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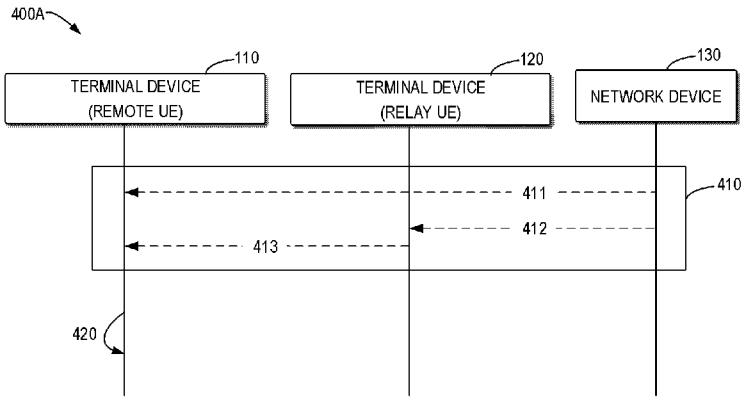

FIG. 4A

(57) **Abstract:** Embodiments of the present disclosure relate to methods, devices and computer readable media of communication. A first terminal device receives an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the first terminal device and a network device and an indirect path between the first terminal device and the network device via a second terminal device, and performs, based on the indication, activation or deactivation of the packet duplication for the split radio bearer. In this way, packet duplication for a split radio bearer may be controlled dynamically.

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METHOD, DEVICE AND COMPUTER STORAGE MEDIUM OF COMMUNICATION

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication, and in particular, to methods, devices and computer storage media of communication for multipath with relay.

BACKGROUND

[0002] It has been proposed to support multipath (MP) with relay, where remote user equipment (UE) is connected to a network via direct and indirect paths. The direct path means that the remote UE is connected to the network directly. The indirect path means that the remote UE is connected to the network via a relay UE using PC5 interface or a non-standardized UE-UE interconnection. The support of MP with relay has a potential to improve reliability or robustness as well as throughput. However, a solution of MP with relay in user plane aspects is still incomplete and needs to be further developed.

SUMMARY

[0003] In general, embodiments of the present disclosure provide methods, devices and computer storage media of communication for MP with relay.

[0004] In a first aspect, there is provided a method of communication. The method comprises: receiving, at a first terminal device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the first terminal device and a network device and an indirect path between the first terminal device and the network device via a second terminal device; and performing, based on the indication, activation or deactivation of the packet duplication for the split radio bearer.

[0005] In a second aspect, there is provided a method of communication. The method comprises: transmitting, at a network device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via a second terminal device.

[0006] In a third aspect, there is provided a method of communication. The method comprises: receiving, at a second terminal device and from a network device, a fifth indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via the second terminal device; and transmitting, to the first terminal device, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer.

[0007] In a fourth aspect, there is provided a device of communication. The device comprises a processor configured to cause the device to perform the method according to any of the first to third aspects of the present disclosure.

[0008] In a fifth aspect, there is provided a computer readable medium having instructions stored thereon. The instructions, when executed on at least one processor, cause the at least one processor to perform the method according to any of the first to third aspects of the present disclosure.

[0009] Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Through the more detailed description of some embodiments of the present disclosure in the accompanying drawings, the above and other objects, features and advantages of the present disclosure will become more apparent, wherein:

[0011] FIG. 1 illustrates an example communication network in which some embodiments of the present disclosure can be implemented;

[0012] FIG. 2 illustrates a diagram illustrating example bearer types for which some embodiments of the present disclosure can be implemented;

[0013] FIG. 3A illustrates an example protocol stack of a MP split data radio bearer (DRB) in which some embodiments of the present disclosure can be implemented;

[0014] FIG. 3B illustrates an example protocol stack of a MP split signaling radio bearer (SRB) in which some embodiments of the present disclosure can be implemented;

[0015] FIG. 3C illustrates another example protocol stack of a MP split DRB in which some embodiments of the present disclosure can be implemented;

[0016] FIG. 3D illustrates another example protocol stack of a MP split SRB in which some embodiments of the present disclosure can be implemented;

[0017] FIG. 4A illustrates a schematic diagram illustrating a process of communication according to embodiments of the present disclosure;

[0018] FIG. 4B illustrates a schematic diagram illustrating another process of communication according to embodiments of the present disclosure;

[0019] FIG. 5 illustrates an example method of communication implemented at a first terminal device in accordance with some embodiments of the present disclosure;

[0020] FIG. 6 illustrates an example method of communication implemented at a network device in accordance with some embodiments of the present disclosure;

[0021] FIG. 7 illustrates an example method of communication implemented at a second terminal device in accordance with some embodiments of the present disclosure; and

[0022] FIG. 8 is a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure.

[0023] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0024] Principle 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 limitations as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

[0025] 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.

[0026] As used herein, the term 'terminal device' refers to any device having wireless or wired communication capabilities. Examples of the terminal device include, but not limited to, user equipment (UE), personal computers, desktops, mobile phones, cellular phones, smart phones, personal digital assistants (PDAs), portable computers, tablets,

wearable devices, internet of things (IoT) devices, Ultra-reliable and Low Latency Communications (URLLC) devices, Internet of Everything (IoE) devices, machine type communication (MTC) devices, device on vehicle for V2X communication where X means pedestrian, vehicle, or infrastructure/network, devices for Integrated Access and Backhaul (IAB), Space borne vehicles or Air borne vehicles in Non-terrestrial networks (NTN) including Satellites and High Altitude Platforms (HAPs) encompassing Unmanned Aircraft Systems (UAS), eXtended Reality (XR) devices including different types of realities such as Augmented Reality (AR), Mixed Reality (MR) and Virtual Reality (VR), the unmanned aerial vehicle (UAV) commonly known as a drone which is an aircraft without any human pilot, devices on high speed train (HST), or image capture devices such as digital cameras, sensors, gaming devices, music storage and playback appliances, or Internet appliances enabling wireless or wired Internet access and browsing and the like. The 'terminal device' can further has 'multicast/broadcast' feature, to support public safety and mission critical, V2X applications, transparent IPv4/IPv6 multicast delivery, IPTV, smart TV, radio services, software delivery over wireless, group communications and IoT applications. It may also incorporate one or multiple Subscriber Identity Module (SIM) as known as Multi-SIM. The term "terminal device" can be used interchangeably with a UE, a mobile station, a subscriber station, a mobile terminal, a user terminal or a wireless device.

[0027] The term "network device" refers to a device which is capable of providing or hosting a cell or coverage where terminal devices can communicate. Examples of a network device include, but not limited to, a Node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a next generation NodeB (gNB), a transmission reception point (TRP), a remote radio unit (RRU), a radio head (RH), a remote radio head (RRH), an IAB node, a low power node such as a femto node, a pico node, a reconfigurable intelligent surface (RIS), and the like.

[0028] The terminal device or the network device may have Artificial intelligence (AI) or Machine learning capability. It generally includes a model which has been trained from numerous collected data for a specific function, and can be used to predict some information.

[0029] The terminal or the network device may work on several frequency ranges, e.g. FR1 (410 MHz to 7125 MHz), FR2 (24.25GHz to 71GHz), frequency band larger than 100GHz as well as Tera Hertz (THz). It can further work on licensed/unlicensed/shared spectrum. The terminal device may have more than one connection with the network

devices under Multi-Radio Dual Connectivity (MR-DC) application scenario. The terminal device or the network device can work on full duplex, flexible duplex and cross division duplex modes.

[0030] The embodiments of the present disclosure may be performed in test equipment, e.g. signal generator, signal analyzer, spectrum analyzer, network analyzer, test terminal device, test network device, channel emulator.

[0031] In some embodiments, the terminal device may be connected with a first network device and a second network device. One of the first network device and the second network device may be a master node and the other one may be a secondary node. The first network device and the second network device may use different radio access technologies (RATs). In some embodiments, the first network device may be a first RAT device and the second network device may be a second RAT device. In some embodiments, the first RAT device is eNB and the second RAT device is gNB. Information related with different RATs may be transmitted to the terminal device from at least one of the first network device or the second network device. In some embodiments, first information may be transmitted to the terminal device from the first network device and second information may be transmitted to the terminal device from the second network device directly or via the first network device. In some embodiments, information related with configuration for the terminal device configured by the second network device may be transmitted from the second network device via the first network device. Information related with reconfiguration for the terminal device configured by the second network device may be transmitted to the terminal device from the second network device directly or via the first network device.

[0032] 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. 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 'at least in part based 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 terms 'first,' 'second,' and the like may refer to different or same objects. Other definitions, explicit and implicit, may be included below.

[0033] In some examples, values, procedures, or apparatus 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.

[0034] In the context of the present disclosure, the term "direct path" may be interchangeably used with "master cell group (MCG)" or "direct transmission" or "direct path transmission", "MCG transmission" or "Uu path". The term "indirect path" may be interchangeably used with "indirect transmission", "indirect path transmission", "PC5 path", "sidelink path" or "relay path". The term "packet duplication" may be interchangeably used with "packet data convergence protocol (PDCP) duplication". The term "a RLC entity for a sidelink interface" may be interchangeably used with "a SL RLC entity" or "a PC5 RLC entity". The term "a RLC entity for an air interface" may be interchangeably used with "a Uu RLC entity".

[0035] In the context of the present disclosure, the term "a first terminal device" may refer to a terminal device functioning as remote UE, and the term "a second terminal device" may refer to a terminal device functioning as relay UE.

[0036] Support of multi-path with relay, where a remote UE is connected to network via direct and indirect paths, has a potential to improve the reliability/robustness as well as throughput, so it needs to be considered as an enhancement area. A MP relay solution may also be utilized to for UE aggregation where UE is connected to a network via a direct path and via another UE using a non-standardized UE-UE interconnection. UE aggregation aims to provide applications requiring high uplink (UL) bitrates on 5G terminals, in cases when normal UEs are too limited by UL UE transmission power to achieve required bitrate, especially at the edge of a cell. Additionally, UE aggregation may improve reliability and stability and reduce delay of services as well. That is, if a channel condition of a terminal is deteriorating, another terminal may be used to make up for traffic performance unsteadiness caused by channel condition variation.

[0037] However, a solution of MP with relay in user plane aspects is still incomplete. For example, it is unclear how to control packet duplication for a MP split radio bearer. Further, it is unclear how to avoid redundant transmission over an indirect path. In addition, it is unclear how to handle a collision between sidelink (SL) and UL transmissions for a remote UE.

[0038] In view of this, embodiments of the present disclosure provide a solution for MP with relay so as to solve the above and other potential issues. In the solution, a network device transmits, via a direct path between a first terminal device (e.g., remote UE) and the network device or an indirect path between the first terminal device and the network device via a second terminal device (e.g., relay UE), an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for the direct and indirect paths. Based on the indication, the first terminal device performs activation or deactivation of the packet duplication for the split radio bearer. In this way, a packet duplication of a MP split radio bearer may be dynamically controlled.

[0039] Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

EXAMPLE OF COMMUNICATION NETWORK

[0040] FIG. 1 illustrates a schematic diagram of an example communication network 100 in which some embodiments of the present disclosure can be implemented. As shown in FIG. 1, the communication network 100 may include a terminal device 110, a terminal device 120 and a network device 130. The network device 130 may provide one or more cells (not shown) to serve one or more terminal devices. In this example, the terminal device 110 and the terminal device 120 are served by the network device 130.

[0041] In some embodiments, the terminal device 110 and the terminal device 120 may be served by the same cell of the network device 130. In some embodiments, the terminal device 110 and the terminal device 120 may be served by different intra-frequency cells of the network device 130. In some embodiments, the terminal device 110 and the terminal device 120 may be served by different inter-frequency cells of the network device 130.

[0042] In some embodiments, the terminal device 110 may directly communicate with the network device 130 (i.e., via a direct path). The terminal device 110 may also communicate with the network device 130 via the terminal device 120 (i.e., via an indirect path). In this case, the terminal device 110 serves as remote UE, and the terminal device 120 serves as relay UE.

[0043] In some embodiments, the terminal device 120 may directly communicate with the network device 130 (i.e., via a direct path). The terminal device 120 may also communicate with the network device 130 via the terminal device 110 (i.e., via an indirect path). In this case, the terminal device 120 serves as remote UE, and the terminal device

110 serves as relay UE.

[0044] For convenience, the following description is given by taking the terminal device 110 as an example of remote UE and taking the terminal device 120 as an example of relay UE.

[0045] In some embodiments, the network device 130 and any of the terminal device 110 and the terminal device 120 may communicate with each other via an air interface (e.g., Uu interface), for example, via a wireless communication channel. The wireless communication channel may comprise a physical uplink control channel (PUCCH), a physical uplink shared channel (PUSCH), a physical random-access channel (PRACH), a physical downlink control channel (PDCCH), a physical downlink shared channel (PDSCH) and a physical broadcast channel (PBCH). Of course, any other suitable channels are also feasible.

[0046] In some embodiments, the terminal device 110 may be connected with the terminal device 120 via a sidelink (SL) interface (for example, PC5 interface or the like). In this case, the terminal device 120 serves as a Layer-2 (L2) UE-to-Network (U2N) relay. In some embodiments, the terminal device 110 and the terminal device 120 may communicate with each other via a SL channel such as a physical sidelink shared channel (PSSCH), a physical sidelink control channel (PSCCH), a physical sidelink feedback channel (PSFCH), a physical sidelink broadcast channel (PSBCH) or the like. For example, a PC5 connection may be established between the terminal device 110 and the second device 120.

[0047] In some embodiments, the terminal device 110 may be connected with the terminal device 120 via an ideal UE-UE inter-connection or backhaul connection.

[0048] It is to be understood that the number of devices in FIG. 1 is given for the purpose of illustration without suggesting any limitations to the present disclosure. The communication network 100 may include any suitable number of network devices and/or terminal devices adapted for implementing implementations of the present disclosure.

[0049] The communications in the communication network 100 may conform to any suitable standards including, but not limited to, Global System for Mobile Communications (GSM), Long Term Evolution (LTE), LTE-Evolution, LTE-Advanced (LTE-A), New Radio (NR), Wideband Code Division Multiple Access (WCDMA), Code Division Multiple Access (CDMA), GSM EDGE Radio Access Network (GERAN), Machine Type Communication (MTC) and the like. The embodiments of the present disclosure may be

performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols, 5.5G, 5G-Advanced networks, or the sixth generation (6G) networks.

[0050] In some embodiments, a direct bearer, an indirect bearer and a MP split bearer (for convenience, also referred to as a split radio bearer herein) may be supported. The direct bearer may refer to a radio bearer mapped to the direct path on an air interface (e.g., Uu interface). The indirect bearer may refer to a radio bearer mapped to the indirect path via relay UE. The MP split bearer may refer to a radio bearer mapped to both of the direct path and the indirect path based on a split bearer framework. This will be detailed in connection with FIG. 2 below.

[0051] FIG. 2 illustrates a diagram 200 illustrating example bearer types for which some embodiments of the present disclosure can be implemented. As shown by 210 in FIG. 2, a Uu PDCP entity may communicate with a Uu radio link control (RLC) entity via a direct bearer, and thus a direct bearer may be formed. As shown by 220 in FIG. 2, a Uu PDCP entity may communicate with a sidelink relay adaptation protocol (SRAP) entity and a SL RLC entity, and thus an indirect bearer may be formed. As shown by 230 in FIG. 2, a Uu PDCP entity may communicate with a Uu RLC entity via a MP split bearer and also communicate with a SRAP entity and a SL RLC entity to form a MP split bearer.

[0052] FIG. 3A illustrates an example protocol stack 300A of a MP split DRB in which some embodiments of the present disclosure can be implemented. In this example, remote UE and relay UE communicate with each other via a SL interface. For a MP split DRB, one PDCP entity at the remote UE is configured with one direct Uu RLC channel and one indirect PC5 RLC channel. For upstream, a PDCP entity delivers to a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side. For downstream, a PDCP entity receives from a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side.

[0053] FIG. 3B illustrates an example protocol stack 300B of a MP split SRB in which some embodiments of the present disclosure can be implemented. In this example, remote UE and relay UE communicate with each other via a SL interface. For a MP split SRB, one PDCP entity at the remote UE is configured with one direct Uu RLC channel and one

indirect PC5 RLC channel. For upstream, a PDCP entity delivers to a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side. For downstream, a PDCP entity receives from a Uu RLC entity and a PC5 RLC entity with SRAP entity in the remote UE side.

[0054] FIG. 3C illustrates another example protocol stack 300C of a MP split DRB in which some embodiments of the present disclosure can be implemented. In this example, remote UE and relay UE communicate with each other via an ideal UE-UE inter-connection. For a MP split DRB, one PDCP entity at the remote UE is configured with one direct Uu RLC channel and one indirect non-standard connection associated with the relay UE. For upstream, a PDCP entity delivers to a Uu RLC entity and a non-standard connection with the relay UE with SRAP entity in the remote UE side. For downstream, a PDCP entity receives from a Uu RLC entity and a non-standard connection associated with the relay UE with SRAP entity in the remote UE side.

[0055] FIG. 3D illustrates another example protocol stack 300D of a MP split SRB in which some embodiments of the present disclosure can be implemented. In this example, remote UE and relay UE communicate with each other via an ideal UE-UE inter-connection. For a MP split SRB, one PDCP entity at the remote UE is configured with one direct Uu RLC channel and one indirect non-standard connection associated with the relay UE. For upstream, a PDCP entity delivers to a Uu RLC entity and a non-standard connection associated with the relay UE with SRAP entity in the remote UE side. For downstream, a PDCP entity receives from a Uu RLC entity and a non-standard connection associated with the relay UE with SRAP entity in the remote UE side.

[0056] Embodiments of the present disclosure provide a solution of communication for MP with relay in user plane aspects. Details of the solution will be described with reference to FIGs. 4A and 4B.

EXAMPLE IMPLEMENTATION OF DYNAMIC CONTROL OF PACKET DUPLICATION FOR MP

[0057] FIG. 4A illustrates a schematic diagram illustrating a process 400A of communication according to embodiments of the present disclosure. For the purpose of discussion, the process 400A will be described with reference to FIG. 1. The process 400A may involve the terminal device 110, the terminal device 120 and the network device 130 as illustrated in FIG. 1. It is assumed that the terminal device 110 serves as remote UE, the terminal device 120 serves as relay UE.

[0058] As shown in FIG. 4A, the network device 130 may transmit 410 an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the terminal device 110 and the network device 130 and an indirect path between the terminal device 110 and the network device 130 via the terminal device 120 (i.e. MP split radio bearer). In some embodiments, the split radio bearer is one split DRB.

[0059] Continue to refer to FIG. 4A, in some embodiments, the network device 130 may transmit 411, via the direct path and to the terminal device 110, an indication (for convenience, also referred to as a first indication herein) indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path. In other words, the network device 130 may indicate to the terminal device 110 to activate or deactivate packet duplication for the MP split radio bearer via the direct path.

[0060] In some embodiments, the network device 130 may transmit the first indication via a radio resource control (RRC) message, e.g., a RRCReconfiguration message or any other suitable messages. In some embodiments, the network device 130 may transmit the first indication via a medium access control (MAC) control element (CE). It is to be noted that any other suitable ways are also feasible.

[0061] In some embodiments, the first indication may comprise an identity of the split radio bearer. In some embodiments, the first indication may indicate whether a packet duplication is activated or deactivated for one split radio bearer. In some embodiments, the first indication may further indicate whether each RLC entity associated with the MP split radio bearer is activated or deactivated.

[0062] In some embodiments, the network device 130 may transmit 412, to the terminal device 120, an indication (for convenience, also referred to as a fifth indication herein) indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path of the terminal device 110.

[0063] In some embodiments, the network device 130 may transmit the fifth indication via a RRC message, e.g., a RRCReconfiguration message or any other suitable messages. In some embodiments, the network device 130 may transmit the fifth indication via a MAC CE. It is to be noted that any other suitable ways are also feasible.

[0064] In some embodiments, the fifth indication may comprise an identity of the terminal

device 110. In some embodiments, the fifth indication may comprise an identity of the split radio bearer. In some embodiments, the fifth indication may comprise both the identity of the terminal device 110 and the identity of the split radio bearer.

[0065] In some embodiments, the fifth indication may indicate whether a packet duplication is activated or deactivated for one split radio bearer. In some embodiments, the fifth indication may further indicate whether each associated RLC entity is activated or deactivated.

[0066] Based on the fifth indication, the terminal device 120 may transmit 413, to the terminal device 110, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path. In some embodiments, the second indication may comprise an identity of the split radio bearer.

[0067] In some embodiments, the terminal device 120 may transmit the second indication to the terminal device 110 via a RRC message. In some embodiments, the terminal device 120 may transmit the second indication to the terminal device 110 via a MAC CE. It is to be noted that any other suitable ways are also feasible.

[0068] Upon reception of the indication (e.g., the first indication or the second indication or both) indicating whether the packet duplication is activated or deactivated for the MP split radio bearer for the direct path and the indirect path, the terminal device 110 performs 420 activation or deactivation of the packet duplication for the MP split radio bearer.

[0069] In some embodiments, when a radio link failure (RLF) is detected for the direct path and the indirect path is available, the terminal device 110 may transmit, to the network device 130 via the indirect path, a RRC message for recovery of the RLF or reporting failure of the direct path. In these embodiments, if packet duplication is not configured or activated for a MP split SRB (e.g., MP split SRB1), and a primary RLC entity of the MP split SRB is a RLC entity associated with the direct path (i.e. Uu RLC entity), the terminal device 110 may set the primary RLC entity to be a RLC entity associated with the indirect path (i.e. PC5 RLC entity). In this way, the PDCP entity of the MP split SRB may deliver the PDCP PDU of the RRC message to the PC5 RLC entity.

[0070] In some embodiments, when a RLF is detected for the indirect path and the direct path is available, the terminal device 110 may transmit, to the network device 130 via the direct path, a RRC message for recovery of the RLF or reporting failure of the indirect path.

In these embodiments, if packet duplication is not configured for a MP split SRB (e.g., MP split SRB1), and a primary RLC entity of the MP split SRB is a RLC entity associated with the indirect path (i.e. PC5 RLC entity), the terminal device 110 may set the primary RLC entity to be a RLC entity associated with the direct path (Uu RLC entity). In this way, the PDCP entity of the MP split SRB may deliver the PDCP PDU of the RRC message to the Uu RLC entity.

EXAMPLE IMPLEMENTATION OF REDUNDANT TRANSMISSION AVOIDANCE

[0071] When packet duplication is activated for a MP split bearer, a PDCP entity may deliver redundant packets to a Uu RLC entity and a SL RLC entity with SRAP entity in a remote UE side. If successful delivery of a PDCP Data protocol data unit (PDU) is confirmed by one Uu RLC entity, the PDCP entity may indicate to the SL RLC entity to discard the duplicated PDCP Data PDU. However, a SL RLC entity at a relay UE is not aware of this information, and would continue the transmission of the packets, which results in radio resource waste.

[0072] In view of this, embodiments of the present disclosure provide solutions of communication to avoid the redundant transmission at the relay UE side. These solutions will be described with reference to FIG. 4B. FIG. 4B illustrates a schematic diagram illustrating another process 400B of communication according to embodiments of the present disclosure. For the purpose of discussion, the process 400B will be described with reference to FIG. 1. The process 400B may involve the terminal device 110, the terminal device 120 and the network device 130 as illustrated in FIG. 1. It is assumed that the terminal device 110 serves as remote UE, the terminal device 120 serves as relay UE.

[0073] As shown in FIG. 4B, a SL RLC entity of the terminal device 110 may receive 431, from an upper layer (e.g., PDCP entity), an indication (for convenience, also referred to as a third indication herein) for discarding a RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, the SL RLC entity of the terminal device 110 may discard 432 the RLC SDU. If the RLC SDU or a segment of the RLC SDU has been submitted to the lower layers, the SL RLC entity of the terminal device 110 may transmit 433, to a SL RLC entity of the terminal device 120, an indication (for convenience, also referred to as a fourth indication herein) for discarding the RLC SDU.

[0074] In some embodiments, the fourth indication may be transmitted via a RLC control PDU. In some embodiments, the RLC control PDU may comprise serial number (SN)

information of a set of RLC SDUs that is to be discarded or has been successfully delivered.

[0075] Upon reception of the fourth indication, the terminal device 120 may discard 434 the RLC SDU. For example, if neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, the SL RLC entity of the terminal device 120 may discard the RLC SDU. In some embodiments, the SL RLC entity of terminal device 120 may indicate 435 to the Uu RLC entity of the terminal device 120 to discard the RLC SDU. For example, if the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, the SL RLC entity of the terminal device 120 may transmit, to a Uu RLC entity of the terminal device 120, an indication (for convenience, also referred to a seventh indication herein) for discarding the RLC SDU. In some embodiments, the Uu RLC entity of the terminal device 120 may discard 436 the RLC SDU upon reception of the indication from the SL RLC entity of the terminal device 120. For example, if neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, the Uu RLC entity of the terminal device 120 may discard the RLC SDU.

[0076] In this way, a SL RLC entity of a remote UE may indicate a SL RLC entity of a relay UE to discard packets which have been successfully delivered. Thus, redundant data may not be transmitted over the indirect path.

[0077] In some alternative embodiments, the network device 130 may transmit 441, to the terminal device 120 (e.g., the Uu RLC entity of the terminal device 120), an indication (for convenience, also referred to as a sixth indication herein) for discarding a RLC SDU. In some embodiments, the sixth indication may be transmitted by a RLC control PDU. In some embodiments, the RLC control PDU may comprise SN information of a set of RLC SDUs that is to be discarded or has been successfully delivered. In some embodiments, the network device 130 may transmit, as the sixth indication, an indication (e.g., the fifth indication) indicating deactivation of packet duplication for the split radio bearer in a MAC CE or a RRC message.

[0078] In some embodiments, upon reception of the sixth indication, the Uu RLC entity of the terminal device 120 may discard 442 the RLC SDU. For example, if neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, the Uu RLC entity of the terminal device 120 may discard the RLC SDU. In some embodiments, the Uu RLC entity of the terminal device 120 may indicate 443 to the SL RLC entity of the

terminal device 120 to discard the SL RLC SDU. For example, if the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, the Uu RLC entity of the terminal device 120 may transmit, to the SL RLC entity of the terminal device 120, an indication (for convenience, also referred to as an eighth indication herein) for discarding the RLC SDU. In some embodiments, the SL RLC entity of the terminal device 120 may discard 444 the RLC SDU. For example, if neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, the SL RLC entity of the terminal device 120 may discard the RLC SDU.

[0079] In this way, a Uu RLC entity of a network may indicate a Uu RLC entity of a relay UE to discard packets which have been successfully delivered. Thus, redundant data may also not be transmitted over the indirect path.

EXAMPLE IMPLEMENTATION OF SL AND UL COLLISION HANDLING

[0080] Conventionally, when SL transmissions and UL transmissions collide, a remote UE may determine to transmit a SL MAC PDU. In this case, less flexibility may be caused. Embodiments of the present disclosure provide a solution for handing the collision of SL and UL transmissions.

[0081] In some embodiments, if a set of uplink transmissions and a set of sidelink transmissions are to be performed, the terminal device 110 may perform the set of sidelink transmissions or the set of uplink transmissions based on priorities of the set of sidelink transmissions and the set of uplink transmissions.

[0082] In some embodiments, if a value of a highest priority among the set of uplink transmissions is higher than or equal to a value of a highest priority among the set of sidelink transmissions, the terminal device 110 may prioritize the set of sidelink transmissions over the set of uplink transmissions. In other words, the terminal device 110 may prioritize the SL MAC PDU for the set of SL transmissions.

[0083] In some embodiments, if a value of a highest priority among the set of uplink transmissions is lower than or equal to a value of a highest priority among the set of sidelink transmissions, the terminal device 110 may prioritize the set of uplink transmissions over the set of sidelink transmissions. In other words, the terminal device 110 may prioritize the UL MAC PDU for the set of UL transmissions.

[0084] In some embodiments, the set of uplink transmissions may comprise a transmission over a set of logical channels and a set of MAC CEs, and the set of sidelink

transmissions comprises a transmission over a set of logical channels and a set of MAC CEs in a SL MAC PDU.

[0085] In this way, a network may control whether to activate or deactivate packet duplication for a MP split radio bearer dynamically.

EXAMPLE IMPLEMENTATION OF METHODS

[0086] Accordingly, embodiments of the present disclosure provide methods of communication implemented at a terminal device and a network device. These methods will be described below with reference to FIGs. 5 to 7.

[0087] FIG. 5 illustrates an example method 500 of communication implemented at a first terminal device in accordance with some embodiments of the present disclosure. For example, the method 500 may be performed at the terminal device 110 as shown in FIG. 1. For the purpose of discussion, in the following, the method 500 will be described with reference to FIG. 1. It is to be understood that the method 500 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[0088] At block 510, a first terminal device (e.g., the terminal device 110) receives an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the terminal device 110 and the network device 130 and an indirect path between the terminal device 110 and the network device 130 via a second terminal device (e.g., the terminal device 120).

[0089] In some embodiments, the terminal device 110 may receive the indication via a MAC CE. In some embodiments, the terminal device 110 may receive the indication via a RRC message. In some embodiments, the indication may further indicate whether each associated RLC entity is activated or deactivated.

[0090] In some embodiments, the terminal device 110 may receive, via the direct path from the network device 130, a first indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path. In some embodiments, the terminal device 110 may receive, via the indirect path from the second terminal device 120, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path. In some embodiments, the second indication may comprise an identity of the split radio bearer.

[0091] At block 520, the terminal device 110 performs, based on the indication, activation or deactivation of the packet duplication for the split radio bearer.

[0092] In some embodiments, the terminal device 110 may receive, at a RLC entity for a sidelink interface from an upper layer of the terminal device 110, a third indication for discarding a RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, the terminal device 110 may discard the RLC SDU by the RLC entity for the sidelink interface. If the RLC SDU or a segment of the RLC SDU has been submitted to the lower layers, the terminal device 110 may transmit, to a RLC entity for a sidelink interface of the second terminal device, a fourth indication for discarding the RLC SDU.

[0093] In some embodiments, the terminal device 110 may transmit the fourth indication via a RLC control PDU. In some embodiments, the RLC control PDU may comprise serial number information of a set of RLC SDUs that is to be discarded or has been successfully delivered.

[0094] In some embodiments, if a set of uplink transmissions and a set of sidelink transmissions are to be performed, the terminal device 110 may perform the set of sidelink transmissions or the set of uplink transmissions based on priorities of the set of sidelink transmissions and the set of uplink transmissions.

[0095] In some embodiments, if a value of a highest priority among the set of uplink transmissions is higher than or equal to a value of a highest priority among the set of sidelink transmissions, the terminal device 110 may prioritize the set of sidelink transmissions over the set of uplink transmissions.

[0096] In some embodiments, the set of uplink transmissions may comprise a transmission over a set of logical channels and a set of MAC CEs, and the set of sidelink transmissions may comprise a transmission over a set of logical channels and a set of MAC CEs in a sidelink MAC PDU.

[0097] FIG. 6 illustrates an example method 600 of communication implemented at a network device in accordance with some embodiments of the present disclosure. For example, the method 600 may be performed at the network device 130 as shown in FIG. 1. For the purpose of discussion, in the following, the method 600 will be described with reference to FIG. 1. It is to be understood that the method 600 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present

disclosure is not limited in this regard.

[0098] At block 610, the network device 130 transmits an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device (e.g., the terminal device 110) and the network device 130 and an indirect path between the terminal device 110 and the network device 130 via a second terminal device (e.g., the terminal device 120).

[0099] In some embodiments, the network device 130 may transmit the indication via a MAC CE. In some embodiments, the network device 130 may transmit the indication via a RRC message. In some embodiments, the indication may further indicate whether each associated RLC entity is activated or deactivated.

[00100] In some embodiments, the network device 130 may transmit, to the first terminal device via the direct path, a first indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path. In some embodiments, the network device 130 may transmit to the second terminal device 120, a fifth indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path of the terminal device 110.

[00101] In some embodiments, the network device 130 may transmit, to the second terminal device 120, a sixth indication for discarding a RLC SDU.

[00102] In some embodiments, the network device 130 may transmit the sixth indication via a RLC control PDU. In some embodiments, the RLC control PDU may comprise serial number information of a set of RLC SDUs that is to be discarded or has been successfully delivered. In some embodiments, the network device 130 may transmit, as the sixth indication, an indication (e.g., the fifth indication) indicating deactivation of packet duplication for the split radio bearer in a MAC CE or in a RRC message.

[00103] FIG. 7 illustrates an example method 700 of communication implemented at a second terminal device in accordance with some embodiments of the present disclosure. For example, the method 700 may be performed at the terminal device 120 as shown in FIG. 1. For the purpose of discussion, in the following, the method 700 will be described with reference to FIG. 1. It is to be understood that the method 700 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard.

[00104] At block 710, a second terminal device (e.g., the terminal device 120) receives,

from the network device 130, a fifth indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the terminal device 120 and the network device 130 and an indirect path between the terminal device 120 and the network device 130 via the terminal device 120.

[00105] At block 720, the terminal device 120 transmits, to the terminal device 110, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer.

[00106] In some embodiments, the terminal device 120 may receive the fifth indication via a MAC CE. In some embodiments, the terminal device 120 may receive the fifth indication via a RRC message.

[00107] In some embodiments, the fifth indication comprises at least one of an identity of the terminal device 110 or an identity of the split radio bearer.

[00108] In some embodiments, the terminal device 120 may transmit the second indication via a MAC CE. In some embodiments, the terminal device 120 may transmit the second indication via a RRC message.

[00109] In some embodiments, the second indication may comprise an identity of the split radio bearer.

[00110] In some embodiments, at least one of the fifth indication or the second indication may further indicate whether each associated RLC entity is activated or deactivated.

[00111] In some embodiments, the terminal device 120 may receive, by a RLC entity for a sidelink interface of the terminal device 120 and from a RLC entity for a sidelink interface of the terminal device 110, a fourth indication for discarding a RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, the terminal device 120 may discard the RLC SDU by the RLC entity for the sidelink interface of the terminal device 120. If the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, the terminal device 120 may transmit, from the RLC entity for the sidelink interface of the terminal device 120 to a RLC entity for an air interface of the terminal device 120, a seventh indication for discarding the RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers by the RLC entity for the air interface of the terminal device 120, the terminal device 120 may discard the RLC SDU by the RLC entity for the air interface.

[00112] In some embodiments, the terminal device 120 may receive the fourth indication via a RLC control PDU.

[00113] In some embodiments, the terminal device 120 may receive, from the network device 130, a sixth indication for discarding a RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, the terminal device 120 may discard the RLC SDU by a RLC entity for an air interface of the terminal device 120. If the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, the terminal device 120 may transmit, from the RLC entity for the air interface of the terminal device 120 to a RLC entity for a sidelink interface of the terminal device 120, an eighth indication for discarding the RLC SDU. If neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers by the RLC entity for the sidelink interface of the terminal device 120, the terminal device 120 may discard the RLC SDU by the RLC entity for the sidelink interface.

[00114] In some embodiments, the terminal device 120 may receive the sixth indication via a RLC control PDU. In some embodiments, the RLC control PDU may comprise SN information of a set of RLC SDUs that is to be discarded or has been successfully delivered.

[00115] It is to be understood that the operations of methods 500 to 700 are similar as that described in connection with FIGs. 4A and 4B, and thus other details are not repeated here for concise.

EXAMPLE IMPLEMENTATION OF DEVICES AND APPARATUSES

[00116] FIG. 8 is a simplified block diagram of a device 800 that is suitable for implementing embodiments of the present disclosure. The device 800 can be considered as a further example implementation of the terminal device 110 or the terminal device 120 or the network device 130 as shown in FIG. 1. Accordingly, the device 800 can be implemented at or as at least a part of the terminal device 110 or the terminal device 120 or the network device 130.

[00117] As shown, the device 800 includes a processor 810, a memory 820 coupled to the processor 810, a suitable transmitter (TX) and receiver (RX) 840 coupled to the processor 810, and a communication interface coupled to the TX/RX 840. The memory 810 stores at least a part of a program 830. The TX/RX 840 is for bidirectional communications. The TX/RX 840 has at least one antenna to facilitate communication, though in practice an

Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements, such as X2/Xn interface for bidirectional communications between eNBs/gNBs, S1/NG interface for communication between a Mobility Management Entity (MME)/Access and Mobility Management Function (AMF)/SGW/UPF and the eNB/gNB, Un interface for communication between the eNB/gNB and a relay node (RN), or Uu interface for communication between the eNB/gNB and a terminal device.

[00118] The program 830 is assumed to include program instructions that, when executed by the associated processor 810, enable the device 800 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to FIGs. 1 to 7. The embodiments herein may be implemented by computer software executable by the processor 810 of the device 800, or by hardware, or by a combination of software and hardware. The processor 810 may be configured to implement various embodiments of the present disclosure. Furthermore, a combination of the processor 810 and memory 820 may form processing means 850 adapted to implement various embodiments of the present disclosure.

[00119] The memory 820 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples. While only one memory 820 is shown in the device 800, there may be several physically distinct memory modules in the device 800. The processor 810 may be of any type suitable to the local technical network, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 800 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00120] In some embodiments, a first terminal device comprises a circuitry configured to: receive an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the first terminal device and a network device and an indirect path between the first terminal device and the network device via a second terminal device; and perform, based on the indication, activation or deactivation of the

packet duplication for the split radio bearer..

[00121] In some embodiments, a network device comprises a circuitry configured to: transmit an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via a second terminal device.

[00122] In some embodiments, a second terminal device comprises a circuitry configured to: receive, from a network device, a fifth indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via the second terminal device; and transmit, to the first terminal device, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer.

[00123] The term "circuitry" used herein may refer to hardware circuits and/or combinations of hardware circuits and software. For example, the circuitry may be a combination of analog and/or digital hardware circuits with software/firmware. As a further example, the circuitry may be any portions of hardware processors with software including digital signal processor(s), software, and memory(ies) that work together to cause an apparatus, such as a terminal device or a network device, to perform various functions. In a still further example, the circuitry may be hardware circuits and or processors, such as a microprocessor or a portion of a microprocessor, that requires software/firmware for operation, but the software may not be present when it is not needed for operation. As used herein, the term circuitry also covers an implementation of merely a hardware circuit or processor(s) or a portion of a hardware circuit or processor(s) and its (or their) accompanying software and/or firmware.

[00124] In summary, embodiments of the present disclosure provide the following solutions.

[00125] In one solution, a method of communication comprises: receiving, at a first terminal device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the first terminal device and a network device and an indirect path between the first terminal device and the network device via a second terminal device; and performing, based on the indication, activation or

deactivation of the packet duplication for the split radio bearer.

[00126] In some embodiments, receiving the indication comprises at least one of the following: receiving, via the direct path from the network device, a first indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path; receiving, via the indirect path from the second terminal device, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path; receiving the first indication via a medium access control (MAC) control element (CE); or receiving the first indication via a radio resource control (RRC) message.

[00127] In some embodiments, the indication further indicates whether each associated radio link control (RLC) entity is activated or deactivated.

[00128] In some embodiments, the method above further comprises: receiving, at a radio link control (RLC) entity for a sidelink interface from an upper layer of the first terminal device, a third indication for discarding a RLC service data unit (SDU); in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, discarding the RLC SDU by the RLC entity for the sidelink interface; and in accordance with a determination that the RLC SDU or a segment of the RLC SDU has been submitted to the lower layers, transmitting, to a RLC entity for a sidelink interface of the second terminal device, a fourth indication for discarding the RLC SDU.

[00129] In some embodiments, transmitting the fourth indication comprises: transmitting the fourth indication via a RLC control protocol data unit (PDU).

[00130] In some embodiments, the method above further comprises: in accordance with a determination that a set of uplink transmissions and a set of sidelink transmissions are to be performed, performing the set of sidelink transmissions or the set of uplink transmissions based on priorities of the set of sidelink transmissions and the set of uplink transmissions.

[00131] In some embodiments, performing the set of sidelink transmissions or the set of uplink transmissions comprises: in accordance with a determination that a value of a highest priority among the set of uplink transmissions is higher than or equal to a value of a highest priority among the set of sidelink transmissions, prioritizing the set of sidelink transmissions over the set of uplink transmissions.

[00132] In some embodiments, the set of uplink transmissions comprises a transmission

over a set of logical channels and a set of medium access control (MAC) control elements (CEs), and the set of sidelink transmissions comprises a transmission over a set of logical channels and a set of MAC CEs in a sidelink MAC protocol data unit (PDU).

[00133] In another solution, a method of communication comprises: transmitting, at a network device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via a second terminal device.

[00134] In some embodiments, transmitting the indication comprises at least one of the following: transmitting, to the first terminal device via the direct path, a first indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path; transmitting, to the second terminal device, a fifth indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path of the first terminal device; transmitting the first indication via a medium access control (MAC) control element (CE); or transmitting the first indication via a radio resource control (RRC) message.

[00135] In some embodiments, the indication further indicates whether each associated radio link control (RLC) entity is activated or deactivated.

[00136] In some embodiments, the method above further comprises: transmitting, to the second terminal device, a sixth indication for discarding a radio link control (RLC) service data unit (SDU).

[00137] In some embodiments, transmitting the sixth indication comprises at least one of the following: transmitting the sixth indication via a RLC control protocol data unit (PDU); or transmitting, as the sixth indication, an indication indicating deactivation of packet duplication for the split radio bearer in a medium access control (MAC) control element (CE) or a radio resource control (RRC) message.

[00138] In another solution, a method of communication comprises: receiving, at a second terminal device and from a network device, a fifth indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via the second terminal device; and transmitting, to the first terminal device, a second indication indicating whether the packet duplication is activated

or deactivated for the split radio bearer.

[00139] In some embodiments, receiving the fifth indication comprises at least one of the following: receiving the fifth indication via a medium access control (MAC) control element (CE); or receiving the fifth indication via a radio resource control (RRC) message.

[00140] In some embodiments, the fifth indication comprises at least one of an identity of the first terminal device or an identity of the split radio bearer.

[00141] In some embodiments, transmitting the second indication comprises at least one of the following: transmitting the second indication via a medium access control (MAC) control element (CE); or transmitting the second indication via a radio resource control (RRC) message.

[00142] In some embodiments, the second indication comprises an identity of the split radio bearer.

[00143] In some embodiments, at least one of the fifth indication or the second indication further indicates whether each associated radio link control (RLC) entity is activated or deactivated.

[00144] In some embodiments, the method above further comprises: receiving, by a radio link control (RLC) entity for a sidelink interface of the second terminal device and from a RLC entity for a sidelink interface of the first terminal device, a fourth indication for discarding a RLC service data unit (SDU); in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, discarding the RLC SDU by the RLC entity for the sidelink interface of the second terminal device; in accordance with a determination that the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, transmitting, to a RLC entity for an air interface of the second terminal device, a seventh indication for discarding the RLC SDU; and in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, discarding the RLC SDU by the RLC entity for the air interface of the second terminal device.

[00145] In some embodiments, receiving the fourth indication comprises: receiving the fourth indication via a RLC control protocol data unit (PDU).

[00146] In some embodiments, the method further comprises: receiving, by the second terminal device and from the network device, a sixth indication for discarding a radio link

control (RLC) service data unit (SDU); in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, discarding the RLC SDU by an RLC entity for an air interface of the second terminal device; in accordance with a determination that the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, transmitting, to a RLC entity for a sidelink interface of the second terminal device, an eighth indication for discarding the RLC SDU; and in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, discarding the RLC SDU by the RLC entity for the sidelink interface of the second terminal device.

[00147] In some embodiments, receiving the sixth indication comprises: receiving the sixth indication via a RLC control protocol data unit (PDU).

[00148] In some embodiments, the RLC control PDU comprises serial number information of a set of RLC SDUs that is to be discarded or has been successfully delivered.

[00149] In another solution, a device of communication comprises: a processor configured to cause the device to perform any of the methods above.

[00150] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00151] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the process or method as described above with reference to FIGs. 1 to 7. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data

types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed device, program modules may be located in both local and remote storage media.

[00152] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00153] The above program code may be embodied on a machine readable medium, which may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The machine readable medium may be a machine readable signal medium or a machine readable storage medium. A machine readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00154] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various

features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00155] Although the present disclosure has been described in language specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A method of communication, comprising:

receiving, at a first terminal device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between the first terminal device and a network device and an indirect path between the first terminal device and the network device via a second terminal device; and

performing, based on the indication, activation or deactivation of the packet duplication for the split radio bearer.

2. The method of claim 1, wherein receiving the indication comprises at least one of the following:

receiving, via the direct path from the network device, a first indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path;

receiving, via the indirect path from the second terminal device, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path;

receiving the indication via a medium access control (MAC) control element (CE); or

receiving the indication via a radio resource control (RRC) message.

3. The method of claim 1, wherein the indication further indicates whether each associated radio link control (RLC) entity is activated or deactivated.

4. The method of claim 1, further comprising:

receiving, at a radio link control (RLC) entity for a sidelink interface from an upper layer of the first terminal device, a third indication for discarding a RLC service data unit (SDU);

in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, discarding the RLC SDU by the RLC entity for the sidelink interface; and

in accordance with a determination that the RLC SDU or a segment of the RLC SDU has been submitted to the lower layers, transmitting, to a RLC entity for a sidelink

interface of the second terminal device, a fourth indication for discarding the RLC SDU.

5. The method of claim 4, wherein transmitting the fourth indication comprises:

transmitting the fourth indication via a RLC control protocol data unit (PDU).

6. The method of claim 1, further comprising:

in accordance with a determination that a set of uplink transmissions and a set of sidelink transmissions are to be performed, performing the set of sidelink transmissions or the set of uplink transmissions based on priorities of the set of sidelink transmissions and the set of uplink transmissions.

7. The method of claim 6, wherein performing the set of sidelink transmissions or the set of uplink transmissions comprises:

in accordance with a determination that a value of a highest priority among the set of uplink transmissions is higher than or equal to a value of a highest priority among the set of sidelink transmissions, prioritizing the set of sidelink transmissions over the set of uplink transmissions.

8. The method of claim 6, wherein the set of uplink transmissions comprises a transmission over a set of logical channels and a set of medium access control (MAC) control elements (CEs), and the set of sidelink transmissions comprises a transmission over a set of logical channels and a set of MAC CEs in a sidelink MAC protocol data unit (PDU).

9. A method of communication, comprising:

transmitting, at a network device, an indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via a second terminal device.

10. The method of claim 9, wherein transmitting the indication comprises at least one of the following:

transmitting, to the first terminal device via the direct path, a first indication indicating whether the packet duplication is activated or deactivated for the split radio

bearer for the direct path and the indirect path;

transmitting, to the second terminal device, a fifth indication indicating whether the packet duplication is activated or deactivated for the split radio bearer for the direct path and the indirect path of the first terminal device;

transmitting the indication via a medium access control (MAC) control element (CE); or

transmitting the indication via a radio resource control (RRC) message.

11. The method of claim 9, wherein the indication further indicate whether each associated radio link control (RLC) entity is activated or deactivated.

12. The method of claim 9, further comprising:

transmitting, to the second terminal device, a sixth indication for discarding a radio link control (RLC) service data unit (SDU).

13. The method of claim 12, wherein transmitting the sixth indication comprises at least one of the following:

transmitting the sixth indication via a RLC control protocol data unit (PDU); or

transmitting, as the sixth indication, an indication indicating deactivation of packet duplication for the split radio bearer in a medium access control (MAC) control element (CE) or a radio resource control (RRC) message.

14. A method of communication, comprising:

receiving, at a second terminal device and from a network device, a fifth indication indicating whether a packet duplication is activated or deactivated for a split radio bearer for a direct path between a first terminal device and the network device and an indirect path between the first terminal device and the network device via the second terminal device; and

transmitting, to the first terminal device, a second indication indicating whether the packet duplication is activated or deactivated for the split radio bearer.

15. The method of claim 14, wherein receiving the fifth indication comprises at least one of the following:

receiving the fifth indication via a medium access control (MAC) control element

(CE); or

receiving the fifth indication via a radio resource control (RRC) message.

16. The method of claim 14, wherein the fifth indication comprises at least one of an identity of the first terminal device or an identity of the split radio bearer.

17. The method of claim 14, wherein transmitting the second indication comprises at least one of the following:

transmitting the second indication via a medium access control (MAC) control element (CE); or

transmitting the second indication via a radio resource control (RRC) message.

18. The method of claim 2 or 14, wherein the second indication comprises an identity of the split radio bearer.

19. The method of claim 14, wherein at least one of the fifth indication or the second indication further indicates whether each associated radio link control (RLC) entity is activated or deactivated.

20. The method of claim 14, further comprising:

receiving, by a radio link control (RLC) entity for a sidelink interface of the second terminal device and from a RLC entity for a sidelink interface of the first terminal device, a fourth indication for discarding a RLC service data unit (SDU);

in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been delivered to an upper layer, discarding the RLC SDU by the RLC entity for the sidelink interface of the second terminal device;

in accordance with a determination that the RLC SDU or a segment of the RLC SDU has been delivered to the upper layer, transmitting, to a RLC entity for an air interface of the second terminal device, a seventh indication for discarding the RLC SDU; and

in accordance with a determination that neither the RLC SDU nor a segment of the RLC SDU has been submitted to lower layers, discarding the RLC SDU by the RLC entity for the air interface of the second terminal device.

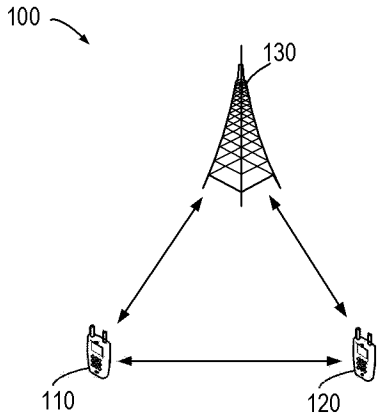


FIG. 1

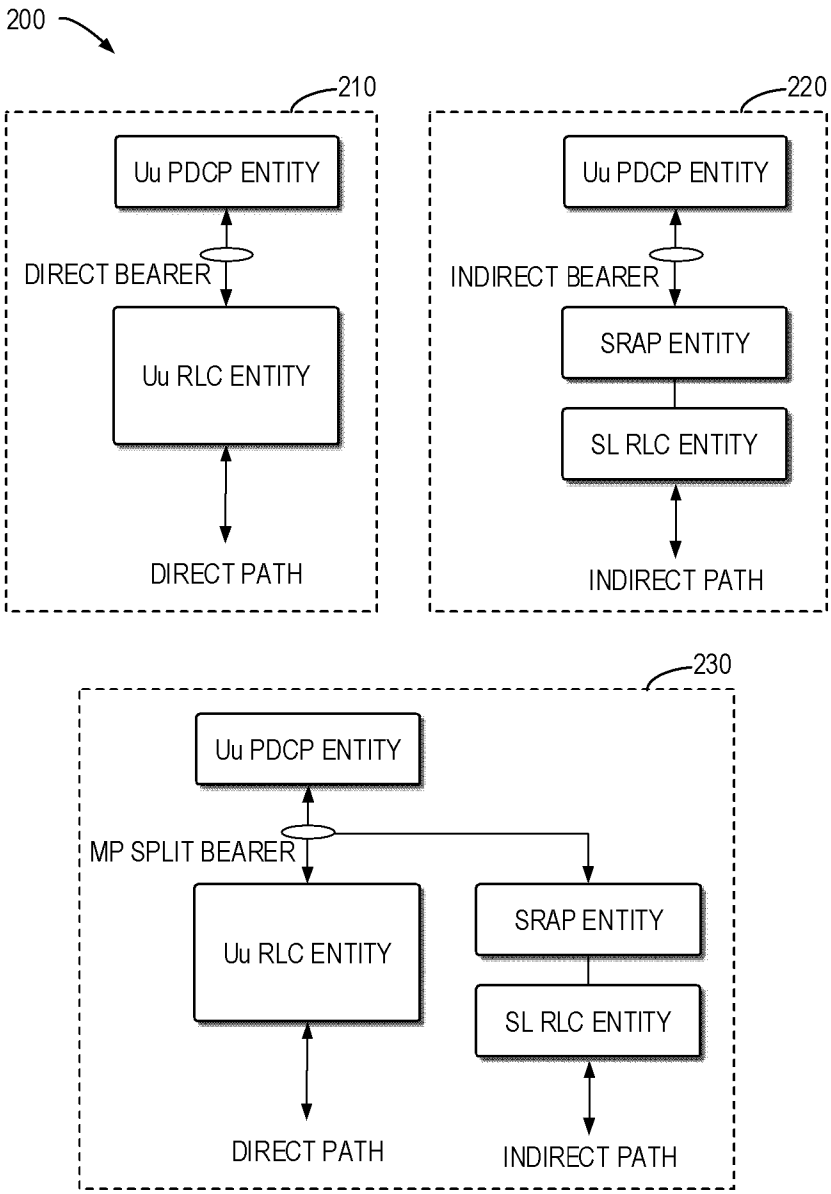
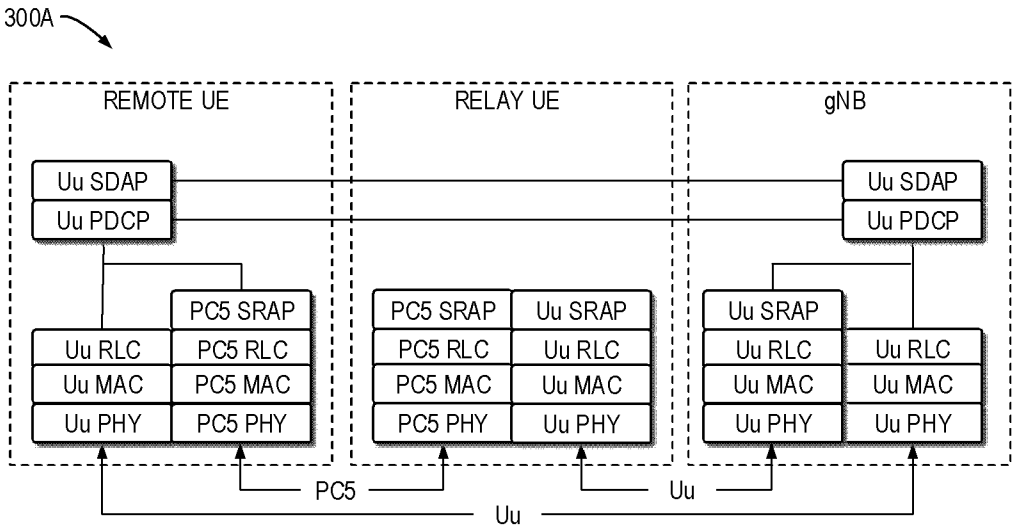

200
210
Uu PDCP ENTITY
DIRECT BEARER
Uu RLC ENTITY
DIRECT PATH
220
Uu PDCP ENTITY
INDIRECT BEARER
SRAP ENTITY
SL RLC ENTITY
INDIRECT PATH
230
Uu PDCP ENTITY
MP SPLIT BEARER
Uu RLC ENTITY
SRAP ENTITY
SL RLC ENTITY
DIRECT PATH
INDIRECT PATH

FIG. 2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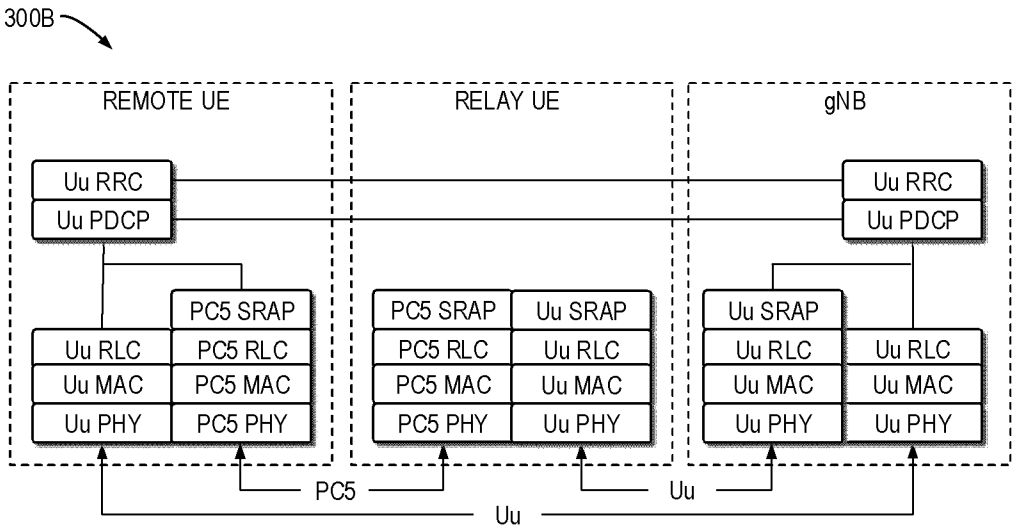
RELAY UE
gNB
Uu SDAP
Uu PDCP
PC5 SRAP
Uu RLC
PC5 RLC
Uu MAC
PC5 MAC
Uu PHY
PC5 PHY
Uu SRAP
Uu SDAP
Uu PDCP
Uu RLC
Uu MAC
Uu PHY
PC5
Uu
Uu

FIG. 3A


300B
REMOTE UE
RELAY UE
gNB
Uu RRC
Uu PDCP
PC5 SRAP
Uu RLC
PC5 RLC
Uu MAC
PC5 MAC
Uu PHY
PC5 PHY
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Uu RRC
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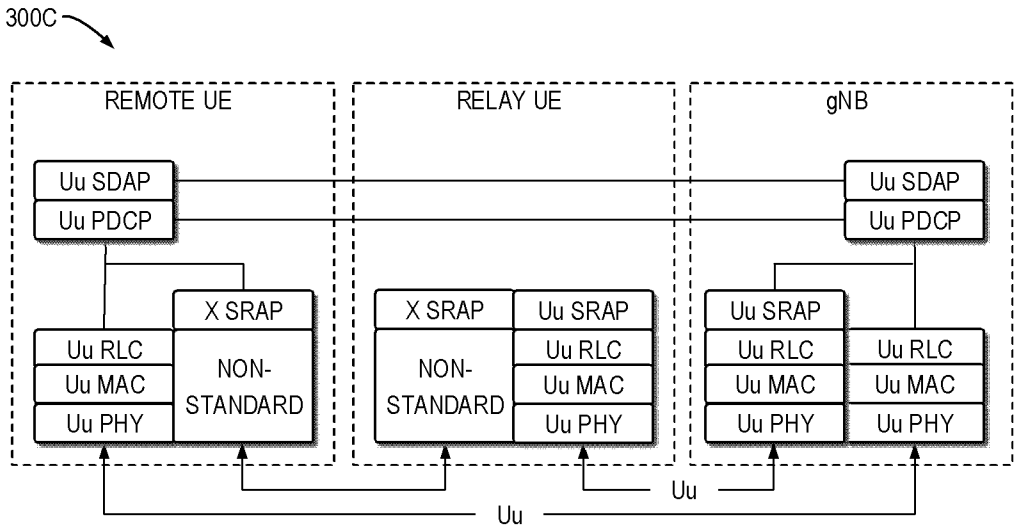
Uu RLC
Uu MAC
Uu PHY
PC5
Uu
Uu

FIG. 3B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REMOTE UE
RELAY UE
gNB
Uu SDAP
Uu PDCP
X SRAP
Uu RLC
Uu MAC
Uu PHY
NON-STANDARD
X SRAP
Uu SRAP
NON-STANDARD
Uu RLC
Uu MAC
Uu PHY
Uu SRAP
Uu RLC
Uu MAC
Uu PHY
Uu SDAP
Uu PDCP
Uu RLC
Uu MAC
Uu PHY
Uu
Uu

FIG. 3C

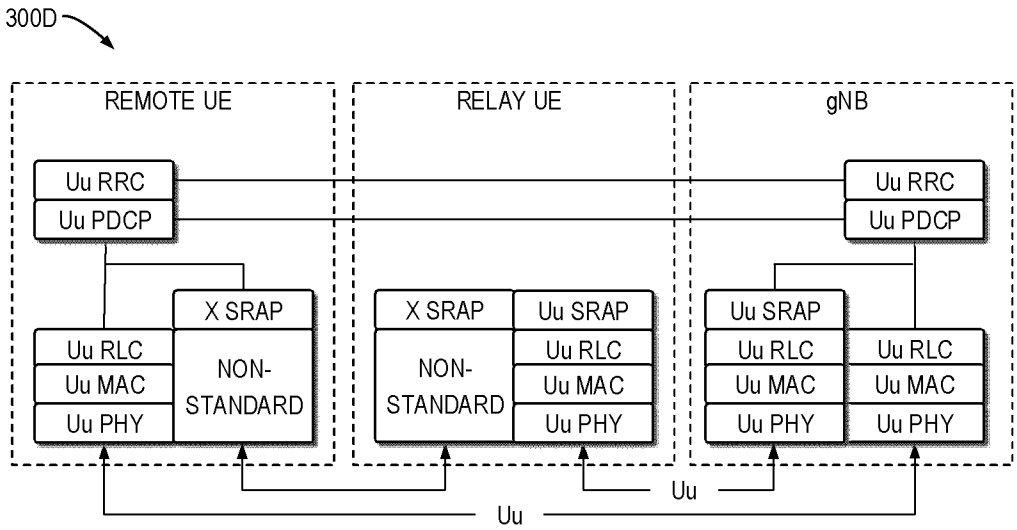

300D
REMOTE UE
RELAY UE
gNB
Uu RRC
Uu PDCP
X SRAP
Uu RLC
Uu MAC
Uu PHY
NON-STANDARD
X SRAP
Uu SRAP
NON-STANDARD
Uu RLC
Uu MAC
Uu PHY
Uu SRAP
Uu RLC
Uu MAC
Uu PHY
Uu RRC
Uu PDCP
Uu RLC
Uu MAC
Uu PHY
Uu
Uu

FIG. 3D

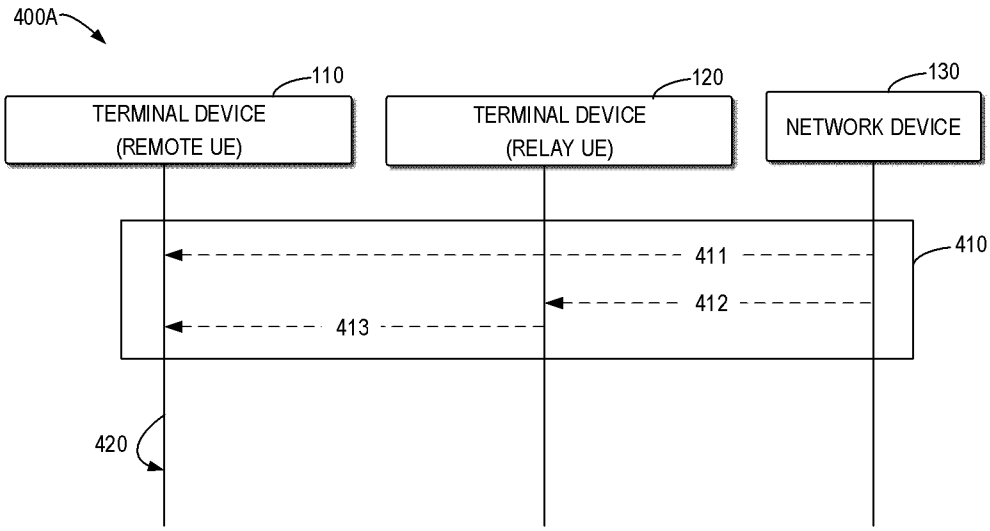
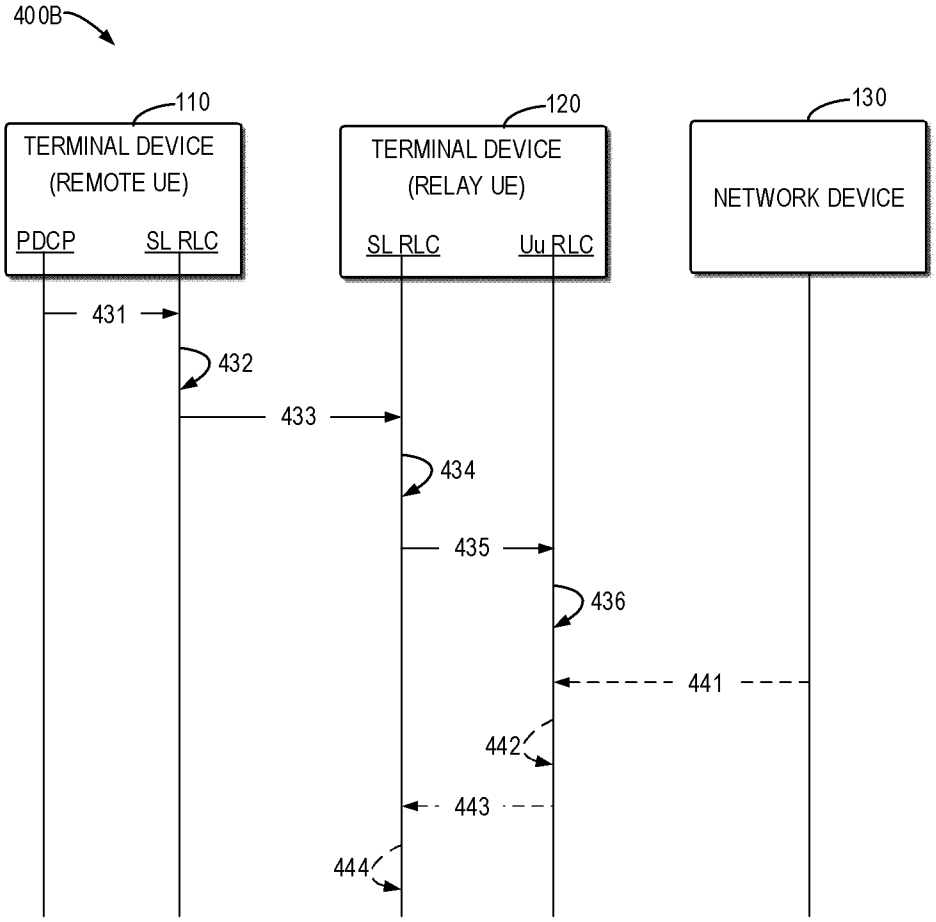

400A
110
TERMINAL DEVICE
(REMOTE UE)
120
TERMINAL DEVICE
(RELAY UE)
130
NETWORK DEVICE
410
411
412
413
420

FIG. 4A


400B
110
TERMINAL DEVICE
(REMOTE UE)
PDCP
SL RLC
120
TERMINAL DEVICE
(RELAY UE)
SL RLC
Uu RLC
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431
432
433
434
435
436
441
442
443
444

FIG. 4B

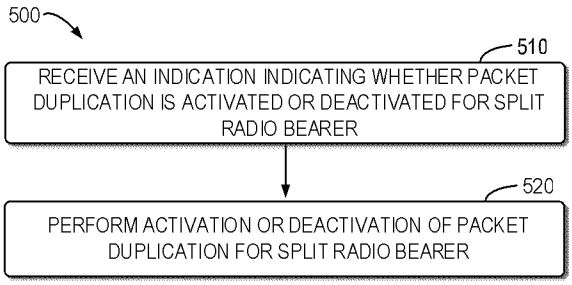
500
510
RECEIVE AN INDICATION INDICATING WHETHER PACKET DUPLICATION IS ACTIVATED OR DEACTIVATED FOR SPLIT RADIO BEARER
520
PERFORM ACTIVATION OR DEACTIVATION OF PACKET DUPLICATION FOR SPLIT RADIO BEARER

FIG. 5

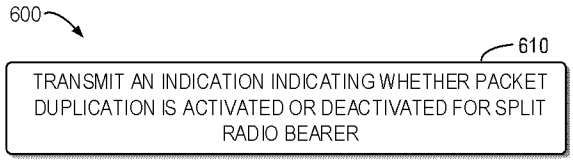

FIG. 6

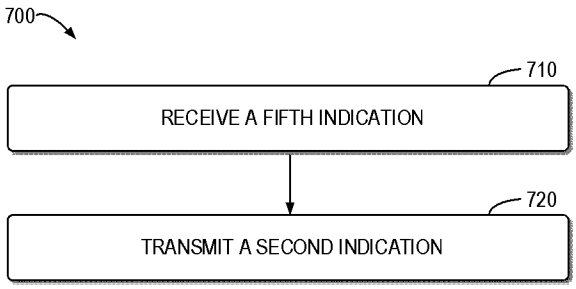

FIG. 7

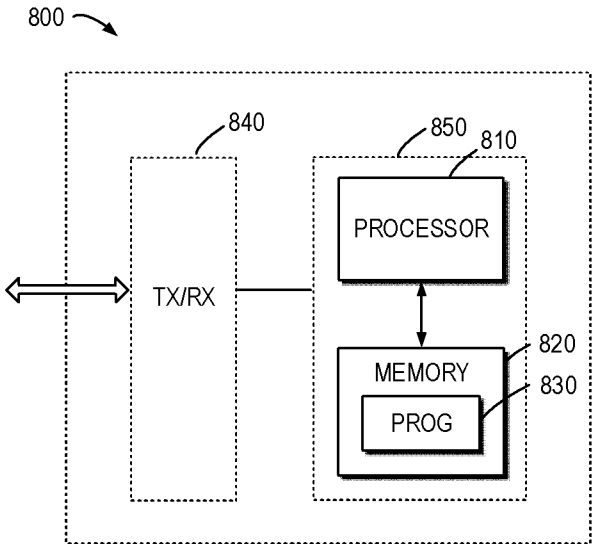

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/120370

A. CLASSIFICATION OF SUBJECT MATTER

H04L 45/24(2022.01)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)

H04L; H04W

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

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

CNTXT;ENTXT;WPABS;CNKI;3GPP;IEEE:split+, radio bearer, RB, DRB, relay, sidelink, SL, direct, indirect, activat+, deactivat+, multipath, MP

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2021153063 A1 (HUAWEI TECH. CO., LTD.) 20 May 2021 (2021-05-20) description, paragraphs 102-331, FIG. 4A, FIG. 4B, FIG. 4C, FIG. 8	1-20
A	US 2020084663 A1 (PARK, Kyungmin et al.) 12 March 2020 (2020-03-12) the whole document	1-20
A	US 2019174513 A1 (PANASONIC IP. CORP. AMERICA) 06 June 2019 (2019-06-06) 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
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2022	**28 December 2022**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing** **100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **REN,Ling** Telephone No. **86-(010)-62089840**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/120370

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2021153063 A1	20 May 2021	WO 2021098804 A1	27 May 2021
		EP 4049507 A1	31 August 2022
		BR 112022009661 A2	16 August 2022
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US 2020084663 A1	12 March 2020	US 2022225165 A1	14 July 2022
US 2019174513 A1	31 December 2021	US 2019174513 A1	06 June 2019
		AU 2017336823 A1	07 February 2019
		EP 3955683 A1	16 February 2022
		JP 2022009350 A	14 January 2022
		CN 109565494 A	02 April 2019
		WO 2018061438 A1	05 April 2018
		EP 3520345 A1	07 August 2019
		US 2021105799 A1	08 April 2021
		RU 2734646 C1	21 October 2020
		JP 2019537852 A	26 December 2019
		BR 112019000785 A2	24 April 2019
		MX 2019000606 A	04 July 2019
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		ZA 201900608 B	30 June 2021
		CN 113872913 A	31 December 2021