[0054] Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

[0055] A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a midhaul communication link (e.g., F1, F1-C, F1-U), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

[0056] The core network 106 may support user authentication, access authorization, tracking, connectivity, and other access, routing, or mobility functions. The core network 106 may be an evolved packet core (EPC), or a 5G core (5GC), which may include a control plane entity that manages access and mobility (e.g., a mobility management entity (MME), an access and mobility management functions (AMF)) and a user plane entity that routes packets or interconnects to external networks (e.g., a serving gateway (S-GW), a Packet Data Network (PDN) gateway (P-GW), or a user plane function (UPF)). In some implementations, the control plane entity may manage non-access stratum (NAS) functions, such as mobility, authentication, and bearer management (e.g., data bearers, signal bearers, etc.) for the one or more UEs 104 served by the one or more network entities 102 associated with the core network 106.

[0057] The core network 106 may communicate with the packet data network 108 over one or more backhaul links 116 (e.g., via an S1, N2, N3, or another network interface). The packet data network 108 may include an application server 118. In some implementations, one or more UEs 104 may communicate with the application server 118. A UE 104 may establish a session (e.g., a protocol data unit (PDU) session, or the like) with the core network 106 via a network entity 102. The core network 106 may route traffic (e.g., control

information, data, and the like) between the UE 104 and the application server 118 using the established session (e.g., the established PDU session). The PDU session may be an example of a logical connection between the UE 104 and the core network 106 (e.g., one or more network functions of the core network 106).

[0058] In the wireless communications system 100, the network entities 102 and the UEs 104 may use resources of the wireless communications system 100 (e.g., time resources (e.g., symbols, slots, subframes, frames, or the like) or frequency resources (e.g., subcarriers, carriers)) to perform various operations (e.g., wireless communications). In some implementations, the network entities 102 and the UEs 104 may support different resource structures. For example, the network entities 102 and the UEs 104 may support different frame structures. In some implementations, such as in 4G, the network entities 102 and the UEs 104 may support a single frame structure. In some other implementations, such as in 5G and among other suitable radio access technologies, the network entities 102 and the UEs 104 may support various frame structures (i.e., multiple frame structures). The network entities 102 and the UEs 104 may support various frame structures based on one or more numerologies.

[0059] One or more numerologies may be supported in the wireless communications system 100, and a numerology may include a subcarrier spacing and a cyclic prefix. A first numerology (e.g., μ=0) may be associated with a first subcarrier spacing (e.g., 15 kHz) and a normal cyclic prefix. In some implementations, the first numerology (e.g., μ=0) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., μ=1) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., μ=2) may be associated with a third subcarrier spacing (e.g., 60 kHz) and a normal cyclic prefix or an extended cyclic prefix. A fourth numerology (e.g., μ=3) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., μ=4) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0060] A time interval of a resource (e.g., a communication resource) may be organized according to frames (also referred to as radio frames). Each frame may have a duration, for example, a 10 millisecond (*ms*) duration. In some implementations, each frame may include multiple subframes. For example, each frame may include 10 subframes, and each subframe may have a duration, for example, a 1 *ms* duration. In some implementations, each frame may have the same duration. In some implementations, each subframe of a

frame may have the same duration.

[0061] Additionally or alternatively, a time interval of a resource (e.g., a communication resource) may be organized according to slots. For example, a subframe may include a number (e.g., quantity) of slots. The number of slots in each subframe may also depend on the one or more numerologies supported in the wireless communications system 100. For instance, the first, second, third, fourth, and fifth numerologies (i.e., μ=0, μ=1, μ=2, μ=3, μ=4) associated with respective subcarrier spacings of 15 kHz, 30 kHz, 60 kHz, 120 kHz, and 240 kHz may utilize a single slot per subframe, two slots per subframe, four slots per subframe, eight slots per subframe, and 16 slots per subframe, respectively. Each slot may include a number (e.g., quantity) of symbols (e.g., OFDM symbols). In some implementations, the number (e.g., quantity) of slots for a subframe may depend on a numerology. For a normal cyclic prefix, a slot may include 14 symbols. For an extended cyclic prefix (e.g., applicable for 60 kHz subcarrier spacing), a slot may include 12 symbols. The relationship between the number of symbols per slot, the number of slots per subframe, and the number of slots per frame for a normal cyclic prefix and an extended cyclic prefix may depend on a numerology. It should be understood that reference to a first numerology (e.g., μ=0) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0062] In the wireless communications system 100, an electromagnetic (EM) spectrum may be split, based on frequency or wavelength, into various classes, frequency bands, frequency channels, etc. By way of example, the wireless communications system 100 may support one or multiple operating frequency bands, such as frequency range designations FR1 (410 MHz – 7.125 GHz), FR2 (24.25 GHz – 52.6 GHz), FR3 (7.125 GHz – 24.25 GHz), FR4 (52.6 GHz – 114.25 GHz), FR4a or FR4-1 (52.6 GHz – 71 GHz), and FR5 (114.25 GHz – 300 GHz). In some implementations, the network entities 102 and the UEs 104 may perform wireless communications over one or more of the operating frequency bands. In some implementations, FR1 may be used by the network entities 102 and the UEs 104, among other equipment or devices for cellular communications traffic (e.g., control information, data). In some implementations, FR2 may be used by the network entities 102 and the UEs 104, among other equipment or devices for short-range, high data rate capabilities.

[0063] FR1 may be associated with one or multiple numerologies (e.g., at least three numerologies). For example, FR1 may be associated with a first numerology (e.g., μ=0), which includes 15 kHz subcarrier spacing; a second numerology (e.g., μ=1), which includes

30 kHz subcarrier spacing; and a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing. FR2 may be associated with one or multiple numerologies (e.g., at least 2 numerologies). For example, FR2 may be associated with a third numerology (e.g., μ=2), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., μ=3), which includes 120 kHz subcarrier spacing.

[0064] In the context of the present disclosure, the term "proximity communication 5 (PC5) link" may be used interchangeably with PC5 interface, sidelink (SL), PC5 unicast link, SL unicast link, device-to-device (D2D) link, user-to-user link, UE-to-UE (U2U) link, or the like. The term "relay UE" may be used interchangeably with U2U relay UE, layer 2 (L2) relay UE, L2 U2U relay UE, or the like. The term "relay UE ID" may be used interchangeably with link ID, path ID, L2 relay UE ID, or the like. The term "remote UE" may be used interchangeably with U2U remote UE, L2 remote UE, L2 U2U remote UE, or the like.

[0065] A wireless communications system may include one or more devices, such as one or more base stations and/or one or more UEs. In some implementations, two different UEs may communicate with each other via a PC5 link (PC5 interface), two different base stations may communicate with each other via an Xn link (Xn interface), and a UE and a base station may communicate with each via a Uu link (Uu interface).

[0066] FIG. 2A illustrates a schematic diagram of an example communication network 210 in which some embodiments of the present disclosure can be implemented. As shown in FIG. 2A, a UE 211 may communicate with a base station via a relay UE. The base station may be a gNB 212 or an NG-eNB 213, and the relay UE may be a relay UE 214 or a relay UE 215. For example, the NG-eNB 213 may be an evolved long term evolution (eLTE) base station that supports an NG interface. In some embodiments, the sidelink transmission and reception over the PC5 link are supported when the UE 211 is inside Next Generation Radio Access Network (NG-RAN) coverage, irrespective of which RRC state the UE is in, and also supported and when the UE 211 is outside NG-RAN coverage.

[0067] For a PC5 communication between two different UEs, the control plane protocol stack may include multiple layers, which may include an access stratum (AS) layer, a PC5 signalling (PC5-S) layer, an RRC layer, etc.

[0068] FIG. 2B illustrates an example RRC reconfiguration sidelink procedure 220. A shown in FIG. 2B, a UE 221 may transmit a reconfiguration message for Sidelink e.g. *RRCReconfigurationSidelink* message to a UE 222, and the UE 222 may transmit a

reconfiguration complete message e.g. *RRCReconfigurationCompleteSidelink* message back to the UE 221.

[0069] The purpose of the procedure 220 is to modify a PC5-RRC connection, e.g. to establish/modify/release sidelink data radio bearers (DRBs), to configure NR sidelink measurement and reporting, to configure sidelink channel state indicator (CSI) reference signal resources.

[0070] The UE (such as the UE 221) may initiate the sidelink RRC reconfiguration procedure and perform an operation on the corresponding PC5-RRC connection in following cases:

- the release of sidelink DRBs associated with the peer UE (such as the UE 222),
- the establishment of sidelink DRBs associated with the peer UE,
- the modification for the parameters included in sidelink radio bearer-configuration (SLRB-Config) of sidelink DRBs associated with the peer UE,
- the configuration of the peer UE to perform NR sidelink measurement and report,
- the configuration of the sidelink CSI reference signal resources.

[0071] The L2 U2U Remote UE needs to establish end-to-end SL-SRB/DRBs with the peer L2 U2U Remote UE before user plane data transmission. FIG. 2C illustrates an example procedure 230 for L2 U2U remote UE connection establishment, which applies to L2 U2U Relay UE and L2 U2U Remote UE.

[0072] Step 1. The L2 U2U Remote UE, L2 U2U Relay UE, and peer L2 U2U Remote UE perform discovery procedure or integrated discovery procedure.

[0073] Step 2a. The L2 U2U Remote UE establishes/modifies a PC5-RRC connection with the selected L2 U2U Relay UE.

[0074] Step 2b. The L2 U2U Relay UE establishes/modifies a PC5-RRC connection with the peer L2 U2U Remote UE.

[0075] Step 3. The L2 U2U Relay UE allocates two local IDs and it is delivered via RRCReconfigurationSidelink message to each of the L2 U2U Remote UEs: one local ID to identify the L2 U2U Remote UE, the other local ID to identify the peer L2 U2U Remote UE. When the local ID is delivered, an L2 ID of the peer L2 U2U Remote UE is also delivered to the U2U Remote UE for making the association between the local ID and the L2 ID of the

peer U2U Remote UE.

[0076] Step 4. The L2 U2U Remote UE establishes end-to-end PC5-RRC connection with the peer L2 U2U Remote UE via the L2 U2U Relay UE. For the end-to-end connection establishment, fixed indexes (i.e., 0/1/2/3) are defined for end-to-end SL-SRB 0/1/2/3 respectively, and specified PC5 Relay RLC Channel configuration is used on each hop. The sidelink UE capability is exchanged between the L2 U2U Remote UEs via PC5-RRC (e.g., SL-SRB3) message.

[0077] Step 5. The L2 U2U Remote UE sends to the L2 U2U Relay UE all the QoS profiles for the end-to-end QoS flows via PC5-RRC.

[0078] Step 6. The L2 U2U Relay UE performs QoS split only for PDB.

[0079] Step 7. The L2 U2U Relay UE sends the split QoS value (i.e., PDB) via PC5-RRC message to the L2 U2U Remote UE.8. The L2 U2U Remote UE or the serving gNB of the L2 U2U Remote UE derives the PDCP and SDAP configuration for end-to-end SL-DRB and provides the portion of the configuration related to reception to the peer L2 U2U Remote UE using end-to-end RRCReconfigurationSidelink messages. The end-to-end bearer IDs for SL-SRB and SL-DRB are used as input for the L2 U2U Relay ciphering and deciphering at PDCP.

[0080] Step 9a. The L2 U2U Remote UE or the serving gNB of the L2 U2U Remote UE derives the first hop configuration (e.g. PC5 Relay RLC Channel configuration) for SL-DRB and provides to the L2 U2U Relay UE of the configuration related to receiving on the first hop (i.e., Rx by the relay UE), using per-hop RRCReconfigurationSidelink message.

[0081] Step 9b. The L2 U2U Relay UE or the serving gNB of the L2 U2U Relay UE derives the second hop configuration (e.g. PC5 Relay RLC Channel configuration) for each SL-DRB and provides to the peer L2 U2U Remote UE of the configuration related to receiving data packets on the second hop (i.e., RX by the peer remote UE), using per-hop RRCReconfigurationSidelink message.

[0082] Step 10. The L2 U2U Remote UE and the peer L2 U2U Remote UE transmit or receive data via L2 U2U Relay UE.

[0083] Embodiments of the present disclosure provide a solution of communication. In the solution, a first UE, which is a remote UE in U2U relay scenario, may determine a channel quality of a link between the first UE and a second UE (e.g., the relay UE), and may further perform at least one operation associated with the end-to-end connection if the channel

quality is lower than a threshold for triggering relay selection or reselection. As such, the threshold may be used as a condition for the at least one operation associated with the end-to-end connection. Therefore, a communication for the remote UE may be guaranteed. Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

[0084] FIG. 2D illustrates a schematic diagram of an example communication network 240 in which some embodiments of the present disclosure can be implemented. As shown in FIG. 2D, the communication network 240 may include a first UE 241, a second UE 242, and a third UE 243.

[0085] The first UE 241 and the third UE 243 may communicate with each other via the second UE 242. For example, the first UE 241 and the third UE 243 are remote UEs, and the second UE 242 is a relay UE.

[0086] A BS 250, such as a gNB, is also shown in FIG. 2D. For example, the BS 250 may be a serving gNB of the first UE 241. For example, the BS 250 may communicate with the first UE 241 via a Uu link. It is to be understood that there may be a serving gNB of the third UE 243, which is not shown in FIG. 2D.

[0087] In some cases, as shown in FIG. 2D, there may be a candidate relay UE 245, for example, a relay reselection may be performed, and the candidate relay UE 245 will be used as a relay UE for the communication between the first UE 241 and the second UE 242.

[0088] It is to be understood that the number of devices in FIG. 2D is given for the purpose of illustration without suggesting any limitations to the present disclosure.

[0089] In the present disclosure, a release message may be generated by a PC5-S layer of a UE, and may also be referred to as a PC5-S release message, a PC5-S layer release message, a PC5 unicast link release message, or the like, the present disclosure does not limit for this aspect.

[0090] In the present disclosure, a notification message may be generated by an RRC layer of a UE, and may also be referred to as an RRC layer notification message, such as a *NotificationMessageSidelink*, or the like, the present disclosure does not limit for this aspect.

[0091] Reference is now made to FIG. 3, which illustrates a signalling chart illustrating communication process 300 in accordance with some example embodiments of the present disclosure. The process 300 may involve the first UE 241, the second UE 242, and the third

UE 243 as shown in FIG. 2D. It is to be understood that the process 300 may also be applied to another scenario different from that shown in FIG. 2D, the present disclosure does not limit this aspect.

[0092] For ease of description, the first UE 241 is also referred to as a first remote UE, a source remote UE, a U2U remote UE, or the like; the second UE 242 is also referred to as a relay UE, a U2U relay UE, or the like; and the third UE 243 is also referred to as a second remote UE, a target remote UE, a destination remote UE, a peer U2U remote UE, or the like.

[0093] An end-to-end PC5 connection may be established at 310. In some implementations, the first PC5 RRC connection for the first hop between the first UE 241 and the second UE 242 may be established, and the second PC5 RRC connection for the second hop between the second UE 242 and the third UE 243 may be established. In some example embodiments, the end-to-end connection for unicast mode communication is established in a PC5-S layer.

[0094] In some implementations, the first UE 241 and/or the third UE 243 may receive a configuration from its serving gNB. With reference to FIG. 2D, the first UE 241 may receive a configuration from the BS 250. In some example embodiments, the configuration (e.g., sl-RemoteUE-ConfigU2U) may be transmitted via system information or dedicated RRC signalling.

[0095] In some embodiments, the configuration may include a first threshold (e.g., sl-RSRP-ThreshU2U) and/or a second threshold (e.g., sd-RSRP-ThreshU2U), for triggering relay UE selection/reselection. In some embodiments, the configuration may include a first coefficient (e.g., sl-FilterCoefficientU2U) and/or a second coefficient (e.g., sd-FilterCoefficientU2U).

[0096] In some examples, the first threshold (sl-RSRP-ThreshU2U) indicates the threshold of SL-RSRP for a U2U Remote UE to perform Relay UE selection/ reselection. The U2U remote UE applies the value of this field to evaluate AS layer conditions on direct PC5 link with the peer U2U Remote UE to trigger relay selection, and evaluate AS layer conditions on U2U relay link with U2U Relay UE to trigger relay reselection.

[0097] In some examples, the first coefficient (sl-FilterCoefficientU2U) specifies L3 filter coefficient for SL-RSRP measurement results from L1 filter.

[0098] In some examples, the second threshold (sd-RSRP-ThreshU2U) indicates the threshold of SD-RSRP for a U2U Remote UE to perform discovery and Relay UE selection/

reselection. For discovery, the U2U Remote UE applies the value of this field to evaluate AS layer conditions to decide whether to respond the discovery message when performing the U2U Relay Discovery with Model B. For relay selection and reselection, the U2U remote UE applies the value of this field to evaluate AS layer conditions on direct PC5 link to trigger relay selection, and evaluate AS layer conditions on U2U relay link to trigger relay reselection. The target U2U remote UE applies the value of this field to evaluate AS layer conditions trigger relay selection when performing U2U relay communication with integrated Discovery.

[0099] In some examples, the second coefficient (sd-FilterCoefficientU2U) specifies L3 filter coefficient for SD-RSRP measurement results from L1 filter.

[00100] In some implementations, the end-to-end (e2e) PC5 RRC connection between the first UE 241 and the third UE 243 is established. In some embodiments, for each e2e PC5-RRC connection of unicast, one e2e sidelink SRB (i.e., e2e SL-SRB0) is used to transmit the e2e PC5-S message(s) before the e2e PC5-S security has been established. One e2e sidelink SRB (i.e., e2e SL-SRB1) is used to transmit the e2e PC5-S messages to establish the e2e PC5-S security. One e2e sidelink SRB (i.e., SL-SRB2) is used to transmit the e2e PC5-S messages after the e2e PC5-S security has been established, which is protected. One e2e sidelink SRB (i.e., e2e SL-SRB3) is used to transmit the e2e PC5-RRC signalling, which is protected and only sent after the e2e PC5-S security has been established.

[00101] In addition or alternatively, after end-to-end PC5 RRC connection between the first UE 241 and the third UE 243 is established (at 310), some configuration(s) may be exchanged between the first UE 241 and the third UE 243. For example, the first UE 241 may transmit, to the third UE 243 via the second UE 242, the configuration for receiving data.

[00102] In some embodiments, after the end-to-end PC5 connection has been established, the U2U configuration, such as a sidelink relay adaptation protocol (SRAP) configuration, may be configured. In some examples, the U2U configuration may be configured via sl-L2RelayUE-Config or sl-L2RemoteUE-Config included in the RRC reconfiguration message. For example, the sl-L2RelayUE-Config or sl-L2RemoteUE-Config may include a configuration related to the second UE 242 (i.e. the U2U relay).

[00103] In the process 300, the first UE 241 determines a channel quality of a link between the first UE 241 and the second UE 242. As shown in FIG. 3, the first UE 241 may determine that the channel quality of the link between the first UE 241 and the second UE

242 is lower than a pre-configured threshold at 320. For example, the pre-configured threshold may be a threshold for triggering relay UE selection or reselection. For example, an AS layer of the first UE 241 may evaluate whether the threshold is met. For example, the pre-configured threshold may be the first threshold or the second threshold discussed above. For example, the channel quality may be the RSRP of the link.

[00104] In some examples, the SL-RSRP of the link between the first UE 241 and the second UE 242 (e.g., currently selected NR sidelink U2U Relay UE) is available and is below the threshold for SL-RSRP for the first UE 241 (a U2U Remote UE) to perform relay UE selection/ reselection (i.e., the first threshold, sl-RSRP-ThreshU2U) by L3 filter coefficient (e.g., the first coefficient, sl-FilterCoefficientU2U) within sl-RemoteUE-ConfigU2U if configured. For instance, the SL-RSRP of the link is based on a measurement result of the data for communication.

[00105] In some examples, the SD-RSRP of the link between the first UE 241 and the second UE 242 (e.g., currently selected NR sidelink U2U Relay UE) is available, and is below the threshold of SD-RSRP for the first UE 241 (a U2U Remote UE) to perform discovery and relay UE selection/ reselection (i.e., the second threshold, sd-RSRP-ThreshU2U) by L3 filter coefficient for SD-RSRP measurement results (e.g., the second coefficient, sd-FilterCoefficientU2U) within sl-RemoteUE-ConfigU2U if configured. For instance, the SD-RSRP of the link is based on a measurement result of the discovery message.

[00106] In addition or alternatively, the first UE 241 may trigger the relay selection or reselection at 325, if the channel quality falling below the threshold. In some examples, the candidate relay UE 245 may be selected as a new relay for communication between the first UE 241 and the third UE 243.

[00107] In addition or alternatively, the first UE 241 performs at least one operation associated with the end-to-end PC5 connection at 330, if the channel quality falling below the threshold. As shown in FIG. 3, the at least one operation may include one or multiple of operations 331-337.

[00108] At 331, the first UE 241 may release the RLC entity and/or corresponding logical channel associated with an RLC channel ID of a specific destination. For example, the RLC entity between the first UE 241 and the second UE 242 can be released. As such, the threshold for triggering relay selection/reselection can be added as a condition for releasing RLC entity. For example, the corresponding logical channel associated with an RLC

channel ID (e.g. *SL-RLC-ChannelID*) of the specific destination (e.g., the third UE 243) can be released.

[00109] At 332, the first UE 241 may release end-to-end DRBs and/or SRBs for the end-to-end PC5 connection. For example, the end-to-end DRBs for the end-to-end PC5 connection can be released. For example, the end-to-end SRBs for the end-to-end PC5 connection can be released.

[00110] At 333, the first UE 241 may discard an end-to-end sidelink communication related configuration for the end-to-end PC5 connection. For example, the end-to-end NR sidelink communication related configuration for the end-to-end PC5 connection can be released.

[00111] At 334, the first UE 241 may determine a failure of the end-to-end PC5 connection. For example, the first UE 241 may consider the end-to-end PC5 connection failure.

[00112] At 335, the first UE 241 may determine that an RRC connection is released for the end-to-end PC5 connection. For example, the first UE 241 may consider the end-to-end PC5-RRC connection is released for the end-to-end PC5 connection.

[00113] At 336, the first UE 241 may indicate the release of the RRC connection to an upper layer. For example, an indication may be provided from an RRC layer to an upper layer (e.g. a PC5-S layer) of the first UE 241, and the indication may indicate a release of the end-to-end PC5-RRC connection.

[00114] At 337, the first UE 241 may transmit a release message or a notification message to the second UE 242. For example, the threshold for triggering relay UE selection or reselection can be used as one condition for triggering of a transmission of the release message or the notification message to the second UE 242 (i.e. the current connected relay UE). In some examples, an upper layer message, such as the release message (i.e. PC5-S release message) may be transmitted to the second UE 242. In some examples, an upper layer (e.g. a PC5-S layer) may provide an indication to the lower layer (e.g., the RRC layer) and the indication may indicate the PC5 unicast link release, then the lower layer (the RRC layer) may transmit a lower layer message, such as the notification message (i.e. RRC notification message) to the second UE 242.

[00115] It is to be noted that although the operations 331-337 are illustrated in FIG. 3, the operations performed by the first UE 241 are not limited in the present disclosure, for example some operations may not be performed, for example some operations can be combined, for example some additional operations may be further included.

[00116] As such, the threshold for triggering relay selection/reselection can be added as a condition for releasing RLC entity, or can be added as a condition for declaring an end-to-end PC5 connection failure.

[00117] For the relay perspective, the second UE 242 may perform the operation 341 and/or the operation 342. In some implementations, if the second UE 242 determines that the channel quality of the link between the first UE 241 and the second UE 242 is lower than the threshold, or if the release/notification message is received from the first UE 241 (e.g. at 337), the operation 341 and/or the operation 342 may be performed by the second UE 242.

[00118] At 341, the second UE 242 can release the RLC entity and/or corresponding logical channel associated with an RLC channel ID (e.g. *SL-RLC-ChannelID*) of the specific destination. At 342, the second UE 242 may transmit a further release message or a further notification message to the third UE 243.

[00119] According to some embodiments with reference to FIG. 3, in case a channel quality between a remote UE and a relay UE falling below a threshold, e.g. a threshold for triggering relay selection/reselection, at least one operation associated with an end-to-end PC5 connection between the remote UE and another remote UE via the relay UE may be performed. As such, the threshold may be used as one condition for the at least operation associated with the end-to-end PC5 connection. Accordingly, the end-to-end PC5 connection can be used for communication between two remote UEs.

[00120] Reference is further made to FIG. 4, which illustrates a signalling chart illustrating communication process 400 in accordance with some example embodiments of the present disclosure. The process 400 may involve the first UE 241, the second UE 242, and the third UE 243 as shown in FIG. 2D. It is to be understood that the process 400 may also be applied to another scenario different from that shown in FIG. 2D, the present disclosure does not limit this aspect.

[00121] An end-to-end PC5 connection may be established at 410. In some implementations, the first PC5 RRC connection for the first hop between the first UE 241 and the second UE 242 may be established, and the second PC5 RRC connection for the second hop between the second UE 242 and the third UE 243 may be established. In addition or alternatively, after end-to-end PC5 RRC connection between the first UE 241 and the third UE 243 is established (at 410), some configuration may be exchanged between the first UE 241 and the third UE 243. For example, the first UE 241 may transmit, to the third

UE 243 via the second UE 242, the configuration for receiving data. In some example embodiments, the operation 410 may be similar with the operation 310 discussed with reference to FIG. 3, details of which will not be repeated herein.

[00122] In the process 400, the second UE 242 may determine that a release condition is met or a sidelink RLF occurs at 420. In some example embodiments, the release condition and/or the SL RLF is for the link between the second UE 242 and the third UE 243.

[00123] In some implementations, the second UE 242 may determine that the release condition for the link between the second UE 242 and the third UE 243 is met. In some examples, an upper layer (i.e. PC5-S layer) of the second UE 242 may provide an indication to a lower layer (i.e. RRC layer) of the second UE 242, where the indication indicates a release of the RRC connection between the second UE 242 and the third UE 243. For example, the upper layer may provide information associated with a release of the PC5-RRC connection between the second UE 242 and the third UE 243. In some examples, the RRC layer of the second UE 242 may determine that the release condition is met, e.g., based on the indication from the upper layer. In some examples, the second UE 242 may receive a further release/notification message from the third UE 243, and then the second UE 242 may determine that the release condition is met upon the reception of the further release/notification message from the third UE 243. For example, the further release/notification message may be associated with a release of the link between the second UE 242 and the third UE 243.

[00124] In some implementations, the second UE 242 may determine that a sidelink RLF between the second UE 242 and the third UE 243 occurs. In some examples, the second UE 242 may detect a link quality of the link between the second UE 242 and the third UE 243 and then determine that the SL RLF occurs.

[00125] In the process 400, the second UE 242 transmits a release message or a notification message to the first UE 241 at 430, e.g., based on the determination at 420.

[00126] In some examples, an upper layer message, such as the release message (i.e. PC5-S release message) may be transmitted to the first UE 241. For example, the PC5-S layer of the second UE 242 may generate a PC5 unicast link release message.

[00127] In some examples, a lower layer message, such as the notification message (i.e. RRC notification message) may be transmitted to the first UE 241. For example, the notification message may include an indication type which indicates a release cause. For instance, the

indication type may be set as one of: per-hop release, released by upper layer, or other failure.

[00128] In addition or alternatively, the second UE 242 may consider the end-to-end PC5 connection failure for the end-to-end PC5 connection(s) over the per-hop PC5 link established with the first UE 241, e.g., based on the determination at 420.

[00129] On the other side of communication, the first UE 241 may perform at least one operation associated with the end-to-end PC5 connection at 440, e.g., based on the release/notification message from the second UE 242. As shown in FIG. 4, the at least one operation may include one or multiple of operations 441-445.

[00130] At 441, the first UE 241 may release end-to-end DRBs and/or SRBs for the end-to-end PC5 connection. For example, the end-to-end DRBs for the end-to-end PC5 connection can be released. For example, the end-to-end SRBs for the end-to-end PC5 connection can be released.

[00131] At 442, the first UE 241 may discard an end-to-end sidelink communication related configuration for the end-to-end PC5 connection. For example, the end-to-end NR sidelink communication related configuration for the end-to-end PC5 connection can be released.

[00132] At 443, the first UE 241 may determine a failure of the end-to-end PC5 connection. For example, the first UE 241 may consider the end-to-end PC5 connection failure.

[00133] At 444, the first UE 241 may determine that an RRC connection is released for the end-to-end PC5 connection. For example, the first UE 241 may consider the end-to-end PC5-RRC connection is released for the end-to-end PC5 connection.

[00134] At 445, the first UE 241 may indicate the release of the RRC connection to an upper layer. For example, an indication may be provided from an RRC layer to an upper layer (e.g. a PC5-S layer) of the first UE 241, and the indication may indicate a release of the end-to-end PC5-RRC connection.

[00135] According to some embodiments discussed with reference to FIG. 4, it is proposed that the relay UE may transmit a release or notification message to a remote UE (first UE) once the relay UE detects the SL RLF towards to another remote UE (third UE) or when an upper layer requests the release. As such, corresponding operation(s) may be further performed for the end-to-end PC5 connection.

[00136] It is to be appreciated that although the process 300 and the process 400 are described separately in FIGS. 3-4, they can be combined in some embodiments. For

example, the third UE 243 in FIG. 3 may receive the further release/notification message from the second UE 242 at 342, and may further perform some operations similar with operations 441-445 in FIG. 4.

[00137] It is to be understood that the embodiments with reference to FIGS. 3-4 are only for illustration without any limitation, for example, some step(s) may be omitted, reordered, modified, or combined, some further step(s) may be also included, the present disclosure does not limit for this aspect. It is understood that some additional embodiments based on FIGS. 3-4 are still in the protection scope of the present disclosure.

[00138] In some implementations, as mentioned above, after the end-to-end PC5 connection has been established, the U2U configuration (such as the SRAP configuration) may be configured, e.g., via sl-L2RelayUE-Config or sl-L2RemoteUE-Config included in the RRC reconfiguration message. For example, the sl-L2RelayUE-Config or sl-L2RemoteUE-Config may include a configuration related to the second UE 242 (i.e. the U2U relay). In some instances, the configuration related to the U2U relay will be released during an RRC connection re-establishment procedure.

[00139] In some examples, the U2U configuration may not be released (e.g. maintained) after the first UE 241 (or the third UE 243) initiates the re-establishment procedure. The first UE 241 (or the third UE 243) may report the configuration to the re-established gNB after completing the re-establishment procedure. In addition, the re-established gNB may further update the configuration.

[00140] In some examples, a further U2U configuration from system information may be used by the first UE 241 (or the third UE 243) while a timer T301 or T311 is running. For example, regarding the re-establishment procedure, after the first UE 241 (or the third UE 243) releases the dedicated configuration upon the initiation of re-establishment procedure, the first UE 241 (or the third UE 243) may perform a cell selection/reselection and start a timer for cell selection/reselection e.g. T301. Once the cell selection/reselection is finished, e.g., a suitable cell or a suitable relay UE is selected, the timer T301 may be stopped. In addition, the first UE 241 (or the third UE 243) may transmit an RRC reestablishment request and start the timer T311. The first UE 241 may receive a further U2U configuration from system information e.g. SIB12. The first UE 241 may use the further U2U configuration from system information while a timer associated with a cell selection or reselection is running or a further timer associated with a reestablishment request is running.

[00141] FIG. 5 illustrates an example of a device 500 that is suitable for implementing embodiments of the present disclosure. The device 500 may be an example of a UE as described herein. The device 500 may support wireless communication with the first UE 241, the second UE 242, the third UE 243, or any combination thereof. The device 500 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 502, a memory 504, a transceiver 506, and, optionally, an I/O controller 508. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[00142] The processor 502, the memory 504, the transceiver 506, or various combinations thereof or various components thereof may be examples of means for performing various aspects of the present disclosure as described herein. For example, the processor 502, the memory 504, the transceiver 506, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[00143] In some implementations, the processor 502, the memory 504, the transceiver 506, or various combinations or components thereof may be implemented in hardware (e.g., in communications management circuitry). The hardware may include a processor, a digital signal processor (DSP), an application-specific integrated circuit (ASIC), a field-programmable gate array (FPGA) or other programmable logic device, a discrete gate or transistor logic, discrete hardware components, or any combination thereof configured as or otherwise supporting a means for performing the functions described in the present disclosure. In some implementations, the processor 502 and the memory 504 coupled with the processor 502 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 502, instructions stored in the memory 504).

[00144] For example, the processor 502 may support wireless communication at the device 500 in accordance with examples as disclosed herein. The processor 502 may be configured to operable to support a means for actions discussed above.

[00145] The processor 502 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 502 may be configured to operate a memory array using a memory controller. In some other

implementations, a memory controller may be integrated into the processor 502. The processor 502 may be configured to execute computer-readable instructions stored in a memory (e.g., the memory 504) to cause the device 500 to perform various functions of the present disclosure.

[00146] The memory 504 may include random access memory (RAM) and read-only memory (ROM). The memory 504 may store computer-readable, computer-executable code including instructions that, when executed by the processor 502 cause the device 500 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. In some implementations, the code may not be directly executable by the processor 502 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 504 may include, among other things, a basic I/O system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[00147] The I/O controller 508 may manage input and output signals for the device 500. The I/O controller 508 may also manage peripherals not integrated into the device M02. In some implementations, the I/O controller 508 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 508 may utilize an operating system such as iOS®, ANDROID®, MS-WINDOWS®, OS/2®, UNIX®, LINUX®, or another known operating system. In some implementations, the I/O controller 508 may be implemented as part of a processor, such as the processor 506. In some implementations, a user may interact with the device 500 via the I/O controller 508 or via hardware components controlled by the I/O controller 508.

[00148] In some implementations, the device 500 may include a single antenna 510. However, in some other implementations, the device 500 may have more than one antenna 510 (i.e., multiple antennas), including multiple antenna panels or antenna arrays, which may be capable of concurrently transmitting or receiving multiple wireless transmissions. The transceiver 506 may communicate bi-directionally, via the one or more antennas 510, wired, or wireless links as described herein. For example, the transceiver 506 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 506 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 510 for transmission, and to demodulate packets received from the one or more antennas 510. The transceiver 506 may include one or more

transmit chains, one or more receive chains, or a combination thereof.

[00149] A transmit chain may be configured to generate and transmit signals (e.g., control information, data, packets). The transmit chain may include at least one modulator for modulating data onto a carrier signal, preparing the signal for transmission over a wireless medium. The at least one modulator may be configured to support one or more techniques such as amplitude modulation (AM), frequency modulation (FM), or digital modulation schemes like phase-shift keying (PSK) or quadrature amplitude modulation (QAM). The transmit chain may also include at least one power amplifier configured to amplify the modulated signal to an appropriate power level suitable for transmission over the wireless medium. The transmit chain may also include one or more antennas 510 for transmitting the amplified signal into the air or wireless medium.

[00150] A receive chain may be configured to receive signals (e.g., control information, data, packets) over a wireless medium. For example, the receive chain may include one or more antennas 510 for receive the signal over the air or wireless medium. The receive chain may include at least one amplifier (e.g., a low-noise amplifier (LNA)) configured to amplify the received signal. The receive chain may include at least one demodulator configured to demodulate the receive signal and obtain the transmitted data by reversing the modulation technique applied during transmission of the signal. The receive chain may include at least one decoder for decoding the processing the demodulated signal to receive the transmitted data.

[00151] FIG. 6 illustrates an example of a processor 600 that is suitable for implementing some embodiments of the present disclosure. The processor 600 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 600 may include a controller 602 configured to perform various operations in accordance with examples as described herein. The processor 600 may optionally include at least one memory 604, such as L1/L2/L3 cache. Additionally, or alternatively, the processor 600 may optionally include one or more arithmetic-logic units (ALUs) 606. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[00152] The processor 600 may be a processor chipset and include a protocol stack (e.g., a software stack) executed by the processor chipset to perform various operations (e.g.,

receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) in accordance with examples as described herein. The processor chipset may include one or more cores, one or more caches (e.g., memory local to or included in the processor chipset (e.g., the processor 600) or other memory (e.g., random access memory (RAM), read-only memory (ROM), dynamic RAM (DRAM), synchronous dynamic RAM (SDRAM), static RAM (SRAM), ferroelectric RAM (FeRAM), magnetic RAM (MRAM), resistive RAM (RRAM), flash memory, phase change memory (PCM), and others).

[00153] The controller 602 may be configured to manage and coordinate various operations (e.g., signaling, receiving, obtaining, retrieving, transmitting, outputting, forwarding, storing, determining, identifying, accessing, writing, reading) of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. For example, the controller 602 may operate as a control unit of the processor 600, generating control signals that manage the operation of various components of the processor 600. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[00154] The controller 602 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 604 and determine subsequent instruction(s) to be executed to cause the processor 600 to support various operations in accordance with examples as described herein. The controller 602 may be configured to track memory address of instructions associated with the memory 604. The controller 602 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 602 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 600 to cause the processor 600 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 602 may be configured to manage flow of data within the processor 600. The controller 602 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 600.

[00155] The memory 604 may include one or more caches (e.g., memory local to or included in the processor 600 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 604 may reside within or on a processor chipset (e.g., local to the processor 600). In some other implementations, the

memory 604 may reside external to the processor chipset (e.g., remote to the processor 600).

[00156] The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 600, cause the processor 600 to perform various functions described herein. The code may be stored in a non-transitory computer-readable medium such as system memory or another type of memory. The controller 602 and/or the processor 600 may be configured to execute computer-readable instructions stored in the memory 604 to cause the processor 600 to perform various functions. For example, the processor 600 and/or the controller 602 may be coupled with or to the memory 604, the processor 600, the controller 602, and the memory 604 may be configured to perform various functions described herein. In some examples, the processor 600 may include multiple processors and the memory 604 may include multiple memories. One or more of the multiple processors may be coupled with one or more of the multiple memories, which may, individually or collectively, be configured to perform various functions herein.

[00157] The one or more ALUs 606 may be configured to support various operations in accordance with examples as described herein. In some implementations, the one or more ALUs 606 may reside within or on a processor chipset (e.g., the processor 600). In some other implementations, the one or more ALUs 606 may reside external to the processor chipset (e.g., the processor 600). One or more ALUs 606 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 606 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 606 be configured with a variety of logical and arithmetic circuits, including adders, subtractors, shifters, and logic gates, to process and manipulate the data according to the operation. Additionally, or alternatively, the one or more ALUs 606 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 606 to handle conditional operations, comparisons, and bitwise operations.

[00158] The processor 600 may support wireless communication in accordance with examples as disclosed herein. The processor 600 may be configured to or operable to support a means for operations described in some embodiments of the present disclosure.

[00159] FIG. 7 illustrates a flowchart of a method 700 performed by a first UE in accordance with aspects of the present disclosure. The operations of the method 700 may be implemented by a device or its components as described herein. For example, the

operations of the method 700 may be performed by the first UE 241 in FIG. 2D. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[00160] At 710, the method may include determining a channel quality of a link between the first UE and a second UE, wherein an end-to-end PC5 connection has been established between the first UE with a third UE via the second UE. The operations of 710 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 710 may be performed by the first UE 241 as described with reference to FIG. 2D.

[00161] At 720, the method may include triggering a relay selection or reselection for the end-to-end PC5 connection based on a determination that the channel quality being lower than a threshold. The operations of 720 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 720 may be performed by the first UE 241 as described with reference to FIG. 2D.

[00162] At 730, the method may include performing at least one operation associated with the end-to-end PC5 connection based on a determination that the channel quality being lower than the threshold. The operations of 730 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 730 may be performed by the first UE 241 as described with reference to FIG. 2D.

[00163] FIG. 8 illustrates a flowchart of a method 800 performed by a second UE in accordance with aspects of the present disclosure. The operations of the method 800 may be implemented by a device or its components as described herein. For example, the operations of the method 800 may be performed by the second UE 242 in FIG. 2D. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[00164] At 810, the method may include determining that a release condition for a link between the second UE and a third UE is met or a sidelink RLF occurs, wherein an end-to-end connection has been established between a first UE with the third UE via the second UE. The operations of 810 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 810 may be performed by the second

UE 242 as described with reference to FIG. 2D.

[00165] At 820, the method may include transmitting, to the first UE, a message being a release message or a notification message. The operations of 820 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 820 may be performed by the second UE 242 as described with reference to FIG. 2D.

[00166] FIG. 9 illustrates a flowchart of a method 900 performed by a first UE in accordance with aspects of the present disclosure. The operations of the method 900 may be implemented by a device or its components as described herein. For example, the operations of the method 900 may be performed by the first UE 241 in FIG. 2D. In some implementations, the device may execute a set of instructions to control the function elements of the device to perform the described functions. Additionally, or alternatively, the device may perform aspects of the described functions using special-purpose hardware.

[00167] At 910, the method may include receiving, from a second UE, a message being a release message or a notification message, wherein an end-to-end connection has been established between the first UE with a third UE via the second UE. The operations of 910 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 910 may be performed by the first UE 241 as described with reference to FIG. 2D.

[00168] At 920, the method may include performing at least one operation associated with the end-to-end PC5 connection based on the message. The operations of 920 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 920 may be performed by the first UE 241 as described with reference to FIG. 2D.

[00169] It should be noted that the methods described herein describes possible implementations, and that the operations and the steps may be rearranged or otherwise modified and that other implementations are possible. Further, aspects from two or more of the methods may be combined.

[00170] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the

functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any 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, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[00171] The functions described herein may be implemented in hardware, software executed by a processor, firmware, or any combination thereof. If implemented in software executed by a processor, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. Other examples and implementations are within the scope of the disclosure and appended claims. For example, due to the nature of software, functions described herein may be implemented using software executed by a processor, hardware, firmware, hardwiring, or combinations of any of these. Features implementing functions may also be physically located at various positions, including being distributed such that portions of functions are implemented at different physical locations.

[00172] Computer-readable media includes both non-transitory computer storage media and communication media including any medium that facilitates transfer of a computer program from one place to another. A non-transitory storage medium may be any available medium that may be accessed by a general-purpose or special-purpose computer. By way of example, non-transitory computer-readable media may include RAM, ROM, electrically erasable programmable ROM (EEPROM), flash memory, compact disk (CD) ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other non-transitory medium that may be used to carry or store desired program code means in the form of instructions or data structures and that may be accessed by a general-purpose or special-purpose computer, or a general-purpose or special-purpose processor.

[00173] As used herein, including in the claims, an article "a" before an element is unrestricted and understood to refer to "at least one" of those elements or "one or more" of those elements. The terms "a," "at least one," "one or more," and "at least one of one or more" may be interchangeable. As used herein, including in the claims, "or" as used in a list of items (e.g., a list of items prefaced by a phrase such as "at least one of" or "one or more of" or "one or both of") indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase "based on" shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as "based on condition A"

may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase "based on" shall be construed in the same manner as the phrase "based at least in part on. Further, as used herein, including in the claims, a "set" may include one or more elements.

[00174] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

CLAIMS

1. A first user equipment (UE) comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the first UE to:

determine a channel quality of a link between the first UE and a second UE, wherein an end-to-end proximity communication 5 (PC5) connection has been established between the first UE with a third UE via the second UE;

trigger a relay selection or reselection for the end-to-end PC5 connection based on a determination that the channel quality being lower than a threshold; and

perform at least one operation associated with the end-to-end PC5 connection based on a determination that the channel quality being lower than the threshold.

2. The first UE of claim 1, wherein the channel quality is determined based on a measurement result of communication data, and wherein the threshold comprises a sidelink reference signal received power (SL-RSRP) threshold.

3. The first UE of claim 1, wherein the channel quality is determined based on a measurement result of discovery message, and wherein the threshold comprises a sidelink discovery reference signal received power (SD-RSRP) threshold.

4. The first UE of claim 1, wherein the at least one operation comprises one of:

releasing a radio link control (RLC) entity, or

releasing a logical channel associated with a RLC channel identity (ID) of a specific destination.

5. The first UE of claim 1, wherein the at least one operation comprises one of:

determining a failure of the end-to-end PC5 connection,

releasing end-to-end data radio bearers (DRB) for the end-to-end PC5 connection,

releasing end-to-end signalling radio bearers (SRB) for the end-to-end PC5 connection, or

discarding an end-to-end sidelink communication related configuration for the end-

to-end PC5 connection.

6. The first UE of claim 1, wherein the at least one operation comprises one of:

determining that a radio resource control (RRC) connection is released for the end-to-end PC5 connection, or

indicating, from an RRC layer to an upper layer, a release of the RRC connection.

7. The first UE of claim 1, wherein the at least one operation comprises:

transmitting, to the second UE, a release message or a notification message.

8. The first UE of claim 7, wherein the release message comprises a proximity communication 5 signalling (PC5-S) layer release message, the notification message comprises an RRC layer notification message.

9. The first UE of claim 1, wherein the at least one processor is further configured to cause the first UE to:

maintain a UE-to-UE (U2U) relay configuration after initiating an RRC connection re-establishment procedure, wherein the U2U relay configuration is received from a serving base station after the end-to-end PC5 connection has been established; and

report the UE-to-UE relay configuration to a re-established gNB after completing the re-establishment procedure.

10. The first UE of claim 1, wherein the at least one processor is further configured to cause the first UE to:

release a U2U relay configuration after initiating an RRC connection re-establishment procedure, wherein the U2U configuration is received from a serving base station after the end-to-end PC5 connection has been established; and

use a further U2U relay configuration from system information while a timer associated with a cell selection or reselection is running or a further timer associated with a reestablishment request is running.

11. A second user equipment (UE) comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause

the second UE to:

determine that a release condition for a link between the second UE and a third UE is met or a sidelink radio link failure (RLF) occurs, wherein an end-to-end proximity communication 5 (PC5) connection has been established between a first UE with the third UE via the second UE; and

transmit, to the first UE, a message being a release message or a notification message.

12. The second UE of claim 11, wherein the release condition comprises:

an indication, from an upper layer to a radio resource control (RRC) layer, for releasing an RRC connection between the second UE and the third UE.

13. The second UE of claim 11, wherein the release condition comprises:

a reception of a further release message or a further notification message from the third UE.

14. The second UE of claim 11, wherein the notification message comprises an indication type, and the indication type indicates a release cause.

15. The second UE of claim 11, wherein the release message comprises a proximity communication 5 signalling (PC5-S) layer release message, the notification message comprises an RRC layer notification message.

16. A first user equipment (UE) comprising:

at least one memory; and

at least one processor coupled with the at least one memory and configured to cause the first UE to:

receive, from a second UE, a message being a release message or a notification message, wherein an end-to-end proximity communication 5 (PC5) connection has been established between the first UE with a third UE via the second UE; and

perform at least one operation associated with the end-to-end PC5 connection based on the message.

17. The first UE of claim 16, wherein the at least one operation comprises one of:

determining a failure of the end-to-end PC5 connection,

releasing end-to-end data radio bearers (DRB) for the end-to-end PC5 connection,

releasing end-to-end signalling radio bearers (SRB) for the end-to-end PC5 connection, or

discarding an end-to-end sidelink communication related configuration for the end-to-end PC5 connection.

18. The first UE of claim 16, wherein the at least one operation comprises one of:

determining that a radio resource control (RRC) connection is released for the end-to-end PC5 connection, or

indicating, from an RRC layer to an upper layer, a release of the RRC connection.

19. The first UE of claim 16, wherein the message indicates a sidelink radio link failure (RLF) of a link between the second UE and the third UE.

20. The first UE of claim 16, wherein the release message comprises a proximity communication 5 signalling (PC5-S) layer release message, the notification message comprises an RRC layer notification message.

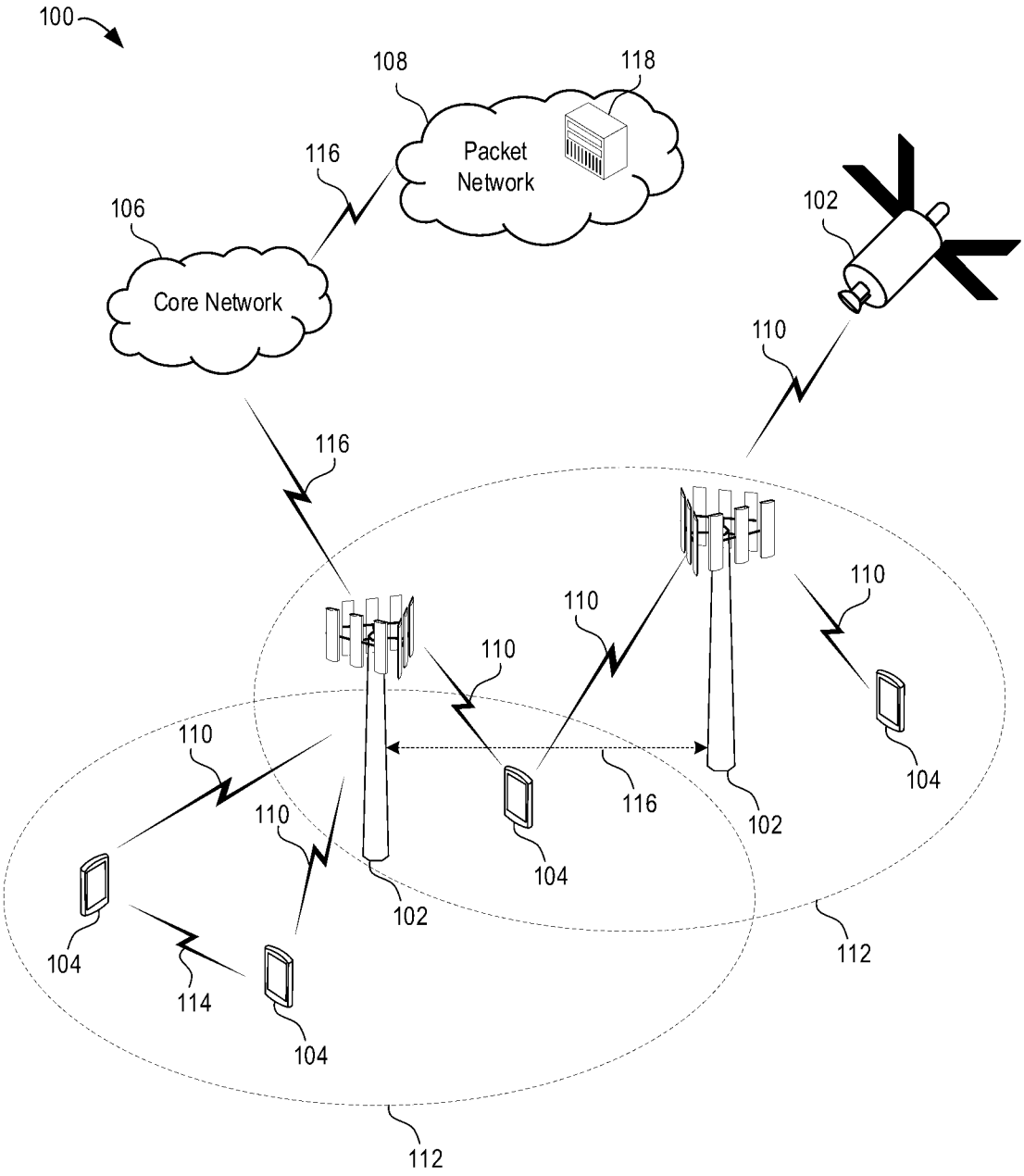
100
108
118
Packet Network
116
106
Core Network
102
110
116
110
110
110
110
110
104
116
102
104
110
110
102
104
112
114
104
112

FIG. 1

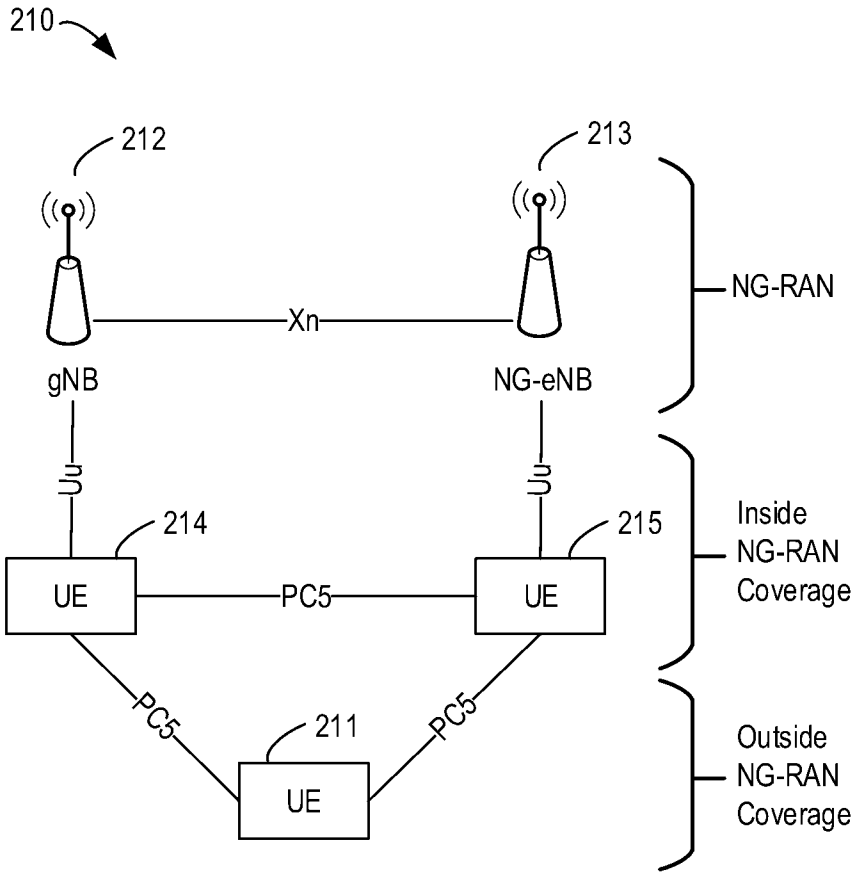
210
212
213
Xn
NG-RAN
gNB
NG-eNB
Uu
Uu
214
215
UE
PC5
UE
Inside
NG-RAN
Coverage
PC5
PC5
211
UE
Outside
NG-RAN
Coverage

FIG. 2A

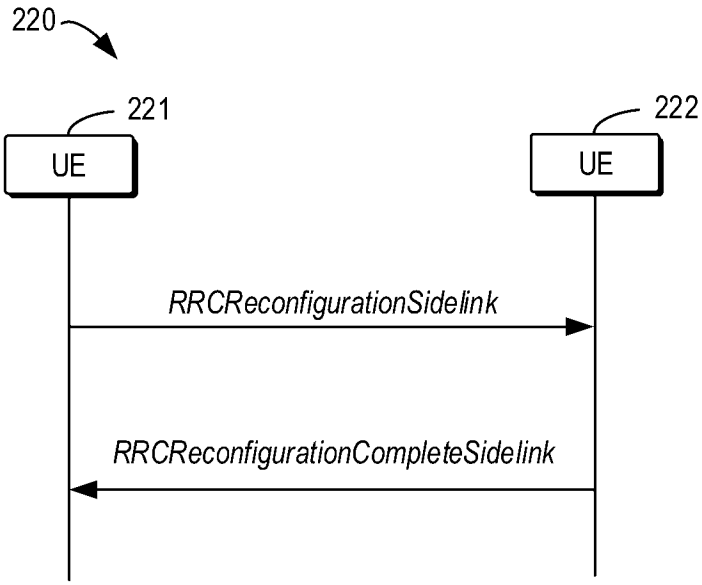
220
221
222
UE
UE
RRCReconfigurationSidelink
RRCReconfigurationCompleteSidelink

FIG. 2B

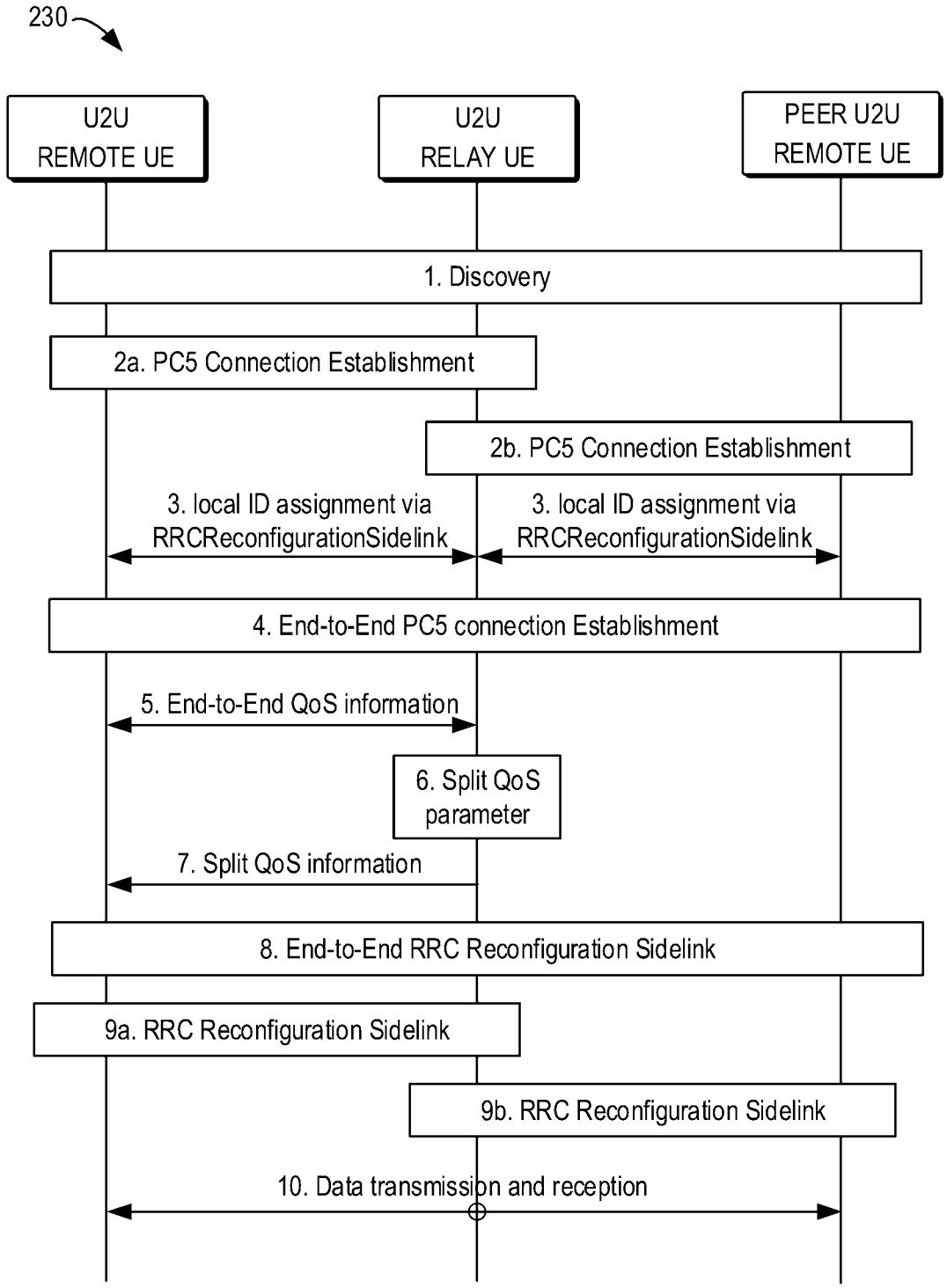
230
U2U REMOTE UE
U2U RELAY UE
PEER U2U REMOTE UE
1. Discovery
2a. PC5 Connection Establishment
2b. PC5 Connection Establishment
3. local ID assignment via RRCReconfigurationSidelink
3. local ID assignment via RRCReconfigurationSidelink
4. End-to-End PC5 connection Establishment
5. End-to-End QoS information
6. Split QoS parameter
7. Split QoS information
8. End-to-End RRC Reconfiguration Sidelink
9a. RRC Reconfiguration Sidelink
9b. RRC Reconfiguration Sidelink
10. Data transmission and reception

FIG. 2C

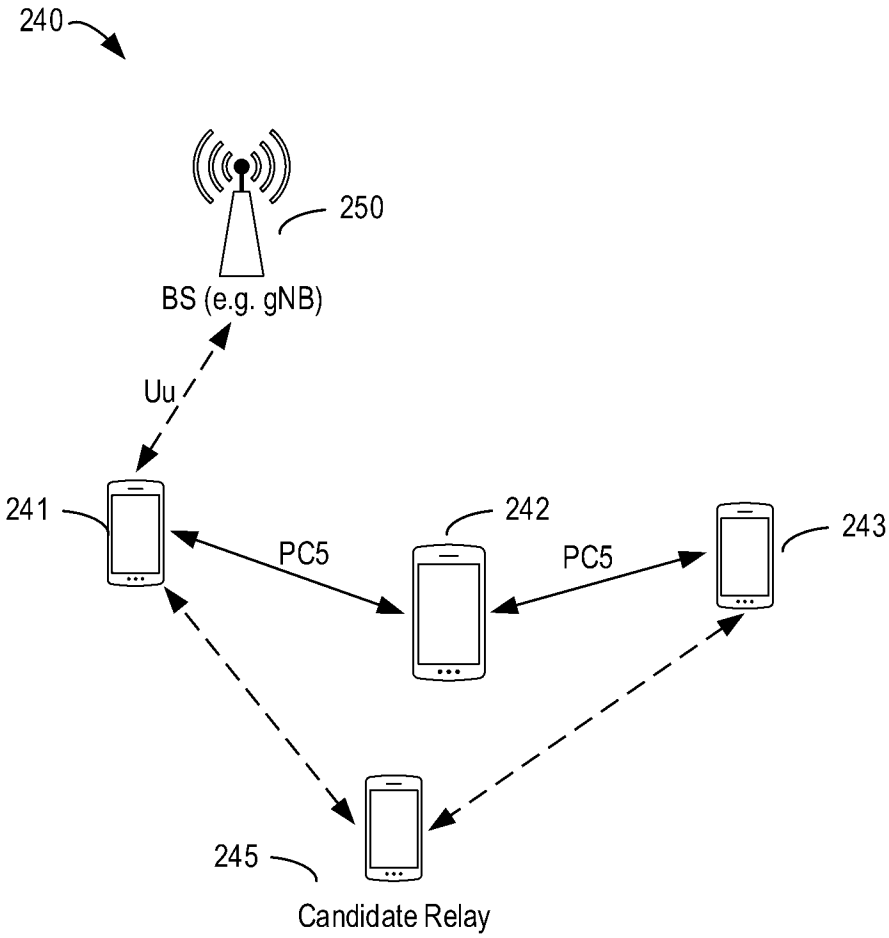

FIG. 2D

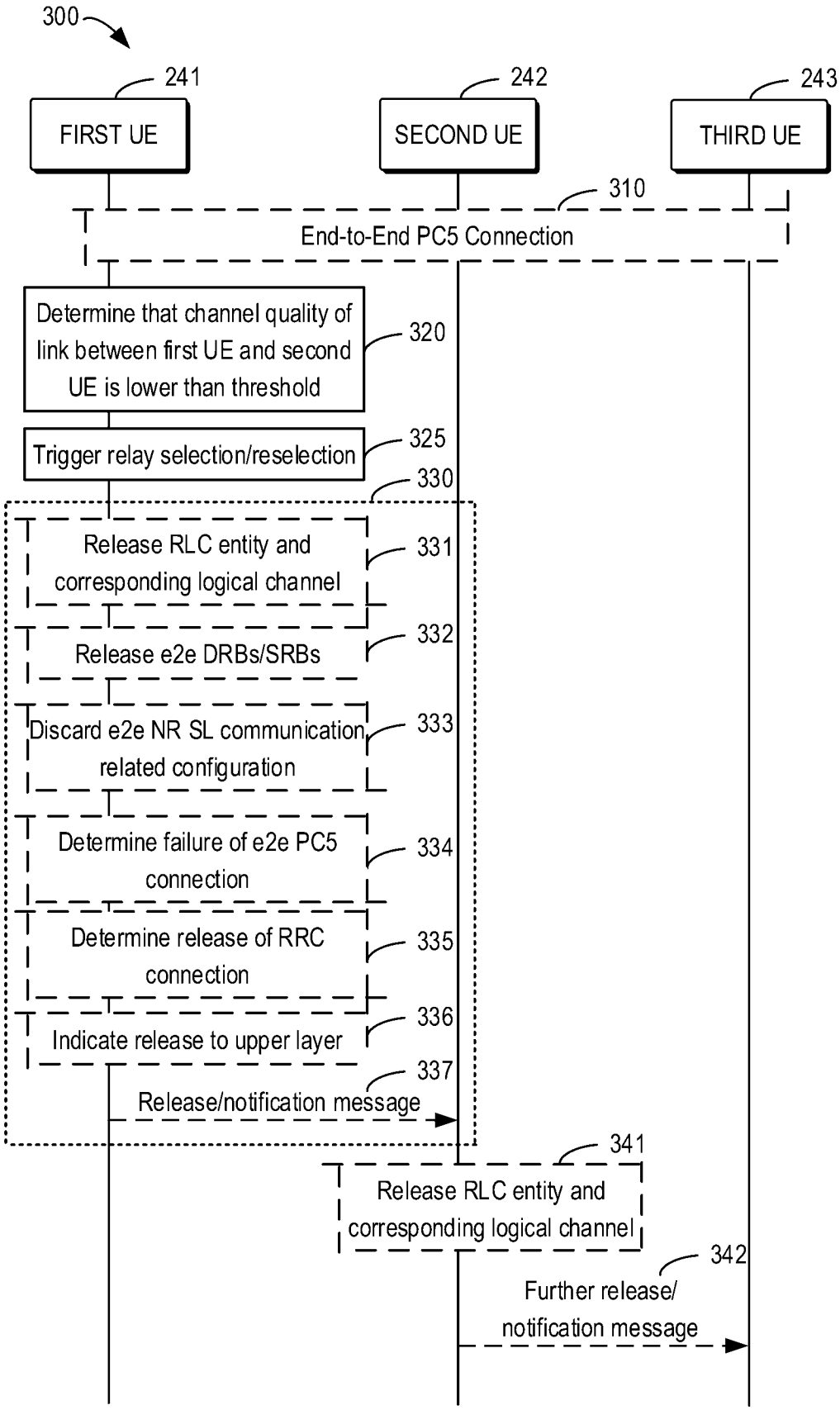
300
241
FIRST UE
242
SECOND UE
243
THIRD UE
310
End-to-End PC5 Connection
Determine that channel quality of link between first UE and second UE is lower than threshold
320
Trigger relay selection/reselection
325
330
Release RLC entity and corresponding logical channel
331
Release e2e DRBs/SRBs
332
Discard e2e NR SL communication related configuration
333
Determine failure of e2e PC5 connection
334
Determine release of RRC connection
335
Indicate release to upper layer
336
Release/notification message
337
341
Release RLC entity and corresponding logical channel
342
Further release/ notification message

FIG. 3

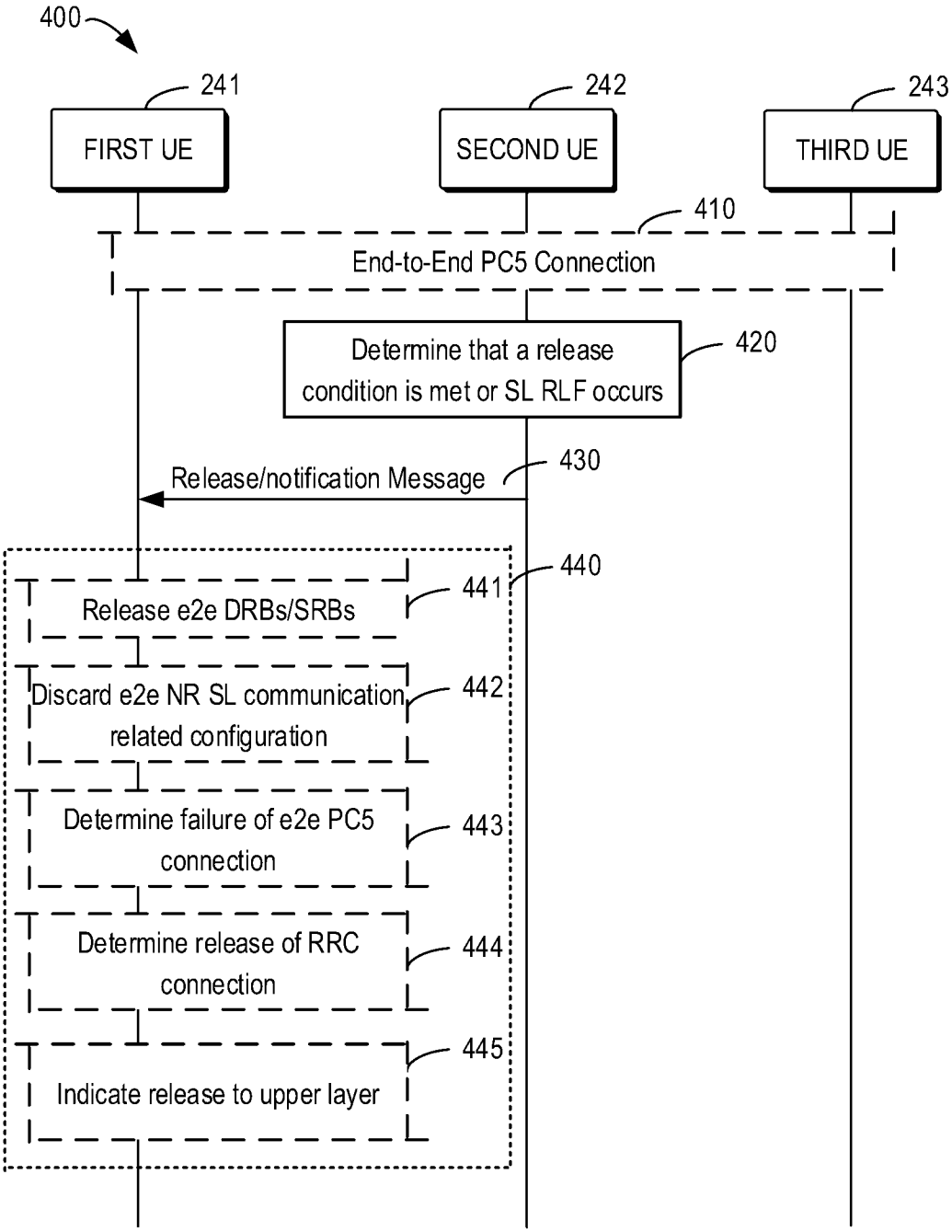
400
241
242
243
FIRST UE
SECOND UE
THIRD UE
410
End-to-End PC5 Connection
Determine that a release condition is met or SL RLF occurs
420
Release/notification Message
430
440
441
Release e2e DRBs/SRBs
442
Discard e2e NR SL communication related configuration
443
Determine failure of e2e PC5 connection
444
Determine release of RRC connection
445
Indicate release to upper layer

FIG. 4

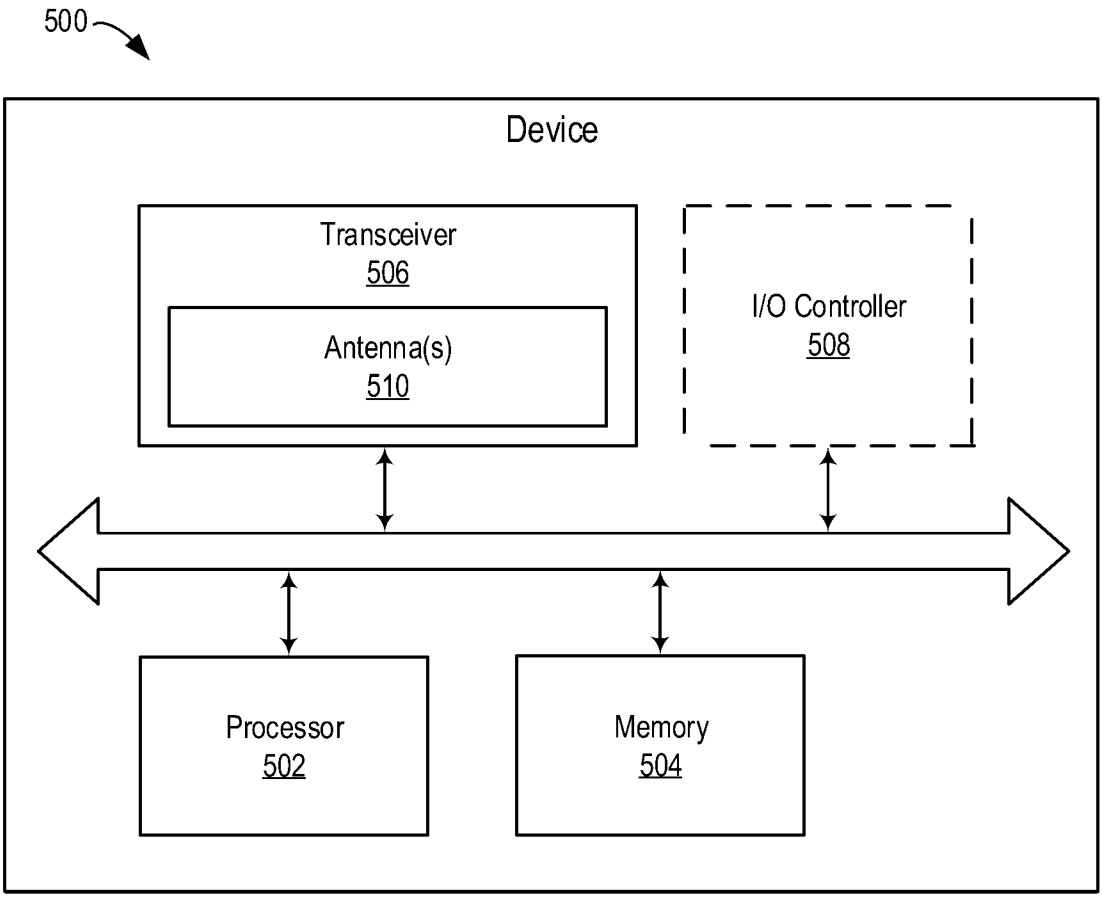
500
Device
Transceiver
506
Antenna(s)
510
I/O Controller
508
Processor
502
Memory
504

FIG. 5

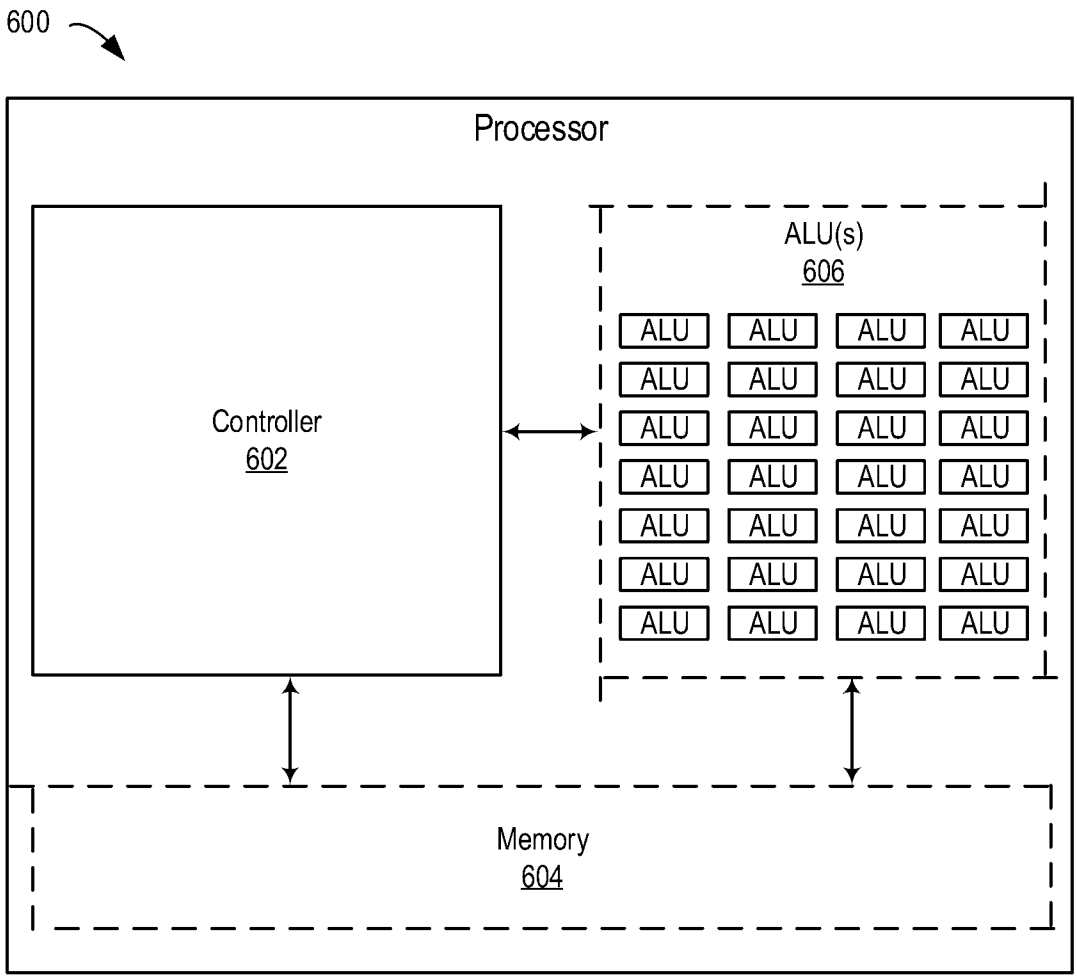

FIG. 6

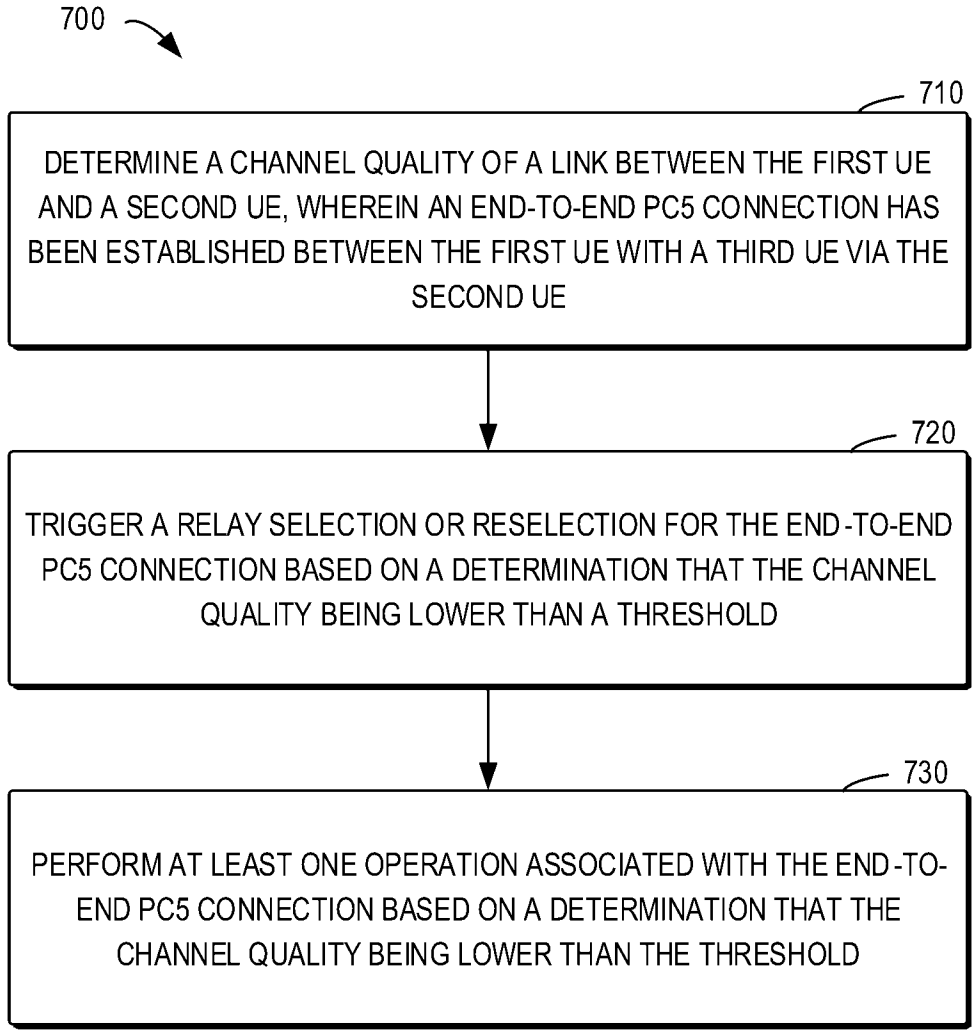
700
710
DETERMINE A CHANNEL QUALITY OF A LINK BETWEEN THE FIRST UE AND A SECOND UE, WHEREIN AN END-TO-END PC5 CONNECTION HAS BEEN ESTABLISHED BETWEEN THE FIRST UE WITH A THIRD UE VIA THE SECOND UE
720
TRIGGER A RELAY SELECTION OR RESELECTION FOR THE END-TO-END PC5 CONNECTION BASED ON A DETERMINATION THAT THE CHANNEL QUALITY BEING LOWER THAN A THRESHOLD
730
PERFORM AT LEAST ONE OPERATION ASSOCIATED WITH THE END-TO-END PC5 CONNECTION BASED ON A DETERMINATION THAT THE CHANNEL QUALITY BEING LOWER THAN THE THRESHOLD

FIG. 7

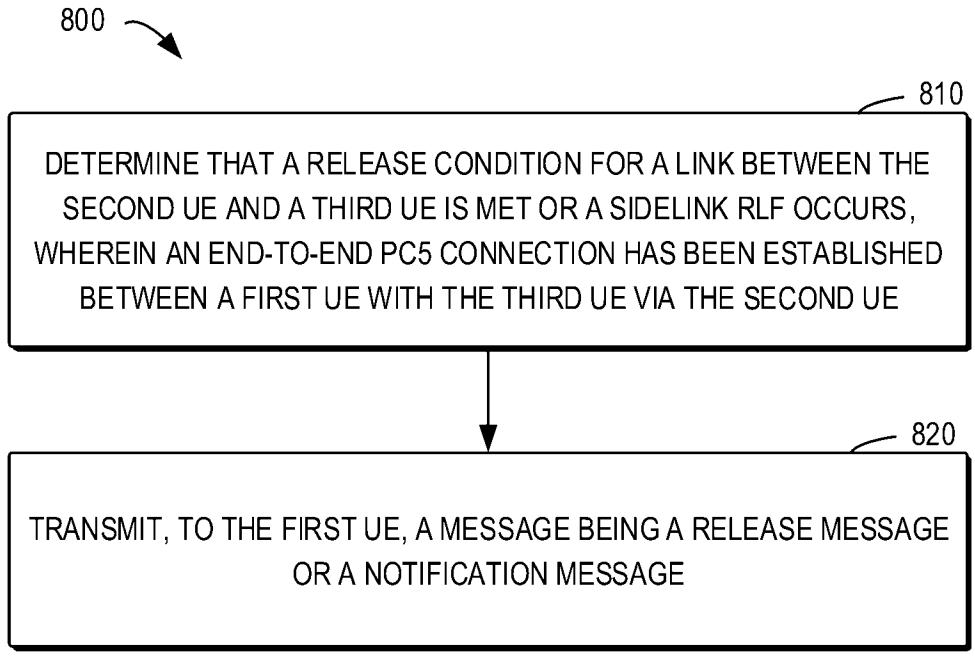
800
810
DETERMINE THAT A RELEASE CONDITION FOR A LINK BETWEEN THE SECOND UE AND A THIRD UE IS MET OR A SIDELINK RLF OCCURS, WHEREIN AN END-TO-END PC5 CONNECTION HAS BEEN ESTABLISHED BETWEEN A FIRST UE WITH THE THIRD UE VIA THE SECOND UE
820
TRANSMIT, TO THE FIRST UE, A MESSAGE BEING A RELEASE MESSAGE OR A NOTIFICATION MESSAGE

FIG. 8

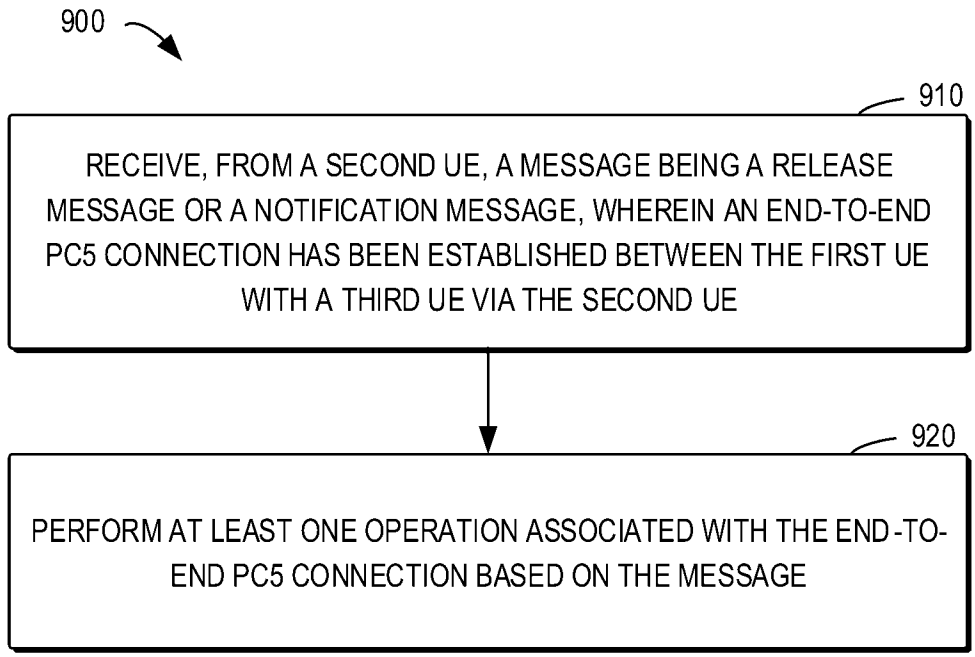
900
910
RECEIVE, FROM A SECOND UE, A MESSAGE BEING A RELEASE MESSAGE OR A NOTIFICATION MESSAGE, WHEREIN AN END-TO-END PC5 CONNECTION HAS BEEN ESTABLISHED BETWEEN THE FIRST UE WITH A THIRD UE VIA THE SECOND UE
920
PERFORM AT LEAST ONE OPERATION ASSOCIATED WITH THE END-TO-END PC5 CONNECTION BASED ON THE MESSAGE

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2024/087088

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/14(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)

IPC: H04W H04L H04Q

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

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

CNTXT,ENTXT,DWPI,CNKI,3GPP: sidelink, PC5, end-to-end, UE-to-UE relay, relay UE, reselection, relay selection, channel quality, RLF

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 114390634 A (DATANG MOBILE COMMUNICATIONS EQUIPMENT CO., LTD.) 22 April 2022 (2022-04-22) description, paragraphs [0099]-[0141]	1-20
A	CN 114080062 A (HUAWEI TECHNOLOGIES CO., LTD.) 22 February 2022 (2022-02-22) the whole document	1-20
A	CN 114173368 A (HUAWEI TECHNOLOGIES CO., LTD.) 11 March 2022 (2022-03-11) the whole document	1-20
A	US 2021321365 A1 (QUALCOMM INCORPORATED) 14 October 2021 (2021-10-14) the whole document	1-20

☐ 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
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
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"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
10 December 2024	**23 December 2024**
Name and mailing address of the ISA/CN **CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	Authorized officer **ZHENG,Hao** Telephone No. **(+86) 010-53961587**

Form PCT/ISA/210 (second sheet) (July 2022)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2024/087088

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	114390634	A	22 April 2022	WO	2022078071	A1	21 April 2022
CN	114080062	A	22 February 2022	WO	2022037456	A1	24 February 2022
CN	114173368	A	11 March 2022	WO	2022052851	A1	17 March 2022
US	2021321365	A1	14 October 2021	WO	2021207058	A1	14 October 2021
				EP	4133903	A1	15 February 2023
				IN	202247048239	A	16 September 2022
				CN	115428585	A	02 December 2022