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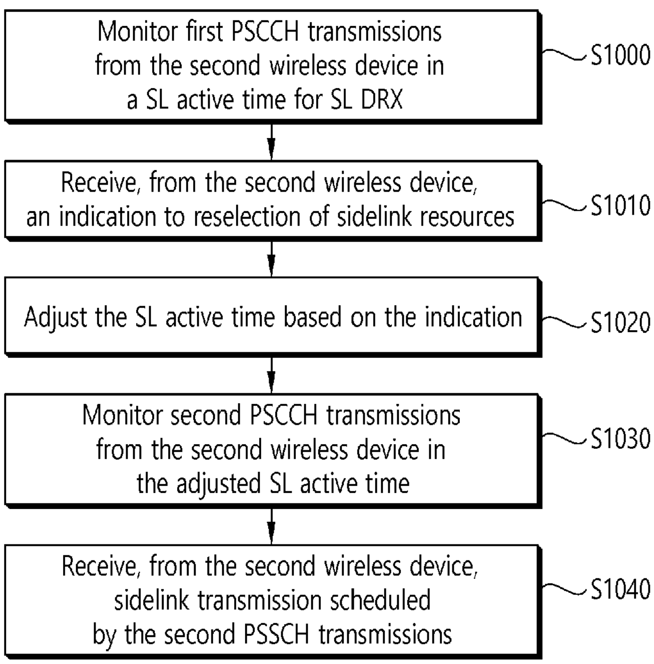
(54) Title: SIDELINK DRX OPERATION BASED ON RESOURCE ALLOCATION



(57) Abstract: A method and apparatus for Sidelink (SL) Discontinuous Reception (DRX) operation based on resource allocation is provided. A first wireless device, e.g., receiving user equipment (RX UE), monitors first Physical Sidelink Control Channel (PSCCH) transmissions from a second wireless device, e.g., transmitting UE (TX UE), in a Sidelink (SL) active time for SL Discontinuous Reception (DRX). The first wireless device receives, from the second wireless device, an indication to reselection of sidelink resources, and adjusts the SL active time based on the indication. The first wireless device monitors second PSCCH transmissions from the second wireless device in the adjusted SL active time.

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Description

Title of Invention: SIDELINK DRX OPERATION BASED ON RESOURCE ALLOCATION

Technical Field

[1] The present disclosure relates to Sidelink (SL) Discontinuous Reception (DRX) operation based on resource allocation.

Background Art

[2] 3rd Generation Partnership Project (3GPP) Long-Term Evolution (LTE) is a technology for enabling high-speed packet communications. Many schemes have been proposed for the LTE objective including those that aim to reduce user and provider costs, improve service quality, and expand and improve coverage and system capacity. The 3GPP LTE requires reduced cost per bit, increased service availability, flexible use of a frequency band, a simple structure, an open interface, and adequate power consumption of a terminal as an upper-level requirement.

[3] Work has started in International Telecommunication Union (ITU) and 3GPP to develop requirements and specifications for New Radio (NR) systems. 3GPP has to identify and develop the technology components needed for successfully standardizing the new RAT timely satisfying both the urgent market needs, and the more long-term requirements set forth by the ITU Radio communication sector (ITU-R) International Mobile Telecommunications (IMT)-2020 process. Further, the NR should be able to use any spectrum band ranging at least up to 100 GHz that may be made available for wireless communications even in a more distant future.

[4] The NR targets a single technical framework addressing all usage scenarios, requirements and deployment scenarios including enhanced Mobile BroadBand (eMBB), massive Machine Type Communications (mMTC), Ultra-Reliable and Low Latency Communications (URLLC), etc. The NR shall be inherently forward compatible.

[5] Vehicle-to-everything (V2X) communication is the passing of information from a vehicle to any entity that may affect the vehicle, and vice versa. It is a vehicular communication system that incorporates other more specific types of communication as Vehicle-to-Infrastructure (V2I), Vehicle-to-Network (V2N), Vehicle-to-Vehicle (V2V), Vehicle-to-Pedestrian (V2P), Vehicle-to-Device (V2D) and Vehicle-to-Grid (V2G).

Disclosure of Invention

Technical Problem

[6] The present disclosure provides a method and apparatus for adjusting sidelink (SL) Discontinuous Reception (DRX) operation based on resource allocation and/or

resource reselection.

Solution to Problem

[7] In an aspect, a method performed by a first wireless device operating in a wireless communication system is provided. The method includes monitoring first Physical Sidelink Control Channel (PSCCH) transmissions from the second wireless device in a Sidelink (SL) active time for SL Discontinuous Reception (DRX), receiving, from the second wireless device, an indication to reselection of sidelink resources, adjusting the SL active time based on the indication, and monitoring second PSCCH transmissions from the second wireless device in the adjusted SL active time.

[8] In another aspect, a method performed by a second wireless device operating in a wireless communication system is provided. The method includes transmitting, to a first wireless device, first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous Reception (DRX), transmitting, to the first wireless device, an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication, and transmitting, to the first wireless device, second PSCCH transmissions in the adjusted SL active time.

[9] In another aspect, apparatuses for implementing the above methods are provided.

Advantageous Effects of Invention

[10] The present disclosure can have various advantageous effects.

[11] For example, the SL active time can be adjusted or increased or decreased according to the SL resource selection or reselection of the other UE to prevent unnecessary SL reception and missed SL transmission.

[12] For example, UE performing transmission or reception on a pool of resources can save UE power, in particular when UE determines whether to monitor sidelink transmission on the pool of resources based on allocated resources.

[13] For example, the system can properly provide power-efficient sidelink reception based on allocated resources.

[14] Advantageous effects which can be obtained through specific embodiments of the present disclosure are not limited to the advantageous effects listed above. For example, there may be a variety of technical effects that a person having ordinary skill in the related art can understand and/or derive from the present disclosure. Accordingly, the specific effects of the present disclosure are not limited to those explicitly described herein, but may include various effects that may be understood or derived from the technical features of the present disclosure.

Brief Description of Drawings

[15] FIG. 1 shows an example of a communication system to which implementations of the present disclosure is applied.

[16] FIG. 2 shows an example of wireless devices to which implementations of the present disclosure is applied.

[17] FIG. 3 shows an example of a wireless device to which implementations of the present disclosure is applied.

[18] FIG. 4 shows an example of UE to which implementations of the present disclosure is applied.

[19] FIGs. 5 and 6 show an example of protocol stacks in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.

[20] FIG. 7 shows a frame structure in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.

[21] FIG. 8 shows a data flow example in the 3GPP NR system to which implementations of the present disclosure is applied.

[22] FIG. 9 shows an example of NG-RAN architecture supporting PC5 interface to which implementations of the present disclosure is applied.

[23] FIG. 10 shows an example of a method performed by a first wireless device to which implementation of the present disclosure is applied.

[24] FIG. 11 shows an example of a method performed by a second wireless device to which implementation of the present disclosure is applied.

[25] FIGS. 12 and 13 shows an example of sidelink transmission and sidelink reception to which implementation of the present disclosure is applied.

Mode for the Invention

[26] The following techniques, apparatuses, and systems may be applied to a variety of wireless multiple access systems. Examples of the multiple access systems include a Code Division Multiple Access (CDMA) system, a Frequency Division Multiple Access (FDMA) system, a Time Division Multiple Access (TDMA) system, an Orthogonal Frequency Division Multiple Access (OFDMA) system, a Single Carrier Frequency Division Multiple Access (SC-FDMA) system, and a Multi Carrier Frequency Division Multiple Access (MC-FDMA) system. CDMA may be embodied through radio technology such as Universal Terrestrial Radio Access (UTRA) or CDMA2000. TDMA may be embodied through radio technology such as Global System for Mobile communications (GSM), General Packet Radio Service (GPRS), or Enhanced Data rates for GSM Evolution (EDGE). OFDMA may be embodied through radio technology such as Institute of Electrical and Electronics Engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, or Evolved UTRA (E-UTRA). UTRA is a part of a Universal Mobile Telecommunications System (UMTS). 3rd Generation Partnership Project (3GPP) Long-Term Evolution (LTE) is a part of Evolved UMTS (E-UMTS) using E-UTRA. 3GPP LTE employs OFDMA in downlink

(DL) and SC-FDMA in uplink (UL). Evolution of 3GPP LTE includes LTE-Advanced (LTE-A), LTE-A Pro, and/or 5G New Radio (NR).

[27] For convenience of description, implementations of the present disclosure are mainly described in regards to a 3GPP based wireless communication system. However, the technical features of the present disclosure are not limited thereto. For example, although the following detailed description is given based on a mobile communication system corresponding to a 3GPP based wireless communication system, aspects of the present disclosure that are not limited to 3GPP based wireless communication system are applicable to other mobile communication systems.

[28] For terms and technologies which are not specifically described among the terms of and technologies employed in the present disclosure, the wireless communication standard documents published before the present disclosure may be referenced.

[29] In the present disclosure, "A or B" may mean "only A", "only B", or "both A and B". In other words, "A or B" in the present disclosure may be interpreted as "A and/or B". For example, "A, B or C" in the present disclosure may mean "only A", "only B", "only C", or "any combination of A, B and C".

[30] In the present disclosure, slash (/) or comma (,) may mean "and/or". For example, "A/B" may mean "A and/or B". Accordingly, "A/B" may mean "only A", "only B", or "both A and B". For example, "A, B, C" may mean "A, B or C".

[31] In the present disclosure, "at least one of A and B" may mean "only A", "only B" or "both A and B". In addition, the expression "at least one of A or B" or "at least one of A and/or B" in the present disclosure may be interpreted as same as "at least one of A and B".

[32] In addition, in the present disclosure, "at least one of A, B and C" may mean "only A", "only B", "only C", or "any combination of A, B and C". In addition, "at least one of A, B or C" or "at least one of A, B and/or C" may mean "at least one of A, B and C".

[33] Also, parentheses used in the present disclosure may mean "for example". In detail, when it is shown as "control information (PDCCH)", "PDCCH" may be proposed as an example of "control information". In other words, "control information" in the present disclosure is not limited to "PDCCH", and "PDDCH" may be proposed as an example of "control information". In addition, even when shown as "control information (i.e., PDCCH)", "PDCCH" may be proposed as an example of "control information".

[34] Technical features that are separately described in one drawing in the present disclosure may be implemented separately or simultaneously.

[35] Although not limited thereto, various descriptions, functions, procedures, suggestions, methods and/or operational flowcharts of the present disclosure disclosed herein can be applied to various fields requiring wireless communication and/or

connection (e.g., 5G) between devices.

[36] Hereinafter, the present disclosure will be described in more detail with reference to drawings. The same reference numerals in the following drawings and/or descriptions may refer to the same and/or corresponding hardware blocks, software blocks, and/or functional blocks unless otherwise indicated.

[37] FIG. 1 shows an example of a communication system to which implementations of the present disclosure is applied.

[38] The 5G usage scenarios shown in FIG. 1 are only exemplary, and the technical features of the present disclosure can be applied to other 5G usage scenarios which are not shown in FIG. 1.

[39] Three main requirement categories for 5G include (1) a category of enhanced Mobile BroadBand (eMBB), (2) a category of massive Machine Type Communication (mMTC), and (3) a category of Ultra-Reliable and Low Latency Communications (URLLC).

[40] Referring to FIG. 1, the communication system 1 includes wireless devices 100a to 100f, Base Stations (BSs) 200, and a network 300. Although FIG. 1 illustrates a 5G network as an example of the network of the communication system 1, the implementations of the present disclosure are not limited to the 5G system, and can be applied to the future communication system beyond the 5G system.

[41] The BSs 200 and the network 300 may be implemented as wireless devices and a specific wireless device may operate as a BS/network node with respect to other wireless devices.

[42] The wireless devices 100a to 100f represent devices performing communication using Radio Access Technology (RAT) (e.g., 5G NR or LTE) and may be referred to as communication/radio/5G devices. The wireless devices 100a to 100f may include, without being limited to, a robot 100a, vehicles 100b-1 and 100b-2, an eXtended Reality (XR) device 100c, a hand-held device 100d, a home appliance 100e, an Internet-of-Things (IoT) device 100f, and an Artificial Intelligence (AI) device/server 400. For example, the vehicles may include a vehicle having a wireless communication function, an autonomous driving vehicle, and a vehicle capable of performing communication between vehicles. The vehicles may include an Unmanned Aerial Vehicle (UAV) (e.g., a drone). The XR device may include an Augmented Reality (AR)/Virtual Reality (VR)/Mixed Reality (MR) device and may be implemented in the form of a Head-Mounted Device (HMD), a Head-Up Display (HUD) mounted in a vehicle, a television, a smartphone, a computer, a wearable device, a home appliance device, a digital signage, a vehicle, a robot, etc. The hand-held device may include a smartphone, a smartpad, a wearable device (e.g., a smartwatch or a smartglasses), and a computer (e.g., a notebook). The home appliance may include a TV, a refrigerator,

and a washing machine. The IoT device may include a sensor and a smartmeter.

[43] In the present disclosure, the wireless devices 100a to 100f may be called User Equipments (UEs). A UE may include, for example, a cellular phone, a smartphone, a laptop computer, a digital broadcast terminal, a Personal Digital Assistant (PDA), a Portable Multimedia Player (PMP), a navigation system, a slate Personal Computer (PC), a tablet PC, an ultrabook, a vehicle, a vehicle having an autonomous traveling function, a connected car, an UAV, an AI module, a robot, an AR device, a VR device, an MR device, a hologram device, a public safety device, an MTC device, an IoT device, a medical device, a FinTech device (or a financial device), a security device, a weather/environment device, a device related to a 5G service, or a device related to a fourth industrial revolution field.

[44] The UAV may be, for example, an aircraft aviated by a wireless control signal without a human being onboard.

[45] The VR device may include, for example, a device for implementing an object or a background of the virtual world. The AR device may include, for example, a device implemented by connecting an object or a background of the virtual world to an object or a background of the real world. The MR device may include, for example, a device implemented by merging an object or a background of the virtual world into an object or a background of the real world. The hologram device may include, for example, a device for implementing a stereoscopic image of 360 degrees by recording and reproducing stereoscopic information, using an interference phenomenon of light generated when two laser lights called holography meet.

[46] The public safety device may include, for example, an image relay device or an image device that is wearable on the body of a user.

[47] The MTC device and the IoT device may be, for example, devices that do not require direct human intervention or manipulation. For example, the MTC device and the IoT device may include smartmeters, vending machines, thermometers, smartbulbs, door locks, or various sensors.

[48] The medical device may be, for example, a device used for the purpose of diagnosing, treating, relieving, curing, or preventing disease. For example, the medical device may be a device used for the purpose of diagnosing, treating, relieving, or correcting injury or impairment. For example, the medical device may be a device used for the purpose of inspecting, replacing, or modifying a structure or a function. For example, the medical device may be a device used for the purpose of adjusting pregnancy. For example, the medical device may include a device for treatment, a device for operation, a device for (in vitro) diagnosis, a hearing aid, or a device for procedure.

[49] The security device may be, for example, a device installed to prevent a danger that

may arise and to maintain safety. For example, the security device may be a camera, a Closed-Circuit TV (CCTV), a recorder, or a black box.

[50] The FinTech device may be, for example, a device capable of providing a financial service such as mobile payment. For example, the FinTech device may include a payment device or a Point of Sales (PoS) system.

[51] The weather/environment device may include, for example, a device for monitoring or predicting a weather/environment.

[52] The wireless devices 100a to 100f may be connected to the network 300 via the BSs 200. An AI technology may be applied to the wireless devices 100a to 100f and the wireless devices 100a to 100f may be connected to the AI server 400 via the network 300. The network 300 may be configured using a 3G network, a 4G (e.g., LTE) network, a 5G (e.g., NR) network, and a beyond-5G network. Although the wireless devices 100a to 100f may communicate with each other through the BSs 200/network 300, the wireless devices 100a to 100f may perform direct communication (e.g., sidelink communication) with each other without passing through the BSs 200/network 300. For example, the vehicles 100b-1 and 100b-2 may perform direct communication (e.g., Vehicle-to-Vehicle (V2V)/Vehicle-to-everything (V2X) communication). The IoT device (e.g., a sensor) may perform direct communication with other IoT devices (e.g., sensors) or other wireless devices 100a to 100f.

[53] Wireless communication/connections 150a, 150b and 150c may be established between the wireless devices 100a to 100f and/or between wireless device 100a to 100f and BS 200 and/or between BSs 200. Herein, the wireless communication/connections may be established through various RATs (e.g., 5G NR) such as uplink/downlink communication 150a, sidelink communication (or Device-to-Device (D2D) communication) 150b, inter-base station communication 150c (e.g., relay, Integrated Access and Backhaul (IAB)), etc. The wireless devices 100a to 100f and the BSs 200/the wireless devices 100a to 100f may transmit/receive radio signals to/from each other through the wireless communication/connections 150a, 150b and 150c. For example, the wireless communication/connections 150a, 150b and 150c may transmit/receive signals through various physical channels. To this end, at least a part of various configuration information configuring processes, various signal processing processes (e.g., channel encoding/decoding, modulation/demodulation, and resource mapping/de-mapping), and resource allocating processes, for transmitting/receiving radio signals, may be performed based on the various proposals of the present disclosure.

[54] AI refers to the field of studying artificial intelligence or the methodology that can create it, and machine learning refers to the field of defining various problems addressed in the field of AI and the field of methodology to solve them. Machine learning is also defined as an algorithm that increases the performance of a task

through steady experience on a task.

[55] Robot means a machine that automatically processes or operates a given task by its own ability. In particular, robots with the ability to recognize the environment and make self-determination to perform actions can be called intelligent robots. Robots can be classified as industrial, medical, home, military, etc., depending on the purpose or area of use. The robot can perform a variety of physical operations, such as moving the robot joints with actuators or motors. The movable robot also includes wheels, brakes, propellers, etc., on the drive, allowing it to drive on the ground or fly in the air.

[56] Autonomous driving means a technology that drives on its own, and autonomous vehicles mean vehicles that drive without user's control or with minimal user's control. For example, autonomous driving may include maintaining lanes in motion, automatically adjusting speed such as adaptive cruise control, automatic driving along a set route, and automatically setting a route when a destination is set. The vehicle covers vehicles equipped with internal combustion engines, hybrid vehicles equipped with internal combustion engines and electric motors, and electric vehicles equipped with electric motors, and may include trains, motorcycles, etc., as well as cars. Autonomous vehicles can be seen as robots with autonomous driving functions.

[57] Extended reality is collectively referred to as VR, AR, and MR. VR technology provides objects and backgrounds of real world only through Computer Graphic (CG) images. AR technology provides a virtual CG image on top of a real object image. MR technology is a CG technology that combines and combines virtual objects into the real world. MR technology is similar to AR technology in that they show real and virtual objects together. However, there is a difference in that in AR technology, virtual objects are used as complementary forms to real objects, while in MR technology, virtual objects and real objects are used as equal personalities.

[58] NR supports multiples numerologies (and/or multiple Sub-Carrier Spacings (SCS)) to support various 5G services. For example, if SCS is 15 kHz, wide area can be supported in traditional cellular bands, and if SCS is 30 kHz/60 kHz, dense-urban, lower latency, and wider carrier bandwidth can be supported. If SCS is 60 kHz or higher, bandwidths greater than 24.25 GHz can be supported to overcome phase noise.

[59] The NR frequency band may be defined as two types of frequency range, i.e., Frequency Range 1 (FR1) and Frequency Range 2 (FR2). The numerical value of the frequency range may be changed. For example, the frequency ranges of the two types (FR1 and FR2) may be as shown in Table 1 below. For ease of explanation, in the frequency ranges used in the NR system, FR1 may mean "sub 6 GHz range", FR2 may mean "above 6 GHz range," and may be referred to as millimeter Wave (mmW).

[60] [Table 1]

Frequency Range designation	Corresponding frequency range	Subcarrier Spacing
FR1	450MHz - 6000MHz	15, 30, 60kHz
FR2	24250MHz - 52600MHz	60, 120, 240kHz

[61] As mentioned above, the numerical value of the frequency range of the NR system may be changed. For example, FR1 may include a frequency band of 410MHz to 7125MHz as shown in Table 2 below. That is, FR1 may include a frequency band of 6GHz (or 5850, 5900, 5925 MHz, etc.) or more. For example, a frequency band of 6 GHz (or 5850, 5900, 5925 MHz, etc.) or more included in FR1 may include an unlicensed band. Unlicensed bands may be used for a variety of purposes, for example for communication for vehicles (e.g., autonomous driving).

[62] [Table 2]

Frequency Range designation	Corresponding frequency range	Subcarrier Spacing
FR1	410MHz - 7125MHz	15, 30, 60kHz
FR2	24250MHz - 52600MHz	60, 120, 240kHz

[63] Here, the radio communication technologies implemented in the wireless devices in the present disclosure may include NarrowBand IoT (NB-IoT) technology for low-power communication as well as LTE, NR and 6G. For example, NB-IoT technology may be an example of Low Power Wide Area Network (LPWAN) technology, may be implemented in specifications such as LTE Cat NB1 and/or LTE Cat NB2, and may not be limited to the above-mentioned names. Additionally and/or alternatively, the radio communication technologies implemented in the wireless devices in the present disclosure may communicate based on LTE-M technology. For example, LTE-M technology may be an example of LPWAN technology and be called by various names such as enhanced MTC (eMTC). For example, LTE-M technology may be implemented in at least one of the various specifications, such as 1) LTE Cat 0, 2) LTE Cat M1, 3) LTE Cat M2, 4) LTE non-bandwidth limited (non-BL), 5) LTE-MTC, 6) LTE Machine Type Communication, and/or 7) LTE M, and may not be limited to the above-mentioned names. Additionally and/or alternatively, the radio communication technologies implemented in the wireless devices in the present disclosure may include at least one of ZigBee, Bluetooth, and/or LPWAN which take into account low-power communication, and may not be limited to the above-mentioned names. For example, ZigBee technology may generate Personal Area Networks (PANs) associated with

small/low-power digital communication based on various specifications such as IEEE 802.15.4 and may be called various names.

[64] FIG. 2 shows an example of wireless devices to which implementations of the present disclosure is applied.

[65] Referring to FIG. 2, a first wireless device 100 and a second wireless device 200 may transmit/receive radio signals to/from an external device through a variety of RATs (e.g., LTE and NR).

[66] In FIG. 2, {the first wireless device 100 and the second wireless device 200} may correspond to at least one of {the wireless device 100a to 100f and the BS 200}, {the wireless device 100a to 100f and the wireless device 100a to 100f} and/or {the BS 200 and the BS 200} of FIG. 1.

[67] The first wireless device 100 may include at least one transceiver, such as a transceiver 106, at least one processing chip, such as a processing chip 101, and/or one or more antennas 108.

[68] The processing chip 101 may include at least one processor, such a processor 102, and at least one memory, such as a memory 104. It is exemplarily shown in FIG. 2 that the memory 104 is included in the processing chip 101. Additional and/or alternatively, the memory 104 may be placed outside of the processing chip 101.

[69] The processor 102 may control the memory 104 and/or the transceiver 106 and may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. For example, the processor 102 may process information within the memory 104 to generate first information/signals and then transmit radio signals including the first information/signals through the transceiver 106. The processor 102 may receive radio signals including second information/signals through the transceiver 106 and then store information obtained by processing the second information/signals in the memory 104.

[70] The memory 104 may be operably connectable to the processor 102. The memory 104 may store various types of information and/or instructions. The memory 104 may store a software code 105 which implements instructions that, when executed by the processor 102, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 105 may implement instructions that, when executed by the processor 102, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 105 may control the processor 102 to perform one or more protocols. For example, the software code 105 may control the processor 102 to perform one or more layers of the radio interface protocol.

[71] Herein, the processor 102 and the memory 104 may be a part of a communication

modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver 106 may be connected to the processor 102 and transmit and/or receive radio signals through one or more antennas 108. Each of the transceiver 106 may include a transmitter and/or a receiver. The transceiver 106 may be interchangeably used with Radio Frequency (RF) unit(s). In the present disclosure, the first wireless device 100 may represent a communication modem/circuit/chip.

[72] The second wireless device 200 may include at least one transceiver, such as a transceiver 206, at least one processing chip, such as a processing chip 201, and/or one or more antennas 208.

[73] The processing chip 201 may include at least one processor, such a processor 202, and at least one memory, such as a memory 204. It is exemplarily shown in FIG. 2 that the memory 204 is included in the processing chip 201. Additional and/or alternatively, the memory 204 may be placed outside of the processing chip 201.

[74] The processor 202 may control the memory 204 and/or the transceiver 206 and may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts described in the present disclosure. For example, the processor 202 may process information within the memory 204 to generate third information/signals and then transmit radio signals including the third information/signals through the transceiver 206. The processor 202 may receive radio signals including fourth information/signals through the transceiver 106 and then store information obtained by processing the fourth information/signals in the memory 204.

[75] The memory 204 may be operably connectable to the processor 202. The memory 204 may store various types of information and/or instructions. The memory 204 may store a software code 205 which implements instructions that, when executed by the processor 202, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 205 may implement instructions that, when executed by the processor 202, perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. For example, the software code 205 may control the processor 202 to perform one or more protocols. For example, the software code 205 may control the processor 202 to perform one or more layers of the radio interface protocol.

[76] Herein, the processor 202 and the memory 204 may be a part of a communication modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver 206 may be connected to the processor 202 and transmit and/or receive radio signals through one or more antennas 208. Each of the transceiver 206 may include a transmitter and/or a receiver. The transceiver 206 may be interchangeably used with RF unit. In the present disclosure, the second wireless device 200 may represent a

communication modem/circuit/chip.

[77] Hereinafter, hardware elements of the wireless devices 100 and 200 will be described more specifically. One or more protocol layers may be implemented by, without being limited to, one or more processors 102 and 202. For example, the one or more processors 102 and 202 may implement one or more layers (e.g., functional layers such as physical (PHY) layer, Media Access Control (MAC) layer, Radio Link Control (RLC) layer, Packet Data Convergence Protocol (PDCP) layer, Radio Resource Control (RRC) layer, and Service Data Adaptation Protocol (SDAP) layer). The one or more processors 102 and 202 may generate one or more Protocol Data Units (PDUs) and/or one or more Service Data Units (SDUs) according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The one or more processors 102 and 202 may generate messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The one or more processors 102 and 202 may generate signals (e.g., baseband signals) including PDUs, SDUs, messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure and provide the generated signals to the one or more transceivers 106 and 206. The one or more processors 102 and 202 may receive the signals (e.g., baseband signals) from the one or more transceivers 106 and 206 and acquire the PDUs, SDUs, messages, control information, data, or information according to the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure.

[78] The one or more processors 102 and 202 may be referred to as controllers, microcontrollers, microprocessors, or microcomputers. The one or more processors 102 and 202 may be implemented by hardware, firmware, software, or a combination thereof. As an example, one or more Application Specific Integrated Circuits (ASICs), one or more Digital Signal Processors (DSPs), one or more Digital Signal Processing Devices (DSPDs), one or more Programmable Logic Devices (PLDs), or one or more Field Programmable Gate Arrays (FPGAs) may be included in the one or more processors 102 and 202. The descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure may be implemented using firmware or software and the firmware or software may be configured to include the modules, procedures, or functions. Firmware or software configured to perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure may be included in the one or more processors 102 and 202 or stored in the one or more memories 104 and 204 so as to be driven by the one or more processors 102 and 202. The descriptions, functions, procedures, sug-

gestions, methods and/or operational flowcharts disclosed in the present disclosure may be implemented using firmware or software in the form of code, commands, and/ or a set of commands.

[79] The one or more memories 104 and 204 may be connected to the one or more processors 102 and 202 and store various types of data, signals, messages, information, programs, code, instructions, and/or commands. The one or more memories 104 and 204 may be configured by Read-Only Memories (ROMs), Random Access Memories (RAMs), Electrically Erasable Programmable ROMs (EEPROMs), flash memories, hard drives, registers, cash memories, computer-readable storage media, and/or combinations thereof. The one or more memories 104 and 204 may be located at the interior and/or exterior of the one or more processors 102 and 202. The one or more memories 104 and 204 may be connected to the one or more processors 102 and 202 through various technologies such as wired or wireless connection.

[80] The one or more transceivers 106 and 206 may transmit user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, to one or more other devices. The one or more transceivers 106 and 206 may receive user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, from one or more other devices. For example, the one or more transceivers 106 and 206 may be connected to the one or more processors 102 and 202 and transmit and receive radio signals. For example, the one or more processors 102 and 202 may perform control so that the one or more transceivers 106 and 206 may transmit user data, control information, or radio signals to one or more other devices. The one or more processors 102 and 202 may perform control so that the one or more transceivers 106 and 206 may receive user data, control information, or radio signals from one or more other devices.

[81] The one or more transceivers 106 and 206 may be connected to the one or more antennas 108 and 208 and the one or more transceivers 106 and 206 may be configured to transmit and receive user data, control information, and/or radio signals/channels, mentioned in the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure, through the one or more antennas 108 and 208. In the present disclosure, the one or more antennas 108 and 208 may be a plurality of physical antennas or a plurality of logical antennas (e.g., antenna ports).

[82] The one or more transceivers 106 and 206 may convert received user data, control information, radio signals/channels, etc., from RF band signals into baseband signals in order to process received user data, control information, radio signals/channels, etc.,

using the one or more processors 102 and 202. The one or more transceivers 106 and 206 may convert the user data, control information, radio signals/channels, etc., processed using the one or more processors 102 and 202 from the base band signals into the RF band signals. To this end, the one or more transceivers 106 and 206 may include (analog) oscillators and/or filters. For example, the one or more transceivers 106 and 206 can up-convert OFDM baseband signals to OFDM signals by their (analog) oscillators and/or filters under the control of the one or more processors 102 and 202 and transmit the up-converted OFDM signals at the carrier frequency. The one or more transceivers 106 and 206 may receive OFDM signals at a carrier frequency and down-convert the OFDM signals into OFDM baseband signals by their (analog) oscillators and/or filters under the control of the one or more processors 102 and 202.

[83] In the implementations of the present disclosure, a UE may operate as a transmitting device in UL and as a receiving device in DL. In the implementations of the present disclosure, a BS may operate as a receiving device in UL and as a transmitting device in DL. Hereinafter, for convenience of description, it is mainly assumed that the first wireless device 100 acts as the UE, and the second wireless device 200 acts as the BS. For example, the processor(s) 102 connected to, mounted on or launched in the first wireless device 100 may be configured to perform the UE behavior according to an implementation of the present disclosure or control the transceiver(s) 106 to perform the UE behavior according to an implementation of the present disclosure. The processor(s) 202 connected to, mounted on or launched in the second wireless device 200 may be configured to perform the BS behavior according to an implementation of the present disclosure or control the transceiver(s) 206 to perform the BS behavior according to an implementation of the present disclosure.

[84] In the present disclosure, a BS is also referred to as a Node B (NB), an eNode B (eNB), or a gNB.

[85] FIG. 3 shows an example of a wireless device to which implementations of the present disclosure is applied.

[86] The wireless device may be implemented in various forms according to a use-case/service (refer to FIG. 1).

[87] Referring to FIG. 3, wireless devices 100 and 200 may correspond to the wireless devices 100 and 200 of FIG. 2 and may be configured by various elements, components, units/portions, and/or modules. For example, each of the wireless devices 100 and 200 may include a communication unit 110, a control unit 120, a memory unit 130, and additional components 140. The communication unit 110 may include a communication circuit 112 and transceiver(s) 114. For example, the communication circuit 112 may include the one or more processors 102 and 202 of FIG. 2 and/or the one or more memories 104 and 204 of FIG. 2. For example, the transceiver(s) 114 may

include the one or more transceivers 106 and 206 of FIG. 2 and/or the one or more antennas 108 and 208 of FIG. 2. The control unit 120 is electrically connected to the communication unit 110, the memory unit 130, and the additional components 140 and controls overall operation of each of the wireless devices 100 and 200. For example, the control unit 120 may control an electric/mechanical operation of each of the wireless devices 100 and 200 based on programs/code/commands/information stored in the memory unit 130. The control unit 120 may transmit the information stored in the memory unit 130 to the exterior (e.g., other communication devices) via the communication unit 110 through a wireless/wired interface or store, in the memory unit 130, information received through the wireless/wired interface from the exterior (e.g., other communication devices) via the communication unit 110.

[88] The additional components 140 may be variously configured according to types of the wireless devices 100 and 200. For example, the additional components 140 may include at least one of a power unit/battery, Input/Output (I/O) unit (e.g., audio I/O port, video I/O port), a driving unit, and a computing unit. The wireless devices 100 and 200 may be implemented in the form of, without being limited to, the robot (100a of FIG. 1), the vehicles (100b-1 and 100b-2 of FIG. 1), the XR device (100c of FIG. 1), the hand-held device (100d of FIG. 1), the home appliance (100e of FIG. 1), the IoT device (100f of FIG. 1), a digital broadcast terminal, a hologram device, a public safety device, an MTC device, a medicine device, a FinTech device (or a finance device), a security device, a climate/environment device, the AI server/device (400 of FIG. 1), the BSs (200 of FIG. 1), a network node, etc. The wireless devices 100 and 200 may be used in a mobile or fixed place according to a use-example/service.

[89] In FIG. 3, the entirety of the various elements, components, units/portions, and/or modules in the wireless devices 100 and 200 may be connected to each other through a wired interface or at least a part thereof may be wirelessly connected through the communication unit 110. For example, in each of the wireless devices 100 and 200, the control unit 120 and the communication unit 110 may be connected by wire and the control unit 120 and first units (e.g., 130 and 140) may be wirelessly connected through the communication unit 110. Each element, component, unit/portion, and/or module within the wireless devices 100 and 200 may further include one or more elements. For example, the control unit 120 may be configured by a set of one or more processors. As an example, the control unit 120 may be configured by a set of a communication control processor, an Application Processor (AP), an Electronic Control Unit (ECU), a Central Processing Unit (CPU), a Graphical Processing Unit (GPU), and a memory control processor. As another example, the memory unit 130 may be configured by a RAM, a Dynamic RAM (DRAM), a ROM, a flash memory, a volatile memory, a non-volatile memory, and/or a combination thereof.

[90] FIG. 4 shows an example of UE to which implementations of the present disclosure is applied.

[91] Referring to FIG. 4, a UE 100 may correspond to the first wireless device 100 of FIG. 2 and/or the wireless device 100 or 200 of FIG. 3.

[92] A UE 100 includes a processor 102, a memory 104, a transceiver 106, one or more antennas 108, a power management module 110, a battery 112, a display 114, a keypad 116, a Subscriber Identification Module (SIM) card 118, a speaker 120, and a microphone 122.

[93] The processor 102 may be configured to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The processor 102 may be configured to control one or more other components of the UE 100 to implement the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. Layers of the radio interface protocol may be implemented in the processor 102. The processor 102 may include ASIC, other chipset, logic circuit and/or data processing device. The processor 102 may be an application processor. The processor 102 may include at least one of DSP, CPU, GPU, a modem (modulator and demodulator). An example of the processor 102 may be found in SNAPDRAGON™ series of processors made by Qualcomm®, EXYNOS™ series of processors made by Samsung®, A series of processors made by Apple®, HELIO™ series of processors made by MediaTek®, ATOM™ series of processors made by Intel® or a corresponding next generation processor.

[94] The memory 104 is operatively coupled with the processor 102 and stores a variety of information to operate the processor 102. The memory 104 may include ROM, RAM, flash memory, memory card, storage medium and/or other storage device. When the embodiments are implemented in software, the techniques described herein can be implemented with modules (e.g., procedures, functions, etc.) that perform the descriptions, functions, procedures, suggestions, methods and/or operational flowcharts disclosed in the present disclosure. The modules can be stored in the memory 104 and executed by the processor 102. The memory 104 can be implemented within the processor 102 or external to the processor 102 in which case those can be communicatively coupled to the processor 102 via various means as is known in the art.

[95] The transceiver 106 is operatively coupled with the processor 102, and transmits and/or receives a radio signal. The transceiver 106 includes a transmitter and a receiver. The transceiver 106 may include baseband circuitry to process radio frequency signals. The transceiver 106 controls the one or more antennas 108 to transmit and/or receive a radio signal.

[96] The power management module 110 manages power for the processor 102 and/or the transceiver 106. The battery 112 supplies power to the power management module 110.

[97] The display 114 outputs results processed by the processor 102. The keypad 116 receives inputs to be used by the processor 102. The keypad 116 may be shown on the display 114.

[98] The SIM card 118 is an integrated circuit that is intended to securely store the International Mobile Subscriber Identity (IMSI) number and its related key, which are used to identify and authenticate subscribers on mobile telephony devices (such as mobile phones and computers). It is also possible to store contact information on many SIM cards.

[99] The speaker 120 outputs sound-related results processed by the processor 102. The microphone 122 receives sound-related inputs to be used by the processor 102.

[100] FIGs. 5 and 6 show an example of protocol stacks in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.

[101] In particular, FIG. 5 illustrates an example of a radio interface user plane protocol stack between a UE and a BS and FIG. 6 illustrates an example of a radio interface control plane protocol stack between a UE and a BS. The control plane refers to a path through which control messages used to manage call by a UE and a network are transported. The user plane refers to a path through which data generated in an application layer, for example, voice data or Internet packet data are transported. Referring to FIG. 5, the user plane protocol stack may be divided into Layer 1 (i.e., a PHY layer) and Layer 2. Referring to FIG. 6, the control plane protocol stack may be divided into Layer 1 (i.e., a PHY layer), Layer 2, Layer 3 (e.g., an RRC layer), and a Non-Access Stratum (NAS) layer. Layer 1, Layer 2 and Layer 3 are referred to as an Access Stratum (AS).

[102] In the 3GPP LTE system, the Layer 2 is split into the following sublayers: MAC, RLC, and PDCP. In the 3GPP NR system, the Layer 2 is split into the following sublayers: MAC, RLC, PDCP and SDAP. The PHY layer offers to the MAC sublayer transport channels, the MAC sublayer offers to the RLC sublayer logical channels, the RLC sublayer offers to the PDCP sublayer RLC channels, the PDCP sublayer offers to the SDAP sublayer radio bearers. The SDAP sublayer offers to 5G core network Quality of Service (QoS) flows.

[103] In the 3GPP NR system, the main services and functions of the MAC sublayer include: mapping between logical channels and transport channels; multiplexing/de-multiplexing of MAC SDUs belonging to one or different logical channels into/from Transport Blocks (TB) delivered to/from the physical layer on transport channels; scheduling information reporting; error correction through Hybrid Automatic Repeat

reQuest (HARQ) (one HARQ entity per cell in case of Carrier Aggregation (CA)); priority handling between UEs by means of dynamic scheduling; priority handling between logical channels of one UE by means of logical channel prioritization; padding. A single MAC entity may support multiple numerologies, transmission timings and cells. Mapping restrictions in logical channel prioritization control which numerology(ies), cell(s), and transmission timing(s) a logical channel can use.

[104] Different kinds of data transfer services are offered by MAC. To accommodate different kinds of data transfer services, multiple types of logical channels are defined, i.e., each supporting transfer of a particular type of information. Each logical channel type is defined by what type of information is transferred. Logical channels are classified into two groups: control channels and traffic channels. Control channels are used for the transfer of control plane information only, and traffic channels are used for the transfer of user plane information only. Broadcast Control Channel (BCCH) is a downlink logical channel for broadcasting system control information, Paging Control Channel (PCCH) is a downlink logical channel that transfers paging information, system information change notifications and indications of ongoing Public Warning Service (PWS) broadcasts, Common Control Channel (CCCH) is a logical channel for transmitting control information between UEs and network and used for UEs having no RRC connection with the network, and Dedicated Control Channel (DCCH) is a point-to-point bi-directional logical channel that transmits dedicated control information between a UE and the network and used by UEs having an RRC connection. Dedicated Traffic Channel (DTCH) is a point-to-point logical channel, dedicated to one UE, for the transfer of user information. A DTCH can exist in both uplink and downlink. In downlink, the following connections between logical channels and transport channels exist: BCCH can be mapped to Broadcast Channel (BCH); BCCH can be mapped to Downlink Shared Channel (DL-SCH); PCCH can be mapped to Paging Channel (PCH); CCCH can be mapped to DL-SCH; DCCH can be mapped to DL-SCH; and DTCH can be mapped to DL-SCH. In uplink, the following connections between logical channels and transport channels exist: CCCH can be mapped to Uplink Shared Channel (UL-SCH); DCCH can be mapped to UL-SCH; and DTCH can be mapped to UL-SCH.

[105] The RLC sublayer supports three transmission modes: Transparent Mode (TM), Unacknowledged Mode (UM), and Acknowledged Mode (AM). The RLC configuration is per logical channel with no dependency on numerologies and/or transmission durations. In the 3GPP NR system, the main services and functions of the RLC sublayer depend on the transmission mode and include: transfer of upper layer PDUs; sequence numbering independent of the one in PDCP (UM and AM); error correction through ARQ (AM only); segmentation (AM and UM) and re-segmentation (AM only)

of RLC SDUs; reassembly of SDU (AM and UM); duplicate detection (AM only); RLC SDU discard (AM and UM); RLC re-establishment; protocol error detection (AM only).

[106] In the 3GPP NR system, the main services and functions of the PDCP sublayer for the user plane include: sequence numbering; header compression and decompression using Robust Header Compression (ROHC); transfer of user data; reordering and duplicate detection; in-order delivery; PDCP PDU routing (in case of split bearers); retransmission of PDCP SDUs; ciphering, deciphering and integrity protection; PDCP SDU discard; PDCP re-establishment and data recovery for RLC AM; PDCP status reporting for RLC AM; duplication of PDCP PDUs and duplicate discard indication to lower layers. The main services and functions of the PDCP sublayer for the control plane include: sequence numbering; ciphering, deciphering and integrity protection; transfer of control plane data; reordering and duplicate detection; in-order delivery; duplication of PDCP PDUs and duplicate discard indication to lower layers.

[107] In the 3GPP NR system, the main services and functions of SDAP include: mapping between a QoS flow and a data radio bearer; marking QoS Flow ID (QFI) in both DL and UL packets. A single protocol entity of SDAP is configured for each individual PDU session.

[108] In the 3GPP NR system, the main services and functions of the RRC sublayer include: broadcast of system information related to AS and NAS; paging initiated by 5G Core network (5GC) or Next-Generation Radio Access Network (NG-RAN); establishment, maintenance and release of an RRC connection between the UE and NG-RAN; security functions including key management; establishment, configuration, maintenance and release of Signaling Radio Bearers (SRBs) and Data Radio Bearers (DRBs); mobility functions (including: handover and context transfer, UE cell selection and reselection and control of cell selection and reselection, inter-RAT mobility); QoS management functions; UE measurement reporting and control of the reporting; detection of and recovery from radio link failure; NAS message transfer to/from NAS from/to UE.

[109] FIG. 7 shows a frame structure in a 3GPP based wireless communication system to which implementations of the present disclosure is applied.

[110] The frame structure shown in FIG. 7 is purely exemplary and the number of subframes, the number of slots, and/or the number of symbols in a frame may be variously changed. In the 3GPP based wireless communication system, OFDM numerologies (e.g., SCS, Transmission Time Interval (TTI) duration) may be differently configured between a plurality of cells aggregated for one UE. For example, if a UE is configured with different SCSs for cells aggregated for the cell, an (absolute time) duration of a time resource (e.g., a subframe, a slot, or a TTI) including the same

number of symbols may be different among the aggregated cells. Herein, symbols may include OFDM symbols (or Cyclic Prefix (CP)-OFDM symbols), SC-FDMA symbols (or Discrete Fourier Transform-spread-OFDM (DFT-s-OFDM) symbols).

[111] Referring to FIG. 7, downlink and uplink transmissions are organized into frames. Each frame has T_f = 10ms duration. Each frame is divided into two half-frames, where each of the half-frames has 5ms duration. Each half-frame consists of 5 subframes, where the duration T_{sf} per subframe is 1ms. Each subframe is divided into slots and the number of slots in a subframe depends on a subcarrier spacing. Each slot includes 14 or 12 OFDM symbols based on a CP. In a normal CP, each slot includes 14 OFDM symbols and, in an extended CP, each slot includes 12 OFDM symbols. The numerology is based on exponentially scalable subcarrier spacing $\Delta f = 2^u*15$ kHz.

[112] Table 3 shows the number of OFDM symbols per slot N^{slot}_{symb}, the number of slots per frame $N^{frame,u}_{slot}$, and the number of slots per subframe $N^{subframe,u}_{slot}$ for the normal CP, according to the subcarrier spacing $\Delta f = 2^u*15$ kHz.

[113] [Table 3]

u	N^{slot}_{symb}	$N^{frame,u}_{slot}$	$N^{subframe,u}_{slot}$
0	14	10	1
1	14	20	2
2	14	40	4
3	14	80	8
4	14	160	16

[114] Table 4 shows the number of OFDM symbols per slot N^{slot}_{symb}, the number of slots per frame $N^{frame,u}_{slot}$, and the number of slots per subframe $N^{subframe,u}_{slot}$ for the extended CP, according to the subcarrier spacing $\Delta f = 2^u*15$ kHz.

[115] [Table 4]

u	N^{slot}_{symb}	$N^{frame,u}_{slot}$	$N^{subframe,u}_{slot}$
2	12	40	4

[116] A slot includes plural symbols (e.g., 14 or 12 symbols) in the time domain. For each numerology (e.g., subcarrier spacing) and carrier, a resource grid of $N^{size,u}_{grid,x}*N^{RB}_{sc}$ subcarriers and $N^{subframe,u}_{symb}$ OFDM symbols is defined, starting at Common Resource Block (CRB) $N^{start,u}_{grid}$ indicated by higher-layer signaling (e.g., RRC signaling), where $N^{size,u}_{grid,x}$ is the number of Resource Blocks (RBs) in the resource grid and the subscript x is DL for downlink and UL for uplink. N^{RB}_{sc} is the number of subcarriers per RB. In the 3GPP based wireless communication system, N^{RB}_{sc} is 12 generally. There is one resource grid for a given antenna port p, subcarrier spacing configuration u, and

transmission direction (DL or UL). The carrier bandwidth $N^{size,u}_{grid}$ for subcarrier spacing configuration *u* is given by the higher-layer parameter (e.g., RRC parameter). Each element in the resource grid for the antenna port *p* and the subcarrier spacing configuration *u* is referred to as a Resource Element (RE) and one complex symbol may be mapped to each RE. Each RE in the resource grid is uniquely identified by an index *k* in the frequency domain and an index *l* representing a symbol location relative to a reference point in the time domain. In the 3GPP based wireless communication system, an RB is defined by 12 consecutive subcarriers in the frequency domain.

[117] In the 3GPP NR system, RBs are classified into CRBs and Physical Resource Blocks (PRBs). CRBs are numbered from 0 and upwards in the frequency domain for subcarrier spacing configuration *u*. The center of subcarrier 0 of CRB 0 for subcarrier spacing configuration *u* coincides with 'point A' which serves as a common reference point for resource block grids. In the 3GPP NR system, PRBs are defined within a BandWidth Part (BWP) and numbered from 0 to $N^{size}_{BWP,i}$-1, where i is the number of the bandwidth part. The relation between the physical resource block n_{PRB} in the bandwidth part i and the common resource block n_{CRB} is as follows: $n_{PRB} = n_{CRB} + N^{size}_{BWP,i}$, where $N^{size}_{BWP,i}$ is the common resource block where bandwidth part starts relative to CRB 0. The BWP includes a plurality of consecutive RBs. A carrier may include a maximum of N (e.g., 5) BWPs. A UE may be configured with one or more BWPs on a given component carrier. Only one BWP among BWPs configured to the UE can active at a time. The active BWP defines the UE's operating bandwidth within the cell's operating bandwidth.

[118] In the present disclosure, the term "cell" may refer to a geographic area to which one or more nodes provide a communication system, or refer to radio resources. A "cell" as a geographic area may be understood as coverage within which a node can provide service using a carrier and a "cell" as radio resources (e.g., time-frequency resources) is associated with bandwidth which is a frequency range configured by the carrier. The "cell" associated with the radio resources is defined by a combination of downlink resources and uplink resources, for example, a combination of a DL Component Carrier (CC) and a UL CC. The cell may be configured by downlink resources only, or may be configured by downlink resources and uplink resources. Since DL coverage, which is a range within which the node is capable of transmitting a valid signal, and UL coverage, which is a range within which the node is capable of receiving the valid signal from the UE, depends upon a carrier carrying the signal, the coverage of the node may be associated with coverage of the "cell" of radio resources used by the node. Accordingly, the term "cell" may be used to represent service coverage of the node sometimes, radio resources at other times, or a range that signals using the radio resources can reach with valid strength at other times.

[119] In CA, two or more CCs are aggregated. A UE may simultaneously receive or transmit on one or multiple CCs depending on its capabilities. CA is supported for both contiguous and non-contiguous CCs. When CA is configured, the UE only has one RRC connection with the network. At RRC connection establishment/ re-establishment/handover, one serving cell provides the NAS mobility information, and at RRC connection re-establishment/handover, one serving cell provides the security input. This cell is referred to as the Primary Cell (PCell). The PCell is a cell, operating on the primary frequency, in which the UE either performs the initial connection establishment procedure or initiates the connection re-establishment procedure. Depending on UE capabilities, Secondary Cells (SCells) can be configured to form together with the PCell a set of serving cells. An SCell is a cell providing additional radio resources on top of Special Cell (SpCell). The configured set of serving cells for a UE therefore always consists of one PCell and one or more SCells. For Dual Connectivity (DC) operation, the term SpCell refers to the PCell of the Master Cell Group (MCG) or the Primary SCell (PSCell) of the Secondary Cell Group (SCG). An SpCell supports Physical Uplink Control Channel (PUCCH) transmission and contention-based random access, and is always activated. The MCG is a group of serving cells associated with a master node, comprised of the SpCell (PCell) and optionally one or more SCells. The SCG is the subset of serving cells associated with a secondary node, comprised of the PSCell and zero or more SCells, for a UE configured with DC. For a UE in RRC_CONNECTED not configured with CA/DC, there is only one serving cell comprised of the PCell. For a UE in RRC_CONNECTED configured with CA/DC, the term "serving cells" is used to denote the set of cells comprised of the SpCell(s) and all SCells. In DC, two MAC entities are configured in a UE: one for the MCG and one for the SCG.

[120] FIG. 8 shows a data flow example in the 3GPP NR system to which implementations of the present disclosure is applied.

[121] Referring to FIG. 8, "RB" denotes a radio bearer, and "H" denotes a header. Radio bearers are categorized into two groups: DRBs for user plane data and SRBs for control plane data. The MAC PDU is transmitted/received using radio resources through the PHY layer to/from an external device. The MAC PDU arrives to the PHY layer in the form of a transport block.

[122] In the PHY layer, the uplink transport channels UL-SCH and Random Access Channel (RACH) are mapped to their physical channels Physical Uplink Shared Channel (PUSCH) and Physical Random Access Channel (PRACH), respectively, and the downlink transport channels DL-SCH, BCH and PCH are mapped to Physical Downlink Shared Channel (PDSCH), Physical Broadcast Channel (PBCH) and PDSCH, respectively. In the PHY layer, Uplink Control Information (UCI) is mapped

to PUCCH, and Downlink Control Information (DCI) is mapped to Physical Downlink Control Channel (PDCCH). A MAC PDU related to UL-SCH is transmitted by a UE via a PUSCH based on an UL grant, and a MAC PDU related to DL-SCH is transmitted by a BS via a PDSCH based on a DL assignment.

[123] Sidelink (SL) transmission and/or communication in 5G NR is described. Section 5.7 and Section 16.9 of 3GPP TS 38.300 V16.1.0 can be referred.

[124] FIG. 9 shows an example of NG-RAN architecture supporting PC5 interface to which implementations of the present disclosure is applied.

[125] Referring to FIG. 9, sidelink transmission and reception over the PC5 interface are supported when the UE is inside NG-RAN coverage, irrespective of which RRC state the UE is in, and when the UE is outside NG-RAN coverage.

[126] Support of V2X services via the PC5 interface can be provided by NR sidelink communication and/or V2X sidelink communication. NR sidelink communication may be used to support other services than V2X services.

[127] NR sidelink communication can support one of three types of transmission modes for a pair of a Source Layer-2 ID and a Destination Layer-2 ID in the AS:

[128] (1) Unicast transmission, characterized by:

[129] - Support of one PC5-RRC connection between peer UEs for the pair;

[130] - Transmission and reception of control information and user traffic between peer UEs in sidelink;

[131] - Support of sidelink HARQ feedback;

[132] - Support of RLC AM;

[133] - Detection of radio link failure for the PC5-RRC connection.

[134] (2) Groupcast transmission, characterized by:

[135] - Transmission and reception of user traffic among UEs belonging to a group in sidelink;

[136] - Support of sidelink HARQ feedback.

[137] (3) Broadcast transmission, characterized by:

[138] - Transmission and reception of user traffic among UEs in sidelink.

[139] Two sidelink resource allocation modes are supported, i.e., mode 1 and mode 2. In mode 1, the sidelink resource allocation is provided by the network. In mode 2, UE decides the SL transmission resources and timing in the resource pool.

[140] Mode 1, which may be called scheduled resource allocation, may be characterized by the following:

[141] - The UE needs to be RRC_CONNECTED in order to transmit data;

[142] - NG-RAN schedules transmission resources.

[143] Mode 2, which may be called UE autonomous resource selection, may be characterized by the following:

[144] - The UE can transmit data when inside NG-RAN coverage, irrespective of which RRC state the UE is in, and when outside NG-RAN coverage;

[145] - The UE autonomously selects transmission resources from a pool of resources.

[146] For NR sidelink communication, the UE performs sidelink transmissions only on a single carrier.

[147] In mode 1, NG-RAN can dynamically allocate resources to the UE via the Sidelink Radio Network Temporary Identifier (SL-RNTI) on PDCCH(s) for NR sidelink communication.

[148] In addition, NG-RAN can allocate sidelink resources to UE with two types of configured sidelink grants:

[149] - With type 1, RRC directly provides the configured sidelink grant only for NR sidelink communication;

[150] - With type 2, RRC defines the periodicity of the configured sidelink grant while PDCCH can either signal and activate the configured sidelink grant, or deactivate it. The PDCCH is addressed to SL Configured Scheduling RNTI (SL-CS-RNTI) for NR sidelink communication and SL semi-persistent scheduling V2X RNTI (V-RNTI) for V2X sidelink communication.

[151] For the UE performing NR sidelink communication, there can be more than one configured sidelink grant activated at a time on the carrier configured for sidelink transmission

[152] When beam failure or physical layer problem occurs on NR Uu, the UE can continue using the configured sidelink grant type 1. During handover, the UE can be provided with configured sidelink grants via handover command, regardless of the type. If provided, the UE activates the configured sidelink grant type 1 upon reception of the handover command.

[153] The UE can send Sidelink Buffer Status Report (SL BSR) to support scheduler operation in NG-RAN. The sidelink buffer status reports refer to the data that is buffered in for a group of Logical Channels (LCG) per destination in the UE. Eight LCGs are used for reporting of the sidelink buffer status reports. Two formats, which are SL BSR and truncated SL BSR, are used.

[154] In mode 2, the UE autonomously selects sidelink grant from a pool of resources provided by broadcast system information or dedicated signalling while inside NG-RAN coverage or by pre-configuration while outside NG-RAN coverage.

[155] For NR sidelink communication, the pools of resources can be provided for a given validity area where the UE does not need to acquire a new pool of resources while moving within the validity area, at least when this pool is provided by System Information Block (SIB) (e.g., reuse valid area of NR SIB). NR SIB validity mechanism is reused to enable validity area for SL resource pool configured via broadcasted

system information.

[156] The UE is allowed to temporarily use UE autonomous resource selection with random selection for sidelink transmission based on configuration of the exceptional transmission resource pool.

[157] When a UE is inside NG-RAN coverage, NR sidelink communication and/or V2X sidelink communication can be configured and controlled by NG-RAN via dedicated signalling or system information:

[158] - The UE should support and be authorized to perform NR sidelink communication and/or V2X sidelink communication in NG-RAN;

[159] - If configured, the UE performs V2X sidelink communication unless otherwise specified;

[160] - NG-RAN can provide the UE with intra-carrier sidelink configuration, inter-carrier sidelink configuration and anchor carrier which provides sidelink configuration via a Uu carrier for NR sidelink communication and/or V2X Sidelink communication;

[161] - When the UE cannot simultaneously perform both NR sidelink transmission and NR uplink transmission in time domain, prioritization between both transmissions is done based on their priorities and thresholds configured by the NG-RAN.

[162] When a UE is outside NG-RAN coverage, Sidelink Radio Bearer (SLRB) configuration are preconfigured to the UE for NR sidelink communication.

[163] The UE in RRC_CONNECTED performs NR sidelink communication and/or V2X sidelink communication. The UE sends Sidelink UE Information to NG-RAN in order to request or release sidelink resources and report QoS information for each destination.

[164] NG-RAN provides *RRCReconfiguration* to the UE in order to provide the UE with dedicated sidelink configuration. The *RRCReconfiguration* may include SLRB configuration for NR sidelink communication as well as either sidelink scheduling configuration or resource pool configuration. If UE has received SLRB configuration via system information, UE should continue using the configuration to perform sidelink data transmissions and receptions until a new configuration is received via the *RRCReconfiguration*.

[165] NG-RAN may also configure measurement and reporting of Channel Busy Ratio (CBR) and reporting of location information to the UE via *RRCReconfiguration*.

[166] During handover, the UE performs sidelink transmission and reception based on configuration of the exceptional transmission resource pool or configured sidelink grant type 1 and reception resource pool of the target cell as provided in the handover command.

[167] The UE in RRC_IDLE or RRC_INACTIVE performs NR sidelink communication and/or V2X sidelink communication. NG-RAN may provide common sidelink con-

figuration to the UE in RRC_IDLE or RRC_INACTIVE via system information for NR sidelink communication and/or V2X sidelink communication. UE receives resource pool configuration and SLRB configuration via *SIB12* for NR sidelink communication, and/or resource pool configuration via *SIB13* and *SIB14* for V2X sidelink communication. If UE has received SLRB configuration via dedicated signalling, UE should continue using the configuration to perform sidelink data transmissions and receptions until a new configuration is received via system information.

[168] When the UE performs cell reselection, the UE interested in V2X service(s) considers at least whether NR sidelink communication and/or V2X sidelink communication are supported by the cell. The UE may consider the following carrier frequency as the highest priority frequency, except for the carrier only providing the anchor carrier:

[169] - the frequency providing both NR sidelink communication and V2X sidelink communication, if configured to perform both NR sidelink communication and V2X sidelink communication;

[170] - the frequency providing NR sidelink communication, if configured to perform only NR sidelink communication.

[171] Radio protocol architecture for NR sidelink communication may be as follows.

[172] - The AS protocol stack for the control plane in the PC5 interface consists of RRC, PDCP, RLC and MAC sublayers, and the physical layer.

[173] - For support of PC5-S protocol, PC5-S is located on top of PDCP, RLC and MAC sublayers, and the physical layer for the control plane in the PC5 interface.

[174] - The AS protocol stack for SBCCH in the PC5 interface consists of RRC, RLC, MAC sublayers, and the physical layer.

[175] - The AS protocol stack for user plane in the PC5 interface consists of SDAP, PDCP, RLC and MAC sublayers, and the physical layer.

[176] SLRB are categorized into two groups: Sidelink Data Radio Bearers (SL DRB) for user plane data and Sidelink Signalling Radio Bearers (SL SRB) for control plane data. Separate SL SRBs using different SCCHs are configured for PC5-RRC and PC5-S signaling respectively.

[177] Physical Sidelink Control Channel (PSCCH) indicates resource and other transmission parameters used by a UE for PSSCH. PSCCH transmission is associated with a De-Modulation Reference Signal (DM-RS).

[178] Physical Sidelink Shared Channel (PSSCH) transmits the TBs of data themselves, and control information for HARQ procedures and Channel State Information (CSI) feedback triggers, etc. At least 5 OFDM symbols within a slot are used for PSSCH transmission. PSSCH transmission is associated with a DM-RS and may be associated with a Phase Tracking Reference Signal (PT-RS).

[179] Physical Sidelink Feedback Channel (PSFCH) carries HARQ feedback over the sidelink from a UE which is an intended recipient of a PSSCH transmission to the UE which performed the transmission. PSFCH sequence is transmitted in one PRB repeated over two OFDM symbols near the end of the sidelink resource in a slot.

[180] The sidelink synchronization signal consists of Sidelink Primary and Sidelink Secondary Synchronization Signals (S-PSS, S-SSS), each occupying 2 symbols and 127 subcarriers. Physical Sidelink Broadcast Channel (PSBCH) occupies 7 and 5 symbols for normal and extended cyclic prefix cases respectively, including the associated DM-RS.

[181] Sidelink HARQ feedback uses PSFCH and can be operated in one of two options. In one option, PSFCH transmits either Acknowledgement (ACK) or Negative ACK (NACK) using a resource dedicated to a single PSFCH transmitting UE. In another option, PSFCH transmits NACK, or no PSFCH signal is transmitted, on a resource that can be shared by multiple PSFCH transmitting UEs.

[182] In sidelink resource allocation mode 1, a UE which received PSFCH can report sidelink HARQ feedback to gNB via PUCCH or PUSCH.

[183] For unicast, CSI Reference Signal (CSI-RS) is supported for CSI measurement and reporting in sidelink. A CSI report is carried in a MAC Control Element (CE).

[184] The MAC sublayer provides the following services and functions over the PC5 interface in addition to the services and functions described above by referring to FIGs. 5 and 6.

[185] - Radio resource selection;

[186] - Packet filtering;

[187] - Priority handling between uplink and sidelink transmissions for a given UE;

[188] - Sidelink CSI reporting.

[189] With Logical Channel Prioritization (LCP) restrictions in MAC, only sidelink logical channels belonging to the same destination can be multiplexed into a MAC PDU for every unicast, groupcast and broadcast transmission which is associated to the destination. NG-RAN can also control whether a sidelink logical channel can utilize the resources allocated to a configured sidelink grant type 1.

[190] For packet filtering, a SL-SCH MAC header including portions of both Source Layer-2 ID and a Destination Layer-2 ID is added to each MAC PDU. Logical channel ID (LCID) included within a MAC subheader uniquely identifies a logical channel within the scope of the Source Layer-2 ID and Destination Layer-2 ID combination.

[191] The following logical channels are used in sidelink:

[192] - Sidelink Control Channel (SCCH): a sidelink channel for transmitting control information from one UE to other UE(s);

[193] - Sidelink Traffic Channel (STCH): a sidelink channel for transmitting user in-

formation from one UE to other UE(s);

[194] - Sidelink Broadcast Control Channel (SBCCH): a sidelink channel for broadcasting sidelink system information from one UE to other UE(s).

[195] The following connections between logical channels and transport channels exist:

[196] - SCCH can be mapped to Sidelink Shared Channel (SL-SCH);

[197] - STCH can be mapped to SL-SCH;

[198] - SBCCH can be mapped to Sidelink Broadcast Channel (SL-BCH).

[199] The RRC sublayer provides the following services and functions over the PC5 interface:

[200] - Transfer of a PC5-RRC message between peer UEs;

[201] - Maintenance and release of a PC5-RRC connection between two UEs;

[202] - Detection of sidelink radio link failure for a PC5-RRC connection.

[203] A PC5-RRC connection is a logical connection between two UEs for a pair of Source and Destination Layer-2 IDs which is considered to be established after a corresponding PC5 unicast link is established. There is one-to-one correspondence between the PC5-RRC connection and the PC5 unicast link. A UE may have multiple PC5-RRC connections with one or more UEs for different pairs of Source and Destination Layer-2 IDs.

[204] Separate PC5-RRC procedures and messages are used for a UE to transfer UE capability and sidelink configuration including SLRB configuration to the peer UE. Both peer UEs can exchange their own UE capability and sidelink configuration using separate bi-directional procedures in both sidelink directions.

[205] If it is not interested in sidelink transmission, if sidelink Radio Link Failure (RLF) on the PC5-RRC connection is declared, or if the Layer-2 link release procedure is completed or if the T400 is expired, UE releases the PC5-RRC connection.

[206] Sidelink resource allocation is described in detail. If the transmitting UE (e.g., TX UE) is in RRC_CONNECTED and configured for gNB scheduled sidelink resource allocation (e.g., mode 1), the TX UE may transmit sidelink UE information including traffic pattern of Service, TX carriers and/or RX carriers mapped to service, QoS information related to service (e.g., 5G QoS Identifier (5QI), ProSe-Per-Packet Priority (PPPP), ProSe-Per-Packet reliability (PPPR), QoS Class Identifier (QCI) value), and destination related to service.

[207] After receiving the sidelink UE information, the gNB constructs sidelink configuration at least including one or more resource pools for service and sidelink BSR configuration. The gNB signals the sidelink configuration to the TX UE and then the TX UE configures lower layers with sidelink configuration.

[208] If a message becomes available in L2 buffer for sidelink transmission, the TX UE triggers Scheduling Request (SR), so that the TX UE transmits PUCCH resource. If

PUCCH resource is not configured, the TX UE performs random access procedure as the SR. If an uplink grant is given at a result of the SR, the TX UE transmits sidelink BSR to the gNB. The sidelink BSR indicates at least a destination index, a LCG, and a buffer size corresponding to the destination.

[209] After receiving the sidelink BSR, the gNB transmits a sidelink grant to the TX UE, e.g., by sending DCI in PDCCH. The DCI may include an allocated sidelink resource. If the TX UE receives the DCI, the TX UE uses the sidelink grant for transmission to the receiving UE (e.g., RX UE).

[210] Alternatively, if the TX UE is configured for UE autonomous scheduling of sidelink resource allocation (e.g., mode 2) regardless of RRC state, the TX UE autonomously select or reselect sidelink resources to create a sidelink grant used for transmission to the RX UE.

[211] Discontinuous Reception (DRX) is described.

[212] The MAC entity may be configured by RRC with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI, CI-RNTI, CS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, and TPC-SRS-RNTI. When using DRX operation, the MAC entity shall also monitor PDCCH. When in RRC_CONNECTED, if DRX is configured, for all the activated Serving Cells, the MAC entity may monitor the PDCCH discontinuously using the DRX operation.

[213] RRC controls DRX operation by configuring the following parameters:

[214] - *drx*-onDurationTimer: the duration at the beginning of a DRX Cycle;

[215] - *drx*-SlotOffset: the delay before starting the *drx*-onDurationTimer;

[216] - *drx*-InactivityTimer: the duration after the PDCCH occasion in which a PDCCH indicates a new UL or DL transmission for the MAC entity;

[217] - *drx*-RetransmissionTimerDL (per DL HARQ process except for the broadcast process): the maximum duration until a DL retransmission is received;

[218] - *drx*-RetransmissionTimerUL (per UL HARQ process): the maximum duration until a grant for UL retransmission is received;

[219] - *drx*-LongCycleStartOffset: the Long DRX cycle and *drx*-StartOffset which defines the subframe where the Long and Short DRX Cycle starts;

[220] - *drx*-ShortCycle (optional): the Short DRX cycle;

[221] - *drx*-ShortCycleTimer (optional): the duration the UE shall follow the Short DRX cycle;

[222] - *drx*-HARQ-RTT-TimerDL (per DL HARQ process except for the broadcast process): the minimum duration before a DL assignment for HARQ retransmission is expected by the MAC entity;

[223] - *drx*-HARQ-RTT-TimerUL (per UL HARQ process): the minimum duration before

a UL HARQ retransmission grant is expected by the MAC entity;

[224] - *ps*-Wakeup (optional): the configuration to start associated *drx*-onDurationTimer in case DCP is monitored but not detected;

[225] - *ps-Periodic_CSI_Transmit* (optional): the configuration to report periodic CSI during the time duration indicated by *drx*-onDurationTimer in case DCP is configured but associated *drx*-onDurationTimer is not started;

[226] - *ps*-TransmitPeriodicL1-RSRP (optional): the configuration to transmit periodic L1-RSRP report(s) during the time duration indicated by *drx*-onDurationTimer in case DCP is configured but associated *drx*-onDurationTimer is not started.

[227] When a DRX cycle is configured, the Active Time includes the time while:

[228] - *drx*-onDurationTimer or *drx*-InactivityTimer or *drx*-RetransmissionTimerDL or *drx*-RetransmissionTimerUL or *ra-ContentionResolutionTimer* is running; or

[229] - a Scheduling Request is sent on PUCCH and is pending; or

[230] - a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble.

[231] When DRX is configured, the MAC entity shall:

[232] 1> if a MAC PDU is received in a configured downlink assignment:

[233] 2> start the *drx*-HARQ-RTT-TimerDL for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback;

[234] 2> stop the *drx*-RetransmissionTimerDL for the corresponding HARQ process.

[235] 1> if a MAC PDU is transmitted in a configured uplink grant:

[236] 2> start the *drx*-HARQ-RTT-TimerUL for the corresponding HARQ process in the first symbol after the end of the first repetition of the corresponding PUSCH transmission;

[237] 2> stop the *drx*-RetransmissionTimerUL for the corresponding HARQ process.

[238] 1> if a *drx*-HARQ-RTT-TimerDL expires:

[239] 2> if the data of the corresponding HARQ process was not successfully decoded:

[240] 3> start the *drx*-RetransmissionTimerDL for the corresponding HARQ process in the first symbol after the expiry of *drx*-HARQ-RTT-TimerDL.

[241] 1> if a *drx*-HARQ-RTT-TimerUL expires:

[242] 2> start the *drx*-RetransmissionTimerUL for the corresponding HARQ process in the first symbol after the expiry of *drx*-HARQ-RTT-TimerUL.

[243] 1> if a DRX Command MAC CE or a Long DRX Command MAC CE is received:

[244] 2> stop *drx*-onDurationTimer;

[245] 2> stop *drx*-InactivityTimer.

[246] 1> if *drx*-InactivityTimer expires or a DRX Command MAC CE is received:

[247] 2> if the Short DRX cycle is configured:

[248] 3> start or restart *drx*-ShortCycleTimer in the first symbol after the expiry of *drx*- InactivityTimer or in the first symbol after the end of DRX Command MAC CE reception;

[249] 3> use the Short DRX Cycle.

[250] 2> else:

[251] 3> use the Long DRX cycle.

[252] 1> if *drx*-ShortCycleTimer expires:

[253] 2> use the Long DRX cycle.

[254] 1> if a Long DRX Command MAC CE is received:

[255] 2> stop *drx*-ShortCycleTimer;

[256] 2> use the Long DRX cycle.

[257] 1> if the Short DRX Cycle is used, and [(SFN × 10) + subframe number] modulo (*drx*-ShortCycle) = (*drx*-StartOffset) modulo (*drx*-ShortCycle):

[258] 2> start *drx*-onDurationTimer after *drx*-SlotOffset from the beginning of the subframe.

[259] 1> if the Long DRX Cycle is used, and [(SFN × 10) + subframe number] modulo (*drx*-LongCycle) = *drx*-StartOffset:

[260] 2> if DCP is configured for the active DL BWP:

[261] 3> if DCP indication associated with the current DRX Cycle received from lower layer indicated to start *drx*-onDurationTimer; or

[262] 3> if all DCP occasion(s) in time domain associated with the current DRX Cycle occurred in Active Time considering grants/assignments/DRX Command MAC CE/ Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to start of the last DCP occasion, or within BWP switching interruption length, or during a measurement gap; or

[263] 3> if *ps*-Wakeup is configured with value *true* and DCP indication associated with the current DRX Cycle has not been received from lower layers:

[264] 4> start *drx*-onDurationTimer after *drx*-SlotOffset from the beginning of the subframe.

[265] 2> else:

[266] 3> start *drx*-onDurationTimer after *drx*-SlotOffset from the beginning of the subframe.

[267] Note: In case of unaligned SFN across carriers in a cell group, the SFN of the SpCell is used to calculate the DRX duration.

[268] 1> if the MAC entity is in Active Time:

[269] 2> monitor the PDCCH;

[270] 2> if the PDCCH indicates a DL transmission:

[271] 3> start the *drx*-HARQ-RTT-TimerDL for the corresponding HARQ process in the first symbol after the end of the corresponding transmission carrying the DL HARQ feedback, regardless of LBT failure indication from lower layers;

[272] Note: When HARQ feedback is postponed by PDSCH-to-HARQ_feedback timing indicating a non-numerical k1 value, the corresponding transmission opportunity to send the DL HARQ feedback is indicated in a later PDCCH requesting the HARQ-ACK feedback.

[273] 3> stop the *drx*-RetransmissionTimerDL for the corresponding HARQ process.

[274] 3> if the PDSCH-to-HARQ_feedback timing indicate a non-numerical k1 value:

[275] 4> start the *drx*-RetransmissionTimerDL in the first symbol after the PDSCH transmission for the corresponding HARQ process.

[276] 2> if the PDCCH indicates a UL transmission:

[277] 3> start the *drx*-HARQ-RTT-TimerUL for the corresponding HARQ process in the first symbol after the end of the first repetition of the corresponding PUSCH transmission, regardless of LBT failure indication from lower layers;

[278] 3> stop the *drx*-RetransmissionTimerUL for the corresponding HARQ process.

[279] 2> if the PDCCH indicates a new transmission (DL or UL):

[280] 3> start or restart *drx*-InactivityTimer in the first symbol after the end of the PDCCH reception.

[281] 1> if DCP is configured for the active DL BWP; and

[282] 1> if the current symbol n occurs within *drx*-onDurationTimer duration; and

[283] 1> if *drx*-onDurationTimer associated with the current DRX cycle is not started; and

[284] 1> if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions:

[285] 2> not transmit periodic SRS and semi-persistent SRS;

[286] 2> not report semi-persistent CSI configured on PUSCH;

[287] 2> if *ps-Periodic_CSI_Transmit* is not configured with value *true*:

[288] 3> if *ps*-TransmitPeriodicL1-RSRP is not configured with value *true*:

[289] 4> not report periodic CSI on PUCCH.

[290] 3> else:

[291] 4> not report periodic CSI on PUCCH, except L1-RSRP report(s).

[292] 1> else:

[293] 2> in current symbol n, if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all

DRX Active Time conditions:

[294] 3> not transmit periodic SRS and semi-persistent SRS;

[295] 3> not report CSI on PUCCH and semi-persistent CSI configured on PUSCH.

[296] 2> if CSI masking (*csi*-Mask) is setup by upper layers:

[297] 3> in current symbol n, if *drx*-onDurationTimer would not be running considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received until 4 ms prior to symbol n when evaluating all DRX Active Time conditions:

[298] 4> not report CSI on PUCCH.

[299] Regardless of whether the MAC entity is monitoring PDCCH or not, the MAC entity transmits HARQ feedback, aperiodic CSI on PUSCH, and aperiodic SRS when such is expected.

[300] The MAC entity needs not to monitor the PDCCH if it is not a complete PDCCH occasion (e.g. the Active Time starts or ends in the middle of a PDCCH occasion).

[301] When UE performs sidelink reception, UE should monitor all slots configured for sidelink transmission because UE does not know when other UE will perform sidelink transmission in which UE is interested. Thus, UE may unnecessarily consume its power to monitor all slots.

[302] Meanwhile, it is discussed to support SL DRX for sidelink in 5G NR Rel-17. In this case, since the base station configures DL DRX, it may be preferable that the base station configures DL DRX with reference to SL DRX. However, the base station has a problem in that it is difficult to understand SL transmission not controlled by the base station, and it is difficult to align the DL DRX and SL DRX because the base station does not know the SL resource selected or reselected by UE.

[303] According to implementations of the present disclosure, a first UE may monitor PSCCH transmission(s) in SL active time to receive sidelink transmission from a second UE.

[304] According to implementations of the present disclosure, upon receiving indication to reselection of sidelink resources from the second UE, the first UE may adjust (or release or add) the SL active time to monitor the PSCCH transmissions.

[305] According to implementations of the present disclosure, upon receiving information on a cancelled, dropped and/or released sidelink transmission from the second UE, the first UE may skip monitoring the PSCCH transmission corresponding to the cancelled, dropped or released sidelink transmission.

[306] The following drawings are created to explain specific embodiments of the present disclosure. The names of the specific devices or the names of the specific signals/ messages/fields shown in the drawings are provided by way of example, and thus the technical features of the present disclosure are not limited to the specific names used in

the following drawings.

[307] FIG. 10 shows an example of a method performed by a first wireless device to which implementation of the present disclosure is applied.

[308] In step S1000, the method includes monitoring first PSCCH transmissions from the second wireless device in a SL active time for SL DRX.

[309] In step S1010, the method includes receiving, from the second wireless device, an indication to reselection of sidelink resources.

[310] In step S1020, the method includes adjusting (or releasing/adding) the SL active time based on the indication.

[311] In step S1030, the method includes monitoring second PSCCH transmissions from the second wireless device in the adjusted SL active time.

[312] In step S1040, the method includes receiving, from the second wireless device, sidelink transmission scheduled by the second PSSCH transmissions.

[313] In some implementations, information on a cancelled, dropped and/or released sidelink transmission may be received from the second wireless device. Monitoring third PSCCH transmissions from the second wireless device corresponding to the cancelled, dropped and/or released sidelink transmission may be skipped. Information on a duration for the skipped monitoring of the third PSCCH transmissions may be informed to the second wireless device and/or a network. That is, the PSCCH duration for the skipped transmission may be informed to the second wireless device and/or a network.

[314] In some implementations, based on third PSCCH transmissions indicating a higher priority value than a priority value of an overlapped transmission and/or the third PSCCH transmissions indicating that sidelink transmission scheduled by the third PSCCH transmissions is deprioritized or not prioritized, monitoring the sidelink transmission scheduled by the third PSCCH transmissions may be skipped. In other words, if the PSCCH transmission indicates a higher priority value than the priority value of an overlapped transmission or reception, and/or if the PSCCH transmission indicates that the corresponding PSSCH transmission is deprioritized or not prioritized, the method may include skipping monitoring the corresponding PSSCH transmission.

[315] In some implementations, one or more pools of resource may be configured by a network. That is, the first wireless device may be configured with one or more pools of resources.

[316] In some implementations, information on the SL DRX on one of the one or more pools of resource may be received from the second wireless device. The information on the SL DRX may be received from the second wireless device via a first stage Sidelink Control Information (SCI) on a PSCCH, a second stage SCI on the PSSCH or a MAC CE on a PSSCH. The information on the SL DRX may include at least one of

i) PSCCH durations for one or more next transmissions from the second wireless device performing periodic transmissions, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[317] In some implementations, the information on the SL DRX may be informed to the network. The information on the SL DRX may be informed to the network via a RRC message or UCI or a MAC CE. The information on the SL DRX may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection.

[318] In some implementations, the method may include receiving DL DRX configuration from the network. The method may include receiving SL DRX configuration from the network and/or the second wireless device. Both the DL DRX configuration and the SL DRX configuration may not be overlapped in time. The SL DRX configuration may be provided for each destination, each pair of source/destination and/or each PC5-RRC connection. Thus, a list of SL DRX configurations may be received. Each SL DRX configuration may be applied to the corresponding destination, corresponding pair of source/destination and/or corresponding PC5-RRC connection.

[319] In some implementations, the method may include monitoring PDCCH according to the DL DRX configuration while monitors SCIs on PSCCH according to the SL DRX configuration.

[320] In some implementations, the method may include considering the PSCCH duration(s) as the SL active time for SL DRX. Based on one of PSCCH durations determined by the SL DRX configuration being overlapped with one of PDCCH durations determined by the DL DRX configuration, the overlapped PSCCH duration may be not included in the SL active time for SL DRX. In other words, if one of the PSCCH durations determined is overlapped with one of PDCCH durations determined by the DL DRX configuration, the overlapped PSCCH duration may not be included in the SL active time. Thus, PSCCH may not be monitored in the overlapped PSCCH duration.

[321] In some implementations, the first wireless device may be in communication with at least one of a mobile device, a network, and/or autonomous vehicles other than the first wireless device.

[322] Furthermore, the method in perspective of the first wireless device described above in FIG. 10 may be performed by the first wireless device 100 shown in FIG. 2, the wireless device 100 shown in FIG. 3, and/or the UE 100 shown in FIG. 4.

[323] More specifically, the first wireless device comprises at least one transceiver, at least one processor, and at least one memory operably connectable to the at least one processor and storing instructions that, based on being executed by the at least one

processor, perform operations below.

[324] The first wireless device monitors, via the at least one transceiver, first PSCCH transmissions from the second wireless device in a SL active time for SL DRX.

[325] The first wireless device receives, from the second wireless device via the at least one transceiver, an indication to reselection of sidelink resources.

[326] The first wireless device adjusts the SL active time based on the indication.

[327] The first wireless device monitors, via the at least one transceiver, second PSCCH transmissions from the second wireless device in the adjusted SL active time.

[328] The first wireless device receives, from the second wireless device via the at least one transceiver, sidelink transmission scheduled by the second PSSCH transmissions.

[329] In some implementations, information on a cancelled, dropped and/or released sidelink transmission may be received from the second wireless device. Monitoring third PSCCH transmissions from the second wireless device corresponding to the cancelled, dropped and/or released sidelink transmission may be skipped. Information on a duration for the skipped monitoring of the third PSCCH transmissions may be informed to the second wireless device and/or a network. That is, the PSCCH duration for the skipped transmission may be informed to the second wireless device and/or a network.

[330] In some implementations, based on third PSCCH transmissions indicating a higher priority value than a priority value of an overlapped transmission and/or the third PSCCH transmissions indicating that sidelink transmission scheduled by the third PSCCH transmissions is deprioritized or not prioritized, monitoring the sidelink transmission scheduled by the third PSCCH transmissions may be skipped. In other words, if the PSCCH transmission indicates a higher priority value than the priority value of an overlapped transmission or reception, and/or if the PSCCH transmission indicates that the corresponding PSSCH transmission is deprioritized or not prioritized, the first wireless device may skip monitoring the corresponding PSSCH transmission.

[331] In some implementations, one or more pools of resource may be configured by a network. That is, the first wireless device may be configured with one or more pools of resources.

[332] In some implementations, information on the SL DRX on one of the one or more pools of resource may be received from the second wireless device. The information on the SL DRX may be received from the second wireless device via a first stage Sidelink Control Information (SCI) on a PSCCH, a second stage SCI on the PSSCH or a MAC CE on a PSSCH. The information on the SL DRX may include at least one of i) PSCCH durations for one or more next transmissions from the second wireless device performing periodic transmissions, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized

or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[333] In some implementations, the information on the SL DRX may be informed to the network. The information on the SL DRX may be informed to the network via a RRC message or UCI or a MAC CE. The information on the SL DRX may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection.

[334] In some implementations, the first wireless device may receive DL DRX configuration from the network. The first wireless device may receive SL DRX configuration from the network and/or the second wireless device. Both the DL DRX configuration and the SL DRX configuration may not be overlapped in time. The SL DRX configuration may be provided for each destination, each pair of source/destination and/or each PC5-RRC connection. Thus, a list of SL DRX configurations may be received. Each SL DRX configuration may be applied to the corresponding destination, corresponding pair of source/destination and/or corresponding PC5-RRC connection.

[335] In some implementations, the first wireless device may monitor PDCCH according to the DL DRX configuration while monitors SCIs on PSCCH according to the SL DRX configuration.

[336] In some implementations, the first wireless device may consider the PSCCH duration(s) as the SL active time for SL DRX. Based on one of PSCCH durations determined by the SL DRX configuration being overlapped with one of PDCCH durations determined by the DL DRX configuration, the overlapped PSCCH duration may be not included in the SL active time for SL DRX. In other words, if one of the PSCCH durations determined is overlapped with one of PDCCH durations determined by the DL DRX configuration, the overlapped PSCCH duration may not be included in the SL active time. Thus, PSCCH may not be monitored in the overlapped PSCCH duration.

[337] Furthermore, the method in perspective of the first wireless device described above in FIG. 10 may be performed by control of the processor 102 included in the first wireless device 100 shown in FIG. 2, by control of the communication unit 110 and/or the control unit 120 included in the wireless device 100 shown in FIG. 3, and/or by control of the processor 102 included in the UE 100 shown in FIG. 4.

[338] More specifically, a processing apparatus operating in a wireless communication system (e.g., first wireless device) comprises at least one processor, and at least one memory operably connectable to the at least one processor. The at least one processor is configured to perform operations comprising: monitoring first PSCCH transmissions in a SL active time for SL DRX, obtaining an indication to reselection of sidelink resources, adjusting the SL active time based on the indication, and monitoring second

PSCCH transmissions in the adjusted SL active time.

[339] Furthermore, the method in perspective of the first wireless device described above in FIG. 10 may be performed by a software code 105 stored in the memory 104 included in the first wireless device 100 shown in FIG. 2.

[340] The technical features of the present disclosure may be embodied directly in hardware, in a software executed by a processor, or in a combination of the two. For example, a method performed by a wireless device in a wireless communication may be implemented in hardware, software, firmware, or any combination thereof. For example, a software may reside in RAM, flash memory, ROM, EPROM, EEPROM, registers, hard disk, a removable disk, a CD-ROM, or any other storage medium.

[341] Some example of storage medium may be coupled to the processor such that the processor can read information from the storage medium. In the alternative, the storage medium may be integral to the processor. The processor and the storage medium may reside in an ASIC. For other example, the processor and the storage medium may reside as discrete components.

[342] The computer-readable medium may include a tangible and non-transitory computer-readable storage medium.

[343] For example, non-transitory computer-readable media may include RAM such as synchronous dynamic random access memory (SDRAM), ROM, non-volatile random access memory (NVRAM), EEPROM, flash memory, magnetic or optical data storage media, or any other medium that can be used to store instructions or data structures. Non-transitory computer-readable media may also include combinations of the above.

[344] In addition, the method described herein may be realized at least in part by a computer-readable communication medium that carries or communicates code in the form of instructions or data structures and that can be accessed, read, and/or executed by a computer.

[345] According to some implementations of the present disclosure, a non-transitory computer-readable medium (CRM) has stored thereon a plurality of instructions.

[346] More specifically, at least one CRM stores instructions that, based on being executed by at least one processor, perform operations comprising: monitoring first PSCCH transmissions in a SL active time for SL DRX, obtaining an indication to reselection of sidelink resources, adjusting the SL active time based on the indication, and monitoring second PSCCH transmissions in the adjusted SL active time.

[347] FIG. 11 shows an example of a method performed by a second wireless device to which implementation of the present disclosure is applied.

[348] In step S1100, the method includes transmitting, to a first wireless device, first PSCCH transmissions in a SL active time for SL DRX.

[349] In step S1110, the method includes transmitting, to the first wireless device, an in-

dication to reselection of sidelink resources. The SL active time for SL DRX is adjusted based on the indication.

[350] In step S1120, the method includes transmitting, to the first wireless device, second PSCCH transmissions in the adjusted SL active time.

[351] In step S1130, the method includes transmitting, to the first wireless device, sidelink transmission scheduled by the second PSSCH transmissions.

[352] In some implementations, the sidelink transmission may be cancelled, dropped and/or released over at least one of reserved resources due to resource reselection, prioritization, sidelink congestion control, pre-emption and/or reevaluation of the reserved resources. In other words, the method may include canceling sidelink transmission over at least one of the reserved resources and/or clearing at least one of the reserved resources due to e.g., resource reselection, prioritization, sidelink congestion control, pre-emption and/or reevaluation of a reserved resource. In this case, information on the cancelled, dropped and/or released sidelink transmission may be transmitted to the first wireless device and/or to a network.

[353] In some implementations, one or more pools of resource may be configured by a network. One of the one or more pools of resource may be selected. For sidelink resource allocation mode 2 (i.e., UE autonomous resource selection), the method may include reserving one or more resources on the selected pool of resources for sidelink transmission only within time durations determined by a SL DRX configuration. Then, if more resources are needed to be reserved, the method include reserving one or more resources outside the time durations. For sidelink resource allocation mode 1 (i.e., scheduled resource allocation), the second wireless device may be configured with one or more grants such as configured grant(s) or dynamic grant(s) on a particular pool of resources selected by the network for sidelink transmission. The grant may be given by the network.

[354] In some implementations, the method may include determining SL DRX information based on the reserved resources and/or the given grants. The method may include transmitting the determined SL DRX information to the first wireless device and/or the network. The determined SL DRX information may be transmitted to the first wireless device and/or the network on the selected pool of resources.

[355] In some implementations, the SL DRX information may be transmitted to the first wireless device via a first stage SCI on a PSCCH, a second stage SCI on the PSSCH or a MAC CE on a PSSCH. The SL DRX information may be transmitted to the network via a RRC message or UCI or a MAC CE. The information on the SL DRX may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection. The SL DRX information may include at least one of i) PSCCH durations for one or more next transmissions from the second wireless device performing

periodic transmissions, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[356] Furthermore, the method in perspective of the second wireless device described above in FIG. 11 may be performed by the second wireless device 200 shown in FIG. 2, the wireless device 100 shown in FIG. 3, and/or the UE 100 shown in FIG. 4.

[357] More specifically, the second wireless device comprises at least one transceiver, at least one processor, and at least one memory operably connectable to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations below.

[358] The second wireless device transmits, to a first wireless device via the at least one transceiver, first PSCCH transmissions in a SL active time for SL DRX.

[359] The second wireless device transmits, to the first wireless device via the at least one transceiver, an indication to reselection of sidelink resources. The SL active time for SL DRX is adjusted based on the indication.

[360] The second wireless device transmits, to the first wireless device via the at least one transceiver, second PSCCH transmissions in the adjusted SL active time.

[361] The second wireless device transmits, to the first wireless device via the at least one transceiver, sidelink transmission scheduled by the second PSSCH transmissions.

[362] In some implementations, the sidelink transmission may be cancelled, dropped and/or released over at least one of reserved resources due to resource reselection, prioritization, sidelink congestion control, pre-emption and/or reevaluation of the reserved resources. In other words, the second wireless device may cancel sidelink transmission over at least one of the reserved resources and/or clear at least one of the reserved resources due to e.g., resource reselection, prioritization, sidelink congestion control, pre-emption and/or reevaluation of a reserved resource. In this case, information on the cancelled, dropped and/or released sidelink transmission may be transmitted to the first wireless device and/or to a network.

[363] In some implementations, one or more pools of resource may be configured by a network. One of the one or more pools of resource may be selected. For sidelink resource allocation mode 2 (i.e., UE autonomous resource selection), the second wireless device reserve one or more resources on the selected pool of resources for sidelink transmission only within time durations determined by a SL DRX configuration. Then, if more resources are needed to be reserved, the second wireless device may reserve one or more resources outside the time durations. For sidelink resource allocation mode 1 (i.e., scheduled resource allocation), the second wireless device may be configured with one or more grants such as configured grant(s) or

dynamic grant(s) on a particular pool of resources selected by the network for sidelink transmission. The grant may be given by the network.

[364] In some implementations, the second wireless device may determine SL DRX information based on the reserved resources and/or the given grants. The second wireless device may transmits the determined SL DRX information to the first wireless device and/or the network. The determined SL DRX information may be transmitted to the first wireless device and/or the network on the selected pool of resources.

[365] In some implementations, the SL DRX information may be transmitted to the first wireless device via a first stage SCI on a PSCCH, a second stage SCI on the PSSCH or a MAC CE on a PSSCH. The SL DRX information may be transmitted to the network via a RRC message or UCI or a MAC CE. The information on the SL DRX may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection. The SL DRX information may include at least one of i) PSCCH durations for one or more next transmissions from the second wireless device performing periodic transmissions, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[366] Furthermore, the method in perspective of the second wireless device described above in FIG. 11 may be performed by control of the processor 202 included in the second wireless device 200 shown in FIG. 2, by control of the communication unit 110 and/or the control unit 120 included in the wireless device 100 shown in FIG. 3, and/or by control of the processor 102 included in the UE 100 shown in FIG. 4.

[367] More specifically, a processing apparatus operating in a wireless communication system (e.g., second wireless device) comprises at least one processor, and at least one memory operably connectable to the at least one processor. The at least one processor is configured to perform operations comprising: generating first PSCCH transmissions in a SL active time for SL DRX, generating an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication, and generating second PSCCH transmissions in the adjusted SL active time.

[368] Furthermore, the method in perspective of the second wireless device described above in FIG. 11 may be performed by a software code 205 stored in the memory 204 included in the second wireless device 200 shown in FIG. 2.

[369] More specifically, at least one CRM stores instructions that, based on being executed by at least one processor, perform operations comprising: generating first PSCCH transmissions in a SL active time for SL DRX, generating an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication, and generating second PSCCH transmissions in the adjusted SL active time.

[370] FIGS. 12 and 13 shows an example of sidelink transmission and sidelink reception to which implementation of the present disclosure is applied.

[371] First, FIG. 12 is described.

[372] In step S1200, the network may transmit system information including resource pool configuration to TX UE and RX UE. According to the resource pool configuration, TX UE and RX UE may be configured with one or more pools of resources.

[373] In step S1202 and S1204, TX UE and RX UE may establish a PC5-RRC connection with each other for a pair of source and destination. TX UE may transmit Direct Communication Request to RX UE, and RX UE may transmit Direct Communication Response to TX UE.

[374] In step S1206, TX UE may select one pool of resources.

[375] In some implementations, for sidelink mode 2 (i.e., UE autonomous resource selection), TXX UE may reserve one or more resources on the selected pool of resources for sidelink transmission only within time durations determined by the SL DRX configuration (e.g., first SL DRX configuration which can be received from the network). Then, if TX UE needs to reserve more resources, TX UE may reserve one or more resources outside the time durations.

[376] In some implementations, for sidelink mode 1 (i.e., scheduled resource allocation), TX UE may be configured with one or more grants such as configured grant(s) or dynamic grant(s) on a particular pool of resources selected by the network for sidelink transmission. The grant may be given by the network.

[377] In step S1208, TX UE may determine SL DRX configuration/information (e.g., the second SL DRX configuration) based on the reserved resources and/or the given grants, and send determined SL DRX configuration/information to the network.

[378] In some implementations, if the network provides the first SL DRX configuration and TX UE determines the second SL DRX configuration for the same destination, same pair of source/destination and/or same PC5-RRC connection, TX UE may determine time durations (e.g., SL active time) as the determined SL DRX information according to first and second SL DRX configurations.

[379] In some implementations, TX UE may determine the first set of time durations according to the first SL DRX configuration and the second set of time durations according to the second SL DRX configuration. Then, TX UE may only monitor time durations overlapped by both the first and second sets of time durations. Alternatively, TX UE may monitor the first set of time durations and the overlapped time durations. Or, (if the other UE is relay UE) TX UE may monitor the second set of time durations and the overlapped time durations. Or, (if the other UE is relay UE) TX UE may monitor both the first set and the second set of time durations. The time duration may be at least PSCCH duration.

[380] In some implementations, TX UE may indicate the determined SL DRX information on the selected pool of resources to the network. The SL DRX information may be transmitted to the network via a RRC message or UCI or MAC CE. The SL DRX information may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection. The SL DRX information may include PSCCH duration(s) for one or more next transmissions from TX UE performing periodic transmissions. The SL DRX information may include the priority of corresponding PSSCH transmission and/or whether the corresponding PSSCH transmission is prioritized or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[381] In step S1210, TX UE may receive RRC reconfiguration message including DL DRX configuration and/or SL DRX configuration from the network.

[382] In step S1212, TX UE may receive a configured grant activation from the network.

[383] In step S1214, TX UE may determine SL DRX configuration/information based on the reserved resources or the given grants and send the determined SL DRX configuration/information to RX UE. TX UE may indicate the SL DRX configuration/information on the selected pool of resources to RX UE.

[384] In some implementations, the SL DRX information may be transmitted to RX UE via 1st stage SCI on PSCCH, 2nd stage SCI on PSSCH or a MAC CE on PSSCH. In some implementations, the SL DRX information may include PSCCH duration(s) for one or more next transmissions from TX UE performing periodic transmissions. In some implementations, the SL DRX information may include the priority of corresponding PSSCH transmission and/or the whether the corresponding PSSCH transmission is prioritized or not. The corresponding PSSCH transmission may be either the PSSCH transmission scheduled by the PSCCH and/or a next PSSCH transmission reserved by the PSCCH.

[385] In some implementations, TX UE may indicate at least one of the following information to RX UE for SL DRX operation:

[386] - An indication to activation and/or deactivation (or release) of a particular pool of resources, i.e., pool index;

[387] - An indication to either transmissions of multiple MAC PDU or transmission of single MAC PDU;

[388] - An indication to Sidelink resource allocation mode 1 or Sidelink resource allocation mode 2 for the pool of resources;

[389] - The resource reservation interval(s) used for a resource reservation procedure on the pool of resources;

[390] - The number(s) of HARQ retransmissions used for a resource reservation procedure on the pool of resources;

[391] - The Modulation and Coding Scheme (MCS) value(s) used for transmission of a particular MAC PDU on the pool of resources;

[392] - The number of symbols in a slot used for a resource reservation procedure on the pool of resources;

[393] - The value(s) of SL_RESOURCE_RESELECTION_COUNTER used for a resource reservation procedure on the pool of resources;

[394] - The value of sl-ReselectAfter used for triggering a resource reselection on the pool of resources;

[395] - The value of any parameter used for resource reservation or resource reselection on the pool of resources; and/or

[396] - PUCCH resource configuration used by other UE

[397] In step S1216, RX UE may inform the network about the received SL DRX information.

[398] In some implementations, the SL DRX information may be transmitted to the network via a RRC message or UCI or MAC CE. The SL DRX information may be constructed for each destination, each pair of source/destination and/or each PC5-RRC connection.

[399] In step 1218, RX UE may receive DL DRX configuration from the network. RX UE may receive SL DRX configuration from the network (and/or from TX UE). Both configurations may not be overlapped in time.

[400] In some implementations, the SL DRX configuration may be provided for each destination, each pair of source/destination and/or each PC5-RRC connection. Thus, RX UE may receive a list of SL DRX configurations. Each SL DRX configuration may be applied to the corresponding destination, corresponding pair of source/destination and/or corresponding PC5-RRC connection.

[401] In step S1220, RX UE may monitor PDCCH according to the DL DRX configuration while monitors SCIs on PSCCH according to the SL DRX configuration. The time duration may be at least PSCCH duration.

[402] Now, FIG. 13 whose operation follows the operation of FIG. 12 is described.

[403] In step S1300, TX UE may perform sidelink transmission to RX UE by using one of the reserved resources.

[404] In step S1302, RX UE may consider the PSCCH duration(s) as a SL active time for sidelink reception from TX UE. RX UE may monitor PSCCH transmission(s) in the SL active time to receive sidelink transmission from RX UE.

[405] In some implementations, if RX UE receives an indication to reselection of sidelink resources from TX UE, TX UE may adjust (or release and add) the SL active time to monitor the PSCCH transmissions. For example, RX UE can receive at least one of the following information via, e.g., SCI from TX UE for SL DRX operation.

[406] - An indication to activation or deactivation (or release) of a particular pool of resources, i.e., pool index: If the indication to activation is received, RX UE may start to monitor PSCCH on the pool of resources for TX UE. If the indication to deactivation is received, RX UE may stop monitoring PSCCH on the pool of resources for TX UE.

[407] - An indication to either transmissions of multiple MAC PDU or transmission of single MAC PDU: If the indication to transmission of multiple MAC PDUs is received, RX UE may periodically monitor PSCCH transmissions on the pool of resources from TX UE. If the indication to transmission of a single MAC PDU is received, TX UE may monitor PSCCH transmissions of a TB on the pool of resources from TX UE. If the TB is successfully received and/or RX UE sends ACK to the TB on PSFCH to TX UE, RX UE may stop monitoring PSCCH transmissions on the pool of resources from TX UE.

[408] - An indication to Sidelink resource allocation mode 1 or Sidelink resource allocation mode 2 for the pool of resources;

[409] - The resource reservation interval(s) used for a resource reservation procedure on the pool of resources: RX UE may periodically monitor PSCCH transmissions according to the resource reservation interval on the pool of resources from TX UE.

[410] - The number(s) of HARQ retransmissions used for a resource reservation procedure on the pool of resources: RX UE may periodically monitor retransmissions according to the number(s) of HARQ retransmissions on the pool of resources from TX UE.

[411] - The MCS value(s) used for transmission of a particular MAC PDU on the pool of resources.

[412] - The number of symbols in a slot used for a resource reservation procedure on the pool of resources: RX UE may monitor PSCCH transmissions according to the number(s) of symbols on the pool of resources from TX UE.

[413] - The value(s) of SL_RESOURCE_RESELECTION_COUNTER used for a resource reservation procedure on the pool of resources: RX UE may periodically monitor PSCCH transmissions according to the resource reservation interval on the pool of resources from TX UE up to the value of SL_RESOURCE_RESELECTION_COUNTER.

[414] - The value of sl-ReselectAfter used for triggering a resource reselection on the pool of resources: If RX UE consecutively detects no PSCCH transmissions in the SL active time according to the value of sl-ReselectAfter on the pool of resources from TX UE, RX UE may stop monitoring PSCCH on the pool of resources from TX UE.

[415] - The value of any parameter used for resource reservation or resource reselection on the pool of resources: RX UE may determine whether to stop monitoring PSCCH on the pool of resources from TX UE based on the value of the parameter.

[416] - PUCCH resource configuration used by other UE: If PUCCH resource is allocated within the SL active time, RX UE may not monitor PSCCH transmission colliding with the PUCCH resource.

[417] In steps S1304 and S1306, RX UE may receive sidelink transmission from TX UE by using one of the reserved resources in the adjusted SL active time. In step S1308, RX UE may receive PDCCH/PDSCH transmission from the network.

[418] In step S1310, TX UE may cancel sidelink transmission over at least one of the reserved resources and/or clear at least one of the reserved resources due to e.g., resource reselection, prioritization, sidelink congestion control, pre-emption or reevaluation of a reserved resource.

[419] In step S1312, TX UE may indicate the cancelled, dropped and/or released sidelink transmission to RX UE (and/or to the network).

[420] In step S1314, if RX UE receives a cancelled, dropped and/or released sidelink transmission from TX UE, RX UE may skip monitoring the PSCCH transmission corresponding to the cancelled, dropped and/or released sidelink transmission.

[421] In some implementations, if the PSCCH transmission indicates a higher priority value than the priority value of an overlapped transmission or reception, and/or if the PSCCH transmission indicates that the corresponding PSSCH transmission is deprioritized or not prioritized, RX receiving UE may skip monitoring the corresponding PSSCH transmission.

[422] In step S1316, RX UE may inform the network (and/or TX UE) about updated SL DRX information including the PSCCH duration for the skipped transmission.

[423] The present disclosure can have various advantageous effects.

[424] For example, the SL active time can be adjusted or increased or decreased according to the SL resource selection or reselection of the other UE to prevent unnecessary SL reception and missed SL transmission.

[425] For example, UE performing transmission or reception on a pool of resources can save UE power, in particular when UE determines whether to monitor sidelink transmission on the pool of resources based on allocated resources.

[426] For example, the system can properly provide power-efficient sidelink reception based on allocated resources.

[427] Advantageous effects which can be obtained through specific embodiments of the present disclosure are not limited to the advantageous effects listed above. For example, there may be a variety of technical effects that a person having ordinary skill in the related art can understand and/or derive from the present disclosure. Accordingly, the specific effects of the present disclosure are not limited to those explicitly described herein, but may include various effects that may be understood or derived from the technical features of the present disclosure.

[428] Claims in the present disclosure can be combined in a various way. For instance, technical features in method claims of the present disclosure can be combined to be implemented or performed in an apparatus, and technical features in apparatus claims can be combined to be implemented or performed in a method. Further, technical features in method claim(s) and apparatus claim(s) can be combined to be implemented or performed in an apparatus. Further, technical features in method claim(s) and apparatus claim(s) can be combined to be implemented or performed in a method. Other implementations are within the scope of the following claims.

Claims

[Claim 1] A method performed by a first wireless device operating in a wireless communication system, the method comprising:
monitoring first Physical Sidelink Control Channel (PSCCH) transmissions from the second wireless device in a Sidelink (SL) active time for SL Discontinuous Reception (DRX);
receiving, from the second wireless device, an indication to reselection of sidelink resources;
adjusting the SL active time based on the indication;
monitoring second PSCCH transmissions from the second wireless device in the adjusted SL active time; and
receiving, from the second wireless device, sidelink transmission scheduled by the second PSSCH transmissions.

[Claim 2] The method of claim 1, wherein information on a cancelled, dropped and/or released sidelink transmission is received from the second wireless device.

[Claim 3] The method of claim 2, wherein monitoring third PSCCH transmissions from the second wireless device corresponding to the cancelled, dropped and/or released sidelink transmission is skipped.

[Claim 4] The method of claim 3, wherein information on a duration for the skipped monitoring of the third PSCCH transmissions is informed to the second wireless device and/or a network.

[Claim 5] The method of claim 1, wherein, based on third PSCCH transmissions indicating a higher priority value than a priority value of an overlapped transmission and/or the third PSCCH transmissions indicating that sidelink transmission scheduled by the third PSCCH transmissions is deprioritized or not prioritized, monitoring the sidelink transmission scheduled by the third PSCCH transmissions is skipped.

[Claim 6] The method of claim 1, wherein one or more pools of resource is configured by a network, and
wherein information on the SL DRX on one of the one or more pools of resource is received from the second wireless device via a first stage Sidelink Control Information (SCI) on a PSCCH, a second stage SCI on the PSSCH or a Media Access Control (MAC) Control Element (CE) on a Physical Sidelink Shared Channel (PSSCH).

[Claim 7] The method of claim 6, wherein the received information on the SL DRX includes at least one of i) PSCCH durations for one or more next transmissions from the second wireless device, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized or not.

[Claim 8] The method of claim 6, wherein the received information on the SL DRX is informed to the network via a Radio Resource Control (RRC) message or Uplink Control Information (UCI) or a MAC CE.

[Claim 9] The method of claim 1, wherein a Downlink (DL) DRX configuration and a SL DRX configuration are received,
wherein a Physical Downlink Control Channel (PDCCH) is monitored based on the DL DRX configuration, and
wherein the first PSCCH transmissions and/or the second PSCCH transmissions are monitored based on the SL DRX configuration.

[Claim 10] The method of claim 9, wherein, based on one of PSCCH durations determined by the SL DRX configuration being overlapped with one of PDCCH durations determined by the DL DRX configuration, the overlapped PSCCH duration is not included in the SL active time for SL DRX.

[Claim 11] The method of claim 1, wherein the first wireless device is in communication with at least one of a mobile device, a network, and/or autonomous vehicles other than the first wireless device.

[Claim 12] A first wireless device operating in a wireless communication system, the first wireless device comprising:
at least one transceiver;
at least processor; and
at least one memory operably connectable to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising:
monitoring, via the at least one transceiver, first Physical Sidelink Control Channel (PSCCH) transmissions from the second wireless device in a Sidelink (SL) active time for SL Discontinuous reception (DRX);
receiving, from the second wireless device via the at least one transceiver, an indication to reselection of sidelink resources;
adjusting the SL active time based on the indication;
monitoring, via the at least one transceiver, second PSCCH transmissions from the second wireless device in the adjusted SL active time; and
receiving, from the second wireless device via the at least one

transceiver, sidelink transmission scheduled by the second PSSCH transmissions.

[Claim 13] The first wireless device of claim 12, wherein information on a cancelled, dropped and/or released sidelink transmission is received from the second wireless device.

[Claim 14] The first wireless device of claim 13, wherein monitoring third PSCCH transmissions from the second wireless device corresponding to the cancelled, dropped and/or released sidelink transmission is skipped.

[Claim 15] A processing apparatus operating in a wireless communication system, the processing apparatus comprising:
at least one processor; and
at least one memory operably connectable to the at least one processor, wherein the at least one processor is configured to perform operations comprising:
monitoring first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous reception (DRX);
obtaining an indication to reselection of sidelink resources;
adjusting the SL active time based on the indication; and
monitoring second PSCCH transmissions in the adjusted SL active time.

[Claim 16] A computer readable medium (CRM) storing instructions that, based on being executed by at least one processor, perform operations comprising:
monitoring first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous reception (DRX);
obtaining an indication to reselection of sidelink resources;
adjusting the SL active time based on the indication; and
monitoring second PSCCH transmissions in the adjusted SL active time.

[Claim 17] A method performed by a second wireless device operating in a wireless communication system, the method comprising:
transmitting, to a first wireless device, first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous Reception (DRX);
transmitting, to the first wireless device, an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted

based on the indication;
transmitting, to the first wireless device, second PSCCH transmissions in the adjusted SL active time; and
transmitting, to the first wireless device, sidelink transmission scheduled by the second PSSCH transmissions.

[Claim 18] The method of claim 17, wherein the sidelink transmission is cancelled, dropped and/or released over at least one of reserved resources due to resource reselection, prioritization, sidelink congestion control, pre-emption and/or reevaluation of the reserved resources.

[Claim 19] The method of claim 18, wherein information on the cancelled, dropped and/or released sidelink transmission is transmitted to the first wireless device and/or to a network.

[Claim 20] The method of claim 17, wherein one or more pools of resource is configured by a network, and
wherein one of the one or more pools of resource is selected.

[Claim 21] The method of claim 20, wherein one or more resources is reserved on the selected pool of resource within time durations determined by a SL DRX configuration, in an autonomous resource selection mode.

[Claim 22] The method of claim 20, wherein one or more grants is configured on the selected pool of resource in a scheduled resource allocation mode.

[Claim 23] The method of claim 20, wherein information on the SL DRX is determined, and
wherein the information on the SL DRX is indicated to the first wireless device and/or a network on the selected pool of resource.

[Claim 24] The method of claim 23, wherein the information on the SL DRX is indicated to the first wireless device via a first stage Sidelink Control Information (SCI) on a PSCCH, a second stage SCI on the PSSCH or a Media Access Control (MAC) Control Element (CE) on a Physical Sidelink Shared Channel (PSSCH).

[Claim 25] The method of claim 23, wherein the information on the SL DRX is indicated to the network via a Radio Resource Control (RRC) message or Uplink Control Information (UCI) or a MAC CE.

[Claim 26] The method of claim 23, wherein the information on the SL DRX includes at least one of i) PSCCH durations for one or more next transmissions from the second wireless device, ii) a priority of a corresponding PSSCH transmission, and/or iii) whether the corresponding PSSCH transmission is prioritized or not.

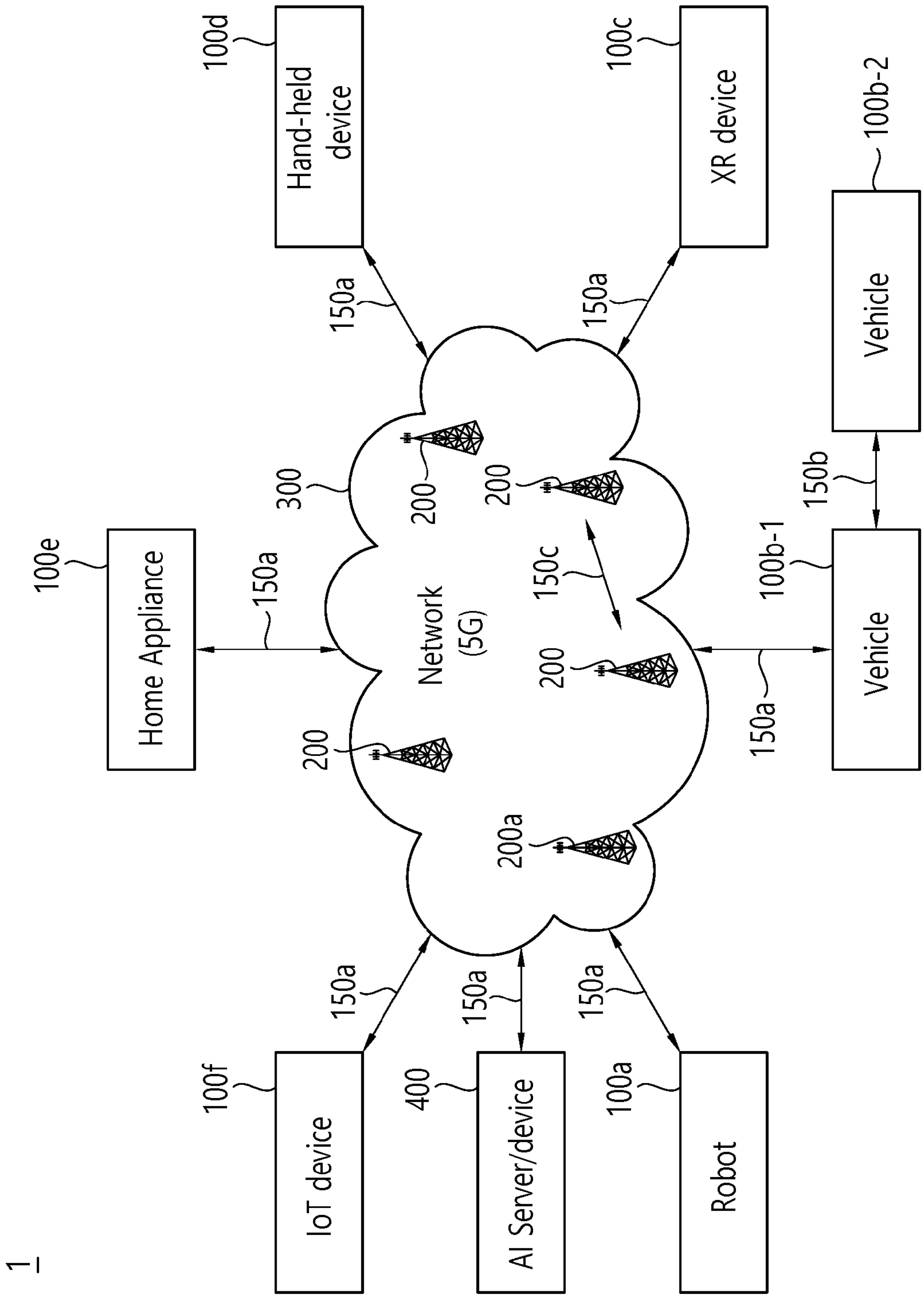
[Claim 27] A second wireless device operating in a wireless communication

system, the second wireless device comprising:
at least one transceiver;
at least processor; and
at least one memory operably connectable to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising:
transmitting, to a first wireless device via the at least one transceiver, first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous Reception (DRX);
transmitting, to the first wireless device via the at least one transceiver, an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication;
transmitting, to the first wireless device via the at least one transceiver, second PSCCH transmissions in the adjusted SL active time; and
transmitting, to the first wireless device via the at least one transceiver, sidelink transmission scheduled by the second PSSCH transmissions.

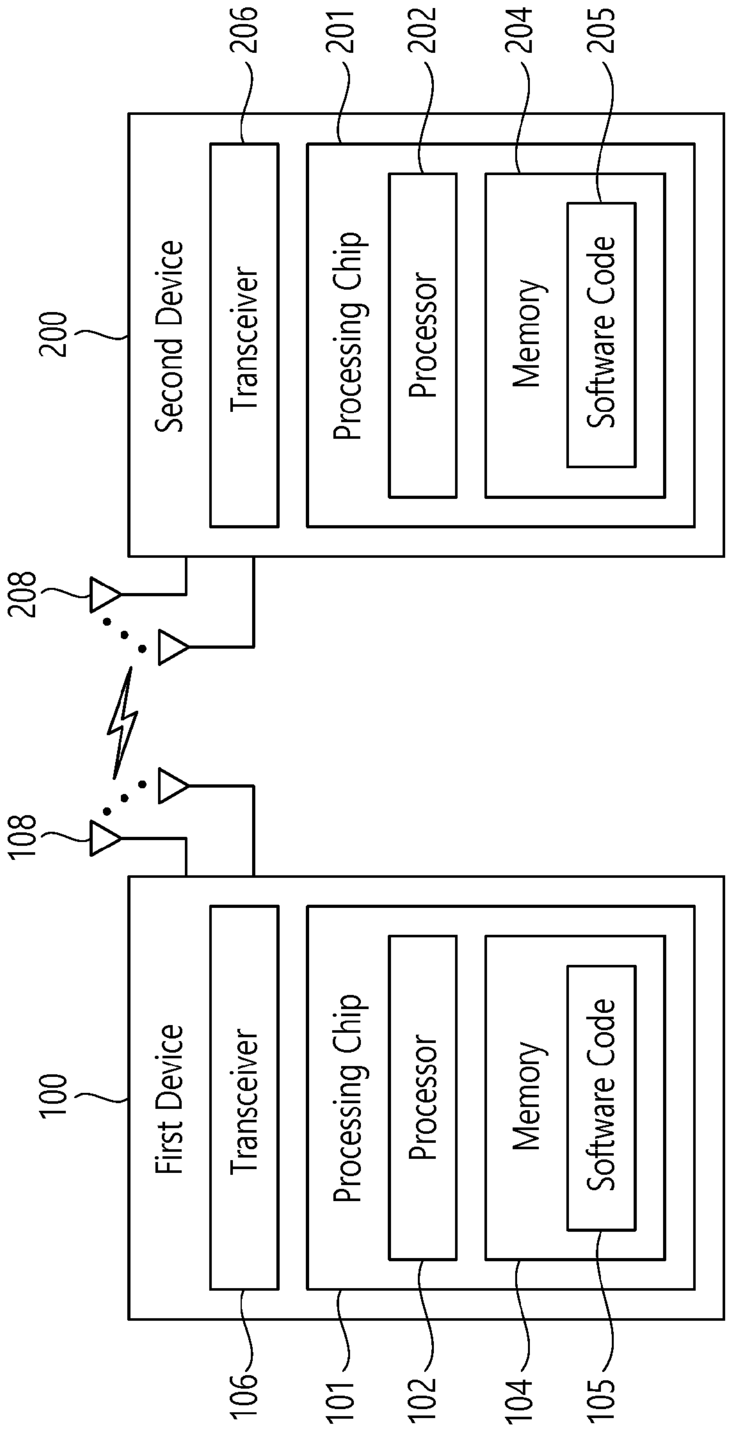
[Claim 28] A processing apparatus operating in a wireless communication system, the processing apparatus comprising:
at least one processor; and
at least one memory operably connectable to the at least one processor, wherein the at least one processor is configured to perform operations comprising:
generating first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous Reception (DRX);
generating an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication; and
generating second PSCCH transmissions in the adjusted SL active time.

[Claim 29] A computer readable medium (CRM) storing instructions that, based on being executed by at least one processor, perform operations comprising:
generating first Physical Sidelink Control Channel (PSCCH) transmissions in a Sidelink (SL) active time for SL Discontinuous Reception (DRX);
generating an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication; and
generating second PSCCH transmissions in the adjusted SL active time.

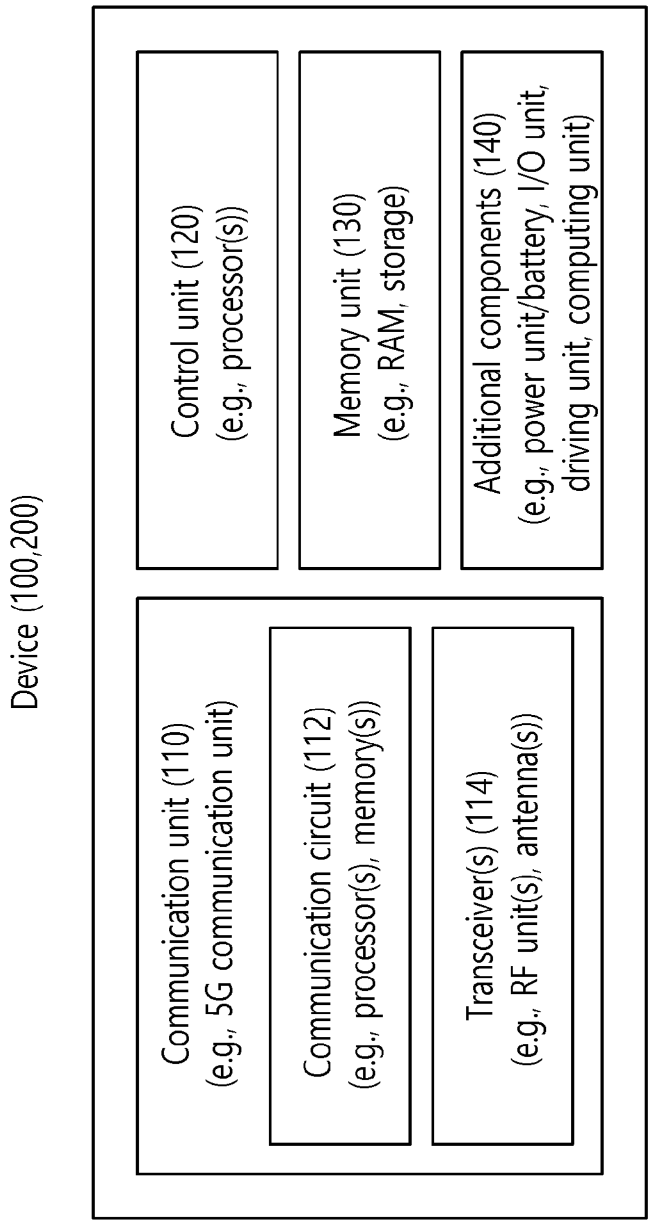
[Fig. 1]


1
Hand-held device
100d
XR device
100c
Vehicle
100b-2
150a
150a
150b
Vehicle
100b-1
150a
Home Appliance
100e
150a
Network (5G)
300
200
200
200
200
200a
150c
150a
150a
150a
IoT device
100f
AI Server/device
400
Robot
100a

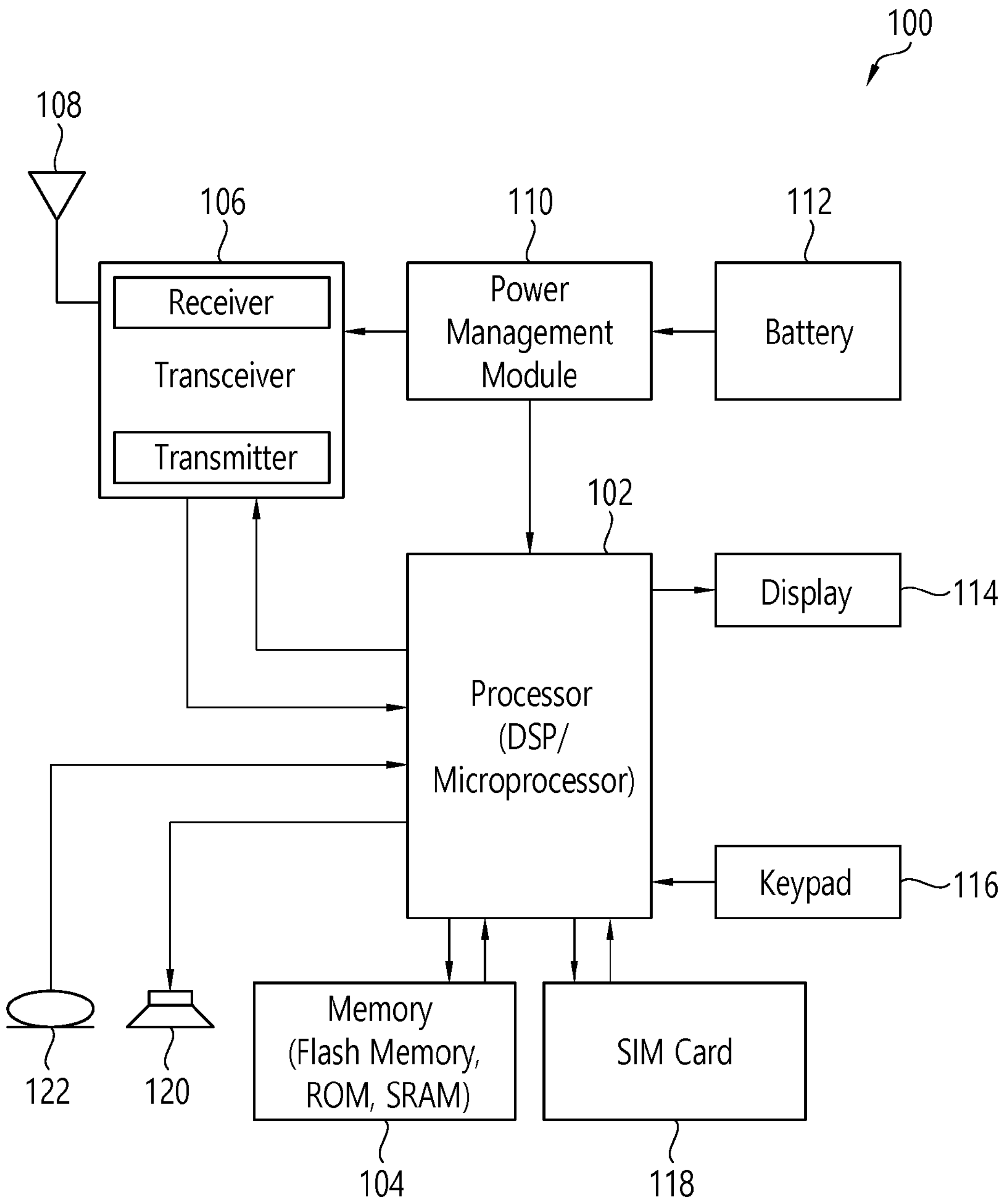
[Fig. 2]


200
Second Device
Transceiver
Processing Chip
Processor
Memory
Software Code
206
201
202
204
205
208
108
100
First Device
Transceiver
Processing Chip
Processor
Memory
Software Code
106
101
102
104
105

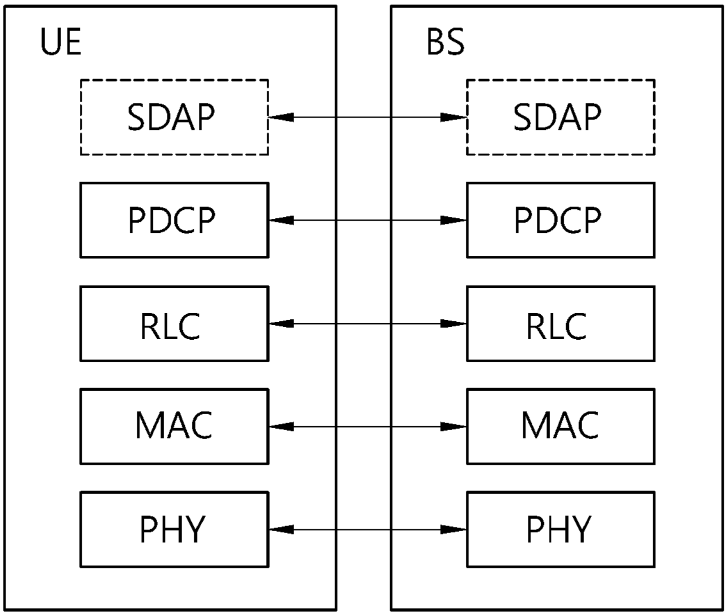
[Fig. 3]


Device (100,200)
Communication unit (110)
(e.g., 5G communication unit)
Communication circuit (112)
(e.g., processor(s), memory(s))
Transceiver(s) (114)
(e.g., RF unit(s), antenna(s))
Control unit (120)
(e.g., processor(s))
Memory unit (130)
(e.g., RAM, storage)
Additional components (140)
(e.g., power unit/battery, I/O unit,
driving unit, computing unit)

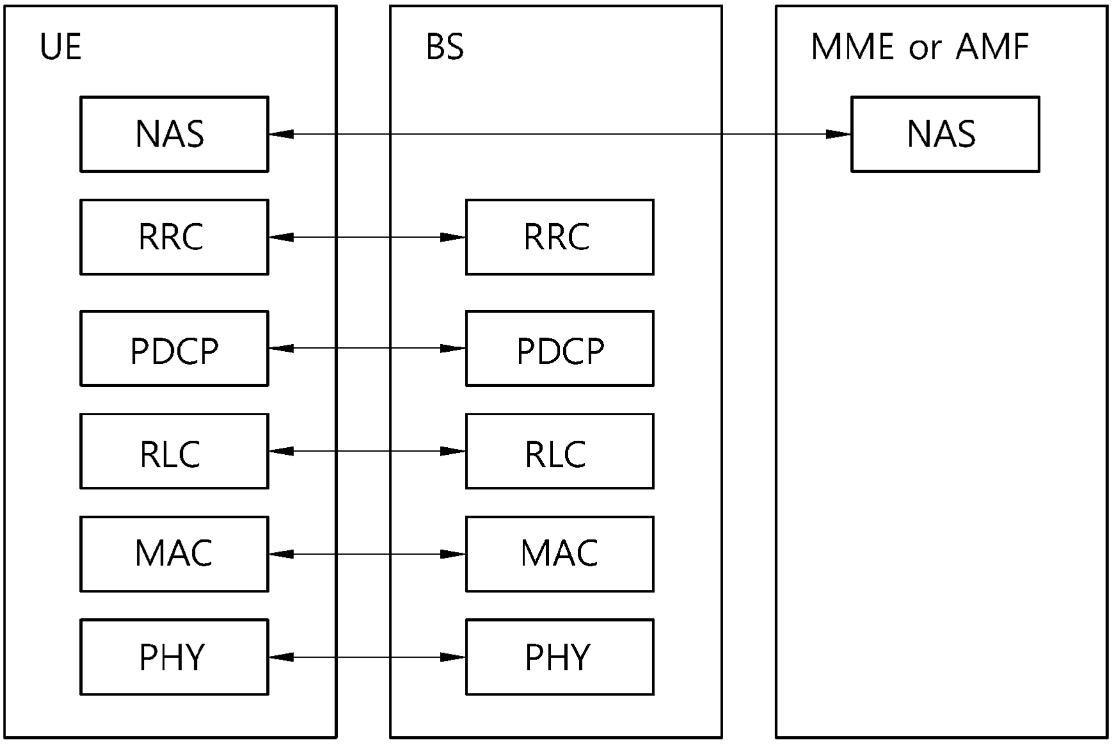
[Fig. 4]


100
108
106
110
112
Receiver
Transceiver
Transmitter
Power
Management
Module
Battery
102
Display
114
Processor
(DSP/
Microprocessor)
Keypad
116
Memory
(Flash Memory,
ROM, SRAM)
SIM Card
122
120
104
118

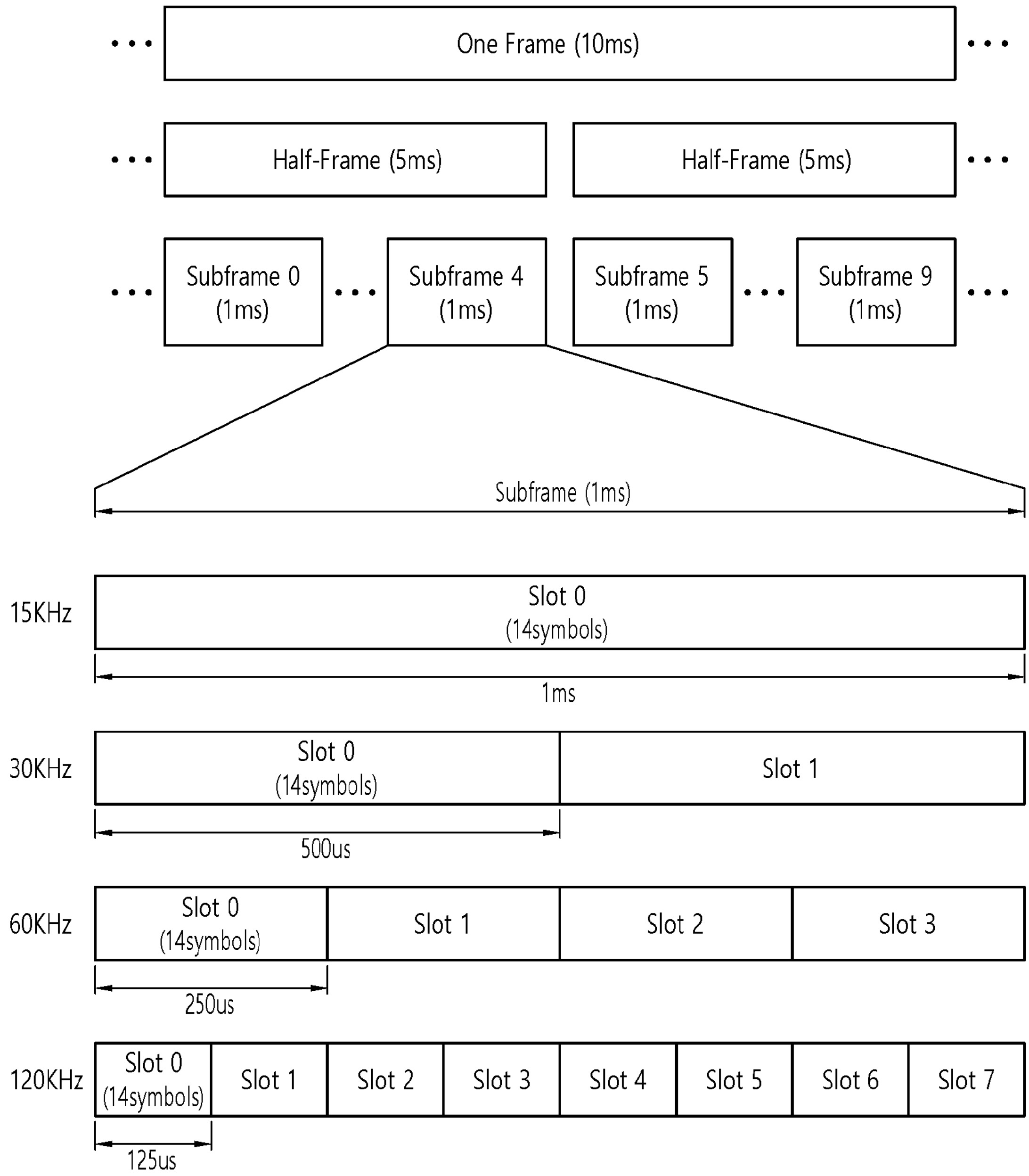
[Fig. 5]


UE
BS
SDAP
SDAP
PDCP
PDCP
RLC
RLC
MAC
MAC
PHY
PHY

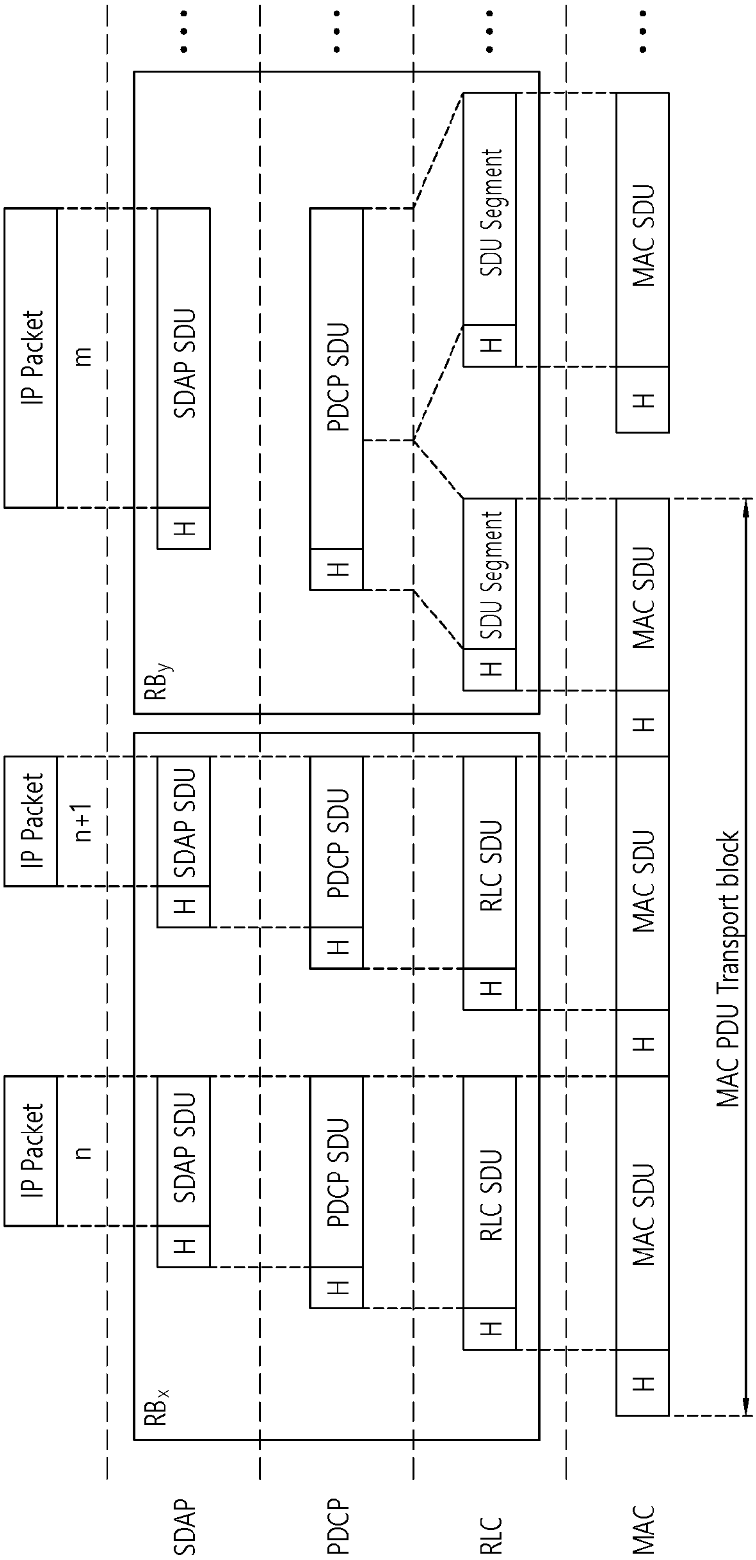
[Fig. 6]


UE
BS
MME or AMF
NAS
NAS
RRC
RRC
PDCP
PDCP
RLC
RLC
MAC
MAC
PHY
PHY

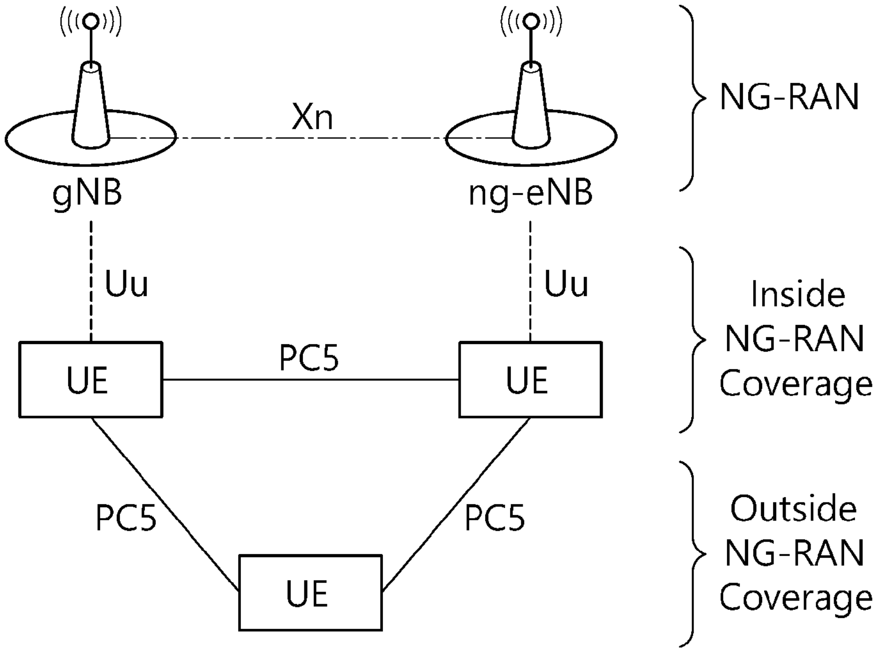
[Fig. 7]


One Frame (10ms)
Half-Frame (5ms)
Half-Frame (5ms)
Subframe 0 (1ms)
Subframe 4 (1ms)
Subframe 5 (1ms)
Subframe 9 (1ms)
Subframe (1ms)
15KHz
Slot 0 (14symbols)
1ms
30KHz
Slot 0 (14symbols)
Slot 1
500us
60KHz
Slot 0 (14symbols)
Slot 1
Slot 2
Slot 3
250us
120KHz
Slot 0 (14symbols)
Slot 1
Slot 2
Slot 3
Slot 4
Slot 5
Slot 6
Slot 7
125us

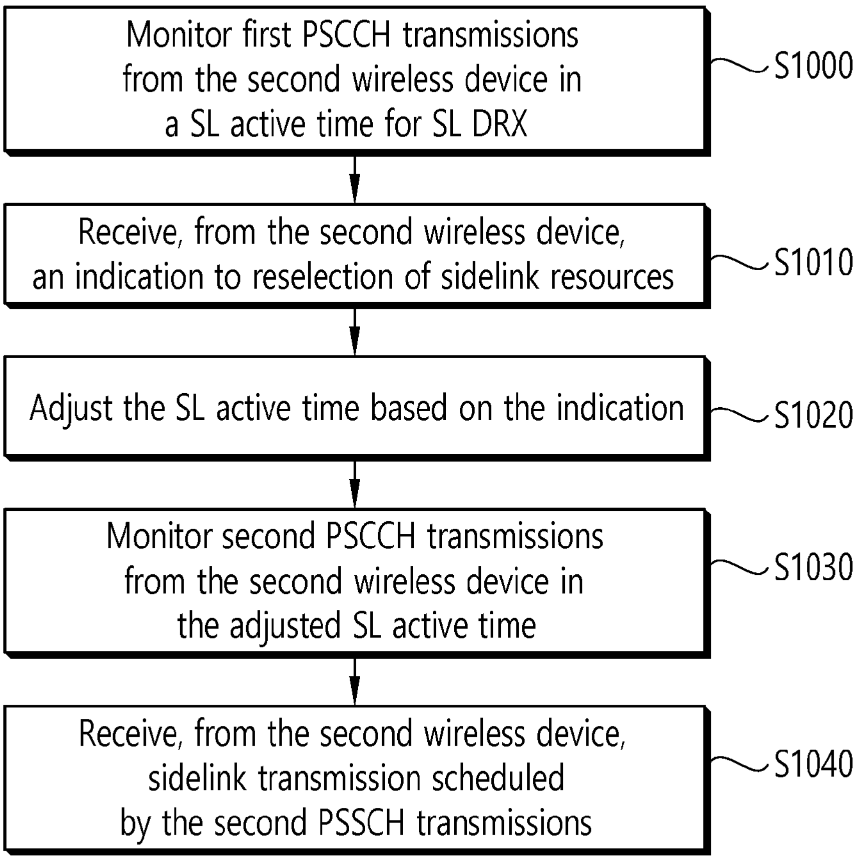
[Fig. 8]


IP Packet
m
IP Packet
n+1
IP Packet
n
SDAP SDU
H
PDCP SDU
H
SDU Segment
H
RLC SDU
MAC SDU
MAC PDU Transport block
RBy
RBx
SDAP
PDCP
RLC
MAC

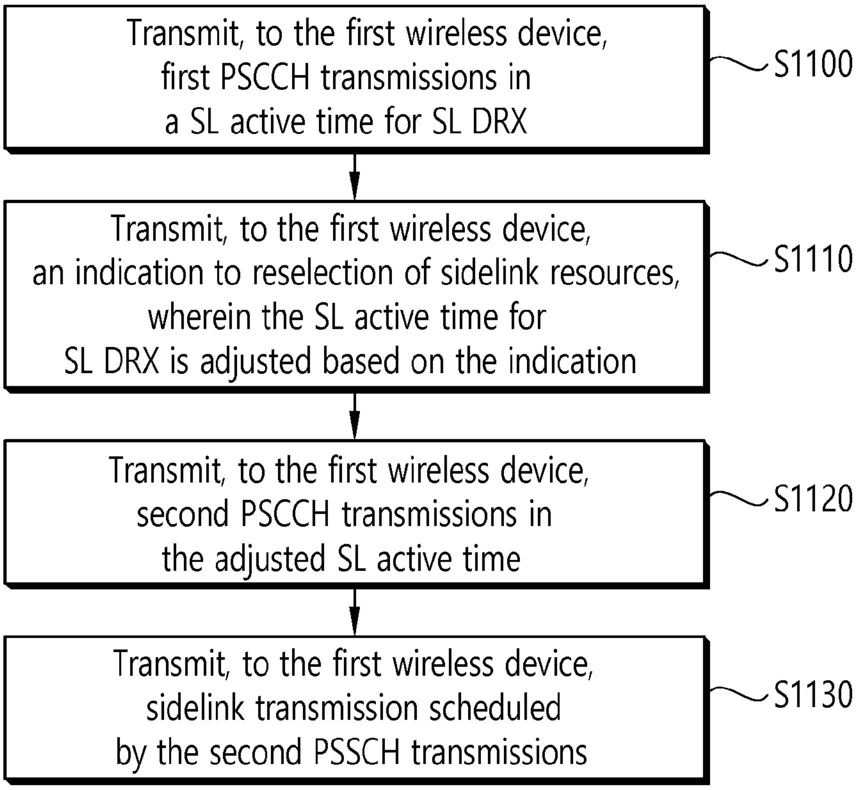
[Fig. 9]


Xn
gNB
ng-eNB
NG-RAN
Uu
Uu
UE
PC5
UE
Inside
NG-RAN
Coverage
PC5
PC5
UE
Outside
NG-RAN
Coverage

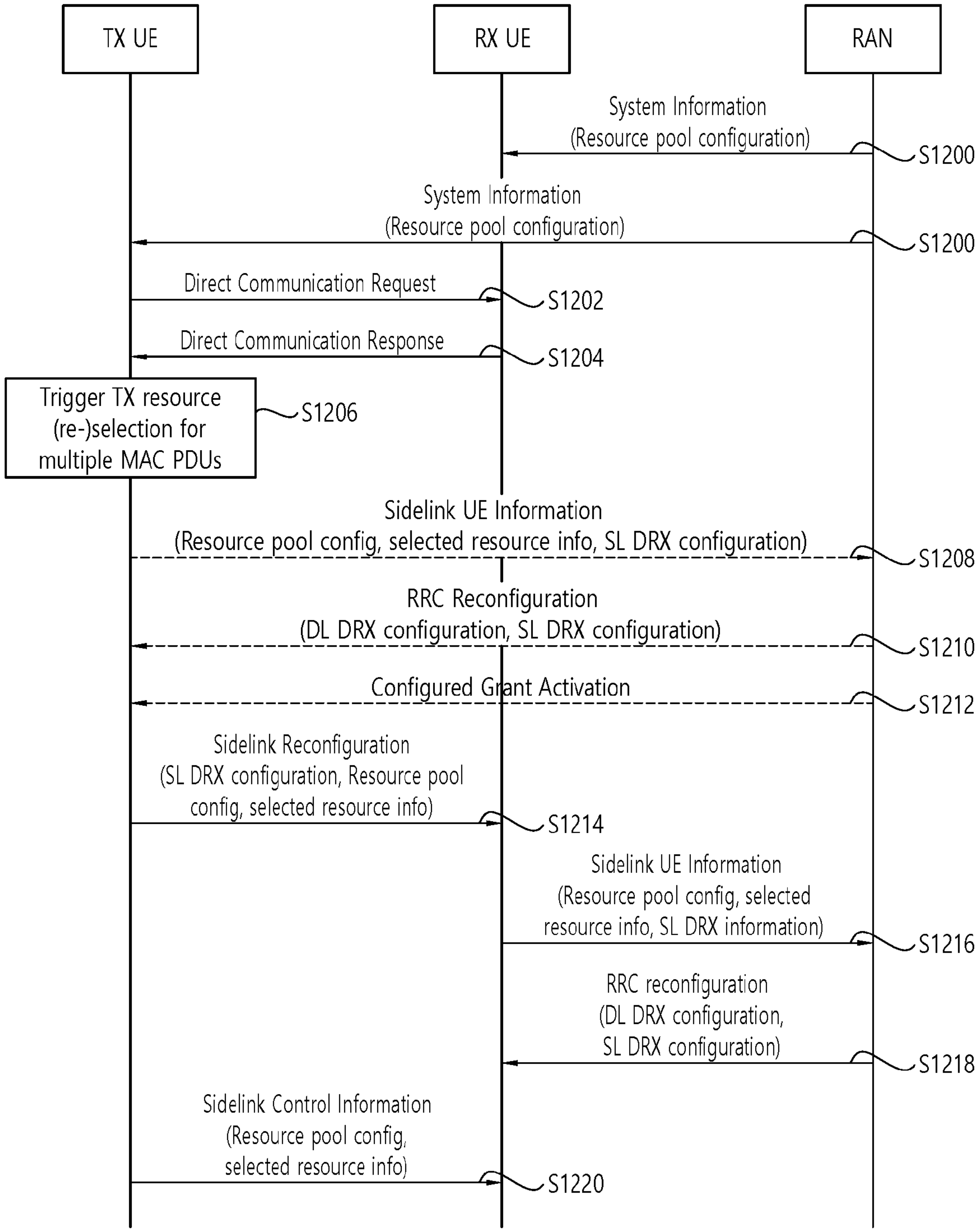
[Fig. 10]


Monitor first PSCCH transmissions from the second wireless device in a SL active time for SL DRX
S1000
Receive, from the second wireless device, an indication to reselection of sidelink resources
S1010
Adjust the SL active time based on the indication
S1020
Monitor second PSCCH transmissions from the second wireless device in the adjusted SL active time
S1030
Receive, from the second wireless device, sidelink transmission scheduled by the second PSSCH transmissions
S1040

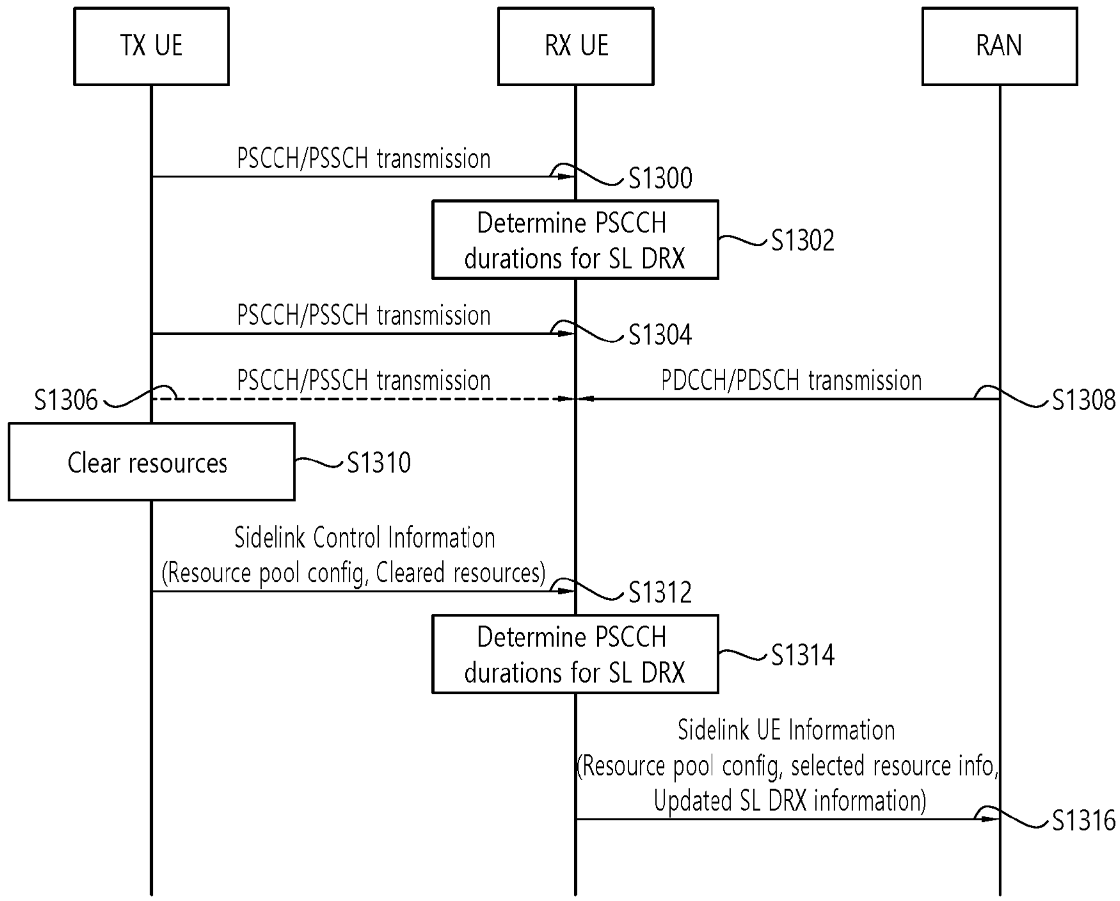
[Fig. 11]


Transmit, to the first wireless device, first PSCCH transmissions in a SL active time for SL DRX
S1100
Transmit, to the first wireless device, an indication to reselection of sidelink resources, wherein the SL active time for SL DRX is adjusted based on the indication
S1110
Transmit, to the first wireless device, second PSCCH transmissions in the adjusted SL active time
S1120
Transmit, to the first wireless device, sidelink transmission scheduled by the second PSSCH transmissions
S1130

[Fig. 12]


TX UE
RX UE
RAN
System Information
(Resource pool configuration)
S1200
System Information
(Resource pool configuration)
S1200
Direct Communication Request
S1202
Direct Communication Response
S1204
Trigger TX resource (re-)selection for multiple MAC PDUs
S1206
Sidelink UE Information
(Resource pool config, selected resource info, SL DRX configuration)
S1208
RRC Reconfiguration
(DL DRX configuration, SL DRX configuration)
S1210
Configured Grant Activation
S1212
Sidelink Reconfiguration
(SL DRX configuration, Resource pool config, selected resource info)
S1214
Sidelink UE Information
(Resource pool config, selected resource info, SL DRX information)
S1216
RRC reconfiguration
(DL DRX configuration, SL DRX configuration)
S1218
Sidelink Control Information
(Resource pool config, selected resource info)
S1220

[Fig. 13]


TX UE
RX UE
RAN
PSCCH/PSSCH transmission
S1300
Determine PSCCH durations for SL DRX
S1302
PSCCH/PSSCH transmission
S1304
S1306
PSCCH/PSSCH transmission
PDCCH/PDSCH transmission
S1308
Clear resources
S1310
Sidelink Control Information
(Resource pool config, Cleared resources)
S1312
Determine PSCCH durations for SL DRX
S1314
Sidelink UE Information
(Resource pool config, selected resource info, Updated SL DRX information)
S1316

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2021/008966

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/28(2018.01)i; **H04W 76/14**(2018.01)i; **H04W 72/12**(2009.01)i; **H04W 72/02**(2009.01)i; **H04W 72/04**(2009.01)i; **H04W 92/18**(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W 76/28(2018.01); H04L 5/00(2006.01); H04W 4/40(2018.01); H04W 52/02(2009.01); H04W 68/08(2009.01); H04W 76/36(2018.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: sidelink (SL), discontinuous reception (DRX), physical sidelink control channel (PSCCH), reselection, sidelink resource, adjust, SL active time

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2019-0174411 A1 (SONY CORPORATION) 06 June 2019 (2019-06-06) paragraphs [0041]-[0144]; and figures 1-13	1-29
Y	LG ELECTRONICS INC., 'Introduction of 5G V2X with NR Sidelink', R2-2002316, 3GPP TSG-RAN WG2 Meeting #109-e, 06 March 2020 sections 5.x.1.1, 5.x.2.1, 6.1.x, 6.2.1	1-29
A	WO 2020-033563 A1 (INTEL CORPORATION) 13 February 2020 (2020-02-13) page 12, line 21 - page 16, line 2; and figures 6-8	1-29
A	US 2019-0182890 A1 (INTEL IP CORPORATION) 13 June 2019 (2019-06-13) paragraphs [0124]-[0144]; and figures 8-10	1-29
A	EP 3499975 A1 (ZTE CORPORATION) 19 June 2019 (2019-06-19) paragraphs [0120]-[0159]; and figures 4-5	1-29

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 October 2021	**19 October 2021**

Name and mailing address of the ISA/KR	Authorized officer
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Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-8710**

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2019-0174411 A1	06 June 2019	CN 108307486 A	20 July 2018
		CN 109196939 A	11 January 2019
		EP 3500028 A1	19 June 2019
		EP 3500028 B1	24 March 2021
		JP 2019-525607 A	05 September 2019
		KR 10-2019-0039101 A	10 April 2019
		US 10708861 B2	07 July 2020
		US 2020-0296668 A1	17 September 2020
		WO 2018-028416 A1	15 February 2018
WO 2020-033563 A1	13 February 2020	CN 112514299 A	16 March 2021
		EP 3834355 A1	16 June 2021
US 2019-0182890 A1	13 June 2019	US 10966279 B2	30 March 2021
		WO 2018-067400 A1	12 April 2018
EP 3499975 A1	19 June 2019	CN 108307489 A	20 July 2018
		EP 3499975 A4	19 August 2020
		WO 2018-028279 A1	15 February 2018