

PDCP DUPLICATION FOR SLRB

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to devices, methods, apparatuses, and computer readable medium for packet data
5 convergence protocol (PDCP) duplication for a sidelink radio bearer (SLRB).

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
10 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.,
15 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
20 technologies beyond 5G (e.g., sixth generation (6G)).

[0003] It is agreed that a PDCP duplication may be configured per SLRB in new radio (NR) sidelink carrier aggregation (CA). For example, SLRB may configure whether a PDCP duplication is used or not. However, some more details for PDCP duplication need to be further studied.

25 SUMMARY

[0004] The present disclosure relates to devices, methods, apparatuses, and computer readable medium for PDCP duplication for SLRB.

[0005] In a first aspect, 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: obtain a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; determine a start time for the PDCP duplication of the at least one SLRB; and activate or enable the PDCP duplication for the at least one SLRB from the start time.

5 **[0006]** In a second aspect, there is provided a base station. The base station comprises at least one memory; and at least one processor coupled with the at least one memory and configured to cause the base station to: transmit, to a first UE, a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; receive, from the first UE, information about the first UE and the second UE;
10 and transmit, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB.

[0007] In a third aspect, there is provided a method performed by the first UE. The method comprises: obtaining a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; determining a start
15 time for the PDCP duplication of the at least one SLRB; and activating or enabling the PDCP duplication for the at least one SLRB from the start time.

[0008] In a fourth aspect, there is provided a method performed by the base station. The method comprises: transmitting, to a first UE, a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication;
20 receiving, from the first UE, information about the first UE and the second UE; and transmitting, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB.

[0009] In a fifth aspect, there is provided a processor for wireless communication. The processor comprises at least one controller coupled with at least one memory and
25 configured to cause the processor to: obtain a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; determine a start time for the PDCP duplication of the at least one SLRB; and activate or enable the PDCP duplication for the at least one SLRB from the start time.

[0010] In a sixth aspect, there is provided a processor for wireless communication. The processor comprises at least one controller coupled with at least one memory and
30 configured to cause the processor to: transmit, to a first UE, a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP

duplication; receive, from the first UE, information about the first UE and the second UE; and transmit, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB.

5 [0011] In some implementations of the method and the first UE described herein, the first UE determines the start time based on: a first time when a carrier coordination between the first UE and the second UE is finished, and a second time when receiving a capability message from the second UE, wherein the capability message indicates that the second UE supports a PDCP duplication.

10 [0012] In some implementations of the method and the first UE described herein, the first UE determines the start time based on a transmission time of an earliest PC5 message between the first UE and the second UE.

[0013] In some implementations of the method and the first UE described herein, the earliest PC5 message is associated with the at least one SLRB.

15 [0014] In some implementations of the method and the first UE described herein, the start time is determined based on a determination that a service associated with a unicast link between the first UE and the second UE indicates that a carrier aggregation (CA) or a PDCP duplication is supported.

20 [0015] In some implementations of the method and the first UE described herein, the at least one SLRB comprises at least one sidelink signalling radio bearer (SL-SRB), and in accordance with a determination that the PDCP duplication is activated or enabled for at least one sidelink data radio bearer (SL-DRB), the first UE activates or enables the PDCP duplication for the at least one SL-SRB.

25 [0016] In some implementations of the method and the first UE described herein, the first UE activates or enables the PDCP duplication for partial or all messages associated with the at least one SLRB.

[0017] In some implementations of the method and the first UE described herein, the partial or all messages are on a same sidelink control channel (SCCH) or on a same SL-SRB.

30 [0018] In some implementations of the method and the first UE described herein, the first UE determines the start time based on a time when one of following conditions fulfills: a timer T400 is still running and a remaining time length of the timer T400 is shorter than a

time length threshold, a first index of a channel quality indication (CQI) is lower than a CQI threshold being indicated in a sidelink channel state information (SL-CSI) report, a first reference signal received power (RSRP) of the sidelink determined by the second UE is lower than a power threshold, a consecutive discontinuous transmission (DTX) number is larger than a DTX threshold, a received negative acknowledgement (NACK) number is larger than a NACK threshold, or a sum of a DTX number and a received NACK number is larger than a number threshold.

[0019] In some implementations of the method and the first UE described herein, the first UE determines an end time based on a time when one of following conditions fulfills: a second index of a CQI is not lower than the CQI threshold in the SL-CSI report, a second RSRP of the sidelink is not lower than the power threshold, a measured channel busy rate (CBR) is not lower than a CBR threshold, or all SL RBs associated with the sidelink have deactivated the PDCP duplication; and deactivates or disables the PDCP duplication for the at least one SLRB from the end time.

[0020] In some implementations of the method and the first UE described herein, in accordance with a determination that a sidelink resource between the first UE and the second UE is scheduled by a base station, the first UE determines the start time based on a reception of an indication from the base station, wherein the indication indicates activating or enabling the PDCP duplication for the at least one SLRB.

[0021] In some implementations of the method and the first UE described herein, the first UE receives, from the second UE, capability information of the second UE, wherein the capability information of the second UE indicates that the second UE supports PDCP duplication; transmits, to the base station, the capability information of the second UE; and receives, from the base station, the indication.

[0022] In some implementations of the method and the first UE described herein, the first UE transmits, to the base station, information indicating one of: an index of a CQI, an RSRP of the sidelink, a consecutive DTX number, or a received NACK number; and receives, from the base station, the indication, wherein the indication is determined by the base station based on the information.

[0023] In some implementations of the method and the first UE described herein, in accordance with a determination that the at least one SLRB is to be transmitted on one or more unlicensed band carriers, the first UE determines the start time based on a time when

one of the following conditions fulfills: one or more indications of listen before talk (LBT) failure for the at least one SLRB are received, a consecutive LBT failure occurs for a resource block (RB) set the at least one SLRB transmits, a number of RB sets for which a consecutive LBT failure occurs is larger than a threshold, a resource reselection is triggered
5 by a consecutive LBT failure, or a number of conditional primary secondary cell (PSCell) addition or change (CPAC) of the at least one SLRB is larger than a further threshold.

[0024] In some implementations of the method and the first UE described herein, in accordance with a determination that the at least one SLRB is to be transmitted on one or more carriers with frequency range 2 (FR2), the first UE determines the start time based on
10 a time when one of the following conditions fulfills: a number of received beam failure indications is larger than a threshold value, or a beam failure associated with the at least one SLRB is detected.

[0025] In some implementations of the method and the first UE described herein, the first UE transmits, to a base station, capability information of the first UE indicating one of:
15 whether the first UE supports PDCP duplication, at least one band or carrier supporting the PDCP duplication, or a number of carriers supporting the PDCP duplication.

[0026] In some implementations of the method and the first UE described herein, the at least one SLRB comprises at least one SL SRB being used for a transmission of a RC5 radio resource control (RRC) message or for a transmission of a PC5-S message.

[0027] In some implementations of the method and the first UE described herein, the first UE setups two or more radio link control (RLC) entities for a same PDCP entity associated with the at least one SLRB; and duplicates a plurality of PDCP packet data units (PDUs) for the two or more RLC entities.

[0028] In some implementations of the method and the base station described herein, the
25 information comprises capability information of the second UE, wherein the capability information of the second UE indicates that the second UE supports PDCP duplication.

[0029] In some implementations of the method and the base station described herein, the information comprises capability information of the first UE indicating one of: whether the first UE supports PDCP duplication, at least one band or carrier supporting the PDCP
30 duplication, or a number of carriers supporting the PDCP duplication.

[0030] In some implementations of the method and the base station described herein, the information indicates one of: an index of a CQI, an RSRP of the sidelink determined by the

second UE, a consecutive DTX number, or a received NACK number.

[0031] In some implementations of the method and the base station described herein, the base station schedules a sidelink resource between the first UE and the second UE.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 **[0032]** FIG. 1 illustrates an example of a wireless communications system in which some embodiments of the present disclosure can be implemented;
- [0033]** FIG. 2A illustrates a schematic diagram of a Duplication Activation/ Deactivation MAC CE;
- [0034]** FIG. 2B illustrates a schematic diagram of a Duplication RLC Activation/
- 10 Deactivation MAC CE;
- [0035]** FIG. 3 illustrates a schematic diagram of an example communication network in which some embodiments of the present disclosure can be implemented;
- [0036]** FIG. 4A illustrates an example RRC reconfiguration sidelink procedure;
- [0037]** FIG. 4B illustrates another example RRC reconfiguration sidelink procedure;
- 15 **[0038]** FIG. 4C illustrates an example sidelink UE capability transfer procedure;
- [0039]** FIG. 5 illustrates a signalling chart illustrating communication process in accordance with some example embodiments of the present disclosure;
- [0040]** FIG. 6 illustrates an example of a device that is suitable for implementing embodiments of the present disclosure;
- 20 **[0041]** FIG. 7 illustrates an example of a processor that is suitable for implementing some embodiments of the present disclosure;
- [0042]** FIG. 8 illustrates a flowchart of an example method implemented at a UE in accordance with aspects of the present disclosure; and
- [0043]** FIG. 9 illustrates a flowchart of an example method implemented at a base station
- 25 in accordance with some embodiments of the present disclosure.
- [0044]** Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0045] 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.

5 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.

[0046] 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
10 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.

[0047] 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
20 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
25 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.

[0048] The terminology used herein is for the purpose of describing particular
30 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.

10 **[0049]** 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 15 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 20 code division multiple access (CDMA), etc.

[0050] 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, 30 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.

[0051] 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, message, 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.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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).

[0056] 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.

[0057] 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
5 virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0058] 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
10 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 adaptation protocol (SDAP), Packet Data Convergence
15 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.

[0059] Additionally, or alternatively, a functional split of the protocol stack may be
20 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
25 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).

[0060] 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
30 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.

[0061] 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.

[0062] 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).

[0063] 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.

[0064] 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., $\mu=0$) 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., $\mu=0$) associated with the first subcarrier spacing (e.g., 15 kHz) may utilize one slot per subframe. A second numerology (e.g., $\mu=1$) may be associated with a second subcarrier spacing (e.g., 30 kHz) and a normal cyclic prefix. A third numerology (e.g., $\mu=2$) 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., $\mu=3$) may be associated with a fourth subcarrier spacing (e.g., 120 kHz) and a normal cyclic prefix. A fifth numerology (e.g., $\mu=4$) may be associated with a fifth subcarrier spacing (e.g., 240 kHz) and a normal cyclic prefix.

[0065] 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.

[0066] 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., $\mu=0$, $\mu=1$, $\mu=2$, $\mu=3$, $\mu=4$) 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., $\mu=0$) associated with a first subcarrier spacing (e.g., 15 kHz) may be used interchangeably between subframes and slots.

[0067] 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.

[0068] 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., $\mu=0$), which includes 15 kHz subcarrier spacing; a second numerology (e.g., $\mu=1$), which includes 30 kHz subcarrier spacing; and a third numerology (e.g., $\mu=2$), 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., $\mu=2$), which includes 60 kHz subcarrier spacing; and a fourth numerology (e.g., $\mu=3$), which includes 120 kHz subcarrier spacing.

[0069] In the context of the present disclosure, the term “proximity communication (PC5) link” may be used interchangeably with PC5 interface, sidelink (SL), unicast link, PC5 unicast link, SL unicast link, device-to-device (D2D) link, user-to-user link, UE-to-UE (U2U) link, or the like.

[0070] 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, 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).

[0071] In the NR system, a UE may be in a dual connectivity (DC) or may be configured in a carrier aggregation (CA), in this case, a duplication for data radio bearer (DRB) may be activated or deactivated, e.g., by a radio resource control (RRC) signalling, a medium access control (MAC) control element (CE), or retransmission scheduling. In addition, a duplication for signalling radio bearer (SRB) in NR is always activated if configured with *pdcp-Duplication*.

[0072] FIG. 2A illustrates a schematic diagram 210 of a Duplication Activation/Deactivation MAC CE. The Duplication Activation/Deactivation MAC CE of one octet is identified by an MAC subheader with a logical channel identify (LCID). It has a fixed size and consists of a single octet containing eight D-fields. FIG. 2B illustrates a schematic diagram 220 of a Duplication RLC Activation/ Deactivation MAC CE. The Duplication RLC Activation/Deactivation MAC CE is identified by an MAC subheader with eLCID. It has a fixed size and consists of a single octet.

[0073] As discussed above, a network device may activate or deactivate the PDCP duplication for one or more RLC entities. However, in a scenario of sidelink, two different UEs may communicate with each other via a PC5 link. In this case, how a PDCP duplication is activated or deactivated should be further studied.

[0074] Embodiments of the present disclosure provide a solution of PDCP duplication for SLRB. In the solution, a first UE may obtain a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication. The first UE may determine a start time for the PDCP duplication of the at least one SLRB; and activate or enable the PDCP duplication for the at least one SLRB from the start time. As such, when to activate the PDCP duplication for SLRB may be determined. Principles and implementations of the present disclosure will be described in detail below with reference to the figures.

[0075] FIG. 3 illustrates a schematic diagram of an example communication network 300 in which some embodiments of the present disclosure can be implemented. As shown in FIG. 3, the communication network 300 may include a UE 310, a UE 320, and a base station 330. For example, the base station 330 may be a serving network device (such as a serving gNB) of the UE 310.

[0076] With reference to FIG. 3, the base station 330 may communicate with the UE 310

via a Uu link, and the UE 310 may communicate with the UE 320 via a PC5 link.

[0077] In some embodiments, the UE 310 and the UE 320 may communicate with each other via a sidelink 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 link or PC5 RRC connection may be established between the UE 310 and the UE 320.

[0078] It is to be understood that the number of devices in FIG. 3 is given for the purpose of illustration without suggesting any limitations to the present disclosure.

[0079] In some embodiments, the UE 320 may locate within the coverage of the base station 330, or may locate outside of the coverage of the base station 330, the present disclosure does not limit this aspect. For example, the base station 330 may communicate with the UE 320 via a Uu link.

[0080] FIG. 4A illustrates an example RRC reconfiguration sidelink procedure 410, and FIG. 4B illustrates another example RRC reconfiguration sidelink procedure 420. A shown in FIG. 4A, a UE 401 may transmit an *RRCReconfigurationSidelink* message to a UE 402, and the UE 402 may transmit an *RRCReconfigurationCompleteSidelink* message back to the UE 401. A shown in FIG. 4B, a UE 401 may transmit an *RRCReconfigurationSidelink* message to a UE 402, and the UE 402 may transmit an *RRCReconfigurationFailureSidelink* message back to the UE 401.

[0081] The purpose of the RRC reconfiguration sidelink procedure 410/420 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.

[0082] The UE (such as the UE 401) 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 402),
- 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.

[0083] In some examples, the UE 401 may be one of UE 310 and UE 320 in FIG. 3, while the UE 402 is the other one of UE 310 and UE 320 in FIG. 3.

[0084] FIG. 4C illustrates an example sidelink UE capability transfer procedure 430. As shown in FIG. 4C, a UE 401 may transmit a *UECapabilityEnquirySidelink* message to a UE 402, and the UE 402 may transmit a *UECapabilityInforamtionSidelink* message back to the UE 401. Similarly, the UE 401 may transmit a *UECapabilityInforamtionSidelink* message to the UE 402.

[0085] In a sidelink communication, a sidelink UE established a PC5 unicast link and corresponding PC5-RRC connection with a peer UE. For the PC5-RRC connection, SL-SRB0 is used to transmit the PC5-S message(s) before the PC5-S security has been established. SL-SRB1 is used to transmit the PC5-S messages to establish the PC5-S security. SL-SRB2 is used to transmit the PC5-S messages after the PC5-S security has been established, which is protected. SL-SRB3 is used to transmit the PC5-RRC signalling, which is protected and only sent after the PC5-S security has been established. And SL-SRB4 is used to transmit/receive the NR sidelink discovery messages.

- SL-SRB0: PC5-S message(s) before the PC5-S security has been established
- SL-SRB1: PC5-S messages to establish the PC5-S security
- SL-SRB2: PC5-S messages after the PC5-S security has been established, which is protected
- SL-SRB3: PC5-RRC signalling
- SL-SRB4: NR sidelink discovery messages

[0086] Reference is further made to FIG. 5, which illustrates a signalling chart illustrating communication process 500 in accordance with some example embodiments of the present disclosure. The process 500 may involve the UE 310, the UE 320, and the base station 330 as shown in FIG. 3. It would be appreciated that the process 500 may be applied to other communication scenarios, which will not be described in detail.

[0087] For ease of description, it is assumed that the UE 310 is a transmitter (Tx UE) and the UE 320 is a receiver (Rx UE). In some examples, the UE 310 may be called as a first UE, and the UE 320 may be called as a second UE.

[0088] In the process 500, the UE 310 obtains a configuration message, where the configuration message indicates that at least one SLRB is configured a PDCP duplication. For example, the configuration message may indicate that one or more SLRBs enable

PDCCP duplication.

[0089] In some example embodiments, the configuration message may be pre-configured. For example, a base station, which may be the base station 330 or may be a previously serving network device different from the base station 330, may transmit the configuration message. For example, one or more pre-configured parameters may be pre-stored (or pre-defined) in the UE 310 from the beginning.

[0090] In some other example embodiments, the base station 330 may transmit 510 the configuration message 515 to the UE 310. And on the other side of communication, the UE 310 obtains the configuration message 515 by receiving. In some examples, the configuration message 515 may be implemented as an RRC message or RRS signalling.

[0091] In addition or alternatively, the UE 310 may transmit capability information of the UE 310 to the base station. In some examples, the capability information of the UE 310 may indicate one or more of: whether the UE 310 supports PDCCP duplication, at least one band or carrier supporting the PDCCP duplication, or a number of carriers supporting the PDCCP duplication. In the present disclosure, it is assumed that the UE 310 supports the PDCCP duplication.

[0092] In the process 500, the UE 310 determines 540 a start time for PDCCP duplication. In addition, the UE 310 activate (or enable) 560 the PDCCP duplication for the at least one SLRB from the start time.

[0093] In some example embodiments, the UE 310 may determine when to activate (or enable) the PDCCP duplication based on a resource allocation mode used by the communication between the UE 310 and the UE 320 (i.e., sidelink communication) via a unicast link. Some detailed implementations are discussed below with reference to different resource allocation modes.

[0094] In some implementations, the sidelink communication between the UE 310 and the UE 320 may use a resource allocation mode 2. In mode 2, UE decides the SL transmission resources in the resource pool based on sensing result.

[0095] In some example embodiments, the UE 310 may determine the start time based on at least one of: a first time when a carrier coordination between the first UE and the second UE is finished e.g. there are multiple carriers for sidelink transmission and reception between the first UE and the second UE, or a second time when receiving a capability message from the second UE 320, wherein the capability message indicates that the second

UE supports a PDCP duplication, or both above conditions have fulfilled.

5 [0096] In some examples, the UE 310 may receive a capability message from the UE 320 at a second time, where the capability message includes capability information of the UE 320, which may indicate that the UE 320 supports a PDCP duplication. In some examples, multiple carrier coordination between the UE 310 and the UE 320 may be finished (done) at a first time. For example, the start time may be or be after a later one of the first time and the second time.

10 [0097] In some other example embodiments, the UE 310 may determine the start time based on a transmission time of an earliest PC5 message between the UE 310 and the UE 320. In some examples, the earliest PC5 message may be the first one of PC5 messages that are associated with the at least one SLRB.

[0098] For example, the at least one SLRB may include SL-SRB3 for PC5-RRC message, the earliest PC5 message may be the first PC5-RRC message.

15 [0099] In some examples, the start time may be determined based on a determination that a service associated with the unicast link indicates that a CA or a PDCP duplication is supported. In some examples, if a profile (of the UE 310) of corresponding services associated with the unicast link indicates that CA or PDCP duplication is supported, then the PDCP duplication may be activated or enabled from the first PC5-RRC message. In some examples, if a service associated with the unicast link is a new service which
20 implicitly indicates that the PDCP duplication is supported, then the PDCP duplication may be activated or enabled from the first PC5-RRC message.

[00100] For example, the at least one SLRB may include one of SL-SRB0, SL-SRB1, or SL-SRB2 for a PC5-S message. For example, the at least one SLRB may include SL-SRB4 for an NR SL discovery message.

25 [00101] In some other example embodiments, the UE 310 may determine the start time based on a transmission time of an intermediate PC5 message between the UE 310 and the UE 320. In some embodiments, if a PDCP duplication has been activated or enabled for at least one SL-DRB, then the UE 310 may determine to activate (or enable) the PDCP duplication for at least one SL-SRB.

30 [00102] In some examples, the PDCP duplication for at least one SL-SRB (such as SL-SRB3) is activated or enabled when one of SL-DRBs associated with the unicast link or the PC5-RRC connection has activated PDCP duplication. In some examples, the PDCP

duplication for at least one SL-SRB (such as SL-SRB3) is deactivated or disabled when all of SL-DRBs associated with the unicast link or the PC5-RRC connection have deactivated PDCP duplication.

5 [00103] In some other example embodiments, the UE 310 may activate or enable the PDCP duplication for partial or all messages associated with the at least one SLRB. In some examples, the partial or all messages are on a same SCCH or on a same SL-SRB.

[00104] In some examples, the at least one SLRB may include SL-SRB3 for PC5-RRC message. For the SL-SRBs, the base station 330 may transmit a configuration to the UE 310, where the configuration may be the configuration message 515 above or may be a
10 different message. For example, the configuration may indicate a first group of messages using the SL-SRB3 for which the PDCP duplication can be activated (or enabled) and a second group of messages using the SL-SRB3 for which the PDCP duplication cannot be activated (or enabled). Accordingly, the UE 310 may activate (or enable) the PDCP duplication for the first group of messages using the SL-SRB3, but not activate (or enable)
15 the PDCP duplication for the second group of messages using the SL-SRB3. For example, the first group of messages may include one or more important PC5-RRC messages using the SL-SRB3. For example, the first group of message may include one or more of: *UuMessageTransferSidelink*, *NotificationMessageSidelink*, or the like.

[00105] In some implementations, the sidelink communication between the UE 310 and the
20 UE 320 may use resource allocation mode 2. In some example embodiments, the start time of the PDCP duplication may be determined dynamically.

[00106] In some example embodiments, the UE 310 may determine that start time based on a time when one of following conditions fulfills: a timer T400 is still running and a remaining time length of the timer T400 is shorter than a time length threshold, a first index
25 of a CQI is lower than a CQI threshold being indicated in an SL-CSI report, a first RSRP of the sidelink determined by the second UE is lower than a power threshold, a consecutive DTX number is larger than a DTX threshold, a received NACK number is larger than a NACK threshold, or a sum of a DTX number and a received NACK number is larger than a number threshold.

30 [00107] In some example embodiments, the at least one SLRB may include SL-SRB3 for PC5-RRC message.

[00108] In some embodiments, a condition may include: a first index of a CQI (i.e., CQI

index) is lower than a CQI threshold, where the CQI threshold is indicated in the SL-CSI report. In some embodiments, the UE 310 may determine the CQI index of at least one carrier that transmit the PC5-RRC message, or determine the CQI index of all carriers that may be used for transmitting PC5-RRC messages. In some examples, if only one carrier
5 (such as a primary carrier) is allowed to transmit the PC5-PRC message, the CQI index of the primary carrier is considered. In some other examples, if some or all carriers are allowed to transmit the PC5-PRC message, the CQI indexes of the some or all carriers are considered.

[00109] For a specific example, assume that there are 4 carriers between the UE 310 and
10 the UE 320: carrier #1, carrier #2, carrier #3, and carrier #4. In one embodiment, if only carrier #1 is used for transmitting the PC5-RRC message, then the CQI indexes of carrier #1 is considered. For example, if the CQI index of carrier #1 is lower than the CQI threshold, then the condition is fulfilled. In another embodiment, the CQI indexes of carrier #1 to carrier #4 are all considered. For example, if the CQI index of carrier #1, the
15 CQI index of carrier #2, the CQI index of carrier #3, and the CQI index of carrier #4 are all is lower than the CQI threshold, then the condition is fulfilled.

[00110] In some embodiments, a condition may include: a first RSRP of the sidelink (i.e., SL-RSRP) determined by the second UE 320 is lower than a power threshold. For example, the second UE 320 may determine the SL-RSRP and report it to the UE 310
20 through a measurement report. In some embodiments, the UE 310 may determine the SL-RSRP of at least one carrier that transmit the PC5-RRC message, or determine the SL-RSRP of all carriers that may be used for transmitting PC5-RRC messages. In some examples, if only one carrier (such as a primary carrier) is allowed to transmit the PC5-PRC message, the SL-RSRP of the primary carrier is considered. In some other examples, if
25 some or all carriers are allowed to transmit the PC5-PRC message, the SL-RSRPs of the some or all carriers are considered.

[00111] For a specific example, assume that there are 4 carriers between the UE 310 and the UE 320: carrier #1, carrier #2, carrier #3, and carrier #4. In one embodiment, if only carrier #1 is used for transmitting the PC5-RRC message, then the SL-RSRPs of carrier #1
30 is considered. For example, if the SL-RSRP of carrier #1 is lower than the power threshold, then the condition is fulfilled. In another embodiment, the SL-RSRPs of carrier #1 to carrier #4 are all considered. For example, if the SL-RSRP of carrier #1, the SL-RSRP of carrier #2, the SL-RSRP of carrier #3, and the SL-RSRP of carrier #4 are all is

lower than the power threshold, then the condition is fulfilled.

[00112] In some embodiments, a condition may include: a consecutive DTX number is larger than a DTX threshold. In some embodiments, the UE 310 may determine the consecutive DTX number of at least one carrier that transmit the PC5-RRC message, or
5 determine the consecutive DTX number of all carriers that may be used for transmitting PC5-RRC messages. In some examples, if only one carrier (such as a primary carrier) is allowed to transmit the PC5-PRC message, the consecutive DTX number of the primary carrier is considered. In some other examples, if some or all carriers are allowed to transmit the PC5-PRC message, the consecutive DTX numbers of the some or all carriers
10 are considered.

[00113] For a specific example, assume that there are 4 carriers between the UE 310 and the UE 320: carrier #1, carrier #2, carrier #3, and carrier #4. In one embodiment, if only carrier #1 is used for transmitting the PC5-RRC message, then the consecutive DTX numbers of carrier #1 is considered. For example, if the consecutive DTX number of
15 carrier #1 exceeds the DTX threshold, then the condition is fulfilled. In another embodiment, the consecutive DTX numbers of carrier #1 to carrier #4 are all considered. For example, if the consecutive DTX number of carrier #1, the consecutive DTX number of carrier #2, the consecutive DTX number of carrier #3, and the consecutive DTX number of carrier #4 all exceed the DTX threshold, then the condition is fulfilled.

[00114] In some embodiments, a condition may include: a received NACK number is larger than a NACK threshold. In some examples, the received NACK number may be a quantity of received NACK messages within a specific time period.

[00115] In some example embodiments, the at least one SLRB may include one or more SL-DRBs.

[00116] In some example embodiments, the UE 310 may further determine an end time based on a time when one of following conditions fulfills: a second index of a CQI is not lower than the CQI threshold in the SL-CSI report, a second RSRP of the sidelink is not lower than the power threshold, a measured CBR) is not lower than a CBR threshold, or all SL RBs associated with the sidelink have deactivated the PDCP duplication. In addition,
25 the UE 310 may deactivate (or disable) the PDCP duplication for the at least one SLRB from the end time.
30

[00117] Similarly as that discussed above, the second index of a CQI may be a CQI index

of a carrier or some carriers or all carriers, the second RSRP of the sidelink may be an SL-RSRP of a carrier or some carriers or all carriers, the present disclosure does not limit this aspect.

5 [00118] It is understood that keeping the PDCP duplication activated (or enabled) may cause a large overhead and in some cases (such as a channel quality is good enough) may be not necessary. Therefore, a power saving and a small overhead may be guaranteed if the UE 310 active (or enable) the PDCP duplication dynamically and deactivate (or disable) the PDCP duplication in some cases.

10 [00119] In some implementations, the sidelink communication between the UE 310 and the UE 320 may use a resource allocation mode 1. In mode 1, the sidelink resource is scheduled by the base station 330.

[00120] In some examples, the base station 330 may transmit a resource indication of the sidelink resource to the UE 310, and the sidelink resource is scheduled by the base station 330 and may be used for a sidelink transmission between the UE 310 and the UE 320.

15 [00121] In some example embodiments, the UE 310 may determine the start time based on a reception of an indication from the base station 330, where the indication may indicate activating or enabling the PDCP duplication for the at least one SLRB. In other words, the PDCP duplication may be activated or enabled by the base station 330. In some examples, the indication may be carried in one of: an RRC message, an MAC CE, or a DCI (L1 signalling).

20 [00122] In some examples, the UE 320 may transmit capability information of the UE 320 to the UE 310. In some examples, the UE 310 may transmit, to the base station 330, the capability information of the UE 320. For example, the capability information of the UE 320 indicates that the UE 320 supports PDCP duplication. In some examples, the UE 310 may transmit, to the base station 330, capability information of the UE 310. For example, the capability information of the UE 310 indicates that the UE 310 supports PDCP duplication. In some examples, the base station 330 may determine when to activate or enable the PDCP duplication for the at least one SLRB based on the capability information of the UE 310 and the UE 320.

30 [00123] In some other examples, the UE 310 may determine information associated with the unicast link, and may further transmit the information to the base station 330. In some examples, the base station 330 may determine when to activate or enable the PDCP

duplication for the at least one SLRB based on the information from the UE 310. In some examples, the information may indicate one of: an index of a CQI, an RSRP of the sidelink, a consecutive DTX number, or a received NACK number. For example, the information may include an index of a CQI, i.e., a CQI index, of a carrier or some carriers or all carriers.

5 For example, the information may include an RSRP of the sidelink, i.e., an SL-RSRP, of a carrier or some carriers or all carriers. For example, the information may include a consecutive DTX number. of a carrier or some carriers or all carriers. For example, the information may include a received NACK number within a specific time period.

[00124] In some implementations, the sidelink communication between the UE 310 and the
10 UE 320 may use unlicensed band carriers.

[00125] In some example embodiments, if at least one SLRB is to be transmitted on one or more unlicensed band carriers, the UE 310 may determine the start time based on a time when one of the following conditions fulfills: one or more indications of LBT failure for the at least one SLRB are received, a consecutive LBT failure occurs for a RB set the at least
15 one SLRB transmits, a number of RB sets for which a consecutive LBT failure occurs is larger than a threshold, a resource reselection is triggered by a consecutive LBT failure, or a number of CPACs of the at least one SLRB is larger than a further threshold.

[00126] In some examples, the configuration message may indicate that one or more SL-SRBs or SL-DRBs are configured with PDCP duplication, e.g., SL-SRB3 (which is for
20 PC5-RRS message). In some examples, the UE 310 may activate or enable the PDCP duplication for the SL-SRB3 (or the PC5-RRS message) or for the SL-DRBs dynamically. For example, if the PC5-RRC message or the SL-DRBs are to be transmitted on unlicensed band carrier, the UE 310 may activate (or enable) the PDCP duplication if one or more following conditions fulfilled:

- 25 a) One or more LBT failure indication received for SL-SRB/SL-DRB transmission,
- b) Consecutive LBT failure happens for RB set where SL-SRB/SL-DRB transmit,
- c) The number of RB sets that happen consecutive LBT failure is larger than a threshold,
- 30 d) The resource (pool) reselection triggered by consecutive LBT failure, or
- e) The CAPC of SL-SRBs/SL-DRBs that associated with unicast link is larger than a further threshold.

[00127] In some example embodiments, if the LBT failure is recovered, the UE 310 may deactivate (or disable) the PDCP duplication.

[00128] In some implementations, the sidelink communication between the UE 310 and the UE 320 may use one or more carriers with FR2.

5 [00129] In some example embodiments, if at least one SLRB is to be transmitted on one or more carriers with FR2, the UE 310 may determine the start time based on a time when one of the following conditions fulfills: a number of received beam failure indications is larger than a threshold value, or a beam failure associated with the at least one SLRB is detected.

[00130] In some examples, the configuration message may indicate that one or more
10 SL-SRBs or SL-DRBs are configured with PDCP duplication, e.g., SL-SRB3 (which is for PC5-RRC message). In some examples, the UE 310 may activate or enable the PDCP duplication for the SL-SRB3 (or the PC5-RRC message) or for the SL-DRBs dynamically. For example, if the PC5-RRC message or the SL-DRBs are to be transmitted on carriers with FR2, the UE 310 may activate (or enable) the PDCP duplication if one or more
15 following conditions fulfilled:

- a) The number of received beam failure instance indications (of carrier(s) for transmitting PC5-RRC message/SL-DRBs, or all carriers) larger than a threshold value, or
- b) Beam failure detected (of carrier(s) for transmitting PC5-RRC message
20 /SL-DRBs, or all carriers that can transmit PC5-RRC message).

[00131] Continue referring to FIG. 5, the UE 310 may further perform a transmission with the UE 320. For example, at least one PC5-RRC message may be transmitted from the UE 310 to the UE 320 via the unicast link.

[00132] In some example embodiments, the UE 310 may setup two or more RLC entities
25 for a same PDCP entity associated with the at least one SLRB; and duplicate multiple PDCP PDUs for the two or more RLC entities. In some example embodiments, the UE 320 may setup two or more RLC entities for the same PDCP entity associated with the at least one SLRB; and receive duplicated multiple PDCP PDUs.

[00133] For example, in case the at least one SLRB includes SL-SRB3 for PC5-RRC
30 message, and the start time is a time of an earliest PC5-RRC message (i.e., the first PC5-RRC message), the UE 310 may setup two or more RLC entities for the same PDCP entity and duplicate PDCP PDUs from the first PC5-RRC message of the associated

PC5-RRC connection, and the UE 320 may setup two or more RLC entities for the same PDCP entity to receive duplicated PDCP PDUs from the first PC5-RRC message of the associated PC5-RRC connection.

5 [00134] According to some embodiments described with reference to FIG. 5, a start time for a PDCP duplication for at least one SLRB may be determined by a Tx UE, and accordingly an issue that when to activate or enable the PDCP duplication in the NR SL scenario may be solved.

10 [00135] FIG. 6 illustrates an example of a device 600 that is suitable for implementing embodiments of the present disclosure. The device 600 may be an example of a UE or a base station as described herein. The device 600 may support wireless communication with the UE 310, the base station 330, or any combination thereof. The device 600 may include components for bi-directional communications including components for transmitting and receiving communications, such as a processor 602, a memory 604, a transceiver 606, and, optionally, an I/O controller 608. These components may be in
15 electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[00136] The processor 602, the memory 604, the transceiver 606, 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 602, the
20 memory 604, the transceiver 606, or various combinations or components thereof may support a method for performing one or more of the operations described herein.

[00137] In some implementations, the processor 602, the memory 604, the transceiver 606, 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
25 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 602 and the memory 604 coupled
30 with the processor 602 may be configured to perform one or more of the functions described herein (e.g., executing, by the processor 602, instructions stored in the memory 604).

[00138] For example, the processor 602 may support wireless communication at the device 600 in accordance with examples as disclosed herein. The processor 602 may be configured to operable to support a means for obtaining a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; 5 means for determining a start time for the PDCP duplication of the at least one SLRB; and means for activating or enabling the PDCP duplication for the at least one SLRB from the start time. The processor 602 may be configured to operable to support a means for transmitting, to a first UE, a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication; means for receiving, 10 from the first UE, information about the first UE and the second UE; and means for transmitting, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB.

[00139] The processor 602 may include an intelligent hardware device (e.g., a general-purpose processor, a DSP, a CPU, a microcontroller, an ASIC, an FPGA, a 15 programmable logic device, a discrete gate or transistor logic component, a discrete hardware component, or any combination thereof). In some implementations, the processor 602 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 602. The processor 602 may be configured to execute computer-readable instructions 20 stored in a memory (e.g., the memory 604) to cause the device 600 to perform various functions of the present disclosure.

[00140] The memory 604 may include random access memory (RAM) and read-only memory (ROM). The memory 604 may store computer-readable, computer-executable code including instructions that, when executed by the processor 602 cause the device 600 25 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 602 but may cause a computer (e.g., when compiled and executed) to perform functions described herein. In some implementations, the memory 604 may include, among other things, a basic I/O 30 system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[00141] The I/O controller 608 may manage input and output signals for the device 600. The I/O controller 608 may also manage peripherals not integrated into the device M02.

In some implementations, the I/O controller 608 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 608 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 608 may be implemented as part of a processor, such as the processor 606. In some implementations, a user may interact with the device 600 via the I/O controller 608 or via hardware components controlled by the I/O controller 608.

[00142] In some implementations, the device 600 may include a single antenna 610. However, in some other implementations, the device 600 may have more than one antenna 610 (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 606 may communicate bi-directionally, via the one or more antennas 610, wired, or wireless links as described herein. For example, the transceiver 606 may represent a wireless transceiver and may communicate bi-directionally with another wireless transceiver. The transceiver 606 may also include a modem to modulate the packets, to provide the modulated packets to one or more antennas 610 for transmission, and to demodulate packets received from the one or more antennas 610. The transceiver 606 may include one or more transmit chains, one or more receive chains, or a combination thereof.

[00143] 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 610 for transmitting the amplified signal into the air or wireless medium.

[00144] 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 610 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
5 the transmitted data.

[00145] FIG. 7 illustrates an example of a processor 700 that is suitable for implementing some embodiments of the present disclosure. The processor 700 may be an example of a processor configured to perform various operations in accordance with examples as described herein. The processor 700 may include a controller 702 configured to perform
10 various operations in accordance with examples as described herein. The processor 700 may optionally include at least one memory 704, such as L1/L2/L3 cache. Additionally, or alternatively, the processor 700 may optionally include one or more arithmetic-logic units (ALUs) 700. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically,
15 electrically) via one or more interfaces (e.g., buses).

[00146] The processor 700 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.
20 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 700) 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
25 (PCM), and others).

[00147] The controller 702 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 700 to cause the processor 700 to support various operations in accordance with examples as described
30 herein. For example, the controller 702 may operate as a control unit of the processor 700, generating control signals that manage the operation of various components of the processor 700. These control signals include enabling or disabling functional units, selecting data paths, initiating memory access, and coordinating timing of operations.

[00148] The controller 702 may be configured to fetch (e.g., obtain, retrieve, receive) instructions from the memory 704 and determine subsequent instruction(s) to be executed to cause the processor 700 to support various operations in accordance with examples as described herein. The controller 702 may be configured to track memory address of instructions associated with the memory 704. The controller 702 may be configured to decode instructions to determine the operation to be performed and the operands involved. For example, the controller 702 may be configured to interpret the instruction and determine control signals to be output to other components of the processor 700 to cause the processor 700 to support various operations in accordance with examples as described herein. Additionally, or alternatively, the controller 702 may be configured to manage flow of data within the processor 700. The controller 702 may be configured to control transfer of data between registers, arithmetic logic units (ALUs), and other functional units of the processor 700.

[00149] The memory 704 may include one or more caches (e.g., memory local to or included in the processor 700 or other memory, such RAM, ROM, DRAM, SDRAM, SRAM, MRAM, flash memory, etc. In some implementations, the memory 704 may reside within or on a processor chipset (e.g., local to the processor 700). In some other implementations, the memory 704 may reside external to the processor chipset (e.g., remote to the processor 700).

[00150] The memory 704 may store computer-readable, computer-executable code including instructions that, when executed by the processor 700, cause the processor 700 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 702 and/or the processor 700 may be configured to execute computer-readable instructions stored in the memory 704 to cause the processor 700 to perform various functions. For example, the processor 700 and/or the controller 702 may be coupled with or to the memory 704, the processor 700, the controller 702, and the memory 704 may be configured to perform various functions described herein. In some examples, the processor 700 may include multiple processors and the memory 704 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.

[00151] The one or more ALUs 700 may be configured to support various operations in

accordance with examples as described herein. In some implementations, the one or more ALUs 700 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 700 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 700 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 700 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 700 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 700 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 700 to handle conditional operations, comparisons, and bitwise operations.

[00152] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 700 may be configured to or operable to support a means for operations described in some embodiments of the present disclosure.

[00153] FIG. 8 illustrates a flowchart of a method 800 performed by a 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 a UE 310 in FIG. 3. 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.

[00154] At 810, the method may include obtaining a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication. 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 UE 310 as described with reference to FIG. 3.

[00155] At 820, the method may include determining a start time for the PDCP duplication of the at least one SLRB. 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 UE 310 as described with reference to FIG. 3.

[00156] At 830, the method may include activating or enabling the PDCP duplication for

the at least one SLRB from the start time. The operations of 830 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 830 may be performed by the UE 310 as described with reference to FIG. 3.

5 [00157] FIG. 9 illustrates a flowchart of a method 900 performed by a base station 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 base station 330 in FIG. 3. 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,
10 the device may perform aspects of the described functions using special-purpose hardware.

[00158] At 910, the method may include transmitting, to a first UE, a configuration message indicating that at least one SLRB associated with a second UE is configured with a PDCP duplication. 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
15 performed by the base station 330 as described with reference to FIG. 3.

[00159] At 920, the method may include receiving, from the first UE, information about the first UE and the second UE. 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 base station 330 as described with reference to FIG. 3.

20 [00160] At 930, the method may include transmitting, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB. The operations of 930 may be performed in accordance with examples as described herein. In some implementations, aspects of the operations of 930 may be performed by the base station 330 as described with reference to FIG. 3.

25 [00161] 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.

[00162] The various illustrative blocks and components described in connection with the
30 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.

[00163] 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.

[00164] 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.

[00165] 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
5 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.

[00166] 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
10 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.

What is claimed is:

1. A first user equipment (UE) comprising:
at least one memory; and
5 at least one processor coupled with the at least one memory and configured to cause the first UE to:
obtain a configuration message indicating that at least one sidelink radio bearer (SLRB) associated with a second UE is configured with a packet data convergence protocol (PDCP) duplication;
10 determine a start time for the PDCP duplication of the at least one SLRB; and
activate or enable the PDCP duplication for the at least one SLRB from the start time.
2. The first UE of claim 1, wherein the at least one processor is configured to
15 cause the first UE to:
determine the start time based on:
a first time when a carrier coordination between the first UE and the second UE is finished, and
a second time when receiving a capability message from the second UE, wherein the
20 capability message indicates that the second UE supports a PDCP duplication.
3. The first UE of claim 1, wherein the at least one processor is configured to cause the first UE to:
determine the start time based on a transmission time of an earliest PC5 message
25 between the first UE and the second UE.
4. The first UE of claim 3, wherein the earliest PC5 message is associated with the at least one SLRB.
- 30 5. The first UE of claim 3, wherein the start time is determined based on a determination that a service associated with a unicast link between the first UE and the second UE indicates that a carrier aggregation (CA) or a PDCP duplication is supported.

6. The first UE of claim 1, wherein the at least one SLRB comprises at least one sidelink signalling radio bearer (SL-SRB), and wherein the at least one processor is configured to cause the first UE to:

in accordance with a determination that the PDCP duplication is activated or enabled for at least one sidelink data radio bearer (SL-DRB), activate or enable the PDCP duplication for the at least one SL-SRB.

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

activate or enable the PDCP duplication for partial or all messages associated with the at least one SLRB.

8. The first UE of claim 7, wherein the partial or all messages are on a same sidelink control channel (SCCH) or on a same SL-SRB.

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

determine the start time based on a time when one of following conditions fulfills:

a timer T400 is still running and a remaining time length of the timer T400 is shorter than a time length threshold,

a first index of a channel quality indication (CQI) is lower than a CQI threshold being indicated in a sidelink channel state information (SL-CSI) report,

a first reference signal received power (RSRP) of the sidelink determined by the second UE is lower than a power threshold,

a consecutive discontinuous transmission (DTX) number is larger than a DTX threshold,

a received negative acknowledgement (NACK) number is larger than a NACK threshold, or

a sum of a DTX number and a received NACK number is larger than a number threshold.

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

determine an end time based on a time when one of following conditions fulfills:

a second index of a CQI is not lower than the CQI threshold in the SL-CSI report,

a second RSRP of the sidelink is not lower than the power threshold,

a measured channel busy rate (CBR) is not lower than a CBR threshold, or

5 all SL RBs associated with the sidelink have deactivated the PDCP duplication;

and

deactivate or disable the PDCP duplication for the at least one SLRB from the end time.

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

in accordance with a determination that a sidelink resource between the first UE and the second UE is scheduled by a base station, determine the start time based on a reception of an indication from the base station, wherein the indication indicates activating or
15 enabling the PDCP duplication for the at least one SLRB.

12. The first UE of claim 11, wherein the at least one processor is configured to cause the first UE to:

receive, from the second UE, capability information of the second UE, wherein the
20 capability information of the second UE indicates that the second UE supports PDCP duplication;

transmit, to the base station, the capability information of the second UE; and

receive, from the base station, the indication.

25 13. The first UE of claim 11, wherein the at least one processor is configured to cause the first UE to:

transmit, to the base station, information indicating one of: an index of a CQI, an RSRP of the sidelink, a consecutive DTX number, or a received NACK number; and

receive, from the base station, the indication, wherein the indication is determined
30 by the base station based on the information.

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

in accordance with a determination that the at least one SLRB is to be transmitted

on one or more unlicensed band carriers, determine the start time based on a time when one of the following conditions fulfills:

one or more indications of listen before talk (LBT) failure for the at least one SLRB are received,

5 a consecutive LBT failure occurs for a resource block (RB) set the at least one SLRB transmits,

a number of RB sets for which a consecutive LBT failure occurs is larger than a threshold,

a resource reselection is triggered by a consecutive LBT failure, or

10 a number of conditional primary secondary cell (PSCell) addition or change (CPAC) of the at least one SLRB is larger than a further threshold.

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

15 in accordance with a determination that the at least one SLRB is to be transmitted on one or more carriers with frequency range 2 (FR2), determine the start time based on a time when one of the following conditions fulfills:

a number of received beam failure indications is larger than a threshold value,

or

20 a beam failure associated with the at least one SLRB is detected.

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

transmit, to a base station, capability information of the first UE indicating one of:

25 whether the first UE supports PDCP duplication,

at least one band or carrier supporting the PDCP duplication, or

a number of carriers supporting the PDCP duplication.

17. A base station comprising:

30 at least one memory; and

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

transmit, to a first user equipment (UE), a configuration message indicating that at least one sidelink radio bearer (SLRB) associated with a second UE is configured

with a packet data convergence protocol (PDCP) duplication;

receive, from the first UE, information about the first UE and the second UE;

and

transmit, to the first UE, an indication indicating to the first UE to activate or

5 enable the PDCP duplication for the at least one SLRB.

18. The base station of claim 17, wherein the information comprises one of:

capability information of the second UE, wherein the capability information of the

second UE indicates that the second UE supports PDCP duplication,

10 capability information of the first UE indicating one of: whether the first UE supports PDCP duplication, at least one band or carrier supporting the PDCP duplication, or a number of carriers supporting the PDCP duplication,

an index of a channel quality indication (CQI),

a reference signal received power (RSRP) of the sidelink determined by the second

15 UE,

a consecutive discontinuous transmission (DTX) number, or

a received negative acknowledgement (NACK) number.

19. A method performed by a first user equipment (UE), comprising:

20 obtaining a configuration message indicating that at least one sidelink radio bearer (SLRB) associated with a second UE is configured with a packet data convergence protocol (PDCP) duplication;

determining a start time for the PDCP duplication of the at least one SLRB; and

activating or enabling the PDCP duplication for the at least one SLRB from the start

25 time.

20. A method performed by a base station, comprising:

transmitting, to a first user equipment (UE), a configuration message indicating that at least one sidelink radio bearer (SLRB) associated with a second UE is configured with a

30 packet data convergence protocol (PDCP) duplication;

receiving, from the first UE, information about the first UE and the second UE; and

transmitting, to the first UE, an indication indicating to the first UE to activate or enable the PDCP duplication for the at least one SLRB.