

RESOURCE POOL SELECTION

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communications, and more specifically to user equipment (UE) and methods for supporting resource pool selection for sidelink (SL) multi-carrier cases.

BACKGROUND

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

[0003] In Release 15, multi-carrier operation was introduced for long term evolution (LTE) vehicle to everything (V2X) system. In the LTE V2X system, multiple carriers can be supported on sidelink and a UE can select one or more of the multiple carriers for data transmission. In that time, the UE selects one or more carriers available for transmission based on channel busy ratio (CBR) measurement report on each carrier, and the UE can also keep the selected carrier when CBR measurement results are lower than a configured threshold to avoid too frequent carrier switching.

[0004] In Release 16, sidelink was firstly introduced for new radio (NR) system, but only one carrier was supported for simplicity purpose.

[0005] In Release 17, to adapt NR sidelink for power sensitive UEs (such as P-UEs,

public safety UEs, or commercial sidelink UEs), some power saving mechanisms were studied and introduced on sidelink, for example, partial sensing and sidelink discontinuous reception (DRX) mechanisms are being specified.

[0006] For further sidelink development in Release 18, it was proposed that multi-carrier operation needs to be introduced for NR sidelink to fulfill much more sidelink services that need high throughput and reliability. In addition, carrier selection scheme is one of the key schemes for multi-carrier operation.

SUMMARY

[0007] The present disclosure relates to UEs and methods that support resource pool selection for sidelink multi-carrier cases. With the UEs and methods, the selected resource pool for grant creation can fulfill a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where sidelink data is available if the sidelink logical channel requests HARQ feedback.

[0008] Some implementations of a UE described herein may include a processor and a transceiver coupled to the processor, wherein the processor is configured to: select at least one carrier for transmission of sidelink data; during or after selecting the at least one carrier, select one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available; and perform the transmission of the sidelink data on at least one resource in the selected resource pool.

[0009] In some implementations, the processor is further configured to: determine a first channel busy ratio (CBR) of a first carrier based on a CBR of a first resource pool among at least one resource pool configured on the first carrier. In such implementations, the processor is configured to select one of the at least one resource pool during selecting the at least one carrier by: based on determining that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel, selecting the first carrier and the first resource pool.

[0010] In some implementations, the processor is configured to select one of the at least one resource pool after selecting the at least one carrier by: after selecting a second carrier for the transmission of the sidelink data, determining whether a second resource pool among at least one resource pool configured on the second carrier fulfills the HARQ

attribute condition of the sidelink logical channel; and based on determining that the second resource pool fulfills the HARQ attribute condition of the sidelink logical channel, selecting the second resource pool.

[0011] In some implementations, the processor is further configured to: based on determining that HARQ feedback is enabled for the sidelink logical channel and the selected resource pool is configured with physical sidelink feedback channel (PSFCH) resources, determine that the selected resource pool fulfills the HARQ attribute condition of the sidelink logical channel.

[0012] Some implementations of a UE described herein may include a processor and a transceiver coupled to the processor, wherein the processor is configured to: determine at least one resource pool configured on a first carrier fulfills a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where sidelink data is available; determine a first channel busy ratio (CBR) of a first carrier based on a CBR of the first resource pool selected from the determined at least one resource pool; and based on determining that the first CBR of the first carrier is below a threshold, determine the first carrier as a candidate carrier for transmission of sidelink data.

[0013] In some implementations, the processor is configured to determine that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel by: based on determining that HARQ feedback is enabled for the sidelink logical channel and the first resource pool is configured with PSFCH resources, determining that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel.

[0014] Some implementations of a method described herein may include: selecting at least one carrier for transmission of sidelink data; during or after selecting the at least one carrier, selecting one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available; and performing the transmission of the sidelink data on at least one resource in the selected resource pool.

[0015] Some implementations of a method described herein may include: determining at least one resource pool configured on a first carrier fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available; determining a first channel busy ratio (CBR) of a first carrier based on a CBR of the first resource pool selected from the determined at least one resource pool; and based on

determining that the first CBR of the first carrier is below a threshold, determining the first carrier as a candidate carrier for transmission of sidelink data.

[0016] Some implementations of a processor described herein may include at least one memory and a controller coupled with the at least one memory and configured to cause the controller to: select at least one carrier for transmission of sidelink data; during or after selecting the at least one carrier, select one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available; and perform the transmission of the sidelink data on at least one resource in the selected resource pool.

[0017] Some implementations of a processor described herein may include at least one memory and a controller coupled with the at least one memory and configured to cause the controller to: determine at least one resource pool configured on a first carrier fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available; determine a first CBR of a first carrier based on a CBR of the first resource pool selected from the determined at least one resource pool; and based on determining that the first CBR of the first carrier is below a threshold, determine the first carrier as a candidate carrier for transmission of sidelink data.

[0018] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Fig. 1 illustrates an example of a wireless communications system that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure;

[0020] Figs. 2 to 5 illustrate a flowchart of a method that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure, respectively;

[0021] Fig. 6 illustrates an example of a device that supports resource pool selection for sidelink multi-carrier cases in accordance with some aspects of the present disclosure;

[0022] Fig. 7 illustrates an example of a processor that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure.

DETAILED DESCRIPTION

[0023] Principles of the present disclosure will now be described with reference to some embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein may be implemented in various manners other than the ones described below.

[0024] 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.

[0025] References in the present disclosure to “one embodiment,” “an example embodiment,” “an embodiment,” “some embodiments,” and the like indicate that the embodiment(s) described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases do not necessarily refer to the same embodiment(s). Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0026] It shall be understood that although the terms “first” and “second” or the like may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another element. For example, a first element could also be termed as a second element, and similarly, a second element could also be termed as a first element, without departing from the scope of embodiments. As used herein, the term “and/or” includes any and all combinations of one or more of the listed terms.

[0027] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example 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, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0028] Aspects of the present disclosure are described in the context of a wireless communications system.

[0029] Fig. 1 illustrates an example of a wireless communications system 100 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The wireless communications system 100 may include one at least one of network entities 102 (also referred to as network equipment (NE)), one or more terminal devices or UEs 104, a core network 106, and a packet data network 108. The wireless communications system 100 may support various radio access technologies. In some implementations, the wireless communications system 100 may be a 4G network, such as an 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 an NR network. In other implementations, the wireless communications system 100 may be a combination of a 4G network and a 5G network, or other suitable radio access technology including institute of electrical and electronics engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20. The wireless communications system 100 may support radio access technologies beyond 5G. Additionally, the wireless communications system 100 may support technologies, such as time division multiple access (TDMA), frequency division multiple access (FDMA), or code division multiple access (CDMA), etc.

[0030] The 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 (BS), a network element, a radio access network (RAN) node, a base transceiver station, an access point, a NodeB, an eNodeB (eNB), a next-generation NodeB (gNB), or other suitable terminology. A network entity 102 and a UE 104 may communicate via a communication link 110, which may be a wireless or wired connection. For example, a

network entity 102 and a UE 104 may perform wireless communication (e.g., receive signaling, transmit signaling) over a Uu interface.

[0031] 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, messaging, broadcast, etc.) for one or more UEs 104 within the geographic coverage area 112. For example, a network entity 102 and a UE 104 may support wireless communication of signals related to services (e.g., voice, video, packet data, messaging, broadcast, etc.) according to one or multiple radio access technologies. In some implementations, a network entity 102 may be moveable, for example, a satellite associated with a non-terrestrial network. In some implementations, different geographic coverage areas 112 associated with the same or different radio access technologies may overlap, but the different geographic coverage areas 112 may be associated with different network entities 102. Information and signals described herein may be represented using any of a variety of different technologies and techniques. For example, data, instructions, commands, information, signals, bits, symbols, and chips that may be referenced throughout the description may be represented by voltages, currents, electromagnetic waves, magnetic fields or particles, optical fields or particles, or any combination thereof.

[0032] 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.

[0033] 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.

[0034] 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 104-1 may support wireless communication directly with another UE 104-2 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. For example, the UE 104-1 may support wireless communication directly with another UE 104-2 over a PC5 interface.

[0035] 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, N2, 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).

[0036] 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 radio access network (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.

[0037] An RU may also be referred to as a radio head, a smart radio head, a remote radio head (RRH), a remote radio unit (RRU), or a transmission reception point (TRP). One or more components of the network entities 102 in a disaggregated RAN architecture may be co-located, or one or more components of the network entities 102 may be located in distributed locations (e.g., separate physical locations). In some implementations, one or more network entities 102 of a disaggregated RAN architecture may be implemented as virtual units (e.g., a virtual CU (VCU), a virtual DU (VDU), a virtual RU (VRU)).

[0038] Split of functionality between a CU, a DU, and an RU may be flexible and may support different functionalities depending upon which functions (e.g., network layer functions, protocol layer functions, baseband functions, radio frequency functions, and any combinations thereof) are performed at a CU, a DU, or an RU. For example, a functional split of a protocol stack may be employed between a CU and a DU such that the CU may support one or more layers of the protocol stack and the DU may support one or more different layers of the protocol stack. In some implementations, the CU may host upper protocol layer (e.g., a layer 3 (L3), a layer 2 (L2)) functionality and signaling (e.g., radio resource control (RRC), service data adaptation protocol (SDAP), packet data convergence protocol (PDCP)). The CU may be connected to one or more DUs or RUs, and the one or more DUs or RUs may host lower protocol layers, such as a layer 1 (L1) (e.g., physical (PHY) layer) or an L2 (e.g., radio link control (RLC) layer, medium access control (MAC) layer) functionality and signaling, and may each be at least partially controlled by the CU.

[0039] Additionally, or alternatively, a functional split of the protocol stack may be employed between a DU and an RU such that the DU may support one or more layers of the protocol stack and the RU may support one or more different layers of the protocol stack. The DU may support one or multiple different cells (e.g., via one or more RUs). In some implementations, a functional split between a CU and a DU, or between a DU and an RU may be within a protocol layer (e.g., some functions for a protocol layer may be performed by one of a CU, a DU, or an RU, while other functions of the protocol layer are performed by a different one of the CU, the DU, or the RU).

[0040] A CU may be functionally split further into CU control plane (CU-CP) and CU user plane (CU-UP) functions. A CU may be connected to one or more DUs via a

midhaul communication link (e.g., F1, F1-c, F1-u), and a DU may be connected to one or more RUs via a fronthaul communication link (e.g., open fronthaul (FH) interface). In some implementations, a midhaul communication link or a fronthaul communication link may be implemented in accordance with an interface (e.g., a channel) between layers of a protocol stack supported by respective network entities 102 that are in communication via such communication links.

[0041] 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.

[0042] 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, N2, 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 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).

[0043] 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.

[0044] 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.

[0045] 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.

[0046] 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.

[0047] 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.

[0048] 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.

[0049] As described above, carrier selection scheme is one of the key schemes for multi-carrier operation.

[0050] Currently, for NR sidelink multi-carrier cases, resource pool selection is for two purposes. One of the two purposes is for determination of a CBR of a carrier, another one is for sidelink grant creation. Currently, resource pool selection for sidelink multi-carrier cases for grant creation is to reuse the selected resource pool for determination of the CBR of the carrier. This will cause the problem that the selected resource pool for grant creation cannot fulfill a HARQ attribute condition if a sidelink logical channel requests HARQ feedback. There will be no HARQ feedback on PC5 interface in this case.

[0051] In view of the above, the present disclosure provides a solution that supports resource pool selection for sidelink multi-carrier cases. In this solution, a UE selects at least one carrier for transmission of sidelink data. During or after selecting the at least one carrier, the UE selects one of at least one resource pool configured on each of the at least one carrier. The selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available. In turn, the UE performs the transmission of the sidelink data on at least one resource in the selected resource pool. With this solution, the selected resource pool for grant creation can fulfill a HARQ attribute condition of a sidelink logical channel where sidelink data is available if the sidelink logical channel requests HARQ feedback.

[0052] Hereinafter, principle of the present disclosure will be described with reference to Figs. 2 to 5.

[0053] Fig. 2 illustrates a flowchart of a method 200 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The method 200 can be implemented at a UE, such as the UE 104-1 or 104-2 as shown in Fig. 1. Hereinafter, the UE 104-1 and the UE 104-2 may be collectively referred to as the UE 104. For the purpose of discussion, the method 200 will be described from the perspective of the UE 104 with reference to Fig. 1.

[0054] As shown in Fig. 2, at 210, the UE 104 selects at least one carrier for transmission of sidelink data.

[0055] In some implementations, the UE 104 may be configured with multiple carriers. The UE 104 may select at least one of the multiple carriers for the transmission

of the sidelink data.

[0056] At 220, during or after selecting the at least one carrier, the UE 104 selects one of at least one resource pool configured on each of the at least one carrier. The selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available.

[0057] In some implementations, if HARQ feedback is enabled for the sidelink logical channel and the selected resource pool is configured with physical sidelink feedback channel (PSFCH) resources, the UE 104 may determine that the selected resource pool fulfills the HARQ attribute condition of the sidelink logical channel.

[0058] At 230, the UE 104 performs the transmission of the sidelink data on at least one resource in the selected resource pool.

[0059] With the method 200, the selected resource pool for grant creation can fulfill a HARQ attribute condition of a sidelink logical channel where sidelink data is available if the sidelink logical channel requests HARQ feedback.

[0060] In some implementations, the UE 104 may select one of the at least one resource pool during selecting the at least one carrier. In such implementations, the UE 104 may determine a first CBR of a first carrier based on a CBR of a first resource pool among at least one resource pool configured on the first carrier. If the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel, the UE 104 may select the first carrier and the first resource pool. This will be described with reference to Fig. 3.

[0061] Fig. 3 illustrates a flowchart of a method 300 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The method 300 may be considered as an example implementation of the method 200 in Fig. 2. For the purpose of discussion, the method 300 will be described from the perspective of the UE 104 with reference to Fig. 1.

[0062] As shown in Fig. 3, at 310, the UE 104 may trigger a transmission (TX) carrier selection or re-selection procedure.

[0063] In some implementations, when the UE 104 is configured with sidelink resource allocation mode 2 to transmit or sidelink resource allocation scheme 2 using

pool(s) of resources in multiple carriers, if a MAC entity of the UE 104 has selected to create a selected sidelink grant corresponding to transmissions of one or multiple MAC PDUs, and sidelink data is available in a sidelink logical channel, and if the MAC entity has not selected a pool of resources allowed for the sidelink logical channel, the MAC entity of the UE 104 may trigger the TX carrier selection or re-selection procedure.

[0064] At 320, the UE 104 may determine candidate carriers based on CBRs of the carriers and a configured CBR threshold.

[0065] In some implementations, during the TX carrier selection or re-selection procedure, if there is no selected sidelink grant on any carrier allowed for the sidelink logical channel where sidelink data is available, for each carrier configured by upper layers associated with the concerned sidelink logical channel, the UE 104 will determine candidate carriers based on CBRs of the carriers and a configured CBR threshold.

[0066] In some implementations, in order to determine a CBR of a carrier, the UE 104 may perform resource pool selection.

[0067] Consider a first example. In the first example, the UE 104 is configured with a carrier #1 and a carrier #2. A resource pool #1 and a resource pool #2 are configured with on the carrier #1. A resource pool #3 and a resource pool #4 are configured with on the carrier #2.

[0068] The UE 104 may determine a CBR of the carrier #1 as a CBR of the resource pool #1 or a CBR of the resource pool#2 based on implementation of the UE 104. In other words, which one of the resource pool #1 and the resource pool#2 is used to determine the CBR of the carrier #1 is up to UE implementation. For example, it is assumed that the UE 104 may determine the CBR of the carrier #1 as the CBR of the resource pool #1. Thus, the resource pool #1 is associated with the carrier #1.

[0069] Similarly, the UE 104 may determine a CBR of the carrier #2 as a CBR of the resource pool #3 or a CBR of the resource pool#4 based on implementation of the UE 104. For example, it is assumed that the UE 104 may determine the CBR of the carrier #2 as the CBR of the resource pool #3. Thus, the resource pool #3 is associated with the carrier #2.

[0070] In turn, the UE 104 may compare the CBR of the carrier #1 with a configured CBR threshold. The configured CBR threshold may be represented by *sl-threshCBR*-

FreqReselection. If the CBR of the carrier #1 is below the configured CBR threshold, the UE 104 may determine the carrier #1 as a candidate carrier.

[0071] Similarly, the UE 104 may compare the CBR of the carrier #2 with the configured CBR threshold. If the CBR of the carrier #2 is below the configured CBR threshold, the UE 104 may determine the carrier #2 as a candidate carrier.

[0072] It is assumed that both the CBR of the carrier #1 and the CBR of the carrier #2 are below the configured CBR threshold, and the UE 104 may determine the carrier #1 and the carrier #2 as candidate carriers.

[0073] Then, at 330, the UE 104 may select one or more carriers and the associated one or more resource pools among the candidate carriers for transmission of sidelink data if the associated one or more resource pools fulfill a HARQ attribute condition of a sidelink logical channel where the sidelink data is available. In other words, the UE 104 may select the associated one or more resource pools during selecting the one or more carriers.

[0074] In some implementations, the UE 104 may select one or more carriers among the candidate carriers in an increasing order of CBRs of the candidate carriers from the lowest CBR.

[0075] Consider the first example. If the resource pool #1 fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available, the UE 104 may select the carrier #1 and the resource pool #1 associated with the carrier #1. For example, if HARQ feedback is enabled for the sidelink logical channel and the resource pool #1 is configured with PSFCH resources, the UE 104 may select the carrier #1 and the resource pool #1.

[0076] On the other hand, if the resource pool #1 does fulfill the HARQ attribute condition of the sidelink logical channel where the sidelink data is available, the UE 104 may not select the carrier #1 for the transmission of sidelink data. For example, if HARQ feedback is enabled for the sidelink logical channel and the resource pool #1 is not configured with PSFCH resources, the UE 104 may not select the carrier #1 and the resource pool #1.

[0077] If the resource pool #3 fulfills the HARQ attribute condition of the sidelink logical channel where the sidelink data is available, the UE 104 may select the carrier #2

and the resource pool #3 associated with the carrier #2. On the other hand, if the resource pool #3 does fulfill the HARQ attribute condition of the sidelink logical channel where the sidelink data is available, the UE 104 may not select the carrier #2 for the transmission of sidelink data.

[0078] In some implementations, in order to select one of the at least one resource pool during selecting the at least one carrier, the UE 104 may perform a procedure as shown in Table 1.

Table 1

TX carrier (re-)selection <i><text omitted></i> If the TX carrier (re-)selection is triggered for a Sidelink process according to clause 5.22.1.1, the MAC entity shall: 1> if there is no selected sidelink grant on any carrier allowed for the sidelink logical channel where data is available as indicated by upper layers (TS 38.331 [5] and TS 23.287 [19]): 2> for each carrier configured by upper layers associated with the concerned sidelink logical channel: 3> if the CBR of the carrier is below <i>sl-threshCBR-FreqReselection</i> associated with the priority of the sidelink logical channel: NOTE 1: In the case of multiple resource pools configured on a carrier, which specific resource pool is used to determine the CBR of this carrier is up to UE implementation. 4> consider the carrier as a candidate carrier for TX carrier (re-)selection for the concerned sidelink logical channel when the carrier satisfies all the following conditions; 5> if <i>sl-HARQ-FeedbackEnabled</i> is set to <i>enabled</i> for the sidelink logical channel: 6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in <i>sl-BWP-DiscPoolConfig</i> or <i>sl-BWP-DiscPoolConfigCommon</i>, if configured. 5> else:
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6> the carrier includes any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

1> else:

2> if the CBR of the carrier is below *sl-threshCBR-FreqKeeping* associated with priority of the sidelink logical channel, for each sidelink logical channel, if any, where data is available and that are allowed on the carrier for which Tx carrier (re-)selection is triggered according to clause 5.22.1.1:

3> select the carrier and the associated pool of resources.

2> else:

3> if the CBR of the carrier is below *sl-threshCBR-FreqReselection* associated with the priority of the sidelink logical channel:

4> consider the carrier as a candidate carrier for TX carrier (re-)selection, for each carrier configured by upper layers on which the sidelink logical channel is allowed when the carrier satisfies all the following conditions;

5> if *sl-HARQ-FeedbackEnabled* is set to *enabled* for the sidelink logical channel:

6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

5> else:

6> the carrier includes any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

<text omitted>

The MAC entity shall:

1> if one or more carriers are considered as the candidate carriers for TX carrier (re-)selection:

2> if Tx carrier (re-)selection is triggered, for each sidelink logical channel allowed on the carrier where data is available:

3>select one or more carrier(s) and associated pool(s) of resources when the pool of resources is configured with PSFCH resources if *sl-HARQ-FeedbackEnabled* is set to enabled for the logical channel among the candidate carriers with increasing order of CBR from the lowest CBR.

<text omitted>

[0079] In some implementations, the UE 104 may select one of the at least one resource pool after selecting the at least one carrier. In such implementations, after selecting a second carrier for the transmission of the sidelink data, the UE 104 may determine whether a second resource pool among at least one resource pool configured on the second carrier fulfills the HARQ attribute condition of the sidelink logical channel. If the second resource pool fulfills the HARQ attribute condition of the sidelink logical channel, the UE 104 may select the second resource pool. This will be described with reference to Fig. 4.

[0080] Fig. 4 illustrates a flowchart of a method 400 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The method 400 may be considered as another example implementation of the method 200 in Fig. 2. For the purpose of discussion, the method 400 will be described from the perspective of the UE 104 with reference to Fig. 1.

[0081] As shown in Fig. 4, at 410, the UE 104 may trigger a TX carrier selection or re-selection procedure.

[0082] In some implementations, when the UE 104 is configured with sidelink resource allocation mode 2 to transmit or sidelink resource allocation scheme 2 using pool(s) of resources in multiple carriers, if a MAC entity of the UE 104 has selected to create a selected sidelink grant corresponding to transmissions of one or multiple MAC PDUs, and sidelink data is available in a sidelink logical channel, and if the MAC entity has not selected a pool of resources allowed for the sidelink logical channel, the MAC entity of the UE 104 may trigger the TX carrier selection or re-selection procedure.

[0083] At 420, the UE 104 may determine candidate carriers based on CBRs of the carriers and a configured CBR threshold.

[0084] In some implementations, during the TX carrier selection or re-selection procedure, if there is no selected sidelink grant on any carrier allowed for the sidelink

logical channel where sidelink data is available, for each carrier configured by upper layers associated with the concerned sidelink logical channel, the UE 104 will determine candidate carriers based on CBRs of the carriers and a configured CBR threshold.

[0085] In some implementations, in order to determine a CBR of a carrier, the UE 104 may perform resource pool selection.

[0086] Consider a second example. In the second example, the UE 104 is configured with a carrier #1 and a carrier #2. A resource pool #1 and a resource pool #2 are configured with on the carrier #1. A resource pool #3 and a resource pool #4 are configured with on the carrier #2.

[0087] The UE 104 may determine a CBR of the carrier #1 as a CBR of the resource pool #1 or a CBR of the resource pool#2 based on implementation of the UE 104. In other words, which one of the resource pool #1 and the resource pool#2 is used to determine the CBR of the carrier #1 is up to UE implementation. For example, it is assumed that the UE 104 may determine the CBR of the carrier #1 as the CBR of the resource pool #1. Thus, the resource pool #1 is associated with the carrier #1.

[0088] Similarly, the UE 104 may determine a CBR of the carrier #2 as a CBR of the resource pool #3 or a CBR of the resource pool#4 based on implementation of the UE 104. For example, it is assumed that the UE 104 may determine the CBR of the carrier #2 as the CBR of the resource pool #3. Thus, the resource pool #3 is associated with the carrier #2.

[0089] In turn, the UE 104 may compare the CBR of the carrier #1 with a configured CBR threshold. The configured CBR threshold may be represented by *sl-threshCBR-FreqReselection*. If the CBR of the carrier #1 is below the configured CBR threshold, the UE 104 may determine the carrier #1 as a candidate carrier.

[0090] Similarly, the UE 104 may compare the CBR of the carrier #2 with the configured CBR threshold. If the CBR of the carrier #2 is below the configured CBR threshold, the UE 104 may determine the carrier #2 as a candidate carrier.

[0091] It is assumed that both the CBR of the carrier #1 and the CBR of the carrier #2 are below the configured CBR threshold, and the UE 104 may determine the carrier #1 and the carrier #2 as candidate carriers.

[0092] Then, at 430, the UE 104 may select one or more carriers among the candidate carriers for transmission of sidelink data.

[0093] In some implementations, the UE 104 may select one or more carriers among the candidate carriers in an increasing order of CBRs of the candidate carriers from the lowest CBR.

[0094] Subsequently, the UE 104 may determine, at 440, whether a second resource pool among at least one resource pool configured on the second carrier fulfills the HARQ attribute condition of the sidelink logical channel.

[0095] If the second resource pool fulfills the HARQ attribute condition of the sidelink logical channel, the UE 104 may select the second resource pool at 450.

[0096] Consider the second example. For the carrier #1, the UE 104 determines whether the resource pool#1 fulfills the HARQ attribute condition of the sidelink logical channel. For example, if HARQ feedback is enabled for the sidelink logical channel, the UE 104 determines whether the resource pool #1 is configured with PSFCH resources. If the resource pool #1 is configured with PSFCH resources, the UE 104 determines that the resource pool#1 fulfills the HARQ attribute condition of the sidelink logical channel. Otherwise, the UE 104 determines that the resource pool#1 does not fulfill the HARQ attribute condition of the sidelink logical channel.

[0097] If the resource pool#1 fulfills the HARQ attribute condition of the sidelink logical channel, the UE 104 selects the resource pool#1. If the resource pool#1 does not fulfill the HARQ attribute condition of the sidelink logical channel, the UE 104 may further determine whether the resource pool #2 is configured with PSFCH resources.

[0098] It is assumed that the resource pool#1 does not fulfill the HARQ attribute condition of the sidelink logical channel while the resource pool#2 fulfills the HARQ attribute condition of the sidelink logical channel. Thus, the UE 104 selects the resource pool#2.

[0099] For the carrier #2, the UE 104 may select one of the the resource pool#3 and the resource pool#4 which fulfills the HARQ attribute condition of the sidelink logical channel.

[0100] It shall be noted that in the second example, although the resource pool#1 is

used to determine the CBR of the carrier #1, the UE 104 does not select the resource pool#1 because the resource pool#1 does not fulfill the HARQ attribute condition of the sidelink logical channel. Instead, the UE 104 selects the resource pool#2 for transmission of the sidelink data because the resource pool#2 fulfills the HARQ attribute condition of the sidelink logical channel. In this way, the selected resource pool for grant creation can fulfill the HARQ attribute condition of the sidelink logical channel where sidelink data is available if the sidelink logical channel requests HARQ feedback.

[0101] In some implementations, in order to select one of the at least one resource pool after selecting the at least one carrier, the UE 104 may perform a procedure as shown in Table 2.

Table 2

TX carrier (re-)selection <i><text omitted></i> If the TX carrier (re-)selection is triggered for a Sidelink process according to clause 5.22.1.1, the MAC entity shall: 1> if there is no selected sidelink grant on any carrier allowed for the sidelink logical channel where data is available as indicated by upper layers (TS 38.331 [5] and TS 23.287 [19]): 2> for each carrier configured by upper layers associated with the concerned sidelink logical channel: 3> if the CBR of the carrier is below <i>sl-threshCBR-FreqReselection</i> associated with the priority of the sidelink logical channel: NOTE 1: In the case of multiple resource pools configured on a carrier, which specific resource pool is used to determine the CBR of this carrier is up to UE implementation. 4> consider the carrier as a candidate carrier for TX carrier (re-)selection for the concerned sidelink logical channel when the carrier satisfies all the following conditions; 5> if <i>sl-HARQ-FeedbackEnabled</i> is set to <i>enabled</i> for the sidelink logical channel: 6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the

pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

5> else:

6> the carrier includes any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

1> else:

2> if the CBR of the carrier is below *sl-threshCBR-FreqKeeping* associated with priority of the sidelink logical channel, for each sidelink logical channel, if any, where data is available and that are allowed on the carrier for which Tx carrier (re-)selection is triggered according to clause 5.22.1.1:

3> select the carrier and the associated pool of resources.

2> else:

3> if the CBR of the carrier is below *sl-threshCBR-FreqReselection* associated with the priority of the sidelink logical channel:

4> consider the carrier as a candidate carrier for TX carrier (re-)selection, for each carrier configured by upper layers on which the sidelink logical channel is allowed when the carrier satisfies all the following conditions;

5> if *sl-HARQ-FeedbackEnabled* is set to *enabled* for the sidelink logical channel:

6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

5> else:

6> the carrier includes any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

The MAC entity shall:

1> if one or more carriers are considered as the candidate carriers for TX carrier (re-)selection:

2> if Tx carrier (re-)selection is triggered, for each sidelink logical channel allowed on the carrier where data is available:

3> select one or more carrier(s) among the candidate carriers with increasing order of CBR from the lowest CBR. And select pool(s) of resources for each selected carrier when pool(s) of resources satisfies the following conditions:

4> if *sl-HARQ-FeedbackEnabled* is set to *enabled* for the concerned logical channel:

5> select any pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

4> else:

5> select any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

<text omitted>

[0102] Fig. 5 illustrates a flowchart of a method 500 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The method 500 can be implemented at a UE, such as the UE 104-1 or 104-2 as shown in Fig. 1. Hereinafter, the UE 104-1 and the UE 104-2 may be collectively referred to as the UE 104. For the purpose of discussion, the method 500 will be described from the perspective of the UE 104 with reference to Fig. 1.

[0103] As shown in Fig. 5, at 510, the UE 104 determines at least one resource pool configured on a first carrier fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available.

[0104] At 520, the UE 104 selects a first resource pool from the determined at least one resource pool.

[0105] At 530, the UE 104 determines a first CBR of the first carrier based on a CBR of the first resource pool.

[0106] In turn, the UE 104 determines whether the first CBR of the first carrier is

below a threshold at 540.

[0107] If the first CBR of the first carrier is below the threshold, the UE 104 determines, at 550, the first carrier as a candidate carrier for transmission of sidelink data.

[0108] Consider a third example. In the third example, the UE 104 is configured with a carrier #1 and a carrier #2. A resource pool #1 and a resource pool #2 are configured with on the carrier #1. A resource pool #3 and a resource pool #4 are configured with on the carrier #2.

[0109] The UE 104 may determine the resource pool #1 fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available while the resource pool #2 does not fulfil the HARQ attribute condition. Thus, the UE 104 may select the resource pool #1 for the carrier #1. In turn, the UE 104 may determine a CBR of the carrier #1 based on a CBR of the resource pool #1.

[0110] For the carrier #2, the UE 104 may determine the resource pool #3 and the resource pool #4 fulfill the HARQ attribute condition of the sidelink logical channel. Thus, the UE 104 may select one of the resource pool #3 and the resource pool #4. For example, the UE 104 may select the resource pool #3. In turn, the UE 104 may determine a CBR of the carrier #2 based on a CBR of the resource pool #3.

[0111] In some implementations, when the UE 104 is configured with sidelink resource allocation mode 2 to transmit or sidelink resource allocation scheme 2 using pool(s) of resources in multiple carriers, if a MAC entity of the UE 104 has selected to create a selected sidelink grant corresponding to transmissions of one or multiple MAC PDUs, and sidelink data is available in a sidelink logical channel, and if the MAC entity has not selected a pool of resources allowed for the sidelink logical channel, the MAC entity of the UE 104 may trigger the TX carrier selection or re-selection procedure. During the TX carrier selection or re-selection procedure, the UE 104 may perform the method 500.

[0112] With the method 500, the UE 104 may select a resource pool which fulfills the HARQ attribute condition of a sidelink logical channel. Then, the UE 104 may use the selected resource pool to determine a CBR of the first carrier. In this way, during selecting the first carrier for transmission of the sidelink data, the UE 104 may select the first carrier and the associated resource pool (i.e., the first resource pool), and the associated resource

pool fulfills the HARQ attribute condition of a sidelink logical channel.

[0113] In some implementations, in order to select one of the at least one resource pool for determination of a CBR of the first carrier, the UE 104 may perform a procedure as shown in Table 3.

Table 3

TX carrier (re-)selection <text omitted> If the TX carrier (re-)selection is triggered for a Sidelink process according to clause 5.22.1.1, the MAC entity shall: 1> if there is no selected sidelink grant on any carrier allowed for the sidelink logical channel where data is available as indicated by upper layers (TS 38.331 [5] and TS 23.287 [19]): 2> for each carrier configured by upper layers associated with the concerned sidelink logical channel: 3> if the CBR of the carrier is below <i>sl-threshCBR-FreqReselection</i> associated with the priority of the sidelink logical channel: NOTE 1: <u>Select pool of resources used to determine the CBR of this carrier among those pools of resources which are configured with PSFCH resource if <i>sl-HARQ-FeedbackEnabled</i> is set to <i>enabled</i> for the concerned logical channel.</u> In the case of multiple resource pools <u>are selected</u>, which specific resource pool is used to determine the CBR of this carrier is up to UE implementation. 4> consider the carrier as a candidate carrier for TX carrier (re-)selection, for each carrier configured by upper layers on which the sidelink logical channel is allowed when the carrier satisfies all the following conditions; 5> if <i>sl-HARQ-FeedbackEnabled</i> is set to <i>enabled</i> for the sidelink logical channel: 6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in <i>sl-BWP-DiscPoolConfig</i> or <i>sl-BWP-DiscPoolConfigCommon</i>, if configured.
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5> else: 6> the carrier includes any pool of resources among the pools of resources except the pool(s) in <i>sl-BWP-DiscPoolConfig</i> or <i>sl-BWP-DiscPoolConfigCommon</i>, if configured. The MAC entity shall: 1> if one or more carriers are considered as the candidate carriers for TX carrier (re-)selection: 2> if Tx carrier (re-)selection is triggered, for each sidelink logical channel allowed on the carrier where data is available: 3> select one or more carrier(s) and associated pool(s) of resources among the candidate carriers with increasing order of CBR from the lowest CBR. <text omitted>
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[0114] Alternatively, in some implementations, in order to select one of the at least one resource pool for determination of a CBR of the first carrier, the UE 104 may perform a procedure as shown in Table 4.

Table 4

TX carrier (re-)selection <text omitted> If the TX carrier (re-)selection is triggered for a Sidelink process according to clause 5.22.1.1, the MAC entity shall: 1> if there is no selected sidelink grant on any carrier allowed for the sidelink logical channel where data is available as indicated by upper layers (TS 38.331 [5] and TS 23.287 [19]): 2> for each carrier configured by upper layers associated with the concerned sidelink logical channel: 3> if the CBR of the carrier is below <i>sl-threshCBR-FreqReselection</i> associated with the priority of the sidelink logical channel: 4> <u>select one or more pool(s) of resources used to determine the CBR of this carrier when the resource pool satisfies the following conditions:</u> 5> <u>if <i>sl-HARQ-FeedbackEnabled</i> is set to <i>enabled</i> for the concerned logical channel:</u>

6> select any pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

5> else:

5> select any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

NOTE 1: In the case of multiple resource pools are selected, which specific resource pool is used to determine the CBR of this carrier is up to UE implementation.

4> consider the carrier as a candidate carrier for TX carrier (re-)selection, for each carrier configured by upper layers on which the sidelink logical channel is allowed when the carrier satisfies all the following conditions;

5> if *sl-HARQ-FeedbackEnabled* is set to *enabled* for the sidelink logical channel:

6> the carrier includes at least one pool of resources configured with PSFCH resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

5> else:

6> the carrier includes any pool of resources among the pools of resources except the pool(s) in *sl-BWP-DiscPoolConfig* or *sl-BWP-DiscPoolConfigCommon*, if configured.

The MAC entity shall:

1> if one or more carriers are considered as the candidate carriers for TX carrier (re-)selection:

2> if Tx carrier (re-)selection is triggered, for each sidelink logical channel allowed on the carrier where data is available:

3> select one or more carrier(s) and associated pool(s) of resources among the candidate carriers with increasing order of CBR from the lowest CBR.

<text omitted>

[0115] Fig. 6 illustrates an example of a device 600 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects of the present disclosure. The device 600 may be an example of a network entity 102 or a UE 104 as described herein. The device 600 may support wireless communication with one or more network entities 102, UEs 104, 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 6014. These components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0116] 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 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.

[0117] 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 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 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).

[0118] 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 performing the following: selecting at least

one carrier for transmission of sidelink data; during or after selecting the at least one carrier, selecting one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available; and performing the transmission of the sidelink data on at least one resource in the selected resource pool.

[0119] Alternatively, in some implementations, the processor 602 may be configured to operable to support a means for performing the following: based on determining that a first resource pool among at least one resource pool configured on a first carrier fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available, selecting the first resource pool; determining a first CBR of the first carrier based on a CBR of the first resource pool; and based on determining that the first CBR of the first carrier is below a threshold, determining the first carrier as a candidate carrier for transmission of sidelink data.

[0120] 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 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 stored in a memory (e.g., the memory 604) to cause the device 600 to perform various functions of the present disclosure.

[0121] 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 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 system (BIOS) which may control basic hardware or software operation such as the interaction with peripheral components or devices.

[0122] The I/O controller 6014 may manage input and output signals for the device 600. The I/O controller 6014 may also manage peripherals not integrated into the device 600. In some implementations, the I/O controller 6014 may represent a physical connection or port to an external peripheral. In some implementations, the I/O controller 6014 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 6014 may be implemented as part of a processor, such as the processor 602. In some implementations, a user may interact with the device 600 via the I/O controller 6014 or via hardware components controlled by the I/O controller 6014.

[0123] 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.

[0124] 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.

[0125] 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 the transmitted data.

[0126] Fig. 7 illustrates an example of a processor 700 that supports resource pool selection for sidelink multi-carrier cases in accordance with aspects 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 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) 706. One or more of these components may be in electronic communication or otherwise coupled (e.g., operatively, communicatively, functionally, electronically, electrically) via one or more interfaces (e.g., buses).

[0127] 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. 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 (PCM), and others).

[0128] 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 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.

[0129] 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.

[0130] 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 implementation, 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).

[0131] 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.

[0132] The one or more ALUs 706 may be configured to support various operations in accordance with examples as described herein. In some implementation, the one or more ALUs 706 may reside within or on a processor chipset (e.g., the processor 700). In some other implementations, the one or more ALUs 706 may reside external to the processor chipset (e.g., the processor 700). One or more ALUs 706 may perform one or more computations such as addition, subtraction, multiplication, and division on data. For example, one or more ALUs 706 may receive input operands and an operation code, which determines an operation to be executed. One or more ALUs 706 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 706 may support logical operations such as AND, OR, exclusive-OR (XOR), not-OR (NOR), and not-AND (NAND), enabling the one or more ALUs 706 to handle conditional operations, comparisons, and bitwise operations.

[0133] The processor 700 may support wireless communication in accordance with examples as disclosed herein. The processor 700 may be configured to operable to support a means for performing the following: selecting at least one carrier for transmission of sidelink data; during or after selecting the at least one carrier, selecting one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a HARQ attribute condition of a sidelink logical channel where the sidelink data is available; and performing the transmission of the sidelink data on at least one resource in the selected resource pool.

[0134] Alternatively, in some implementations, the processor 700 may be configured to operable to support a means for performing the following: based on determining that a first resource pool among at least one resource pool configured on a first carrier fulfills a HARQ attribute condition of a sidelink logical channel where sidelink data is available,

selecting the first resource pool; determining a first CBR of the first carrier based on a CBR of the first resource pool; and based on determining that the first CBR of the first carrier is below a threshold, determining the first carrier as a candidate carrier for transmission of sidelink data.

[0135] 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.

[0136] The various illustrative blocks and components described in connection with the disclosure herein may be implemented or performed with a general-purpose processor, a DSP, an ASIC, a CPU, an FPGA or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but in the alternative, the processor may be any processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices (e.g., a combination of a DSP and a microprocessor, multiple microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration.

[0137] 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.

[0138] 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.

[0139] As used herein, including in the claims, an article “a” before an element is unrestricted and understood to refer to “at least one” of those elements or “one or more” of those elements. The terms “a,” “at least one,” “one or more,” and “at least one of one or more” may be interchangeable. As used herein, including in the claims, “or” as used in a list of items (e.g., a list of items prefaced by a phrase such as “at least one of” or “one or more of” or “one or both of”) indicates an inclusive list such that, for example, a list of at least one of A, B, or C means A or B or C or AB or AC or BC or ABC (i.e., A and B and C). Also, as used herein, the phrase “based on” shall not be construed as a reference to a closed set of conditions. For example, an example step that is described as “based on condition A” may be based on both a condition A and a condition B without departing from the scope of the present disclosure. In other words, as used herein, the phrase “based on” shall be construed in the same manner as the phrase “based at least in part on. Further, as used herein, including in the claims, a “set” may include one or more elements.

[0140] The description herein is provided to enable a person having ordinary skill in the art to make or use the disclosure. Various modifications to the disclosure will be apparent to a person having ordinary skill in the art, and the generic principles defined herein may be applied to other variations without departing from the scope of the disclosure. Thus, the disclosure is not limited to the examples and designs described herein but is to be accorded the broadest scope consistent with the principles and novel features disclosed herein.

WHAT IS CLAIMED IS:

1. A user equipment (UE), comprising:
a processor; and
a transceiver coupled to the processor,
wherein the processor is configured to:
select at least one carrier for transmission of sidelink data;
during or after selecting the at least one carrier, select one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where the sidelink data is available; and
perform the transmission of the sidelink data on at least one resource in the selected resource pool.
2. The UE of claim 1, wherein the processor is further configured to:
determine a first channel busy ratio (CBR) of a first carrier based on a CBR of a first resource pool among at least one resource pool configured on the first carrier; and
wherein the processor is configured to select one of the at least one resource pool during selecting the at least one carrier by:
based on determining that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel, selecting the first carrier and the first resource pool.
3. The UE of claim 1, wherein the processor is configured to select one of the at least one resource pool after selecting the at least one carrier by:
after selecting a second carrier for the transmission of the sidelink data, determining whether a second resource pool among at least one resource pool configured on the second carrier fulfills the HARQ attribute condition of the sidelink logical channel; and
based on determining that the second resource pool fulfills the HARQ attribute condition of the sidelink logical channel, selecting the second resource pool.
4. The UE of claim 1, wherein the processor is further configured to:

based on determining that HARQ feedback is enabled for the sidelink logical channel and the selected resource pool is configured with physical sidelink feedback channel (PSFCH) resources, determine that the selected resource pool fulfills the HARQ attribute condition of the sidelink logical channel.

5. A user equipment (UE), comprising:

a processor; and

a transceiver coupled to the processor,

wherein the processor is configured to:

determine at least one resource pool configured on a first carrier fulfills a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where sidelink data is available;

determine a first channel busy ratio (CBR) of a first carrier based on a CBR of the first resource pool selected from the determined at least one resource pool; and

based on determining that the first CBR of the first carrier is below a threshold, determine the first carrier as a candidate carrier for transmission of sidelink data.

6. The UE of claim 5, wherein the processor is configured to determine that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel by:

based on determining that HARQ feedback is enabled for the sidelink logical channel and the first resource pool is configured with physical sidelink feedback channel (PSFCH) resources, determining that the first resource pool fulfills the HARQ attribute condition of the sidelink logical channel.

7. A processor for wireless communication, comprising:

at least one memory; and

a controller coupled with the at least one memory and configured to cause the controller to:

select at least one carrier for transmission of sidelink data;

during or after selecting the at least one carrier, select one of at least one resource pool configured on each of the at least one carrier, wherein the selected resource pool fulfills a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where the sidelink data is available; and

perform the transmission of the sidelink data on at least one resource in the selected resource pool.

8. A processor for wireless communication, comprising:

at least one memory; and

a controller coupled with the at least one memory and configured to cause the controller to:

determine at least one resource pool configured on a first carrier fulfills a Hybrid Automatic Repeat Request (HARQ) attribute condition of a sidelink logical channel where sidelink data is available;

determine a first channel busy ratio (CBR) of a first carrier based on a CBR of the first resource pool selected from the determined at least one resource pool; and

based on determining that the first CBR of the first carrier is below a threshold, determine the first carrier as a candidate carrier for transmission of sidelink data.