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(54) **METHOD AND APPARATUS FOR PERFORMING COMMUNICATION BASED ON CAPC IN NR V2X**

(57) Provided are a method for performing wireless communication by a first device, and an apparatus for supporting same. The method may comprise: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

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Description

TECHNICAL FIELD

[0001] This disclosure relates to a wireless communication system.

BACKGROUND

[0002] Sidelink (SL) communication is a communication scheme in which a direct link is established between User Equipments (UEs) and the UEs exchange voice and data directly with each other without intervention of an evolved Node B (eNB). SL communication is under consideration as a solution to the overhead of an eNB caused by rapidly increasing data traffic. Vehicle-to-everything (V2X) refers to a communication technology through which a vehicle exchanges information with another vehicle, a pedestrian, an object having an infrastructure (or infra) established therein, and so on. The V2X may be divided into 4 types, such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N), and vehicle-to-pedestrian (V2P). The V2X communication may be provided via a PC5 interface and/or Uu interface.

[0003] Meanwhile, as a wider range of communication devices require larger communication capacities, the need for mobile broadband communication that is more enhanced than the existing Radio Access Technology (RAT) is rising. Accordingly, discussions are made on services and user equipment (UE) that are sensitive to reliability and latency. And, a next generation radio access technology that is based on the enhanced mobile broadband communication, massive Machine Type Communication (MTC), Ultra-Reliable and Low Latency Communication (URLLC), and so on, may be referred to as a new radio access technology (RAT) or new radio (NR). Herein, the NR may also support vehicle-to-everything (V2X) communication.

SUMMARY

[0004] Meanwhile, in conventional NR V2X, according to a medium access control (MAC) protocol data unit (PDU) generation operation, the LTE may select a destination having a sidelink logical channel with the highest priority for available SL data, and the UE may generate a MAC PDU by multiplexing service data unit(s) (SDU(s)) for the same destination into one MAC PDU. Meanwhile, a channel access priority class (CAPC) may be considered for efficient resource occupation in an unlicensed band. In this case, it is necessary to propose a procedure for allocating resources to logical channels in consideration of the CAPC by the UE intending to perform resource occupation or transmit a MAC PDU in an unlicensed band.

[0005] In one embodiment, provided is a method for performing wireless communication by a first device. The method may comprise: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0006] In one embodiment, provided is a first device adapted to perform wireless communication. The first device may comprise: at least one transceiver; at least one processor; and at least one memory connected to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0007] In one embodiment, provided is a processing device adapted to control a first device. The processing device may comprise: at least one processor; and at least one memory connected to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0008] The UE can efficiently perform SL communication in an unlicensed band.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 shows a structure of an NR system, based on an embodiment of the present disclosure.
FIG. 2 shows a radio protocol architecture, based on an embodiment of the present disclosure.
FIG. 3 shows a structure of a radio frame of an NR, based on an embodiment of the present disclosure.
FIG. 4 shows a structure of a slot of an NR frame, based on an embodiment of the present disclosure.
FIG. 5 shows an example of a BWP, based on an embodiment of the present disclosure.
FIG. 6 shows a procedure of performing V2X or SL communication by a LTE based on a transmission mode, based on an embodiment of the present disclosure.
FIG. 7 shows three cast types, based on an embodiment of the present disclosure.
FIG. 8 shows an example of a wireless communication system supporting an unlicensed band, based on an embodiment of the present disclosure.
FIG. 9 shows a method of occupying resources in an unlicensed band, based on an embodiment of the present disclosure.
FIG. 10 shows a case in which a plurality of LBT-SBs are included in an unlicensed band, based on an embodiment of the present disclosure.
FIG. 11 shows CAP operations performed by a base station to transmit a downlink signal through an unlicensed band, based on an embodiment of the present disclosure.
FIG. 12 shows type 1 CAP operations performed by a LTE to transmit an uplink signal, based on an embodiment of the present disclosure.
FIG. 13 shows a procedure for a LTE to perform sidelink communication based on a channel access priority class (CAPC), based on an embodiment of the present disclosure.
FIG. 14 shows a method of generating a MAC PDU based on a channel access priority class (CAPC), based on an embodiment of the present disclosure.
FIG. 15 shows a method for performing wireless communication by a first device, based on an embodiment of the present disclosure.
FIG. 16 shows a method for performing wireless communication by a second device, based on an embodiment of the present disclosure.
FIG. 17 shows a communication system 1, based on an embodiment of the present disclosure.
FIG. 18 shows wireless devices, based on an embodiment of the present disclosure.
FIG. 19 shows a signal process circuit for a transmission signal, based on an embodiment of the present disclosure.
FIG. 20 shows another example of a wireless device, based on an embodiment of the present disclosure.
FIG. 21 shows a hand-held device, based on an embodiment of the present disclosure.
FIG. 22 shows a vehicle or an autonomous vehicle, based on an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0010] In the present disclosure, "A or B" may mean "only A", "only B" or "both A and B." In other words, in the present disclosure, "A or B" may be interpreted as "A and/or B". For example, in the present disclosure, "A, B, or C" may mean "only A", "only B", "only C", or "any combination of A, B, C".

[0011] A slash (/) or comma used in the present disclosure 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".

[0012] In the present disclosure, "at least one of A and B" may mean "only A", "only B", or "both A and B". In addition, in the present disclosure, the expression "at least one of A or B" or "at least one of A and/or B" may be interpreted as "at least one of A and B".

[0013] 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".

[0014] In addition, a parenthesis used in the present disclosure may mean "for example". Specifically, when indicated as "control information (PDCCH)", it may mean that "PDCCH" is proposed as an example of the "control information". In other words, the "control information" of the present disclosure is not limited to "PDCCH", and "PDCCH" may be proposed as an example of the "control information". In addition, when indicated as "control information (i.e., PDCCH)", it may also mean that "PDCCH" is proposed as an example of the "control information".

[0015] In the following description, ‘when, if, or in case of’ may be replaced with ‘based on’.

[0016] A technical feature described individually in one figure in the present disclosure may be individually implemented, or may be simultaneously implemented.

[0017] In the present disclosure, a higher layer parameter may be a parameter which is configured, pre-configured or pre-defined for a LTE. For example, a base station or a network may transmit the higher layer parameter to the UE. For example, the higher layer parameter may be transmitted through radio resource control (RRC) signaling or medium access control (MAC) signaling.

[0018] The technology described below may be used in various wireless communication systems such as code division multiple access (CDMA), frequency division multiple access (FDMA), time division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), single carrier frequency division multiple access (SC-FDMA), and so on. The CDMA may be implemented with a radio technology, such as universal terrestrial radio access (UTRA) or CDMA-2000. The TDMA may be implemented with a radio technology, such as global system for mobile communications (GSM)/general packet ratio service (GPRS)/enhanced data rate for GSM evolution (EDGE). The OFDMA may be implemented with a radio technology, such as institute of electrical and electronics engineers (IEEE) 802.11 (Wi-Fi), IEEE 802.16 (WiMAX), IEEE 802.20, evolved UTRA (E-UTRA), and so on. IEEE 802.16m is an evolved version of IEEE 802.16e and provides backward compatibility with a system based on the IEEE 802.16e. The UTRA is part of a universal mobile telecommunication system (UMTS). 3rd generation partnership project (3GPP) long term evolution (LTE) is part of an evolved UMTS (E-UMTS) using the E-UTRA. The 3GPP LTE uses the OFDMA in a downlink and uses the SC-FDMA in an uplink. LTE-advanced (LTE-A) is an evolution of the LTE.

[0019] 5G NR is a successive technology of LTE-A corresponding to a new Clean-slate type mobile communication system having the characteristics of high performance, low latency, high availability, and so on. 5G NR may use resources of all spectrum available for usage including low frequency bands of less than 1GHz, middle frequency bands ranging from 1GHz to 10GHz, high frequency (millimeter waves) of 24GHz or more, and so on.

[0020] For clarity in the description, the following description will mostly focus on LTE-A or 5G NR. However, technical features according to an embodiment of the present disclosure will not be limited only to this.

[0021] FIG. 1 shows a structure of an NR system, based on an embodiment of the present disclosure. The embodiment of FIG. 1 may be combined with various embodiments of the present disclosure.

[0022] Referring to FIG. 1, a next generation-radio access network (NG-RAN) may include a BS 20 providing a LTE 10 with a user plane and control plane protocol termination. For example, the BS 20 may include a next generation-Node B (gNB) and/or an evolved-NodeB (eNB). For example, the UE 10 may be fixed or mobile and may be referred to as other terms, such as a mobile station (MS), a user terminal (UT), a subscriber station (SS), a mobile terminal (MT), wireless device, and so on. For example, the BS may be referred to as a fixed station which communicates with the UE 10 and may be referred to as other terms, such as a base transceiver system (BTS), an access point (AP), and so on.

[0023] The embodiment of FIG. 1 exemplifies a case where only the gNB is included. The BSs 20 may be connected to one another via Xn interface. The BS 20 may be connected to one another via 5th generation (5G) core network (5GC) and NG interface. More specifically, the BSs 20 may be connected to an access and mobility management function (AMF) 30 via NG-C interface, and may be connected to a user plane function (UPF) 30 via NG-U interface.

[0024] Layers of a radio interface protocol between the UE and the network can be classified into a first layer (layer 1, L1), a second layer (layer 2, L2), and a third layer (layer 3, L3) based on the lower three layers of the open system interconnection (OSI) model that is well-known in the communication system. Among them, a physical (PHY) layer belonging to the first layer provides an information transfer service by using a physical channel, and a radio resource control (RRC) layer belonging to the third layer serves to control a radio resource between the UE and the network. For this, the RRC layer exchanges an RRC message between the UE and the BS.

[0025] FIG. 2 shows a radio protocol architecture, based on an embodiment of the present disclosure. The embodiment of FIG. 2 may be combined with various embodiments of the present disclosure. Specifically, (a) of FIG. 2 shows a radio protocol stack of a user plane for Uu communication, and (b) of FIG. 2 shows a radio protocol stack of a control plane for Uu communication, (c) of FIG. 2 shows a radio protocol stack of a user plane for SL communication, and (d) of FIG. 2 shows a radio protocol stack of a control plane for SL communication.

[0026] Referring to FIG. 2, a physical layer provides an upper layer with an information transfer service through a physical channel. The physical layer is connected to a medium access control (MAC) layer which is an upper layer of the physical layer through a transport channel. Data is transferred between the MAC layer and the physical layer through the transport channel. The transport channel is classified according to how and with what characteristics data is transmitted through a radio interface.

[0027] Between different physical layers, i.e., a physical layer of a transmitter and a physical layer of a receiver, data are transferred through the physical channel. The physical channel is modulated using an orthogonal frequency division multiplexing (OFDM) scheme, and utilizes time and frequency as a radio resource.

[0028] The MAC layer provides services to a radio link control (RLC) layer, which is a higher layer of the MAC layer, via a logical channel. The MAC layer provides a function of mapping multiple logical channels to multiple transport channels. The MAC layer also provides a function of logical channel multiplexing by mapping multiple logical channels

to a single transport channel. The MAC layer provides data transfer services over logical channels.

[0029] The RLC layer performs concatenation, segmentation, and reassembly of Radio Link Control Service Data Unit (RLC SDU). In order to ensure diverse quality of service (QoS) required by a radio bearer (RB), the RLC layer provides three types of operation modes, i.e., a transparent mode (TM), an unacknowledged mode (UM), and an acknowledged mode (AM). An AM RLC provides error correction through an automatic repeat request (ARQ).

[0030] A radio resource control (RRC) layer is defined only in the control plane. The RRC layer serves to control the logical channel, the transport channel, and the physical channel in association with configuration, reconfiguration and release of RBs. The RB is a logical path provided by the first layer (i.e., the physical layer or the PHY layer) and the second layer (i.e., a MAC layer, an RLC layer, a packet data convergence protocol (PDCP) layer, and a service data adaptation protocol (SDAP) layer) for data delivery between the LTE and the network.

[0031] Functions of a packet data convergence protocol (PDCP) layer in the user plane include user data delivery, header compression, and ciphering. Functions of a PDCP layer in the control plane include control-plane data delivery and ciphering/integrity protection.

[0032] A service data adaptation protocol (SDAP) layer is defined only in a user plane. The SDAP layer performs mapping between a Quality of Service (QoS) flow and a data radio bearer (DRB) and QoS flow ID (QFI) marking in both DL and UL packets.

[0033] The configuration of the RB implies a process for specifying a radio protocol layer and channel properties to provide a particular service and for determining respective detailed parameters and operations. The RB can be classified into two types, i.e., a signaling RB (SRB) and a data RB (DRB). The SRB is used as a path for transmitting an RRC message in the control plane. The DRB is used as a path for transmitting user data in the user plane.

[0034] When an RRC connection is established between an RRC layer of the UE and an RRC layer of the E-UTRAN, the UE is in an RRC_CONNECTED state, and, otherwise, the UE may be in an RRC_IDLE state. In case of the NR, an RRC_INACTIVE state is additionally defined, and a LTE being in the RRC_INACTIVE state may maintain its connection with a core network whereas its connection with the BS is released.

[0035] Data is transmitted from the network to the UE through a downlink transport channel. Examples of the downlink transport channel include a broadcast channel (BCH) for transmitting system information and a downlink-shared channel (SCH) for transmitting user traffic or control messages. Traffic of downlink multicast or broadcast services or the control messages can be transmitted on the downlink-SCH or an additional downlink multicast channel (MCH). Data is transmitted from the UE to the network through an uplink transport channel. Examples of the uplink transport channel include a random access channel (RACH) for transmitting an initial control message and an uplink SCH for transmitting user traffic or control messages.

[0036] Examples of logical channels belonging to a higher channel of the transport channel and mapped onto the transport channels include a broadcast channel (BCCH), a paging control channel (PCCH), a common control channel (CCCH), a multicast control channel (MCCH), a multicast traffic channel (MTCH), etc.

[0037] FIG. 3 shows a structure of a radio frame of an NR, based on an embodiment of the present disclosure. The embodiment of FIG. 3 may be combined with various embodiments of the present disclosure.

[0038] Referring to FIG. 3, in the NR, a radio frame may be used for performing uplink and downlink transmission. Aradio frame has a length of 10ms and may be defined to be configured of two half-frames (HFs). A half-frame may include five 1ms subframes (SFs). A subframe (SF) may be divided into one or more slots, and the number of slots within a subframe may be determined based on subcarrier spacing (SCS). Each slot may include 12 or 14 OFDM(A) symbols according to a cyclic prefix (CP).

[0039] In case of using a normal CP, each slot may include 14 symbols. In case of using an extended CP, each slot may include 12 symbols. Herein, a symbol may include an OFDM symbol (or CP-OFDM symbol) and a Single Carrier-FDMA (SC-FDMA) symbol (or Discrete Fourier Transform-spread-OFDM (DFT-s-OFDM) symbol).

[0040] Table 1 shown below represents an example of a number of symbols per slot (N^{slot}_{symb}), a number slots per frame ($N^{frame,u}_{slot}$), and a number of slots per subframe ($N^{subframe,u}_{slot}$) based on an SCS configuration (u), in a case where a normal CP is used.

[Table 1]

SCS ($15*2^u$)	N^{slot}_{symb}	$N^{frame,u}_{slot}$	$N^{subframe,u}_{slot}$
15KHz (u=0)	14	10	1
30KHz (u=1)	14	20	2
60KHz (u=2)	14	40	4
120KHz (u=3)	14	80	8
240KHz (u=4)	14	160	16

[0041] Table 2 shows an example of a number of symbols per slot, a number of slots per frame, and a number of slots per subframe based on the SCS, in a case where an extended CP is used.

[Table 2]

SCS ($15*2^u$)	N^{slot}_{symb}	$N^{frame,u}_{slot}$	$N^{subframe,u}_{slot}$
60KHz (u=2)	12	40	4

[0042] In an NR system, OFDM(A) numerologies (e.g., SCS, CP length, and so on) between multiple cells being integrate to one LTE may be differently configured. Accordingly, a (absolute time) duration (or section) of a time resource (e.g., subframe, slot or TTI) (collectively referred to as a time unit (TU) for simplicity) being configured of the same number of symbols may be differently configured in the integrated cells.

[0043] In the NR, multiple numerologies or SCSs for supporting diverse 5G services may be supported. For example, in case an SCS is 15kHz, a wide area of the conventional cellular bands may be supported, and, in case an SCS is 30kHz/60kHz a dense-urban, lower latency, wider carrier bandwidth may be supported. In case the SCS is 60kHz or higher, a bandwidth that is greater than 24.25GHz may be used in order to overcome phase noise.

[0044] An NR frequency band may be defined as two different types of frequency ranges. The two different types of frequency ranges may be FR1 and FR2. The values of the frequency ranges may be changed (or varied), and, for example, the two different types of frequency ranges may be as shown below in Table 3. Among the frequency ranges that are used in an NR system, FR1 may mean a "sub 6GHz range", and FR2 may mean an "above 6GHz range" and may also be referred to as a millimeter wave (mmW).

[Table 3]

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

[0045] As described above, the values of the frequency ranges in the NR system may be changed (or varied). For example, as shown below in Table 4, FR1 may include a band within a range of 410MHz to 7125MHz. More specifically, FR1 may include a frequency band of 6GHz (or 5850, 5900, 5925 MHz, and so on) and higher. For example, a frequency band of 6GHz (or 5850, 5900, 5925 MHz, and so on) and higher being included in FR1 mat include an unlicensed band. The unlicensed band may be used for diverse purposes, e.g., the unlicensed band for vehicle-specific communication (e.g., automated driving).

[Table 4]

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

[0046] FIG. 4 shows a structure of a slot of an NR frame, based on an embodiment of the present disclosure. The embodiment of FIG. 4 may be combined with various embodiments of the present disclosure.

[0047] Referring to FIG. 4, a slot includes a plurality of symbols in a time domain. For example, in case of a normal CP, one slot may include 14 symbols. However, in case of an extended CP, one slot may include 12 symbols. Alternatively, in case of a normal CP, one slot may include 7 symbols. However, in case of an extended CP, one slot may include 6 symbols.

[0048] A carrier includes a plurality of subcarriers in a frequency domain. A Resource Block (RB) may be defined as a plurality of consecutive subcarriers (e.g., 12 subcarriers) in the frequency domain. A Bandwidth Part (BWP) may be defined as a plurality of consecutive (Physical) Resource Blocks ((P)RBs) in the frequency domain, and the BWP may correspond to one numerology (e.g., SCS, CP length, and so on). A carrier may include a maximum of N number BWPs (e.g., 5 BWPs). Data communication may be performed via an activated BWP. Each element may be referred to as a Resource Element (RE) within a resource grid and one complex symbol may be mapped to each element.

[0049] Hereinafter, a bandwidth part (BWP) and a carrier will be described.

[0050] The BWP may be a set of consecutive physical resource blocks (PRBs) in a given numerology. The PRB may be selected from consecutive sub-sets of common resource blocks (CRBs) for the given numerology on a given carrier

[0051] For example, the BWP may be at least any one of an active BWP, an initial BWP, and/or a default BWP. For example, the LTE may not monitor downlink radio link quality in a DL BWP other than an active DL BWP on a primary cell (PCell). For example, the UE may not receive PDCCH, physical downlink shared channel (PDSCH), or channel state information - reference signal (CSI-RS) (excluding RRM) outside the active DL BWP. For example, the LTE may not trigger a channel state information (CSI) report for the inactive DL BWP. For example, the LTE may not transmit physical uplink control channel (PUCCH) or physical uplink shared channel (PUSCH) outside an active UL BWP. For example, in a downlink case, the initial BWP may be given as a consecutive RB set for a remaining minimum system information (RMSI) control resource set (CORESET) (configured by physical broadcast channel (PBCH)). For example, in an uplink case, the initial BWP may be given by system information block (SIB) for a random access procedure. For example, the default BWP may be configured by a higher layer. For example, an initial value of the default BWP may be an initial DL BWP. For energy saving, if the LTE fails to detect downlink control information (DCI) during a specific period, the UE may switch the active BWP of the UE to the default BWP.

[0052] Meanwhile, the BWP may be defined for SL. The same SL BWP may be used in transmission and reception. For example, a transmitting UE may transmit a SL channel or a SL signal on a specific BWP, and a receiving UE may receive the SL channel or the SL signal on the specific BWP. In a licensed carrier, the SL BWP may be defined separately from a Uu BWP, and the SL BWP may have configuration signaling separate from the Uu BWP. For example, the LTE may receive a configuration for the SL BWP from the BS/network. For example, the UE may receive a configuration for the Uu BWP from the BS/network. The SL BWP may be (pre-)configured in a carrier with respect to an out-of-coverage NR V2X UE and an RRC_IDLE UE. For the UE in the RRC_CONNECTED mode, at least one SL BWP may be activated in the carrier.

[0053] FIG. 5 shows an example of a BWP, based on an embodiment of the present disclosure. The embodiment of FIG. 5 may be combined with various embodiments of the present disclosure. It is assumed in the embodiment of FIG. 5 that the number of BWPs is 3.

[0054] Referring to FIG. 5, a common resource block (CRB) may be a carrier resource block numbered from one end of a carrier band to the other end thereof. In addition, the PRB may be a resource block numbered within each BWP. A point A may indicate a common reference point for a resource block grid.

[0055] The BWP may be configured by a point A, an offset N^{start}_{BWP} from the point A, and a bandwidth N^{size}_{BWP}. For example, the point A may be an external reference point of a PRB of a carrier in which a subcarrier 0 of all numerologies (e.g., all numerologies supported by a network on that carrier) is aligned. For example, the offset may be a PRB interval between a lowest subcarrier and the point A in a given numerology. For example, the bandwidth may be the number of PRBs in the given numerology.

[0056] Hereinafter, V2X or SL communication will be described.

[0057] A sidelink synchronization signal (SLSS) may include a primary sidelink synchronization signal (PSSS) and a secondary sidelink synchronization signal (SSSS), as a SL-specific sequence. The PSSS may be referred to as a sidelink primary synchronization signal (S-PSS), and the SSSS may be referred to as a sidelink secondary synchronization signal (S-SSS). For example, length-127 M-sequences may be used for the S-PSS, and length-127 gold sequences may be used for the S-SSS. For example, a LTE may use the S-PSS for initial signal detection and for synchronization acquisition. For example, the UE may use the S-PSS and the S-SSS for acquisition of detailed synchronization and for detection of a synchronization signal ID.

[0058] A physical sidelink broadcast channel (PSBCH) may be a (broadcast) channel for transmitting default (system) information which must be first known by the UE before SL signal transmission/reception. For example, the default information may be information related to SLSS, a duplex mode (DM), a time division duplex (TDD) uplink/downlink (LTL/DL) configuration, information related to a resource pool, a type of an application related to the SLSS, a subframe offset, broadcast information, or the like. For example, for evaluation of PSBCH performance, in NR V2X, a payload size of the PSBCH may be 56 bits including 24-bit cyclic redundancy check (CRC).

[0059] The S-PSS, the S-SSS, and the PSBCH may be included in a block format (e.g., SL synchronization signal (SS)/PSBCH block, hereinafter, sidelink-synchronization signal block (S-SSB)) supporting periodical transmission. The S-SSB may have the same numerology (i.e., SCS and CP length) as a physical sidelink control channel (PSCCH)/physical sidelink shared channel (PSSCH) in a carrier, and a transmission bandwidth may exist within a (pre-)configured sidelink (SL) BWP. For example, the S-SSB may have a bandwidth of 11 resource blocks (RBs). For example, the PSBCH may exist across 11 RBs. In addition, a frequency position of the S-SSB may be (pre-)configured. Accordingly, the UE does not have to perform hypothesis detection at frequency to discover the S-SSB in the carrier.

[0060] FIG. 6 shows a procedure of performing V2X or SL communication by a LTE based on a transmission mode, based on an embodiment of the present disclosure. The embodiment of FIG. 6 may be combined with various embodiments of the present disclosure. In various embodiments of the present disclosure, the transmission mode may be called a mode or a resource allocation mode. Hereinafter, for convenience of explanation, in LTE, the transmission mode may be called an LTE transmission mode. In NR, the transmission mode may be called an NR resource allocation mode.

[0061] For example, (a) of FIG. 6 shows a UE operation related to an LTE transmission mode 1 or an LTE transmission

mode 3. Alternatively, for example, (a) of FIG. 6 shows a LTE operation related to an NR resource allocation mode 1. For example, the LTE transmission mode 1 may be applied to general SL communication, and the LTE transmission mode 3 may be applied to V2X communication.

[0062] For example, (b) of FIG. 6 shows a UE operation related to an LTE transmission mode 2 or an LTE transmission mode 4. Alternatively, for example, (b) of FIG. 6 shows a LTE operation related to an NR resource allocation mode 2.

[0063] Referring to (a) of FIG. 6, in the LTE transmission mode 1, the LTE transmission mode 3, or the NR resource allocation mode 1, a base station may schedule SL resource(s) to be used by a LTE for SL transmission. For example, in step S600, a base station may transmit information related to SL resource(s) and/or information related to LTL resource(s) to a first UE. For example, the UL resource(s) may include PUCCH resource(s) and/or PUSCH resource(s). For example, the UL resource(s) may be resource(s) for reporting SL HARQ feedback to the base station.

[0064] For example, the first LTE may receive information related to dynamic grant (DG) resource(s) and/or information related to configured grant (CG) resource(s) from the base station. For example, the CG resource(s) may include CG type 1 resource(s) or CG type 2 resource(s). In the present disclosure, the DG resource(s) may be resource(s) configured/allocated by the base station to the first LTE through a downlink control information (DCI). In the present disclosure, the CG resource(s) may be (periodic) resource(s) configured/allocated by the base station to the first UE through a DCI and/or an RRC message. For example, in the case of the CG type 1 resource(s), the base station may transmit an RRC message including information related to CG resource(s) to the first UE. For example, in the case of the CG type 2 resource(s), the base station may transmit an RRC message including information related to CG resource(s) to the first LTE, and the base station may transmit a DCI related to activation or release of the CG resource(s) to the first UE.

[0065] In step S610, the first LTE may transmit a PSCCH (e.g., sidelink control information (SCI) or 1st-stage SCI) to a second UE based on the resource scheduling. In step S620, the first UE may transmit a PSSCH (e.g., 2nd-stage SCI, MAC PDU, data, etc.) related to the PSCCH to the second UE. In step S630, the first UE may receive a PSFCH related to the PSCCH/PSSCH from the second UE. For example, HARQ feedback information (e.g., NACK information or ACK information) may be received from the second UE through the PSFCH. In step S640, the first LTE may transmit/report HARQ feedback information to the base station through the PUCCH or the PUSCH. For example, the HARQ feedback information reported to the base station may be information generated by the first UE based on the HARQ feedback information received from the second LTE. For example, the HARQ feedback information reported to the base station may be information generated by the first UE based on a pre-configured rule. For example, the DCI may be a DCI for SL scheduling. For example, a format of the DCI may be a DCI format 3_0 or a DCI format 3_1.

[0066] Referring to (b) of FIG. 6, in the LTE transmission mode 2, the LTE transmission mode 4, or the NR resource allocation mode 2, a UE may determine SL transmission resource(s) within SL resource(s) configured by a base station/network or pre-configured SL resource(s). For example, the configured SL resource(s) or the pre-configured SL resource(s) may be a resource pool. For example, the LTE may autonomously select or schedule resource(s) for SL transmission. For example, the UE may perform SL communication by autonomously selecting resource(s) within the configured resource pool. For example, the UE may autonomously select resource(s) within a selection window by performing a sensing procedure and a resource (re)selection procedure. For example, the sensing may be performed in a unit of subchannel(s). For example, in step S610, a first LTE which has selected resource(s) from a resource pool by itself may transmit a PSCCH (e.g., sidelink control information (SCI) or 1st-stage SCI) to a second UE by using the resource(s). In step S620, the first UE may transmit a PSSCH (e.g., 2nd-stage SCI, MAC PDU, data, etc.) related to the PSCCH to the second UE. In step S630, the first LTE may receive a PSFCH related to the PSCCH/PSSCH from the second UE.

[0067] Referring to (a) or (b) of FIG. 6, for example, the first UE may transmit a SCI to the second LTE through the PSCCH. Alternatively, for example, the first LTE may transmit two consecutive SCIs (e.g., 2-stage SCI) to the second UE through the PSCCH and/or the PSSCH. In this case, the second UE may decode two consecutive SCIs (e.g., 2-stage SCI) to receive the PSSCH from the first LTE. In the present disclosure, a SCI transmitted through a PSCCH may be referred to as a 1st SCI, a first SCI, a 1st-stage SCI or a 1st-stage SCI format, and a SCI transmitted through a PSSCH may be referred to as a 2nd SCI, a second SCI, a 2nd-stage SCI or a 2nd-stage SCI format. For example, the 1st-stage SCI format may include a SCI format 1-A, and the 2nd-stage SCI format may include a SCI format 2-A and/or a SCI format 2-B.

[0068] Hereinafter, an example of SCI format 1-A will be described.

[0069] SCI format 1-A is used for the scheduling of PSSCH and 2nd-stage-SCI on PSSCH.

[0070] The following information is transmitted by means of the SCI format 1-A:

- Priority - 3 bits
- Frequency resource assignment - ceiling ($\log_2(N^{SL}_{subChannel}(N^{SL}_{subChannel}+1)/2)$) bits when the value of the higher layer parameter sl-MaxNumPerReserve is configured to 2; otherwise ceiling $\log_2(N^{SL}_{subChannel}(N^{SL}_{subChannel}+1)(2N^{SL}_{subChannel}+1)/6)$ bits when the value of the higher layer parameter sl-MaxNumPerReserve is configured to 3

- Time resource assignment - 5 bits when the value of the higher layer parameter sl-MaxNumPerReserve is configured to 2; otherwise 9 bits when the value of the higher layer parameter sl-MaxNumPerReserve is configured to 3
- Resource reservation period - ceiling ($\log_2 N_{rsv_period}$) bits, where N_{rsv_period} is the number of entries in the higher layer parameter sl-ResourceReservePeriodList, if higher layer parameter sl-MultiReserveResource is configured; 0 bit otherwise
- DMRS pattern - ceiling ($\log_2 N_{pattern}$) bits, where $N_{pattern}$ is the number of DMRS patterns configured by higher layer parameter sl-PSSCH-DMRS-TimePatternList
- 2nd-stage SCI format - 2 bits as defined in Table 5
- Beta_offset indicator - 2 bits as provided by higher layer parameter sl-BetaOffsets2ndSCI
- Number of DMRS port - 1 bit as defined in Table 6
- Modulation and coding scheme - 5 bits
- Additional MCS table indicator - 1 bit if one MCS table is configured by higher layer parameter sl-Additional-MCS-Table; 2 bits if two MCS tables are configured by higher layer parameter sl- Additional-MCS-Table; 0 bit otherwise
- PSFCH overhead indication - 1 bit if higher layer parameter sl-PSFCH-Period = 2 or 4; 0 bit otherwise
- Reserved - a number of bits as determined by higher layer parameter sl-NumReservedBits, with value set to zero.

[Table 5]

Value of 2nd-stage SCI format field	2nd-stage SCI format
00	SCI format 2-A
01	SCI format 2-B
10	Reserved
11	Reserved

[Table 6]

Value of the Number of DMRS port field	Antenna ports
0	1000
1	1000 and 1001

[0071] Hereinafter, an example of SCI format 2-A will be described.

[0072] SCI format 2-A is used for the decoding of PSSCH, with HARQ operation when HARQ-ACK information includes ACK or NACK, when HARQ-ACK information includes only NACK, or when there is no feedback of HARQ-ACK information.

[0073] The following information is transmitted by means of the SCI format 2-A:

- HARQ process number - 4 bits
- New data indicator - 1 bit
- Redundancy version - 2 bits
- Source ID - 8 bits
- Destination ID - 16 bits
- HARQ feedback enabled/disabled indicator - 1 bit
- Cast type indicator - 2 bits as defined in Table 7
- CSI request - 1 bit

[Table 7]

Value of Cast type indicator	Cast type
00	Broadcast
01	Groupcast when HARQ-ACK information includes ACK or NACK
10	Unicast

(continued)

Value of Cast type indicator	Cast type
11	Groupcast when HARQ-ACK information includes only NACK

[0074] Hereinafter, an example of SCI format 2-B will be described.

[0075] SCI format 2-B is used for the decoding of PSSCH, with HARQ operation when HARQ-ACK information includes only NACK, or when there is no feedback of HARQ-ACK information.

[0076] The following information is transmitted by means of the SCI format 2-B:

- HARQ process number - 4 bits
- New data indicator - 1 bit
- Redundancy version - 2 bits
- Source ID - 8 bits
- Destination ID - 16 bits
- HARQ feedback enabled/disabled indicator - 1 bit
- Zone ID - 12 bits
- Communication range requirement - 4 bits determined by higher layer parameter sl-ZoneConfigMCR-Index

[0077] Referring to (a) or (b) of FIG. 6, in step S630, the first UE may receive the PSFCH. For example, the first LTE and the second LTE may determine a PSFCH resource, and the second UE may transmit HARQ feedback to the first UE using the PSFCH resource.

[0078] Referring to (a) of FIG. 6, in step S640, the first UE may transmit SL HARQ feedback to the base station through the PUCCH and/or the PUSCH.

[0079] FIG. 7 shows three cast types, based on an embodiment of the present disclosure. The embodiment of FIG. 7 may be combined with various embodiments of the present disclosure. Specifically, (a) of FIG. 7 shows broadcast-type SL communication, (b) of FIG. 7 shows unicast type-SL communication, and (c) of FIG. 7 shows groupcast-type SL communication. In case of the unicast-type SL communication, a LTE may perform one-to-one communication with respect to another UE. In case of the groupcast-type SL transmission, the LTE may perform SL communication with respect to one or more UEs in a group to which the LTE belongs. In various embodiments of the present disclosure, SL groupcast communication may be replaced with SL multicast communication, SL one-to-many communication, or the like.

[0080] Hereinafter, a hybrid automatic repeat request (HARQ) procedure will be described.

[0081] For example, the SL HARQ feedback may be enabled for unicast. In this case, in a non-code block group (non-CBG) operation, if the receiving LTE decodes a PSCCH of which a target is the receiving UE and if the receiving UE successfully decodes a transport block related to the PSCCH, the receiving UE may generate HARQ-ACK. In addition, the receiving UE may transmit the HARQ-ACK to the transmitting UE. Otherwise, if the receiving LTE cannot successfully decode the transport block after decoding the PSCCH of which the target is the receiving UE, the receiving UE may generate the HARQ-NACK. In addition, the receiving UE may transmit HARQ-NACK to the transmitting UE.

[0082] For example, the SL HARQ feedback may be enabled for groupcast. For example, in the non-CBG operation, two HARQ feedback options may be supported for groupcast.

(1) Groupcast option 1: After the receiving UE decodes the PSCCH of which the target is the receiving UE, if the receiving UE fails in decoding of a transport block related to the PSCCH, the receiving LTE may transmit HARQ-NACK to the transmitting UE through a PSFCH. Otherwise, if the receiving UE decodes the PSCCH of which the target is the receiving UE and if the receiving UE successfully decodes the transport block related to the PSCCH, the receiving UE may not transmit the HARQ-ACK to the transmitting UE.

(2) Groupcast option 2: After the receiving UE decodes the PSCCH of which the target is the receiving UE, if the receiving UE fails in decoding of the transport block related to the PSCCH, the receiving UE may transmit HARQ-NACK to the transmitting UE through the PSFCH. In addition, if the receiving UE decodes the PSCCH of which the target is the receiving UE and if the receiving UE successfully decodes the transport block related to the PSCCH, the receiving UE may transmit the HARQ-ACK to the transmitting UE through the PSFCH.

[0083] For example, if the groupcast option 1 is used in the SL HARQ feedback, all UEs performing groupcast communication may share a PSFCH resource. For example, UEs belonging to the same group may transmit HARQ feedback by using the same PSFCH resource.

[0084] For example, if the groupcast option 2 is used in the SL HARQ feedback, each UE performing groupcast communication may use a different PSFCH resource for HARQ feedback transmission. For example, LTEs belonging

to the same group may transmit HARQ feedback by using different PSFCH resources.

[0085] In the present disclosure, HARQ-ACK may be referred to as ACK, ACK information, or positive-ACK information, and HARQ-NACK may be referred to as NACK, NACK information, or negative-ACK information.

[0086] In various embodiments of the present disclosure, a TX LTE and/or an RX LTE may obtain a discontinuous reception (DRX) configuration. For example, the DRX configuration may include a Uu DRX configuration and/or a SL DRX configuration. For example, the TX UE may receive the DRX configuration from a base station, and the RX UE may receive the DRX configuration from the TX UE. For example, the DRX configuration may be configured or pre-configured for the TX UE and/or the RX UE.

[0087] For example, the Uu DRX configuration may include information related to drx-HARQ-RTT-Timer-SL and/or information related to drx-RetransmissionTimer-SL. For example, the timer may be used for the following purposes.

(1) drx-HARQ-RTT-Timer-SL (per HARQ process): drx-HARQ-RTT-Timer-SL may be the minimum duration before a sidelink HARQ retransmission grant is expected by the MAC entity. drx-HARQ-RTT-Timer-SL may refer to the minimum time required until a resource for SL mode 1 retransmission is prepared. That is, the resource for sidelink retransmission cannot be prepared before the drx-HARQ-RTT-Timer-SL timer. Accordingly, the TX UE can reduce power consumption by transitioning to a sleep mode during the drx-HARQ-RTT-Time-SL timer. Or, the TX LTE may not perform mode 1 DCI monitoring from the base station. If the drx-HARQ-RTT-Timer-SL timer expires, the TX UE may determine that a resource for SL retransmission may be prepared. Accordingly, the TX UE may start the drx-RetransmissionTimer-SL timer and monitor whether resource(s) for SL HARQ retransmission is received. As soon as the drx-HARQ-RTT-Timer-SL timer expires, the SL HARQ retransmission resource(s) may or may not be received, so the TX UE may start the drx-RetransmissionTimer-SL timer, and the TX UE may monitor mode 1 DCI from the base station to receive resource(s) for SL HARQ retransmission. For example, the drx-HARQ-RTT-Timer-SL timer may be a duration in which the TX LTE performing sidelink communication based on sidelink resource allocation mode 1 (e.g., the UE supporting Uu DRX operation) does not perform PDCCH (or DCI) monitoring for sidelink mode 1 resource allocation from the base station.

(2) drx-RetransmissionTimer-SL (per HARQ process): drx-RetransmissionTimer-SL may be the maximum duration until a grant for sidelink retransmission is received. That is, the drx-RetransmissionTimer-SL timer may be a timer started when the drx-HARQ-RTT-Timer-SL timer expires, and it may be a timer that allows the TX UE to transition to an active state for SL retransmission. Or, while the corresponding timer is running, the TX LTE may monitor mode 1 DCI from the base station. The TX UE may start monitoring SL mode 1 DCI from the base station, in order to check whether retransmission resource(s) (i.e., grant for sidelink retransmission) to the RX UE is prepared, from a time when drx-RetransmissionTimer-SL starts. And, if retransmission resource(s) is prepared, the TX UE may perform sidelink HARQ retransmission to the RX UE. When transmitting a HARQ retransmission packet to the RX UE, the TX UE may stop the drx-RetransmissionTimer-SL timer. While the drx-RetransmissionTimer-SL timer is running, the UE may maintain an active state. For example, the drx-RetransmissionTimer-SL timer may be a duration in which the TX LTE performing sidelink communication based on sidelink resource allocation mode 1 (e.g., the LTE supporting Uu DRX operation) performs PDCCH (or DCI) monitoring for sidelink mode 1 resource allocation from the base station.

[0088] For example, the SL DRX configuration may include at least one parameter/information among parameters/information described below.

(1) SL drx-onDurationTimer: the duration at the beginning of a SL DRX Cycle
(2) SL drx-SlotOffset: the delay before starting the sl drx-onDurationTimer
(3) SL drx-InactivityTimer: the duration after the PSCCH occasion in which a PSCCH indicates a new SL transmission for the MAC entity
(4) SL drx-RetransmissionTimer (per HARQ process or per sidelink process): the maximum duration until a retransmission is received
(5) SL drx-HARQ-RTT-Timer (per HARQ process or per sidelink process): the minimum duration before PSCCH (Sidelink Control Information) & PSSCH for SL HARQ retransmission is expected by the MAC entity
(6) SL drx-LongCycleStartOffset: the Long DRX cycle and drx-StartOffset which defines the subframe where the Long and Short DRX Cycle starts
(7) SL drx-ShortCycle (optional): the Short DRX cycle
(8) SL drx-ShortCycleTimer (optional): the duration the LTE shall follow the Short DRX cycle
(9) SL drx-HARQ-RTT-Timer (per sidelink process): the minimum duration before an assignment for HARQ retransmission is expected by the MAC entity
(10) SL drx-StartOffset: the subframe where the SL DRX cycle start
(11) SL drx-Cycle: SL DRX cycle

[0089] The SL DRX timer described in the present disclosure may be used for the following purposes.

(1) SL DRX onduration timer: the duration in which the UE performing the SL DRX operation should basically operate in an active time in order to receive a PSCCH/PSSCH from other UE(s)

(2) SL DRX inactivity timer: the duration extending the SL DRX onduration duration, which is the duration in which the LTE performing the SL DRX operation should basically operate in the active time in order to receive the PSCCH/PSSCH from other UE(s)

[0090] For example, the UE may extend the SL DRX onduration timer by the SL DRX inactivity timer duration. In addition, if the UE receives a new packet (e.g., new PSSCH transmission) from other UE(s), the UE may extend the SL DRX onduration timer by starting the SL DRX inactivity timer.

[0091] For example, the SL DRX inactivity timer may be used for extending the SL DRX onduration duration, which is the duration in which the RX UE performing the SL DRX operation should basically operate in the active time in order to receive the PSCCH/PSSCH from other UE(s). That is, the SL DRX onduration timer may be extended by the SL DRX inactivity timer period. In addition, if the RX UE receives a new packet (e.g., new PSSCH transmission) from other TX UE(s), the RX UE may extend the SL DRX onduration timer by starting the SL DRX inactivity timer.

[0092] (3) SL DRX HARQ RTT timer: the duration in which the UE performing the SL DRX operation operates in a sleep mode until receiving a retransmission packet (or PSSCH assignment) transmitted by other UE(s)

[0093] For example, if the UE starts the SL DRX HARQ RTT timer, the UE may determine that other UE(s) will not transmit a sidelink retransmission packet to the UE until the SL DRX HARQ RTT timer expires, and the UE may operate in a sleep mode while the corresponding timer is running. For example, if the LTE starts the SL DRX HARQ RTT timer, the LTE may not monitor a sidelink retransmission packet from other UE(s) until the SL DRX HARQ RTT timer expires. For example, if the RX UE which has received a PSCCH/PSSCH transmitted by the TX UE transmits SL HARQ NACK feedback, the RX UE may start the SL DRX HARQ RTT timer. In this case, the RX UE may determine that other TX UE(s) will not transmit a sidelink retransmission packet to the RX UE until the SL DRX HARQ RTT timer expires, and the RX UE may operate in a sleep mode while the corresponding timer is running.

[0094] (4) SL DRX retransmission timer: the timer which starts when the SL DRX HARQ RTT timer expires, and the duration in which the LTE performing the SL DRX operation operates in an active time in order to receive a retransmission packet (or PSSCH assignment) transmitted by other UE(s)

[0095] For example, for the corresponding timer duration, the LTE may receive or monitor a retransmission sidelink packet (or PSSCH assignment) transmitted by other LTE(s). For example, the RX LTE may receive or monitor a retransmission sidelink packet (or PSSCH assignment) transmitted by other TX UE(s) while the SL DRX retransmission timer is running.

[0096] In the present disclosure, the names of the timer (drx-HARQ-RTT-Timer-SL, drx-RetransmissionTimer-SL, Sidelink DRX Onduration Timer, Sidelink DRX Inactivity Timer, Sidelink DRX HARQ RTT Timer, Sidelink DRX Retransmission Timer, etc.) is exemplary, and a timer performing the same/similar function based on the contents described in each timer may be considered as the same/similar timer regardless of the names of the timer.

[0097] The UE performing a sidelink DRX operation may operate in an active mode during a DRX active time (e.g., an on-duration timer, an inactivity timer, a retransmission timer, or a period operating in an active mode) and may perform PSCCH/PSSCH monitoring. However, the LTE may operate in a sleep mode in a sidelink DRX inactive time period and may not perform PSCCH/PSSCH monitoring for SL data reception.

[0098] In sidelink unicast, the LTE may negotiate/determine a sidelink DRX configuration (SL DRX configuration to be used during sidelink unicast communication) with a counterpart UE with which a unicast connection is established. If there is a connection (RRC connection) between the transmitting UE and the base station, the base station of the transmitting UE may configure a SL DRX configuration to be used by the receiving LTE having a unicast connection with the transmitting LTE and may inform the transmitting UE of the SL DRX configuration, and the transmitting UE may transmit the SL DRX configuration to be used by the receiving UE received from the base station to the receiving UE through a PC5 RRC message. If there is no connection (RRC connection) between the transmitting UE and the base station, the transmitting UE may autonomously configure a SL DRX configuration to be used by the receiving UE having a unicast connection with the transmitting UE and may transmit the SL DRX configuration to the receiving UE through a PC5 RRC message.

[0099] SL DRX is an operation for the receiving LTE, but the transmitting LTE should also know a SL DRX operating status of the receiving UE (an active mode, a sleep mode, a start time of DRX onduration/inactivity/HARQ RTT/retransmit timer, an expiration time of DRX onduration/inactivity/HARQ RTT/retransmit timer, etc.). For example, when allocating resources and performing transmission, the transmitting UE should be able to determine whether the receiving UE is operating in an active mode or a sleep mode. Therefore, the transmitting UE may maintain the same operating status as the receiving UE, such as the SL DRX timer, by applying the same SL DRX configuration as the receiving UE.

[0100] An AS layer of the LTE (RX LTE or TX UE) supporting the SL DRX operation may receive a Tx profile mapped

to an available sidelink service from a higher layer (e.g., V2X layer). The Tx profile may include information for identifying whether an available sidelink service or a sidelink service of interest is a sidelink service for which the SL DRX operation should be performed or not. Therefore, if the AS layer of the UE receives available sidelink data (or sidelink service of interest) and the Tx profile from the higher layer, the UE may determine (or decide) whether the SL DRX operation should be supported for available sidelink data (or sidelink service of interest) or not.

[0101] The TX LTE performing SL transmission (or resource (re)selection operation) based on sidelink mode 2 resource allocation operation may perform a process of reselecting transmission resources reserved for previous SL data (or previous SL TB). For example, the TX LTE may perform an operation of reselecting transmission resources reserved for previous SL data (or previous SL TB), due to congestion control, NR SL dropping by NR SL/LTE SL prioritization, SL dropping by UL/SL prioritization, preemption, etc.

[0102] The transmitting UE may include information on up to three resources in SCI and transmit the SCI to the receiving UE, including information on a resource related to a currently transmitted PSSCH and information on two retransmission resources.

[0103] If the transmitting UE transmits a HARQ Feedback Disabled MAC PDU to the receiving LTE and the receiving LTE checks a HARQ feedback mode indicator set to HARQ Feedback Disabled included in SCI, the receiving UE which has received a PSCCH/PSSCH may not transmit SL HARQ feedback to the transmitting UE, and the receiving UE may monitor a PSCCH/PSSCH additionally transmitted by the transmitting UE. The transmitting LTE may also perform additional PSCCH/PSSCH transmission (blind transmission) without receiving HARQ feedback (ACK or NACK) from the receiving UE when transmitting the HARQ Feedback Disabled MAC PDU.

[0104] Meanwhile, in the conventional unlicensed spectrum (NR-U), a communication method between a LTE and a base station is supported in an unlicensed band. In addition, a mechanism for supporting communication in an unlicensed band between sidelink UEs is planned to be supported in Rel-18.

[0105] In the present disclosure, a channel may refer to a set of frequency domain resources in which Listen-Before-Talk (LBT) is performed. In NR-U, the channel may refer to an LBT bandwidth with 20 MHz and may have the same meaning as an RB set. For example, the RB set may be defined in section 7 of 3GPP TS 38.214 V17.0.0.

[0106] In the present disclosure, channel occupancy (CO) may refer to time/frequency domain resources obtained by the base station or the UE after LBT success.

[0107] In the present disclosure, channel occupancy time (COT) may refer to time domain resources obtained by the base station or the UE after LBT success. It may be shared between the base station (or the UE) and the UE (or the base station) that obtained the CO, and this may be referred to as COT sharing. Depending on the initiating device, this may be referred to as gNB-initiated COT or UE-initiated COT.

[0108] Hereinafter, a wireless communication system supporting an unlicensed band/shared spectrum will be described.

[0109] FIG. 8 shows an example of a wireless communication system supporting an unlicensed band, based on an embodiment of the present disclosure. For example, FIG. 8 may include an unlicensed spectrum (NR-U) wireless communication system. The embodiment of FIG. 8 may be combined with various embodiments of the present disclosure.

[0110] In the following description, a cell operating in a licensed band (hereinafter, L-band) may be defined as an L-cell, and a carrier of the L-cell may be defined as a (DL/UL/SL) LCC. In addition, a cell operating in an unlicensed band (hereinafter, U-band) may be defined as a U-cell, and a carrier of the U-cell may be defined as a (DL/UL/SL) UCC. The carrier/carrier-frequency of a cell may refer to the operating frequency (e.g., center frequency) of the cell. A cell/carrier (e.g., CC) is commonly called a cell.

[0111] When the base station and the UE transmit and receive signals on carrier-aggregated LCC and UCC as shown in (a) of FIG. 8, the LCC and the UCC may be configured as a primary CC (PCC) and a secondary CC (SCC), respectively. The base station and the UE may transmit and receive signals on one UCC or on a plurality of carrier-aggregated UCCs as shown in (b) of FIG. 8. In other words, the base station and the UE may transmit and receive signals only on UCC(s) without using any LCC. For a standalone operation, PRACH transmission, PUCCH transmission, PUSCH transmission, SRS transmission, etc. may be supported on a UCell.

[0112] In the embodiment of FIG. 8, the base station may be replaced with the UE. In this case, for example, PSCCH transmission, PSSCH transmission, PSFCH transmission, S-SSB transmission, etc. may be supported on a UCell.

[0113] Unless otherwise noted, the definitions below are applicable to the following terminologies used in the present disclosure.

- Channel: a carrier or a part of a carrier composed of a contiguous set of RBs in which a channel access procedure is performed in a shared spectrum.
- Channel access procedure (CAP): a procedure of assessing channel availability based on sensing before signal transmission in order to determine whether other communication node(s) are using a channel. A basic sensing unit is a sensing slot with a duration of T_{sl} = 9 us. The base station or the UE senses a channel during a sensing slot duration. If power detected for at least 4 us within the sensing slot duration is less than an energy detection threshold

X_{thresh}, the sensing slot duration T_{sl} is considered to be idle. Otherwise, the sensing slot duration T_{sl} = 9 us is considered to be busy. CAP may also be referred to as listen before talk (LBT).

- Channel occupancy: transmission(s) on channel(s) by the base station/UE after a channel access procedure.
- Channel occupancy time (COT): a total time during which the base station/UE and any base station/UE(s) sharing channel occupancy can perform transmission(s) on a channel after the base station/UE perform a channel access procedure. In the case of determining COT, if a transmission gap is less than or equal to 25 us, the gap duration may be counted in the COT. The COT may be shared for transmission between the base station and corresponding UE(s).
- DL transmission burst: a set of transmissions without any gap greater than 16 us from the base station. Transmissions from the base station, which are separated by a gap exceeding 16 us are considered as separate DL transmission bursts. The base station may perform transmission(s) after a gap without sensing channel availability within a DL transmission burst.
- UL or SL transmission burst: a set of transmissions without any gap greater than 16 us from the UE. Transmissions from the UE, which are separated by a gap exceeding 16 us are considered as separate LTL or SL transmission bursts. The LTE may perform transmission(s) after a gap without sensing channel availability within a LTL or SL transmission burst.
- Discovery burst: a DL transmission burst including a set of signal(s) and/or channel(s) confined within a window and associated with a duty cycle. In the LTE-based system, the discovery burst may be transmission(s) initiated by the base station, which includes PSS, an SSS, and cell-specific RS (CRS) and further includes non-zero power CSI-RS. In the NR-based system, the discover burst may be transmission(s) initiated by the base station, which includes at least an SS/PBCH block and further includes CORESET for a PDCCH scheduling a PDSCH carrying SIB 1, the PDSCH carrying SIB1, and/or non-zero power CSI-RS.

[0114] FIG. 9 shows a method of occupying resources in an unlicensed band, based on an embodiment of the present disclosure. The embodiment of FIG. 9 may be combined with various embodiments of the present disclosure.

[0115] Referring to FIG. 9, a communication node (e.g., base station, LTE) within an unlicensed band should determine whether other communication node(s) is using a channel before signal transmission. To this end, the communication node within the unlicensed band may perform a channel access procedure (CAP) to access channel(s) on which transmission(s) is performed. The channel access procedure may be performed based on sensing. For example, the communication node may perform carrier sensing (CS) before transmitting signals so as to check whether other communication node(s) perform signal transmission. When the other communication node(s) perform no signal transmission, it is said that clear channel assessment (CCA) is confirmed. If a CCA threshold (e.g., X_{Thresh}) is predefined or configured by a higher layer (e.g., RRC), the communication node may determine that the channel is busy if the detected channel energy is higher than the CCA threshold. Otherwise, the communication node may determine that the channel is idle. If it is determined that the channel is idle, the communication node may start the signal transmission in the unlicensed band. The CAP may be replaced with the LBT.

[0116] Table 8 shows an example of the channel access procedure (CAP) supported in NR-U.

[Table 8]

	Type	Explanation
DL	Type 1 CAP	CAP with random back-off - time duration spanned by the sensing slots that are sensed to be idle before a downlink transmission(s) is random
	Type 2 CAP - Type 2A, 2B, 2C	CAP without random back-off - time duration spanned by sensing slots that are sensed to be idle before
		a downlink transmission(s) is deterministic
UL or SL	Type 1 CAP	CAP with random back-off - time duration spanned by the sensing slots that are sensed to be idle before an uplink or sidelink transmission(s) is random
	Type 2 CAP - Type 2A, 2B, 2C	CAP without random back-off - time duration spanned by sensing slots that are sensed to be idle before an uplink or sidelink transmission(s) is deterministic

[0117] Referring to Table 8, the LBT type or CAP for DL/UL/SL transmission may be defined. However, Table 8 is

only an example, and a new type or CAP may be defined in a similar manner. For example, the type 1 (also referred to as Cat-4 LBT) may be a random back-off based channel access procedure. For example, in the case of Cat-4, the contention window may change. For example, the type 2 can be performed in case of COT sharing within COT acquired by the base station (gNB) or the UE.

[0118] Hereinafter, LBT-SubBand (SB) (or RB set) will be described.

[0119] In a wireless communication system supporting an unlicensed band, one cell (or carrier (e.g., CC)) or BWP configured for the UE may have a wideband having a larger bandwidth (BW) than in legacy LTE. However, a BW requiring CCA based on an independent LBT operation may be limited according to regulations. Let a subband (SB) in which LBT is individually performed be defined as an LBT-SB. Then, a plurality of LBT-SBs may be included in one wideband cell/BWP. A set of RBs included in an LBT-SB may be configured by higher-layer (e.g., RRC) signaling. Accordingly, one or more LBT-SBs may be included in one cell/BWP based on (i) the BW of the cell/BWP and (ii) RB set allocation information.

[0120] FIG. 10 shows a case in which a plurality of LBT-SBs are included in an unlicensed band, based on an embodiment of the present disclosure. The embodiment of FIG. 10 may be combined with various embodiments of the present disclosure.

[0121] Referring to FIG. 10, a plurality of LBT-SBs may be included in the BWP of a cell (or carrier). An LBT-SB may have, for example, a 20-MHz band. The LBT-SB may include a plurality of contiguous (P)RBs in the frequency domain, and thus may be referred to as a (P)RB set. While not shown, a guard band (GB) may be interposed between LBT-SBs. Accordingly, the BWP may be configured in the form of {LBT-SB #0 (RB set #0)+GB #0+LBT-SB #1 (RB set #1+GB #1) + ... +LBT-SB #(K-1) (RB set (#K-1))}. For convenience, LBT-SB/RB indexes may be configured/defined in an increasing order from the lowest frequency to the highest frequency.

[0122] Hereinafter, a channel access priority class (CAPC) will be described.

[0123] The CAPCs of MAC CEs and radio bearers may be fixed or configured to operate in FR1:

- Fixed to lowest priority for padding buffer status report (BSR) and recommended bit rate MAC CE;
- Fixed to highest priority for SRB0, SRB1, SRB3 and other MAC CEs;
- Configured by the base station for SRB2 and DRB.

[0124] When selecting a CAPC of a DRB, the base station considers fairness between other traffic types and transmissions while considering 5QI of all QoS flows multiplexed to the corresponding DRB. Table 9 shows which CAPC should be used for standardized 5QI, that is, a CAPC to be used for a given QoS flow. For standardized 5QI, CAPCs are defined as shown in the table below, and for non-standardized 5QI, the CAPC with the best QoS characteristics should be used.

[Table 9]

CAPC	5QI
1	1, 3, 5, 65, 66, 67, 69, 70, 79, 80, 82, 83, 84, 85
2	2, 7, 71
3	4, 6, 8, 9, 72, 73, 74, 76
4	-
NOTE: A lower CAPC value indicates a higher priority.	

[0125] Hereinafter, a method of transmitting a downlink signal through an unlicensed band will be described. For example, a method of transmitting a downlink signal through an unlicensed band may be applied to a method of transmitting a sidelink signal through an unlicensed band.

[0126] The base station may perform one of the following channel access procedures (e.g., CAP) for downlink signal transmission in an unlicensed band.

(1) Type 1 downlink (DL) CAP Method

[0127] In the type 1 DL CAP, the length of a time duration spanned by sensing slots sensed to be idle before transmission(s) may be random. The type 1 DL CAP may be applied to the following transmissions:

- Transmission(s) initiated by the base station including (i) a unicast PDSCH with user plane data or (ii) the unicast

PDSCH with user plane data and a unicast PDCCH scheduling user plane data, or

- Transmission(s) initiated by the base station including (i) a discovery burst only or (ii) a discovery burst multiplexed with non-unicast information.

[0128] FIG. 11 shows CAP operations performed by a base station to transmit a downlink signal through an unlicensed band, based on an embodiment of the present disclosure. The embodiment of FIG. 11 may be combined with various embodiments of the present disclosure.

[0129] Referring to FIG. 11, the base station may sense whether a channel is idle for sensing slot durations of a defer duration T_d. Then, if a counter N is zero, the base station may perform transmission (S134). In this case, the base station may adjust the counter N by sensing the channel for additional sensing slot duration(s) according to the following steps:

Step 1) (S120) The base station sets N to N_{init} (N= N_{init}), where N_{init} is a random number uniformly distributed between 0 and CW_p. Then, step 4 proceeds.
Step 2) (S140) If N>0 and the base station determines to decrease the counter, the base station sets N to N-1 (N=N-1).
Step 3) (S150) The base station senses the channel for the additional sensing slot duration. If the additional sensing slot duration is idle (Y), step 4 proceeds. Otherwise (N), step 5 proceeds.
Step 4) (S130) If N=0 (Y), the base station terminates the CAP (S132). Otherwise (N), step 2 proceeds.
Step 5) (S160) The base station senses the channel until either a busy sensing slot is detected within an additional defer duration T_d or all the slots of the additional defer duration T_d are detected to be idle.
Step 6) (S170) If the channel is sensed to be idle for all the slot durations of the additional defer duration T_d (Y), step 4 proceeds. Otherwise (N), step 5 proceeds.

[0130] Table 10 shows that m_p, a minimum contention window (CW), a maximum CW, a maximum channel occupancy time (MCOT), and an allowed CW size, which are applied to the CAP, vary depending on channel access priority classes.

[Table 10]

Channel Access Priority Class (p)	m_p	$CW_{min,p}$	$CW_{max,p}$	$T_{mcot,p}$	allowed CW_p sizes
1	1	3	7	2 ms	{3,7}
2	1	7	15	3 ms	{7,15}
3	3	15	63	8 or 10 ms	{15,31,63}
4	7	15	1023	8 or 10 ms	{15,31,63,127,255,511,1023}

[0131] Referring to Table 10, a contention window size (CWS), a maximum COT value, etc. for each CAPC may be defined. For example, T_d may be equal to $T_f + m_p * T_{sl}$ ($T_d = T_f + m_p * T_{sl}$).

[0132] The defer duration T_d is configured in the following order: duration T_f (16 us) + m_p consecutive sensing slot durations T_{sl} (9 us). $T\varepsilon$ includes the sensing slot duration T_{sl} at the beginning of the 16 us duration.

[0133] The following relationship is satisfied: $CW_{min,p} <= CW_p <= CW_{max,p}$. CW_p may be configured by $CW_p = CW_{min,p}$ and updated before step 1 based on HARQ-ACK feedback (e.g., the ratio of ACK or NACK) for a previous DL burst (e.g., PDSCH) (CW size update). For example, CW_p may be initialized to $CW_{min,p}$ based on the HARQ-ACK feedback for the previous DL burst. Alternatively, CW_p may be increased to the next higher allowed value or maintained as it is.

(2) Type 2 downlink (DL) CAP Method

[0134] In the type 2 DL CAP, the length of a time duration spanned by sensing slots sensed to be idle before transmission(s) may be determined. The type 2 DL CAP is classified into type 2A/2B/2C DL CAPs.

[0135] The type 2A DL CAP may be applied to the following transmissions. In the type 2A DL CAP, the base station may perform transmission immediately after the channel is sensed to be idle at least for a sensing duration T_{short_dl} = 25 us. Herein, T_{short_dl} includes the ration T_f (=16 us) and one sensing slot duration immediately after the duration $T\varepsilon$, where the duration $T\varepsilon$ includes a sensing slot at the beginning thereof.

- Transmission(s) initiated by the base station including (i) a discovery burst only or (ii) a discovery burst multiplexed with non-unicast information, or
- Transmission(s) by the base station after a gap of 25 us from transmission(s) by the LTE within a shared channel occupancy.

[0136] The type 2B DL CAP is applicable to transmission(s) performed by the base station after a gap of 16 us from transmission(s) by the UE within a shared channel occupancy time. In the type 2B DL CAP, the base station may perform transmission immediately after the channel is sensed to be idle for T_f = 16 us. $T\varepsilon$ includes a sensing slot within 9 us from the end of the duration. The type 2C DL CAP is applicable to transmission(s) performed by the base station after a maximum of 16 us from transmission(s) by the UE within the shared channel occupancy time. In the type 2C DL CAP, the base station does not perform channel sensing before performing transmission.

[0137] Hereinafter, a method of transmitting an uplink signal through an unlicensed band will be described. For example, a method of transmitting an uplink signal through an unlicensed band may be applied to a method of transmitting a sidelink signal through an unlicensed band.

[0138] The UE may perform type 1 or type 2 CAP for UL signal transmission in an unlicensed band. In general, the UE may perform the CAP (e.g., type 1 or type 2) configured by the base station for LTL signal transmission. For example, a LTL grant scheduling PUSCH transmission (e.g., DCI formats 0_0 and 0_1) may include CAP type indication information for the UE.

(1) Type 1 uplink (LTL) CAP Method

[0139] In the type 1 UL CAP, the length of a time duration spanned by sensing slots sensed to be idle before transmission(s) is random. The type 1 LTL CAP may be applied to the following transmissions.

- PUSCH/SRS transmission(s) scheduled and/or configured by the base station
- PUCCH transmission(s) scheduled and/or configured by the base station
- Transmission(s) related to a random access procedure (RAP)

[0140] FIG. 12 shows type 1 CAP operations performed by a LTE to transmit an uplink signal, based on an embodiment of the present disclosure. The embodiment of FIG. 12 may be combined with various embodiments of the present disclosure.

[0141] Referring to FIG. 12, the LTE may sense whether a channel is idle for sensing slot durations of a defer duration T_d. Then, if a counter N is zero, the UE may perform transmission (S234). In this case, the LTE may adjust the counter N by sensing the channel for additional sensing slot duration(s) according to the following steps:

Step 1) (S220) The UE sets N to N_{init} ($N = N_{init}$), where N_{init} is a random number uniformly distributed between 0 and CW_p. Then, step 4 proceeds.
Step 2) (S240) If N>0 and the UE determines to decrease the counter, the UE sets N to N-1 (N = N-1).
Step 3) (S250) The LTE senses the channel for the additional sensing slot duration. If the additional sensing slot duration is idle (Y), step 4 proceeds. Otherwise (N), step 5 proceeds.
Step 4) (S230) If N=0 (Y), the UE terminates the CAP (S232). Otherwise (N), step 2 proceeds.
Step 5) (S260) The UE senses the channel until either a busy sensing slot is detected within an additional defer duration T_d or all the slots of the additional defer duration T_d are detected to be idle.
Step 6) (S270) If the channel is sensed to be idle for all the slot durations of the additional defer duration T_d (Y), step 4 proceeds. Otherwise (N), step 5 proceeds.

[0142] Table 11 shows that m_p, a minimum CW, a maximum CW, a maximum channel occupancy time (MCOT), and an allowed CW size, which are applied to the CAP, vary depending on channel access priority classes.

[Table 11]

Channel Access Priority Class (p)	m_p	$CW_{min,p}$	$CW_{max,p}$	$T_{ulmcot,p}$	allowed CW_p sizes
1	2	3	7	2 ms	{3,7}
2	2	7	15	4 ms	{7,15}
3	3	15	1023	6 or 10 ms	{15,31,63,127,255,511,1023}
4	7	15	1023	6 or 10 ms	{15,31,63,127,255,511,1023}

[0143] Referring to Table 11, a contention window size (CWS), a maximum COT value, etc. for each CAPC may be defined. For example, T_d may be equal to $T_f + m_p * T_{sl}$ ($T_d = T_f + m_p * T_{sl}$).

[0144] The defer duration Ta is configured in the following order: duration T_f(16 us) + m_p consecutive sensing slot durations T_{sl} (9 us). $T\varepsilon$ includes the sensing slot duration T_{sl} at the beginning of the 16 us duration.

[0145] The following relationship is satisfied: $CW_{min,p} <= CW_p <= CW_{max,p}$. CWp may be configured by $CW_p = CW_{min,p}$ and updated before step 1 based on an explicit/implicit reception response for a previous UL burst (e.g., PUSCH) (CW size update). For example, CW_p may be initialized to $CW_{min,p}$ based on the explicit/implicit reception response for the previous LTL burst. Alternatively, CW_p may be increased to the next higher allowed value or maintained as it is.

(2) Type 2 uplink (LTL) CAP Method

[0146] In the type 2 UL CAP, the length of a time duration spanned by sensing slots sensed to be idle before transmission(s) may be determined. The type 2 UL CAP is classified into type 2A/2B/2C UL CAPs. In the type 2A UL CAP, the UE may perform transmission immediately after the channel is sensed to be idle at least for a sensing duration T_{short_dl} = 25 us. Herein, T_{short_dl} includes the duration T_f (=16 us) and one sensing slot duration immediately after the duration $T\varepsilon$. In the type 2A UL CAP, T_f includes a sensing slot at the beginning thereof. In the type 2B UL CAP, the UE may perform transmission immediately after the channel is sensed to be idle for the sensing duration $T\varepsilon$ = 16 us. In the type 2B UL CAP, $T\varepsilon$ includes a sensing slot within 9 us from the end of the duration. In the type 2C LTL CAP, the LTE does not perform channel sensing before performing transmission.

[0147] For example, according to the type 1 LBT-based NR-U operation, the UE having uplink data to be transmitted may select a CAPC mapped to 5QI of data, and the UE may perform the NR-U operation by applying parameters of the corresponding CACP (e.g., minimum contention window size, maximum contention window size, m_p, etc.). For example, the UE may select a backoff counter (BC) after selecting a random value between the minimum CW and the maximum CW mapped to the CAPC. In this case, for example, the BC may be a positive integer less than or equal to the random value. The UE sensing a channel decreases the BC by 1 if the channel is idle. If the BC becomes zero and the UE detects that the channel is idle for the time T_d ($T_d = T\varepsilon + m_p * T_{sl}$), the LTE may attempt to transmit data by occupying the channel. For example, T_{sl} (= 9 usec) is a basic sensing unit or sensing slots, and may include a measurement duration for at least 4 usec. For example, the front 9 usec of $T\varepsilon$ (= 16 usec) may be configured to be T_{sl}.

[0148] For example, according to the type 2 LBT-based NR-U operation, the UE may transmit data by performing the type 2 LBT (e.g., type 2A LBT, type 2B LBT, or type 2C LBT) within COT.

[0149] For example, the type 2A (also referred to as Cat-2 LBT (one shot LBT) or one-shot LBT) may be 25 usec one-shot LBT. In this case, transmission may start immediately after idle sensing for at least a 25 usec gap. The type 2A may be used to initiate transmission of SSB and non-unicast DL information. That is, the UE may sense a channel for 25 usec within COT, and if the channel is idle, the UE may attempt to transmit data by occupying the channel.

[0150] For example, the type 2B may be 16 usec one-shot LBT. In this case, transmission may start immediately after idle sensing for a 16 usec gap. That is, the LTE may sense a channel for 16 usec within COT, and if the channel is idle, the LTE may attempt to transmit data by occupying the channel.

[0151] For example, in the case of the type 2C (also referred to as Cat-1 LBT or No LBT), LBT may not be performed. In this case, transmission may start immediately after a gap of up to 16 usec and a channel may not be sensed before the transmission. The duration of the transmission may be up to 584 usec. The LTE may attempt transmission after 16 usec without sensing, and the UE may perform transmission for up to 584 usec.

[0152] In a sidelink unlicensed band, the UE may perform a channel access operation based on Listen Before Talk (LBT). Before the UE accesses a channel in an unlicensed band, the UE should check whether the channel to be accessed is idle (e.g., a state in which LTEs do not occupy the channel, a state in which UEs can access the corresponding channel and transmit data) or busy (e.g., a state in which the channel is occupied and data transmission/reception is performed on the corresponding channel, and the LTE attempting to access the channel cannot transmit data while the channel is busy). That is, the operation in which the UE checks whether the channel is idle or busy may be referred to as Clear Channel Assessment (CCA), and the UE may check whether the channel is idle or busy for the CCA duration.

[0153] Meanwhile, in conventional NR V2X, according to a MAC PDU generation operation, the UE may select a destination having a sidelink logical channel with the highest priority for available SL data, and the UE may generate a MAC PDU by multiplexing SDU(s) for the same destination into one MAC PDU. Meanwhile, a channel access priority class (CAPC) may be considered for efficient resource occupation in an unlicensed band. In this case, it is necessary to propose a procedure for allocating resources to logical channels in consideration of the CAPC by the LTE intending to perform resource occupation or transmit a MAC PDU in an unlicensed band. Based on various embodiments of the present disclosure, a method for generating a MAC PDU by the transmitting UE in a sidelink unlicensed spectrum and an apparatus supporting the same are proposed. In various embodiments of the present disclosure, an operation of generating a MAC PDU based on a logical channel may refer to an operation of allocating a resource to the logical channel. In other words, since an operation of the UE multiplexing data (e.g., SDU) related to a logical channel to a MAC PDU means an operation of the UE allocating a resource for transmitting the MAC PDU to the logical channel, the operation of the UE multiplexing data (e.g., SDU) related to the logical channel to the MAC PDU may refer to the operation of the UE allocating the resource for transmitting the MAC PDU to the logical channel.

[0154] FIG. 13 shows a procedure for a LTE to perform sidelink communication based on a channel access priority

class (CAPC), based on an embodiment of the present disclosure. The embodiment of FIG. 13 may be combined with various embodiments of the present disclosure.

[0155] Referring to FIG. 13, in step S1310, the LTE may select a SL-CAPC from among a plurality of SL-CAPCs. In step S1320, the UE may generate a MAC PDU based on the SL-CAPC. For example, the UE may allocate a resource for transmitting the MAC PDU to at least one logical channel based on the SL-CAPC. In step S1330, the LTE may perform PSCCH/PSSCH transmission.

[0156] Based on an embodiment of the present disclosure, the UE may first select SL data belonging to a SL-CAPC (e.g., SL-CAPC 1) having the highest priority among a plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4) as candidate data for generating the MAC PDU.

[0157] For data belonging to the SL-CAPC with the highest priority selected first, the UE may select a destination having a sidelink logical channel with the highest priority, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU. If there is space in the MAC PDU that can additionally accommodate SDU(s), for data belonging to a SL-CAPC with the next highest priority, the UE may select a logical channel having the same L2 destination as the data belonging to the SL-CAPC having the highest priority selected first among destination(s) having a sidelink logical channel with the highest priority, and the UE may accommodate it to the MAC PDU.

[0158] For example, the LTE may generate the MAC PDU according to the procedure below.

1> To generate the MAC PDU, the LTE may first select data belonging to a SL-CAPC with the highest priority order.

2> The UE may select a destination having a sidelink logical channel with the highest priority for data belonging to the selected SL-CAPC, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU.

3> If the UE completes MAC PDU generation for the data belonging to the SL-CAPC with the highest priority order, the UE may select a destination having a sidelink logical channel with the highest priority for data belonging to a CAPC with the next highest priority order, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU.

[0159] FIG. 14 shows a method of generating a MAC PDU based on a channel access priority class (CAPC), based on an embodiment of the present disclosure. The embodiment of FIG. 14 may be combined with various embodiments of the present disclosure.

[0160] In the embodiment of FIG. 14, it is assumed that a priority of CAPC #N is higher than a priority of CAPC #K, and the priority of CAPC #K is higher than a priority of CAPC #L. In addition, it is assumed that a priority of logical channel #A is higher than a priority of logical channel #B, and the priority of logical channel #B is higher than a priority of logical channel #C. In addition, it is assumed that a priority of logical channel #D is the same as a priority of logical channel #E, and the priority of logical channel #E is higher than a priority of logical channel #F. In addition, it is assumed that logical channel #A, logical channel #C, and logical channel #E are related to destination #X, and logical channel #B, logical channel #D, and logical channel #F are related to destination #Y. In other words, destination #X may have logical channel #A, logical channel #C and logical channel #E, and destination #Y may have logical channel #B, logical channel #D and logical channel #F.

[0161] Under the above assumption, for data belonging to a SL CAPC with the highest priority (i.e., CAPC #N), the LTE may select a destination (i.e., DST #X) having a sidelink logical channel with the highest priority (i.e., logical channel #A), and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU. Accordingly, the MAC PDU may be generated based on logical channel #A and logical channel #C.

[0162] If there is space that can additionally accommodate SDU(s) in the MAC PDU, for data belonging to a SL-CAPC with the next highest priority (i.e., CAPC #K), the UE may select a logical channel (i.e., logical channel #E) having the same L2 destination as the data belonging to the SL-CAPC having the highest priority selected first among destination(s) having a sidelink logical channel with the highest priority, and the UE may accommodate it to the MAC PDU.

[0163] Based on the above-described embodiment, even if the priority of logical channel #D is higher than the priority of logical channel #A, the LTE can select destination #X by considering the priority of the SL CAPC, and the LTE can preferentially allocate resources to logical channel #A.

[0164] Based on an embodiment of the present disclosure, if a plurality of SL data belonging to a plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4) are in a queue, the UE may generate a MAC PDU through the following procedure, and the UE may transmit the generated MAC PDU.

[0165] If a plurality of SL data belonging to a plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4) are in a queue, the UE may perform random backoff-based contention between the plurality of data belonging to the plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4).

[0166] For example, random backoff-based contention may be performed as follows.

- The "Minimum Contention Window (minCW)" value, the "Maximum Contention Window (MaxCW)" value, the backoff count value and the sensing duration of SL data belonging to each SL-CAPC may be different according to the SL-CAPC (SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4). An SL-CAPC with a higher priority may have a smaller value in minCW, MaxCW, backoff count value, and sensing duration.
- If SL data of a SL-CAPC is accumulated in a data queue, each SL data may compete with each other based on SL-CAPC parameters (minCW, MaxCW, backoff count, sensing duration) mapped to its own data. In addition, if data of a SL-CAPC having a backoff count 1 (or 0) is generated, it may be determined that the data has won the contention, and an opportunity to generate and transmit a MAC PDU may be given. If the UE performs sensing for the sensing duration and detects that a channel is idle, the LTE may decrease the backoff count (or backoff time slot) by 1. In addition, if the backoff count value is 1 or 0, an opportunity to transmit data of a SL-CAPC by generating a MAC PDU may be given. The backoff count may be randomly selected by the UE between minCW and maxCW.

[0167] For data belonging to a SL-CAPC that won the contention among data belonging to a plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4), the UE may first perform MAC PDU generation. For data belonging to a SL-CAPC with the highest priority selected by winning the contention, the UE may select a destination having a sidelink logical channel with the highest priority, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU. If there is space in the MAC PDU that can additionally accommodate SDU(s), for data belonging to a SL-CAPC with the highest priority that won the next contention, the UE may select a logical channel having the same L2 destination as the data belonging to the SL-CAPC having the highest priority selected first among destination(s) having a sidelink logical channel with the highest priority, and the UE may accommodate it to the MAC PDU.

[0168] For example, the LTE may generate the MAC PDU according to the procedure below.

1> If a plurality of SL data belonging to a plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4) are in a queue, the UE may perform random backoff-based contention between the plurality of data belonging to the plurality of SL-CAPCs (e.g., SL-CAPC 1, SL-CAPC 2, SL-CAPC 3, SL-CAPC 4), and the UE may first select data belonging to a SL-CAPC that won the contention.

2> The UE may select a destination having a sidelink logical channel with the highest priority for data belonging to the SL-CAPC selected by winning the contention, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU.

3> If the UE completes generating the MAC PDU for the data belonging to the SL-CAPC selected by winning the contention, the UE may select a destination having a sidelink logical channel with the highest priority for data belonging to a SL-CAPC selected by winning the next contention, and the UE may generate the MAC PDU by multiplexing SDUs for the same L2 destination (or the same cast type) into one MAC PDU.

[0169] For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each resource pool. For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each congestion level. For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each service priority. For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each service type. For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each QoS requirement (e.g., latency, reliability). For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each PQI (5G QoS identifier (5QI) for PC5). For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each traffic type (e.g., periodic generation or aperiodic generation). For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each SL transmission resource allocation mode (e.g., mode 1 or mode 2). For example, whether or not the (some) proposed method/rule of the present disclosure is applied and/or related parameter(s) (e.g., threshold value(s)) may be configured (differently or independently) for each Tx profile (e.g., a Tx profile indicating that a service supports sidelink DRX operation or a Tx profile indicating that a service does not need to support sidelink DRX operation).

[0170] For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) depending on whether a PUCCH configuration is supported (e.g., in case that a PUCCH resource is configured or in case that a PUCCH resource is not

configured). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each resource pool (e.g., a resource pool with a PSFCH or a resource pool without a PSFCH). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each service/packet type. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each service/packet priority. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each QoS requirement (e.g., URLLC/EMBB traffic, reliability, latency). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each PQI. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each PFI. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each cast type (e.g., unicast, groupcast, broadcast). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each (resource pool) congestion level (e.g., CBR). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each SL HARQ feedback option (e.g., NACK-only feedback, ACK/NACK feedback). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for HARQ Feedback Enabled MAC PDU transmission. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for HARQ Feedback Disabled MAC PDU transmission. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) according to whether a PUCCH-based SL HARQ feedback reporting operation is configured or not. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for pre-emption or depending on whether or not pre-emption-based resource reselection is performed. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for re-evaluation or depending on whether or not re-evaluation-based resource reselection is performed. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each (L2 or L1) (source and/or destination) identifier. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each (L2 or L 1) (a combination of source ID and destination ID) identifier. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each (L2 or L 1) (a combination of a pair of source ID and destination ID and a cast type) identifier. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each direction of a pair of source layer ID and destination layer ID. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each PC5 RRC connection/link. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) depending on whether or not SL DRX is performed. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) depending on whether or not SL DRX is supported. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured (differently or independently) for each SL mode type (e.g., resource allocation mode 1 or resource allocation mode 2). For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for the case of performing (a)periodic resource reservation. For example, whether or not the proposed rule of the present disclosure is applied and/or related parameter configuration value(s) may be configured specifically (or differently or independently) for each Tx profile (e.g., a Tx profile indicating that a service supports sidelink DRX operation or a Tx profile indicating that a service does not need to support sidelink DRX operation).

[0171] The proposal and whether or not the proposal rule of the present disclosure is applied (and/or related parameter configuration value(s)) may also be applied to a mmWave SL operation.

[0172] Based on various embodiments of the present disclosure, the UE can perform resource occupation, resource allocation, and/or MAC PDU generation in an unlicensed band in consideration of a channel access priority class (CAPC). Through this, by reflecting channel characteristics of the unlicensed band (e.g., interference, resource collision due to coexistence of various devices, etc.), the UE can efficiently perform resource occupation, resource allocation, and/or

MAC PDU generation in the unlicensed band.

[0173] FIG. 15 shows a method for performing wireless communication by a first device, based on an embodiment of the present disclosure. The embodiment of FIG. 15 may be combined with various embodiments of the present disclosure.

[0174] Referring to FIG. 15, in step S1510, the first device may select a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs. In step S1520, the first device may select a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC. In step S1530, the first device may generate a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination. In step S1540, the first device may transmit, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI. In step S1550, the first device may transmit, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0175] For example, the first SL CAPC may be a SL CAPC having a highest priority among the plurality of SL CAPCs.

[0176] For example, resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in decreasing priority order. For example, the resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority.

[0177] Additionally, for example, the first device may select a second SL CAPC having a lower priority than the first SL CAPC having the highest priority, based on that the MAC PDU can accommodate additional data. For example, at least one second logical channel of one or more logical channels related to the second SL CAPC may be related to the destination. For example, the MAC PDU may be generated based on the at least one first logical channel related to the destination and the at least one second logical channel related to the destination. For example, resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in decreasing priority order, and then allocated to the at least one second logical channel related to the destination in decreasing priority order. For example, resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority, and then allocated to the at least one second logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority. For example, based on that a highest priority of the at least one first logical channel is lower than a highest priority of the at least one second logical channel, resources for the MAC PDU may be allocated to the at least one first logical channel in decreasing priority order, and then allocated to the at least one second logical channel in decreasing priority order.

[0178] For example, the first SL CAPC may be a SL CAPC selected based on a random backoff from among the plurality of SL CAPCs. For example, resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in decreasing priority order. For example, the resources for the MAC PDU may be allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority.

[0179] The proposed method can be applied to device(s) based on various embodiments of the present disclosure. First, the processor 102 of the first device 100 may select a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs. In addition, the processor 102 of the first device 100 may select a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC. In addition, the processor 102 of the first device 100 may generate a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination. In addition, the processor 102 of the first device 100 may control the transceiver 106 to transmit, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI. In addition, the processor 102 of the first device 100 may control the transceiver 106 to transmit, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0180] Based on an embodiment of the present disclosure, a first device adapted to perform wireless communication may be provided. For example, the first device may comprise: at least one transceiver; at least one processor; and at least one memory connected to the at least one processor and storing instructions. For example, the instructions, based on being executed by the at least one processor, may perform operations comprising: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0181] Based on an embodiment of the present disclosure, a processing device adapted to control a first device may be provided. For example, the processing device may comprise: at least one processor; and at least one memory connected to the at least one processor and storing instructions. For example, the instructions, based on being executed

by the at least one processor, may perform operations comprising: selecting a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generating a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmitting, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmitting, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0182] Based on an embodiment of the present disclosure, a non-transitory computer-readable storage medium storing instructions may be provided. For example, the instructions, based on being executed, may cause a first device to: select a first sidelink (SL) channel access priority class (CAPC) from among a plurality of SL CAPCs; select a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC; generate a medium access control (MAC) protocol data unit (PDU) based on at least one first logical channel related to the destination; transmit, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and transmit, through the PSSCH, the second SCI including an identifier (ID) related to the destination and the MAC PDU.

[0183] FIG. 16 shows a method for performing wireless communication by a second device, based on an embodiment of the present disclosure. The embodiment of FIG. 16 may be combined with various embodiments of the present disclosure.

[0184] Referring to FIG. 16, in step S1610, the second device may receive, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI. In step S1620, the second device may receive, through the PSSCH, the second SCI including an identifier (ID) related to a destination and a medium access control (MAC) protocol data unit (PDU). For example, the destination may be related to a logical channel with a highest priority among one or more logical channels related to a first sidelink (SL) channel access priority class (CAPC) among a plurality of SL CAPCs, and the MAC PDU may be generated based on at least one first logical channel related to the destination among the one or more logical channels.

[0185] The proposed method may be applied to device(s) based on various embodiments of the present disclosure. First, the processor 202 of the second device 200 may control the transceiver 106 to receive, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI. In addition, the processor 202 of the second device 200 may control the transceiver 106 to receive, through the PSSCH, the second SCI including an identifier (ID) related to a destination and a medium access control (MAC) protocol data unit (PDU). For example, the destination may be related to a logical channel with a highest priority among one or more logical channels related to a first sidelink (SL) channel access priority class (CAPC) among a plurality of SL CAPCs, and the MAC PDU may be generated based on at least one first logical channel related to the destination among the one or more logical channels.

[0186] Based on an embodiment of the present disclosure, a second device adapted to perform wireless communication may be provided. For example, the second device may comprise: at least one transceiver; at least one processor; and at least one memory connected to the at least one processor and storing instructions. For example, the instructions, based on being executed by the at least one processor, may perform operations comprising: receiving, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and receiving, through the PSSCH, the second SCI including an identifier (ID) related to a destination and a medium access control (MAC) protocol data unit (PDU). For example, the destination may be related to a logical channel with a highest priority among one or more logical channels related to a first sidelink (SL) channel access priority class (CAPC) among a plurality of SL CAPCs, and the MAC PDU may be generated based on at least one first logical channel related to the destination among the one or more logical channels.

[0187] Based on an embodiment of the present disclosure, a processing device adapted to control a second device may be provided. For example, the processing device may comprise: at least one processor; and at least one memory connected to the at least one processor and storing instructions. For example, the instructions, based on being executed by the at least one processor, may perform operations comprising: receiving, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and receiving, through the PSSCH, the second SCI including an identifier (ID) related to a destination and a medium access control (MAC) protocol data unit (PDU). For example, the destination may be related to a logical channel with a highest priority among one or more logical channels related to a first sidelink (SL) channel access priority class (CAPC) among a plurality of SL CAPCs, and the MAC PDU may be generated based on at least one first logical channel related to the destination among the one or more logical channels.

[0188] Based on an embodiment of the present disclosure, a non-transitory computer-readable storage medium storing instructions may be provided. For example, the instructions, based on being executed, may cause a second device to: receive, through a physical sidelink control channel (PSCCH), first sidelink control information (SCI) for scheduling of a physical sidelink shared channel (PSSCH) and second SCI; and receive, through the PSSCH, the second SCI including

an identifier (ID) related to a destination and a medium access control (MAC) protocol data unit (PDU). For example, the destination may be related to a logical channel with a highest priority among one or more logical channels related to a first sidelink (SL) channel access priority class (CAPC) among a plurality of SL CAPCs, and the MAC PDU may be generated based on at least one first logical channel related to the destination among the one or more logical channels.

[0189] Various embodiments of the present disclosure may be combined with each other.

[0190] Hereinafter, device(s) to which various embodiments of the present disclosure can be applied will be described.

[0191] The various descriptions, functions, procedures, proposals, methods, and/or operational flowcharts of the present disclosure described in this document may be applied to, without being limited to, a variety of fields requiring wireless communication/connection (e.g., 5G) between devices.

[0192] Hereinafter, a description will be given in more detail with reference to the drawings. In the following drawings/description, the same reference symbols may denote the same or corresponding hardware blocks, software blocks, or functional blocks unless described otherwise.

[0193] FIG. 17 shows a communication system 1, based on an embodiment of the present disclosure. The embodiment of FIG. 17 may be combined with various embodiments of the present disclosure.

[0194] Referring to FIG. 17, a communication system 1 to which various embodiments of the present disclosure are applied includes wireless devices, Base Stations (BSs), and a network. Herein, the wireless devices represent devices performing communication using Radio Access Technology (RAT) (e.g., 5G New RAT (NR)) or Long-Term Evolution (LTE)) and may be referred to as communication/radio/5G devices. The wireless devices 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 vehicle, and a vehicle capable of performing communication between vehicles. Herein, 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. For example, the BSs and the network may be implemented as wireless devices and a specific wireless device 200a may operate as a BS/network node with respect to other wireless devices.

[0195] Here, wireless communication technology implemented in wireless devices 100a to 100f of the present disclosure may include Narrowband Internet of Things for low-power communication in addition to LTE, NR, and 6G. In this case, for example, NB-IoT technology may be an example of Low Power Wide Area Network (LPWAN) technology and may be implemented as standards such as LTE Cat NB1, and/or LTE Cat NB2, and is not limited to the name described above. Additionally or alternatively, the wireless communication technology implemented in the wireless devices 100a to 100f of the present disclosure may perform communication based on LTE-M technology. In this case, as an example, the LTE-M technology may be an example of the LPWAN and may be called by various names including enhanced Machine Type Communication (eMTC), and the like. For example, the LTE-M technology may be implemented as at least any one of various standards 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 is not limited to the name described above. Additionally or alternatively, the wireless communication technology implemented in the wireless devices 100a to 100f of the present disclosure may include at least one of Bluetooth, Low Power Wide Area Network (LPWAN), and ZigBee considering the low-power communication, and is not limited to the name described above. As an example, the ZigBee technology may generate personal area networks (PAN) related to small/low-power digital communication based on various standards including IEEE 802.15.4, and the like, and may be called by various names.

[0196] 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, or a 5G (e.g., NR) 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/network. 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.

[0197] Wireless communication/connections 150a, 150b, or 150c may be established between the wireless devices 100a to 100fBS 200, or BS 200BS 200. Herein, the wireless communication/connections may be established through various RATs (e.g., 5G NR) such as uplink/downlink communication 150a, sidelink communication 150b (or, D2D communication), or inter BS communication (e.g. relay, Integrated Access Backhaul (IAB)). The wireless devices and the BSs/the wireless devices may transmit/receive radio signals to/from each other through the wireless communication/con-

nections 150a and 150b. For example, the wireless communication/connections 150a and 150b 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/demapping), and resource allocating processes, for transmitting/receiving radio signals, may be performed based on the various proposals of the present disclosure.

[0198] FIG. 18 shows wireless devices, based on an embodiment of the present disclosure. The embodiment of FIG. 18 may be combined with various embodiments of the present disclosure.

[0199] Referring to FIG. 18, a first wireless device 100 and a second wireless device 200 may transmit radio signals through a variety of RATs (e.g., LTE and NR). Herein, {the first wireless device 100 and the second wireless device 200} may correspond to {the wireless device 100x and the BS 200} and/or {the wireless device 100x and the wireless device 100x} of FIG. 17.

[0200] The first wireless device 100 may include one or more processors 102 and one or more memories 104 and additionally further include one or more transceivers 106 and/or one or more antennas 108. The processor(s) 102 may control the memory(s) 104 and/or the transceiver(s) 106 and may be configured to implement the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. For example, the processor(s) 102 may process information within the memory(s) 104 to generate first information/signals and then transmit radio signals including the first information/signals through the transceiver(s) 106. The processor(s) 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(s) 104. The memory(s) 104 may be connected to the processor(s) 102 and may store a variety of information related to operations of the processor(s) 102. For example, the memory(s) 104 may store software code including commands for performing a part or the entirety of processes controlled by the processor(s) 102 or for performing the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. Herein, the processor(s) 102 and the memory(s) 104 may be a part of a communication modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver(s) 106 may be connected to the processor(s) 102 and transmit and/or receive radio signals through one or more antennas 108. Each of the transceiver(s) 106 may include a transmitter and/or a receiver. The transceiver(s) 106 may be interchangeably used with Radio Frequency (RF) unit(s). In the present disclosure, the wireless device may represent a communication modem/circuit/chip.

[0201] The second wireless device 200 may include one or more processors 202 and one or more memories 204 and additionally further include one or more transceivers 206 and/or one or more antennas 208. The processor(s) 202 may control the memory(s) 204 and/or the transceiver(s) 206 and may be configured to implement the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. For example, the processor(s) 202 may process information within the memory(s) 204 to generate third information/signals and then transmit radio signals including the third information/signals through the transceiver(s) 206. The processor(s) 202 may receive radio signals including fourth information/signals through the transceiver(s) 106 and then store information obtained by processing the fourth information/signals in the memory(s) 204. The memory(s) 204 may be connected to the processor(s) 202 and may store a variety of information related to operations of the processor(s) 202. For example, the memory(s) 204 may store software code including commands for performing a part or the entirety of processes controlled by the processor(s) 202 or for performing the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. Herein, the processor(s) 202 and the memory(s) 204 may be a part of a communication modem/circuit/chip designed to implement RAT (e.g., LTE or NR). The transceiver(s) 206 may be connected to the processor(s) 202 and transmit and/or receive radio signals through one or more antennas 208. Each of the transceiver(s) 206 may include a transmitter and/or a receiver. The transceiver(s) 206 may be interchangeably used with RF unit(s). In the present disclosure, the wireless device may represent a communication modem/circuit/chip.

[0202] 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 PHY, MAC, RLC, PDCP, RRC, and SDAP). The one or more processors 102 and 202 may generate one or more Protocol Data Units (PDUs) and/or one or more Service Data Unit (SDUs) according to the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. The one or more processors 102 and 202 may generate messages, control information, data, or information according to the descriptions, functions, procedures, proposals, methods, and/or operational flowcharts disclosed in this document. 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, proposals, methods, and/or operational flowcharts disclosed in this document 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, proposals, methods, and/or operational flowcharts disclosed in this document.

[0203] 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, proposals, methods, and/or operational flowcharts disclosed in this document 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, proposals, methods, and/or operational flowcharts disclosed in this document 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, proposals, methods, and/or operational flowcharts disclosed in this document may be implemented using firmware or software in the form of code, commands, and/or a set of commands.

[0204] 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 Read-Only Memories (EPROMs), 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.

[0205] The one or more transceivers 106 and 206 may transmit user data, control information, and/or radio signals/channels, mentioned in the methods and/or operational flowcharts of this document, 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, proposals, methods, and/or operational flowcharts disclosed in this document, 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. 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, proposals, methods, and/or operational flowcharts disclosed in this document, through the one or more antennas 108 and 208. In this document, the one or more antennas may be a plurality of physical antennas or a plurality of logical antennas (e.g., antenna ports). The one or more transceivers 106 and 206 may convert received 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.

[0206] FIG. 19 shows a signal process circuit for a transmission signal, based on an embodiment of the present disclosure. The embodiment of FIG. 19 may be combined with various embodiments of the present disclosure.

[0207] Referring to FIG. 19, a signal processing circuit 1000 may include scramblers 1010, modulators 1020, a layer mapper 1030, a precoder 1040, resource mappers 1050, and signal generators 1060. An operation/function of FIG. 19 may be performed, without being limited to, the processors 102 and 202 and/or the transceivers 106 and 206 of FIG. 18. Hardware elements of FIG. 19 may be implemented by the processors 102 and 202 and/or the transceivers 106 and 206 of FIG. 18. For example, blocks 1010 to 1060 may be implemented by the processors 102 and 202 of FIG. 18. Alternatively, the blocks 1010 to 1050 may be implemented by the processors 102 and 202 of FIG. 18 and the block 1060 may be implemented by the transceivers 106 and 206 of FIG. 18.

[0208] Codewords may be converted into radio signals via the signal processing circuit 1000 of FIG. 19. Herein, the codewords are encoded bit sequences of information blocks. The information blocks may include transport blocks (e.g., a LTL-SCH transport block, a DL-SCH transport block). The radio signals may be transmitted through various physical channels (e.g., a PUSCH and a PDSCH).

[0209] Specifically, the codewords may be converted into scrambled bit sequences by the scramblers 1010. Scramble sequences used for scrambling may be generated based on an initialization value, and the initialization value may include ID information of a wireless device. The scrambled bit sequences may be modulated to modulation symbol sequences by the modulators 1020. A modulation scheme may include pi/2-Binary Phase Shift Keying (pi/2-BPSK), m-Phase Shift

Keying (m-PSK), and m-Quadrature Amplitude Modulation (m-QAM). Complex modulation symbol sequences may be mapped to one or more transport layers by the layer mapper 1030. Modulation symbols of each transport layer may be mapped (precoded) to corresponding antenna port(s) by the precoder 1040. Outputs z of the precoder 1040 may be obtained by multiplying outputs y of the layer mapper 1030 by an N*M precoding matrix W. Herein, N is the number of antenna ports and M is the number of transport layers. The precoder 1040 may perform precoding after performing transform precoding (e.g., DFT) for complex modulation symbols. Alternatively, the precoder 1040 may perform precoding without performing transform precoding.

[0210] The resource mappers 1050 may map modulation symbols of each antenna port to time-frequency resources. The time-frequency resources may include a plurality of symbols (e.g., a CP-OFDMA symbols and DFT-s-OFDMA symbols) in the time domain and a plurality of subcarriers in the frequency domain. The signal generators 1060 may generate radio signals from the mapped modulation symbols and the generated radio signals may be transmitted to other devices through each antenna. For this purpose, the signal generators 1060 may include Inverse Fast Fourier Transform (IFFT) modules, Cyclic Prefix (CP) inserters, Digital-to-Analog Converters (DACs), and frequency up-converters.

[0211] Signal processing procedures for a signal received in the wireless device may be configured in a reverse manner of the signal processing procedures 1010 to 1060 of FIG. 19. For example, the wireless devices (e.g., 100 and 200 of FIG. 18) may receive radio signals from the exterior through the antenna ports/transceivers. The received radio signals may be converted into baseband signals through signal restorers. To this end, the signal restorers may include frequency downlink converters, Analog-to-Digital Converters (ADCs), CP remover, and Fast Fourier Transform (FFT) modules. Next, the baseband signals may be restored to codewords through a resource demapping procedure, a postcoding procedure, a demodulation processor, and a descrambling procedure. The codewords may be restored to original information blocks through decoding. Therefore, a signal processing circuit (not illustrated) for a reception signal may include signal restorers, resource demappers, a postcoder, demodulators, descramblers, and decoders.

[0212] FIG. 20 shows another example of a wireless device, based on an embodiment of the present disclosure. The wireless device may be implemented in various forms according to a use-case/service (refer to FIG. 17). The embodiment of FIG. 20 may be combined with various embodiments of the present disclosure.

[0213] Referring to FIG. 20, wireless devices 100 and 200 may correspond to the wireless devices 100 and 200 of FIG. 18 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 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 and/or the one or more memories 104 and 204 of FIG. 18. For example, the transceiver(s) 114 may include the one or more transceivers 106 and 206 and/or the one or more antennas 108 and 208 of FIG. 18. The control unit 120 is electrically connected to the communication unit 110, the memory 130, and the additional components 140 and controls overall operation of the wireless devices. For example, the control unit 120 may control an electric/mechanical operation of the wireless device 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.

[0214] The additional components 140 may be variously configured according to types of wireless devices. For example, the additional components 140 may include at least one of a power unit/battery, input/output (I/O) unit, a driving unit, and a computing unit. The wireless device may be implemented in the form of, without being limited to, the robot (100a of FIG. 17), the vehicles (100b-1 and 100b-2 of FIG. 17), the XR device (100c of FIG. 17), the hand-held device (100d of FIG. 17), the home appliance (100e of FIG. 17), the IoT device (100f of FIG. 17), 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. 17), the BSs (200 of FIG. 17), a network node, etc. The wireless device may be used in a mobile or fixed place according to a use-example/service.

[0215] In FIG. 20, 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, an Electronic Control Unit (ECU), a graphical processing unit, and a memory control processor. As another example, the memory 130 may be configured by a Random Access Memory (RAM), a Dynamic RAM (DRAM), a Read Only Memory (ROM)), a flash memory, a volatile memory, a non-volatile memory, and/or a combination thereof.

[0216] Hereinafter, an example of implementing FIG. 20 will be described in detail with reference to the drawings.

[0217] FIG. 21 shows a hand-held device, based on an embodiment of the present disclosure. The hand-held device may include a smartphone, a smartpad, a wearable device (e.g., a smartwatch or a smartglasses), or a portable computer (e.g., a notebook). The hand-held device may be referred to as a mobile station (MS), a user terminal (UT), a Mobile Subscriber Station (MSS), a Subscriber Station (SS), an Advanced Mobile Station (AMS), or a Wireless Terminal (WT). The embodiment of FIG. 21 may be combined with various embodiments of the present disclosure.

[0218] Referring to FIG. 21, a hand-held device 100 may include an antenna unit 108, a communication unit 110, a control unit 120, a memory unit 130, a power supply unit 140a, an interface unit 140b, and an I/O unit 140c. The antenna unit 108 may be configured as a part of the communication unit 110. Blocks 110 to 130/140a to140c correspond to the blocks 110 to 130/140 of FIG. 20, respectively.

[0219] The communication unit 110 may transmit and receive signals (e.g., data and control signals) to and from other wireless devices or BSs. The control unit 120 may perform various operations by controlling constituent elements of the hand-held device 100. The control unit 120 may include an Application Processor (AP). The memory unit 130 may store data/parameters/programs/code/commands needed to drive the hand-held device 100. The memory unit 130 may store input/output data/information. The power supply unit 140a may supply power to the hand-held device 100 and include a wired/wireless charging circuit, a battery, etc. The interface unit 140b may support connection of the hand-held device 100 to other external devices. The interface unit 140b may include various ports (e.g., an audio I/O port and a video I/O port) for connection with external devices. The I/O unit 140c may input or output video information/signals, audio information/signals, data, and/or information input by a user. The I/O unit 140c may include a camera, a microphone, a user input unit, a display unit 140d, a speaker, and/or a haptic module.

[0220] As an example, in the case of data communication, the I/O unit 140c may acquire information/signals (e.g., touch, text, voice, images, or video) input by a user and the acquired information/signals may be stored in the memory unit 130. The communication unit 110 may convert the information/signals stored in the memory into radio signals and transmit the converted radio signals to other wireless devices directly or to a BS. The communication unit 110 may receive radio signals from other wireless devices or the BS and then restore the received radio signals into original information/signals. The restored information/signals may be stored in the memory unit 130 and may be output as various types (e.g., text, voice, images, video, or haptic) through the I/O unit 140c.

[0221] FIG. 22 shows a vehicle or an autonomous vehicle, based on an embodiment of the present disclosure. The vehicle or autonomous vehicle may be implemented by a mobile robot, a car, a train, a manned/unmanned Aerial Vehicle (AV), a ship, etc. The embodiment of FIG. 22 may be combined with various embodiments of the present disclosure.

[0222] Referring to FIG. 22, a vehicle or autonomous vehicle 100 may include an antenna unit 108, a communication unit 110, a control unit 120, a driving unit 140a, a power supply unit 140b, a sensor unit 140c, and an autonomous driving unit 140d. The antenna unit 108 may be configured as a part of the communication unit 110. The blocks 110/130/140a to 140d correspond to the blocks 110/130/140 of FIG. 20, respectively.

[0223] The communication unit 110 may transmit and receive signals (e.g., data and control signals) to and from external devices such as other vehicles, BSs (e.g., gNBs and road side units), and servers. The control unit 120 may perform various operations by controlling elements of the vehicle or the autonomous vehicle 100. The control unit 120 may include an Electronic Control Unit (ECU). The driving unit 140a may cause the vehicle or the autonomous vehicle 100 to drive on a road. The driving unit 140a may include an engine, a motor, a powertrain, a wheel, a brake, a steering device, etc. The power supply unit 140b may supply power to the vehicle or the autonomous vehicle 100 and include a wired/wireless charging circuit, a battery, etc. The sensor unit 140c may acquire a vehicle state, ambient environment information, user information, etc. The sensor unit 140c may include an Inertial Measurement Unit (IMU) sensor, a collision sensor, a wheel sensor, a speed sensor, a slope sensor, a weight sensor, a heading sensor, a position module, a vehicle forward/backward sensor, a battery sensor, a fuel sensor, a tire sensor, a steering sensor, a temperature sensor, a humidity sensor, an ultrasonic sensor, an illumination sensor, a pedal position sensor, etc. The autonomous driving unit 140d may implement technology for maintaining a lane on which a vehicle is driving, technology for automatically adjusting speed, such as adaptive cruise control, technology for autonomously driving along a determined path, technology for driving by automatically setting a path if a destination is set, and the like.

[0224] For example, the communication unit 110 may receive map data, traffic information data, etc. from an external server. The autonomous driving unit 140d may generate an autonomous driving path and a driving plan from the obtained data. The control unit 120 may control the driving unit 140a such that the vehicle or the autonomous vehicle 100 may move along the autonomous driving path according to the driving plan (e.g., speed/direction control). In the middle of autonomous driving, the communication unit 110 may aperiodically/periodically acquire recent traffic information data from the external server and acquire surrounding traffic information data from neighboring vehicles. In the middle of autonomous driving, the sensor unit 140c may obtain a vehicle state and/or surrounding environment information. The autonomous driving unit 140d may update the autonomous driving path and the driving plan based on the newly obtained data/information. The communication unit 110 may transfer information about a vehicle position, the autonomous driving path, and/or the driving plan to the external server. The external server may predict traffic information data using AI

technology, etc., based on the information collected from vehicles or autonomous vehicles and provide the predicted traffic information data to the vehicles or the autonomous vehicles.

[0225] Claims in the present description can be combined in a various way. For instance, technical features in method claims of the present description 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.

Claims

1. A method for performing wireless communication by a first device, the method comprising:

selecting a first sidelink, SL, channel access priority class, CAPC, from among a plurality of SL CAPCs;
selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC;
generating a medium access control, MAC, protocol data unit, PDU, based on at least one first logical channel related to the destination;
transmitting, through a physical sidelink control channel, PSCCH, first sidelink control information, SCI, for scheduling of a physical sidelink shared channel, PSSCH, and second SCI; and
transmitting, through the PSSCH, the second SCI including an identifier, ID, related to the destination and the MAC PDU.

2. The method of claim 1, wherein the first SL CAPC is a SL CAPC having a highest priority among the plurality of SL CAPCs.

3. The method of claim 2, wherein resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in decreasing priority order.

4. The method of claim 3, wherein the resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority.

5. The method of claim 2, further comprising:
selecting a second SL CAPC having a lower priority than the first SL CAPC having the highest priority, based on that the MAC PDU can accommodate additional data.

6. The method of claim 5, wherein at least one second logical channel of one or more logical channels related to the second SL CAPC is related to the destination.

7. The method of claim 6, wherein the MAC PDU is generated based on the at least one first logical channel related to the destination and the at least one second logical channel related to the destination.

8. The method of claim 6, wherein resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in decreasing priority order, and then allocated to the at least one second logical channel related to the destination in decreasing priority order.

9. The method of claim 6, wherein resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority, and then allocated to the at least one second logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority.

10. The method of claim 6, wherein, based on that a highest priority of the at least one first logical channel is lower than a highest priority of the at least one second logical channel, resources for the MAC PDU are allocated to the at least one first logical channel in decreasing priority order, and then allocated to the at least one second logical channel in decreasing priority order.

11. The method of claim 1, wherein the first SL CAPC is a SL CAPC selected based on a random backoff from among

the plurality of SL CAPCs.

12. The method of claim 11, wherein resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in decreasing priority order.

13. The method of claim 12, wherein the resources for the MAC PDU are allocated to the at least one first logical channel related to the destination in order from a logical channel with a high priority to a logical channel with a low priority.

14. A first device adapted to perform wireless communication, the first device comprising:

at least one transceiver;
at least one processor; and
at least one memory connected to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising:

selecting a first sidelink, SL, channel access priority class, CAPC, from among a plurality of SL CAPCs;
selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC;
generating a medium access control, MAC, protocol data unit, PDU, based on at least one first logical channel related to the destination;
transmitting, through a physical sidelink control channel, PSCCH, first sidelink control information, SCI, for scheduling of a physical sidelink shared channel, PSSCH, and second SCI; and
transmitting, through the PSSCH, the second SCI including an identifier, ID, related to the destination and the MAC PDU.

15. A processing device adapted to control a first device, the processing device comprising:

at least one processor; and
at least one memory connected to the at least one processor and storing instructions that, based on being executed by the at least one processor, perform operations comprising:

selecting a first sidelink, SL, channel access priority class, CAPC, from among a plurality of SL CAPCs;
selecting a destination related to a logical channel with a highest priority from among one or more logical channels related to the first SL CAPC;
generating a medium access control, MAC, protocol data unit, PDU, based on at least one first logical channel related to the destination;
transmitting, through a physical sidelink control channel, PSCCH, first sidelink control information, SCI, for scheduling of a physical sidelink shared channel, PSSCH, and second SCI; and
transmitting, through the PSSCH, the second SCI including an identifier, ID, related to the destination and the MAC PDU.

FIG. 1

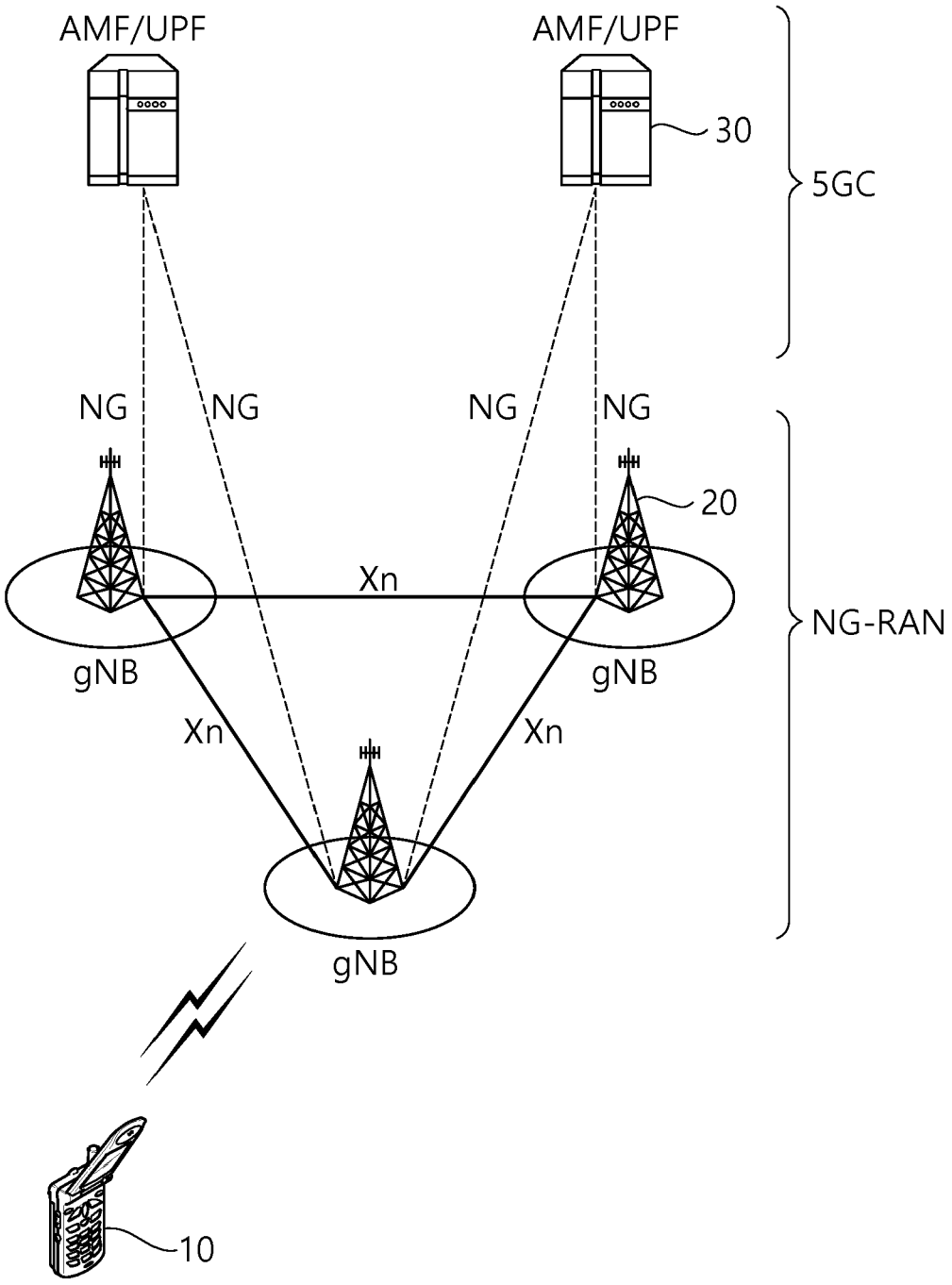
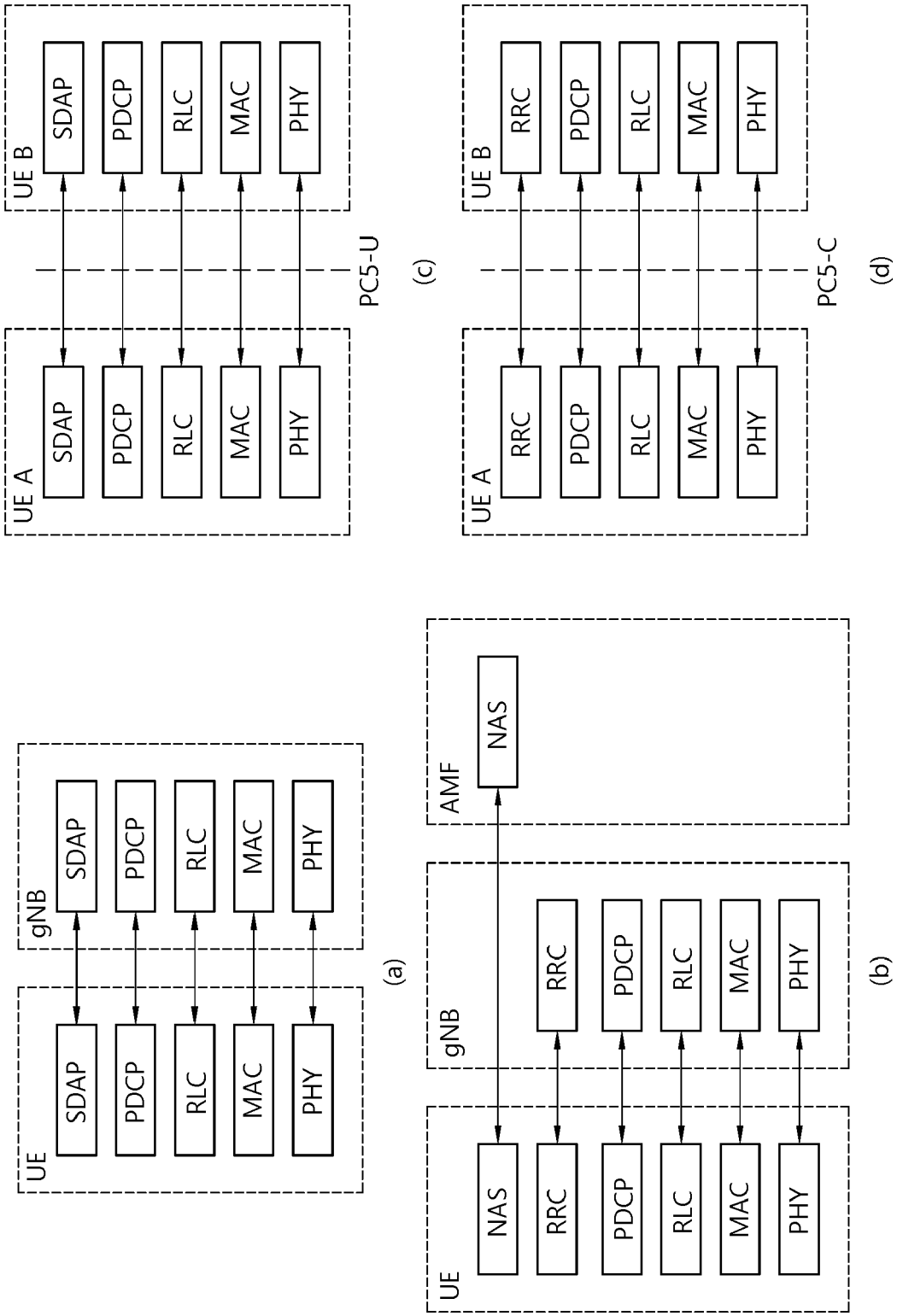


FIG. 2


UE
SDAP
PDCP
RLC
MAC
PHY
gNB
(a)
UE
NAS
RRC
PDCP
RLC
MAC
PHY
gNB
AMF
NAS
(b)
UE A
SDAP
PDCP
RLC
MAC
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RRC
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RLC
MAC
PHY
UE B
PC5-C
(d)

FIG. 3

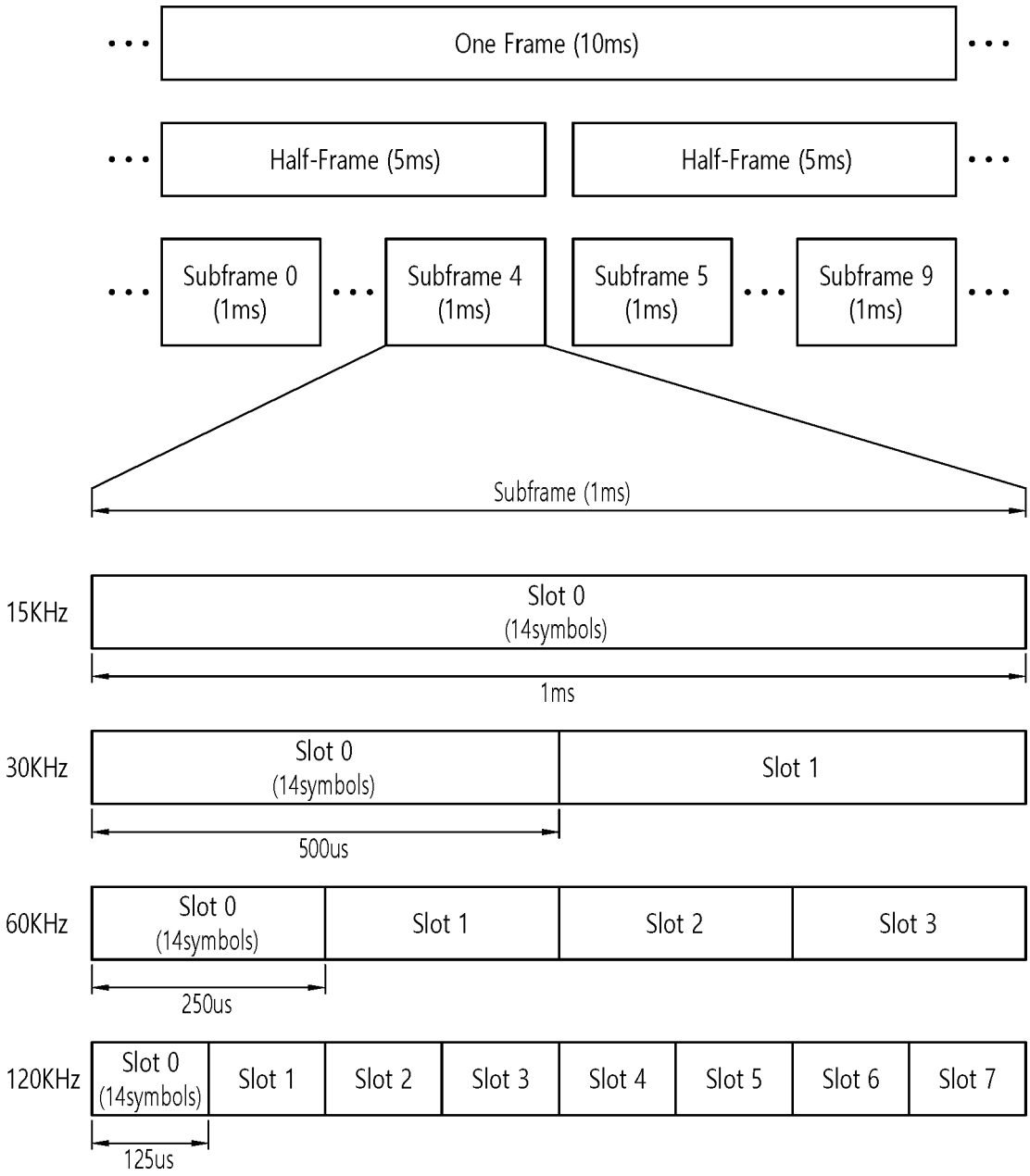

One Frame (10ms)
Half-Frame (5ms)
Half-Frame (5ms)
Subframe 0 (1ms)
Subframe 4 (1ms)
Subframe 5 (1ms)
Subframe 9 (1ms)
Subframe (1ms)
15KHz
Slot 0 (14symbols)
1ms
30KHz
Slot 0 (14symbols)
Slot 1
500us
60KHz
Slot 0 (14symbols)
Slot 1
Slot 2
Slot 3
250us
120KHz
Slot 0 (14symbols)
Slot 1
Slot 2
Slot 3
Slot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

FIG. 4

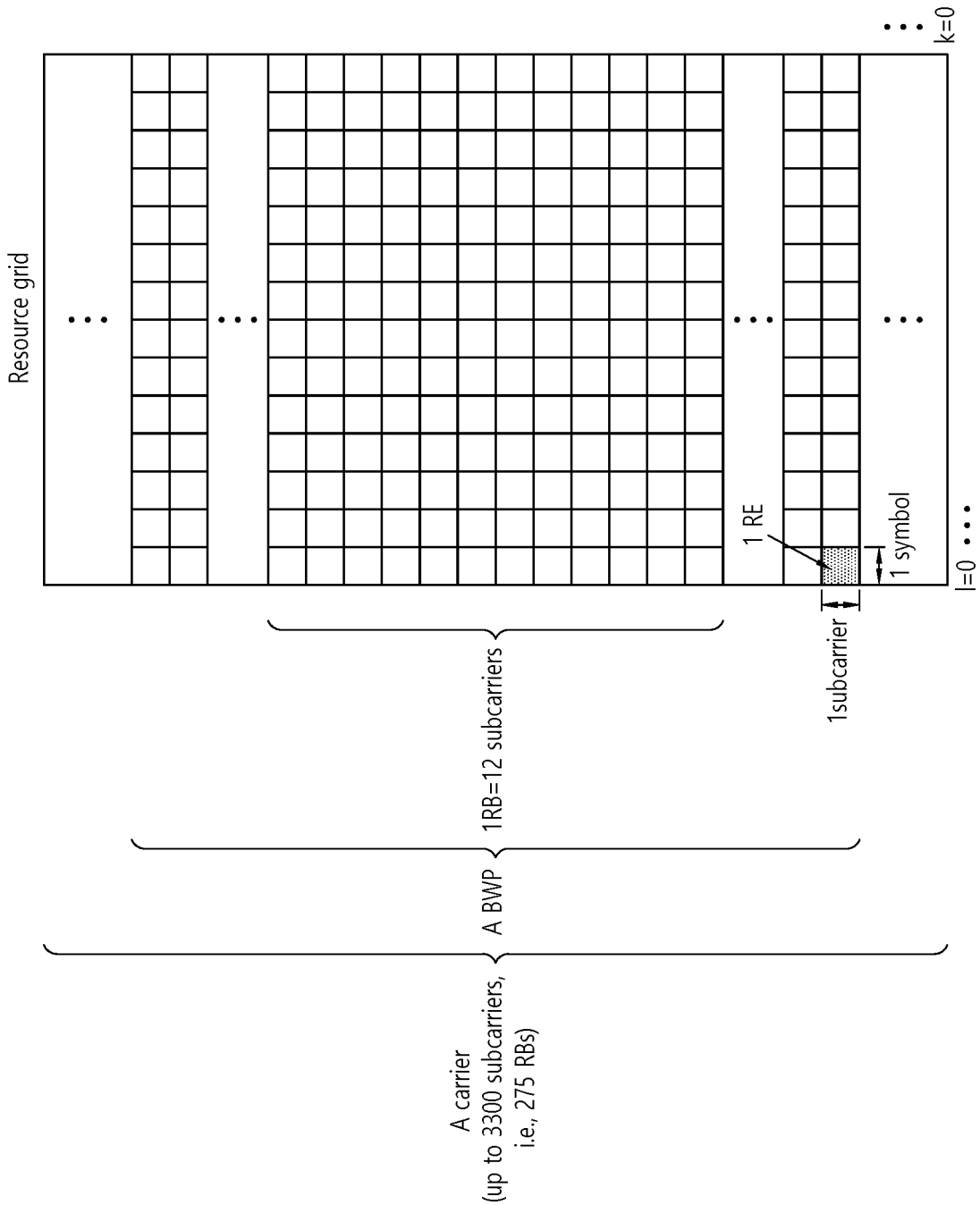

Resource grid
k=0
l=0
1 RE
1 symbol
1subcarrier
1RB=12 subcarriers
A BWP
A carrier
(up to 3300 subcarriers,
i.e., 275 RBs)

FIG. 5

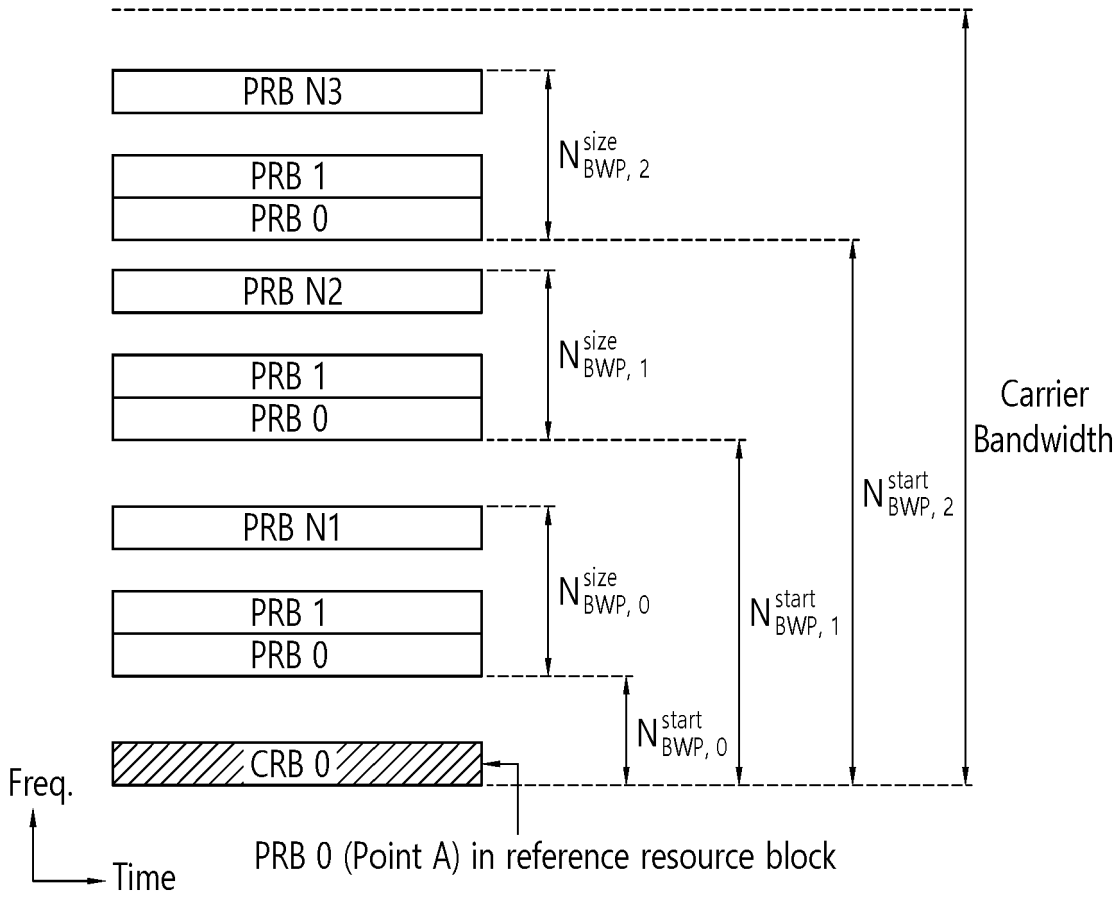

PRB N3
PRB 1
PRB 0
PRB N2
PRB 1
PRB 0
PRB N1
PRB 1
PRB 0
CRB 0
$N^{size}_{BWP,2}$
$N^{size}_{BWP,1}$
$N^{size}_{BWP,0}$
$N^{start}_{BWP,2}$
$N^{start}_{BWP,1}$
$N^{start}_{BWP,0}$
Carrier Bandwidth
Freq.
Time
PRB 0 (Point A) in reference resource block

FIG. 6

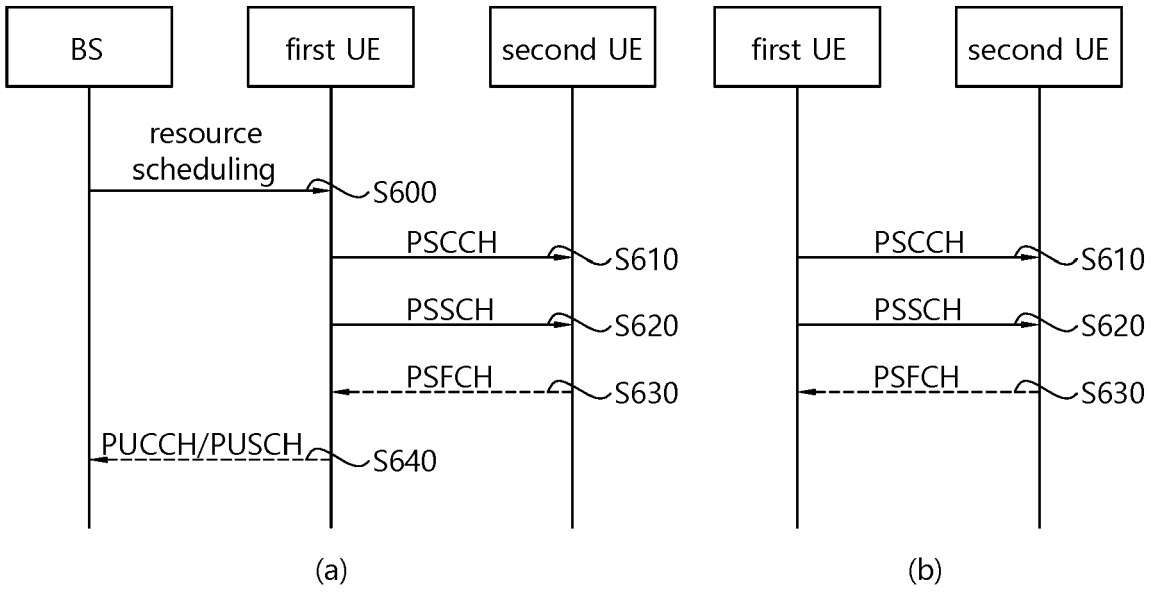

BS
first UE
second UE
resource scheduling
S600
PSCCH
S610
PSSCH
S620
PSFCH
S630
PUCCH/PUSCH
S640
(a)
first UE
second UE
PSCCH
S610
PSSCH
S620
PSFCH
S630
(b)

FIG. 7

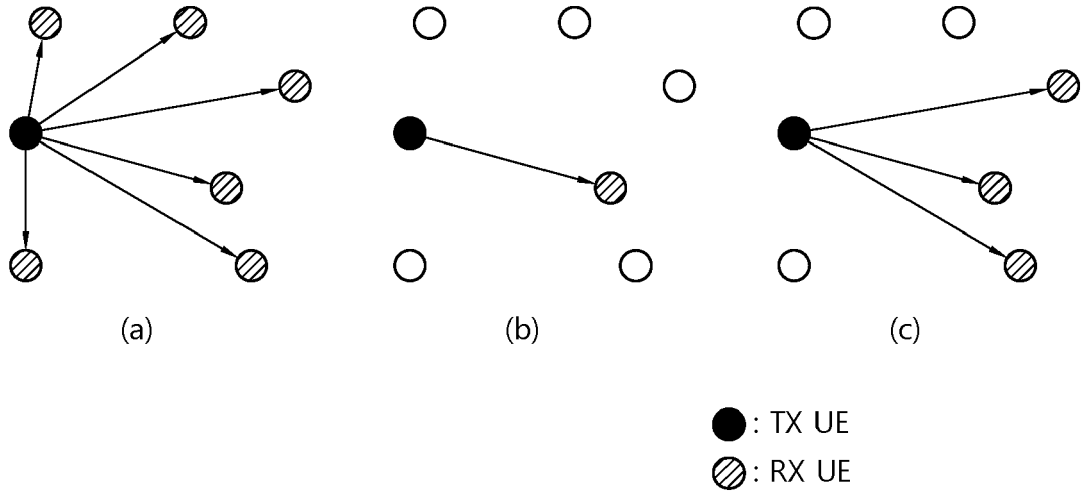
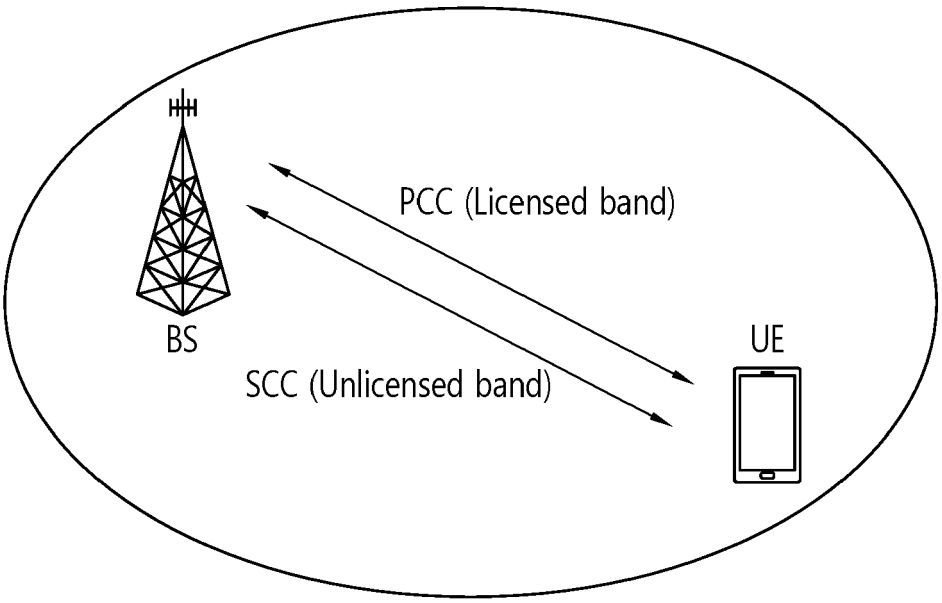
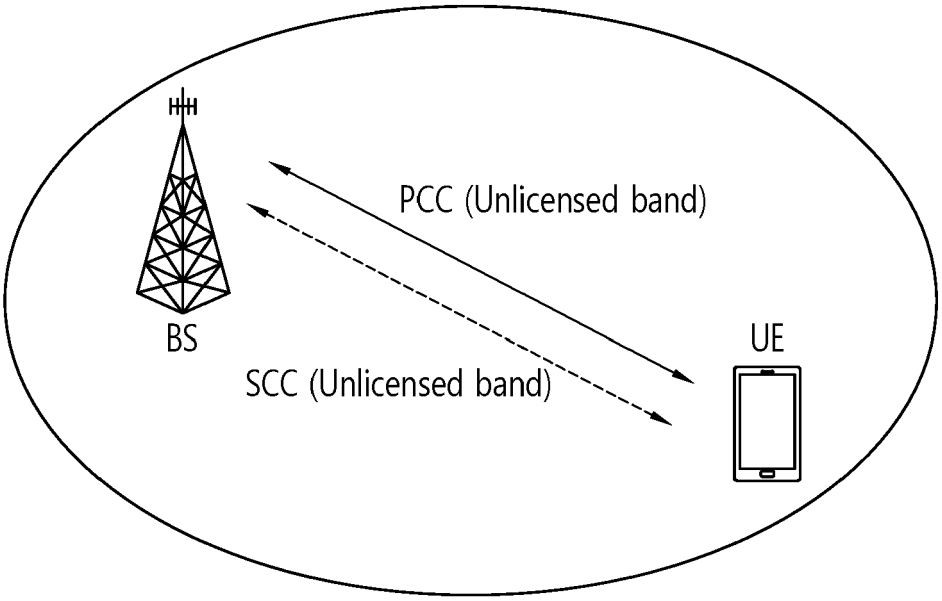


FIG. 8



(a) Carrier aggregation between L-band and U-band



(b) Standalone U-band(s)

FIG. 9

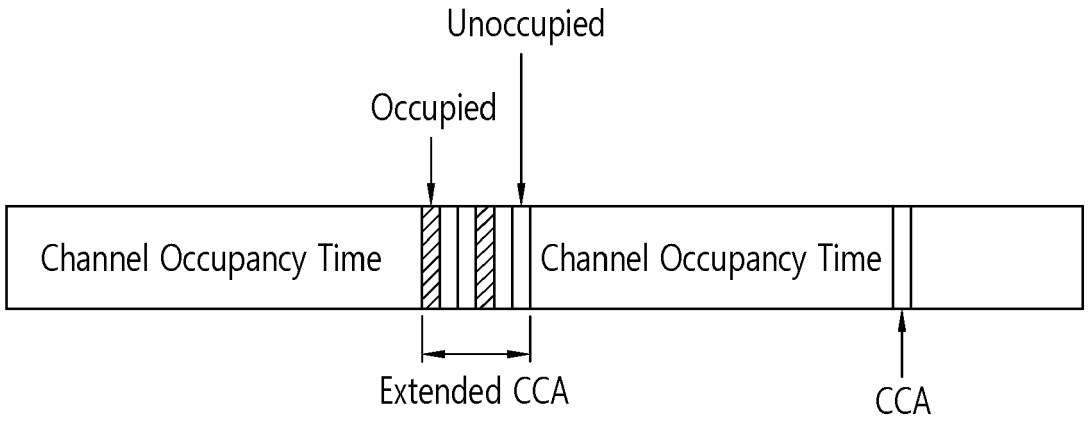

Unoccupied
Occupied
Channel Occupancy Time
Channel Occupancy Time
Extended CCA
CCA

FIG. 10

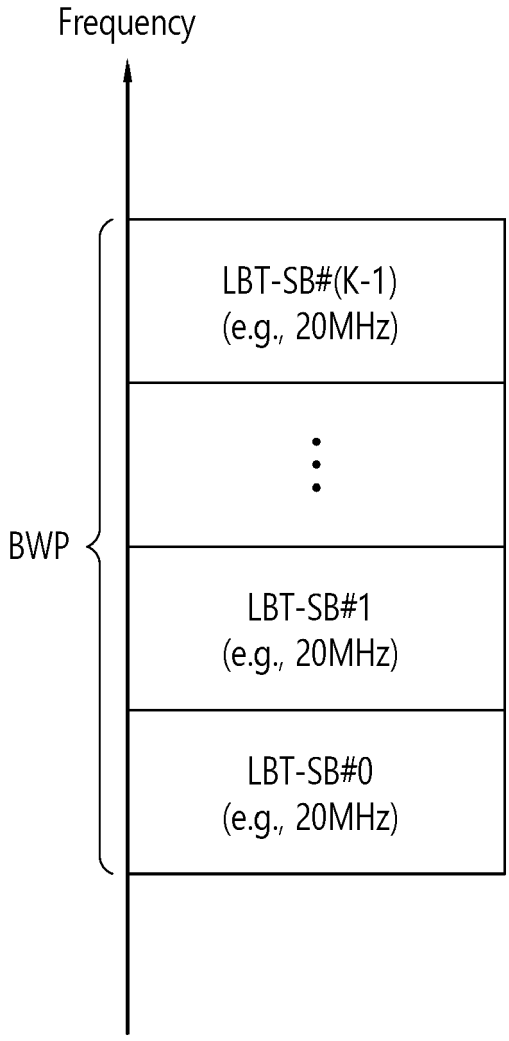

Frequency
BWP
LBT-SB#(K-1)
(e.g., 20MHz)
LBT-SB#1
(e.g., 20MHz)
LBT-SB#0
(e.g., 20MHz)

FIG. 11

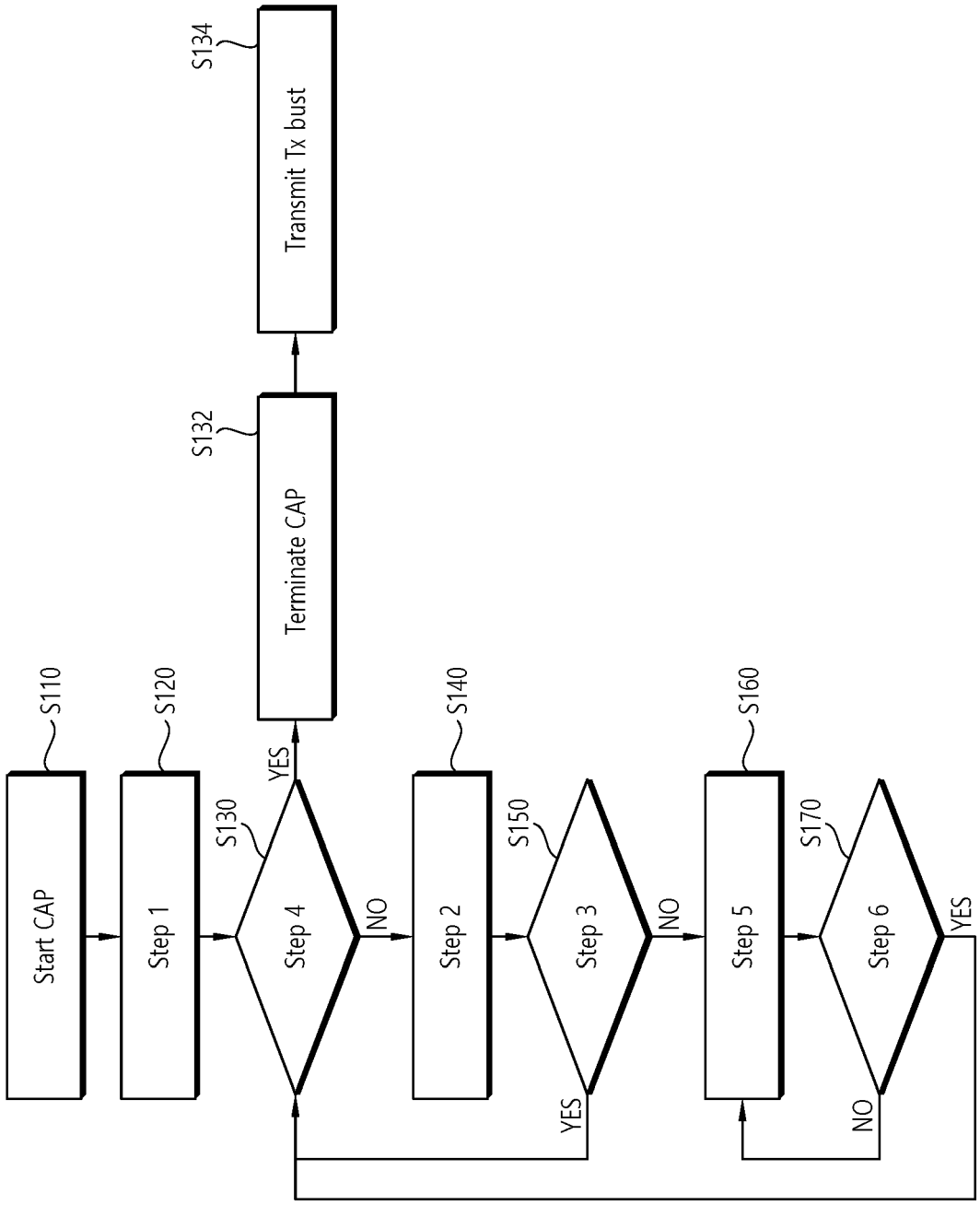

Start CAP
S110
Step 1
S120
Step 4
S130
YES
NO
Terminate CAP
S132
Transmit Tx bust
S134
Step 2
S140
Step 3
S150
YES
NO
Step 5
S160
Step 6
S170
NO
YES

FIG. 12

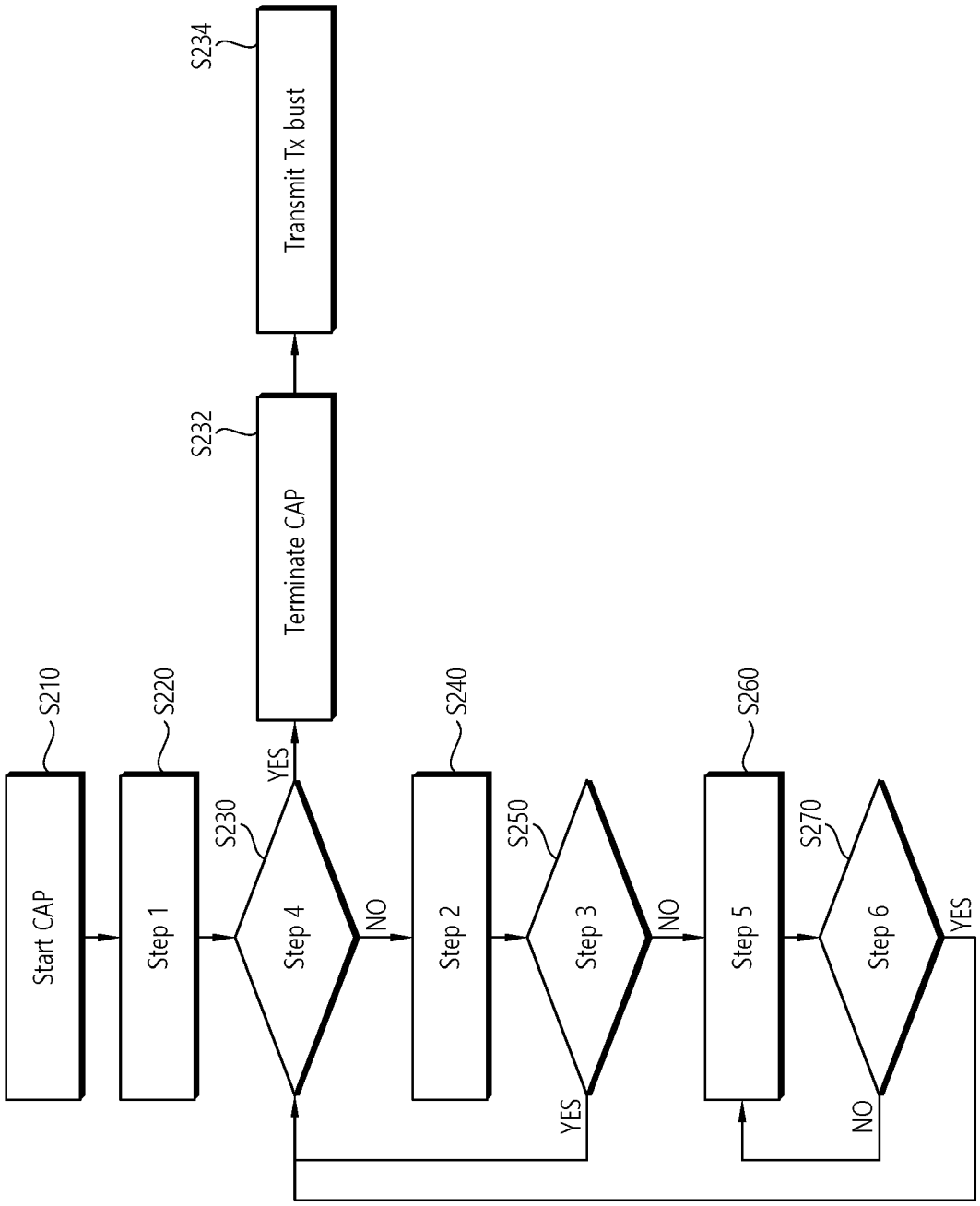

S210
Start CAP
S220
Step 1
S230
Step 4
YES
S232
Terminate CAP
S234
Transmit Tx bust
NO
S240
Step 2
S250
Step 3
YES
NO
S260
Step 5
S270
Step 6
NO
YES

FIG. 13

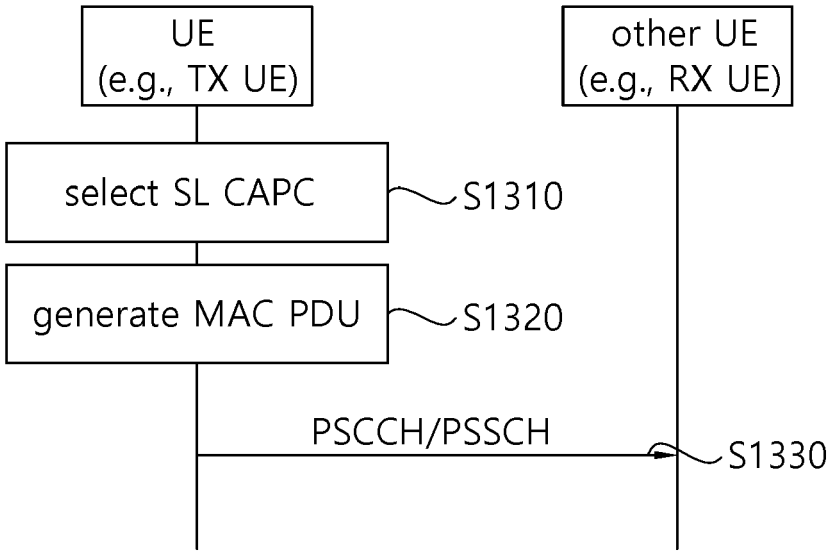

UE
(e.g., TX UE)
other UE
(e.g., RX UE)
select SL CAPC
S1310
generate MAC PDU
S1320
PSCCH/PSSCH
S1330

FIG. 14

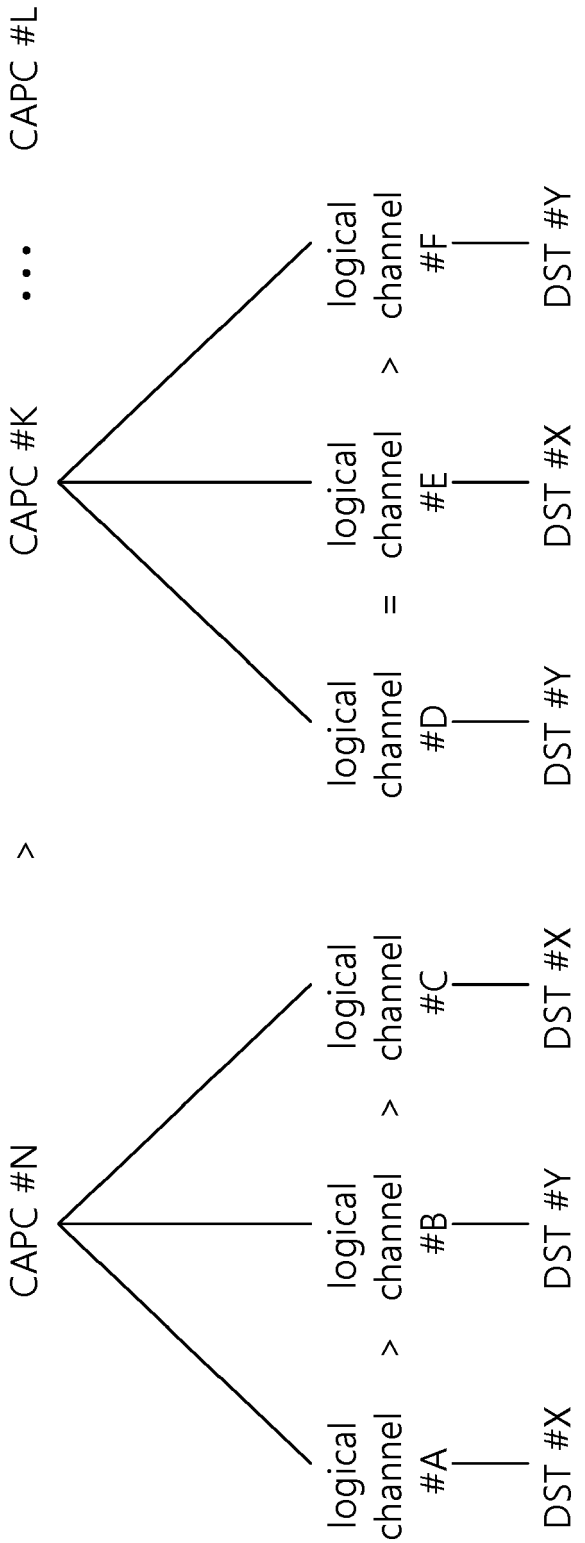

CAPC #N
>
CAPC #K
• • •
CAPC #L
logical channel #A
>
DST #X
logical channel #B
>
DST #Y
logical channel #C
>
DST #X
logical channel #D
=
DST #Y
logical channel #E
>
DST #X
logical channel #F
DST #Y

FIG. 15

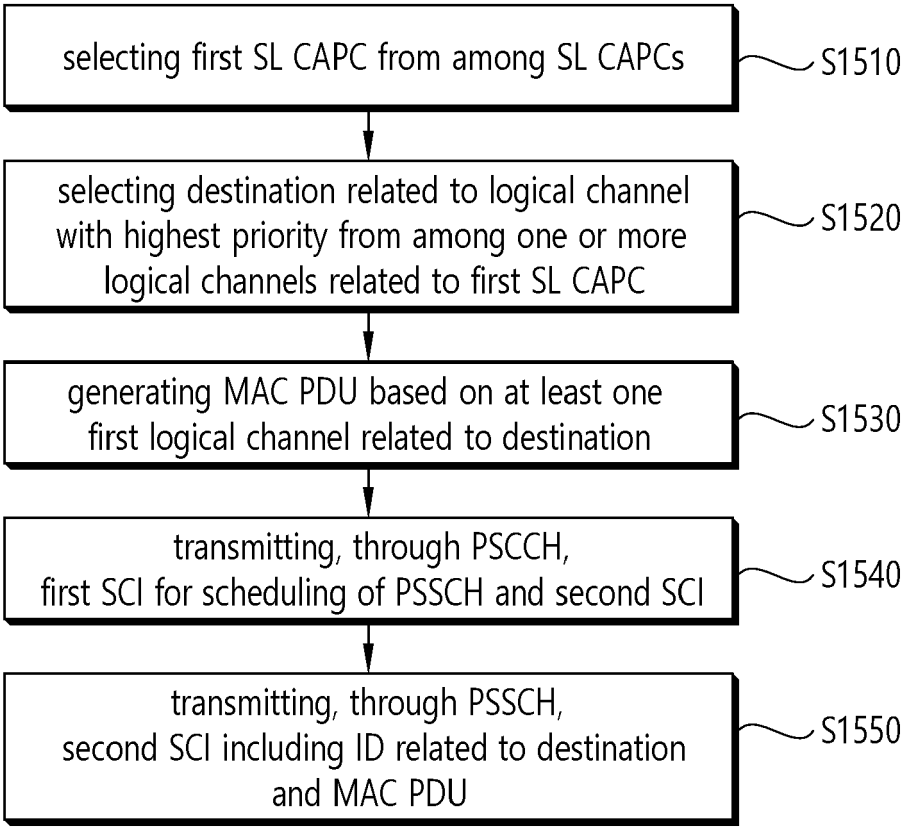

selecting first SL CAPC from among SL CAPCs
S1510
selecting destination related to logical channel with highest priority from among one or more logical channels related to first SL CAPC
S1520
generating MAC PDU based on at least one first logical channel related to destination
S1530
transmitting, through PSCCH, first SCI for scheduling of PSSCH and second SCI
S1540
transmitting, through PSSCH, second SCI including ID related to destination and MAC PDU
S1550

FIG. 16

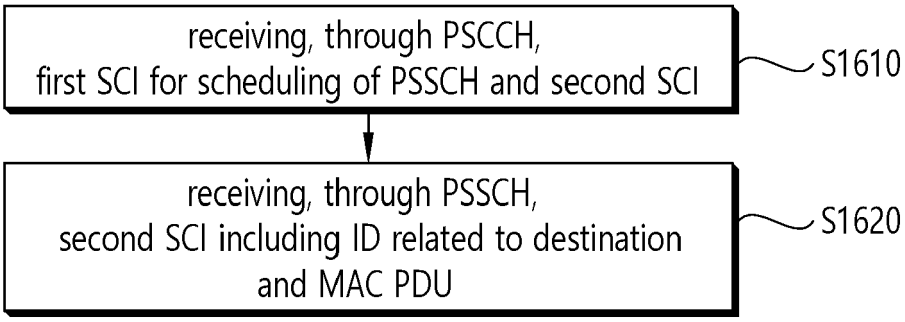

receiving, through PSCCH,
first SCI for scheduling of PSSCH and second SCI
S1610
receiving, through PSSCH,
second SCI including ID related to destination
and MAC PDU
S1620

FIG. 17

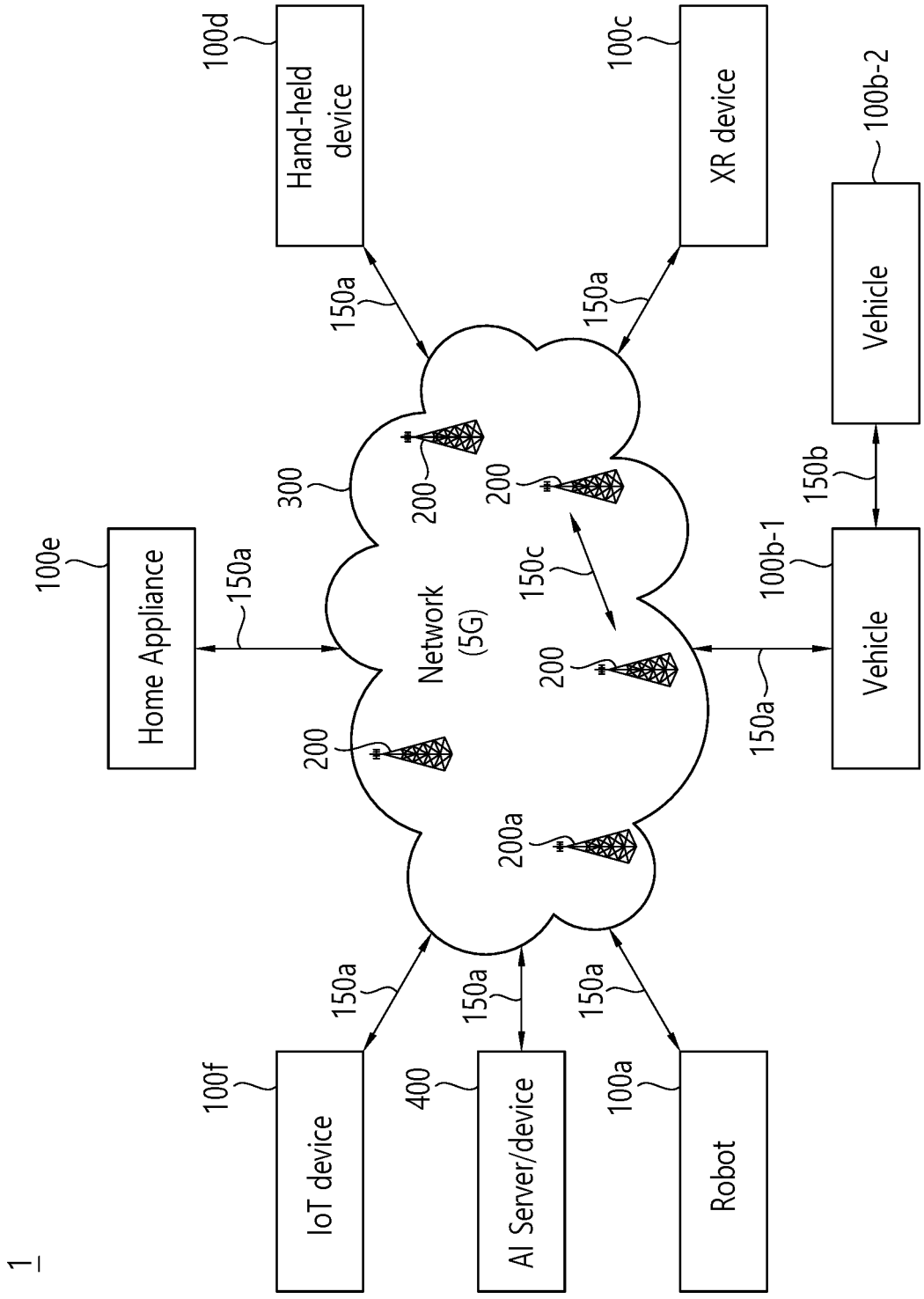

1
Network (5G)
Hand-held device
100d
XR device
100c
Vehicle
100b-2
Home Appliance
100e
Vehicle
100b-1
IoT device
100f
AI Server/device
400
Robot
100a
150a
150b
150c
200
200a
300

FIG. 18

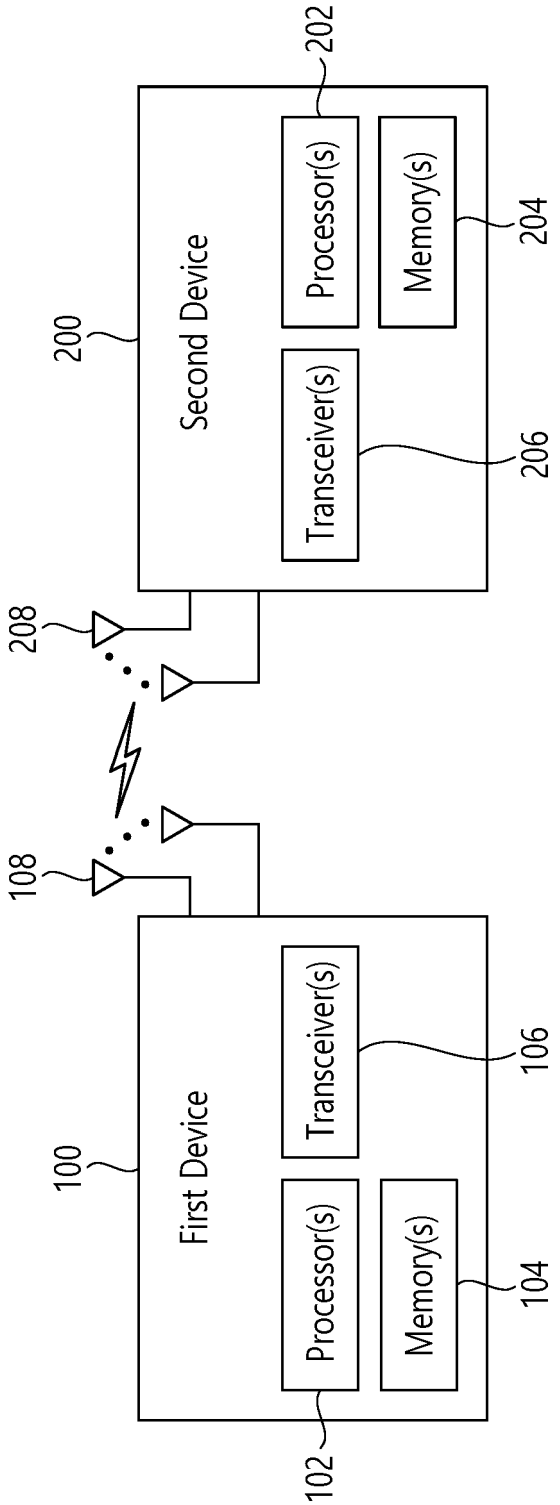

First Device
100
Processor(s)
102
Memory(s)
104
Transceiver(s)
106
108
208
Second Device
200
Processor(s)
202
Memory(s)
204
Transceiver(s)
206

FIG. 19

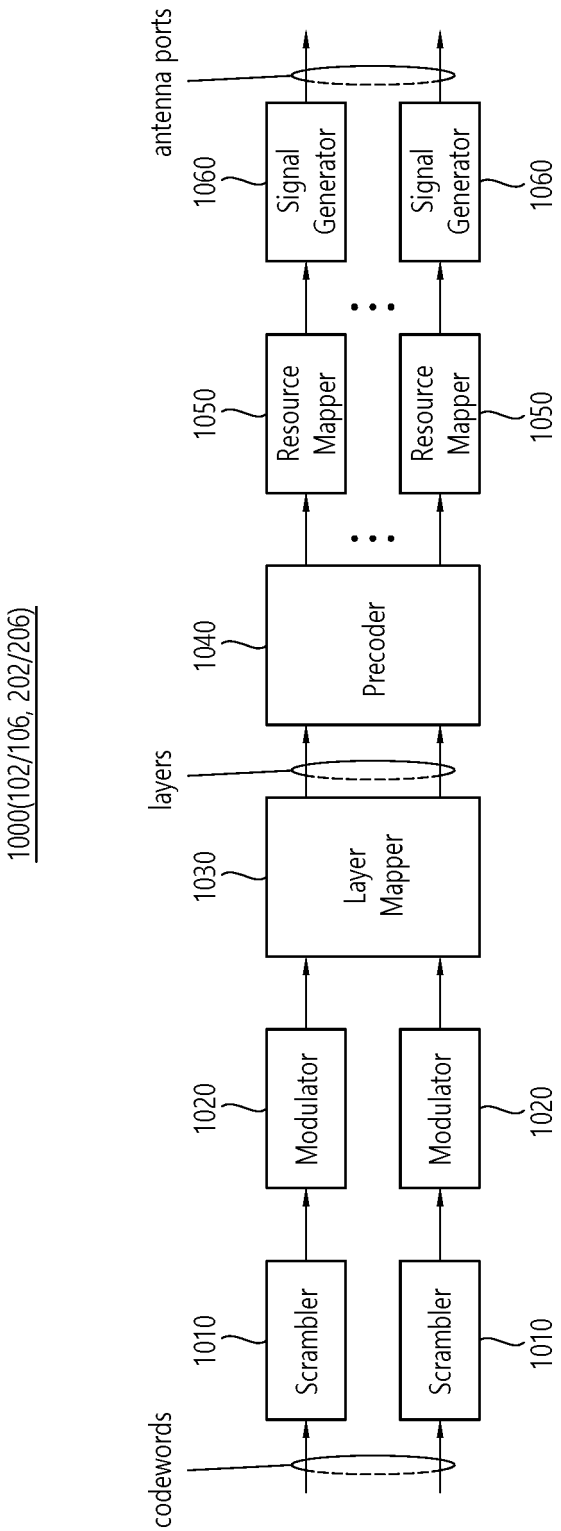

1000(102/106, 202/206)
codewords
1010
Scrambler
1020
Modulator
layers
1030
Layer Mapper
1040
Precoder
1050
Resource Mapper
1060
Signal Generator
antenna ports

FIG. 20

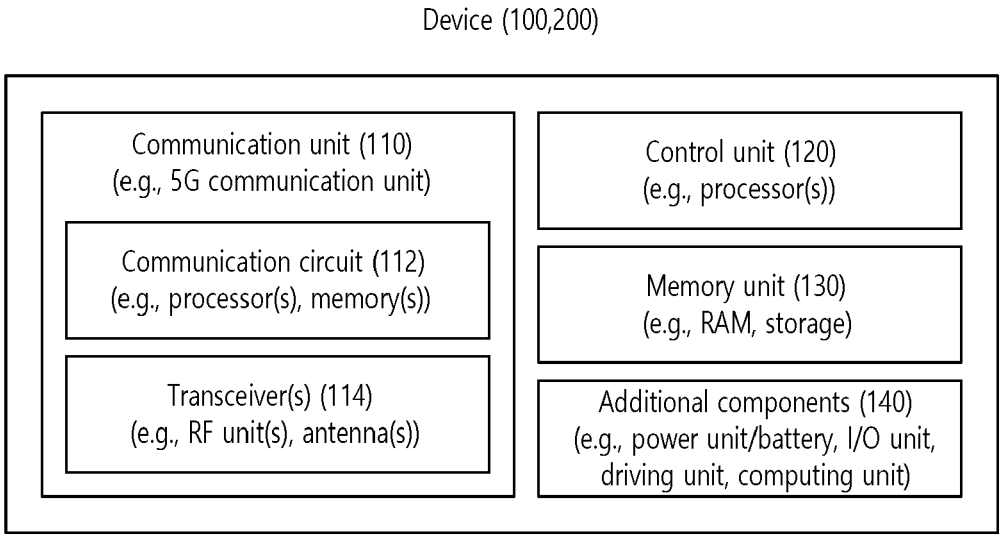

Device (100,200)
Communication unit (110)
(e.g., 5G communication unit)
Communication circuit (112)
(e.g., processor(s), memory(s))
Transceiver(s) (114)
(e.g., RF unit(s), antenna(s))
Control unit (120)
(e.g., processor(s))
Memory unit (130)
(e.g., RAM, storage)
Additional components (140)
(e.g., power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

FIG. 21

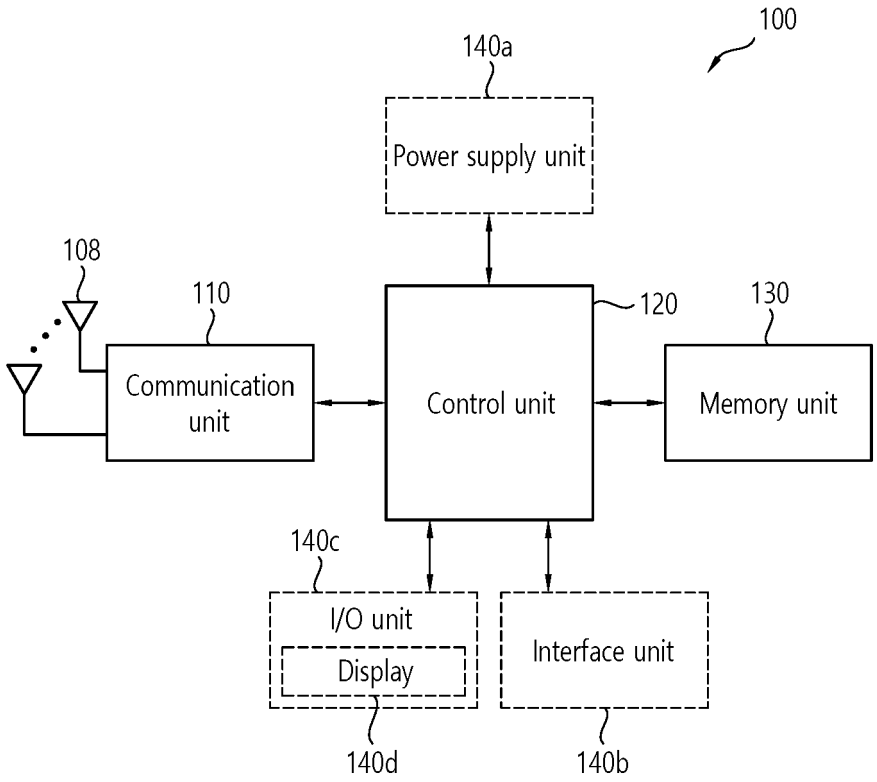
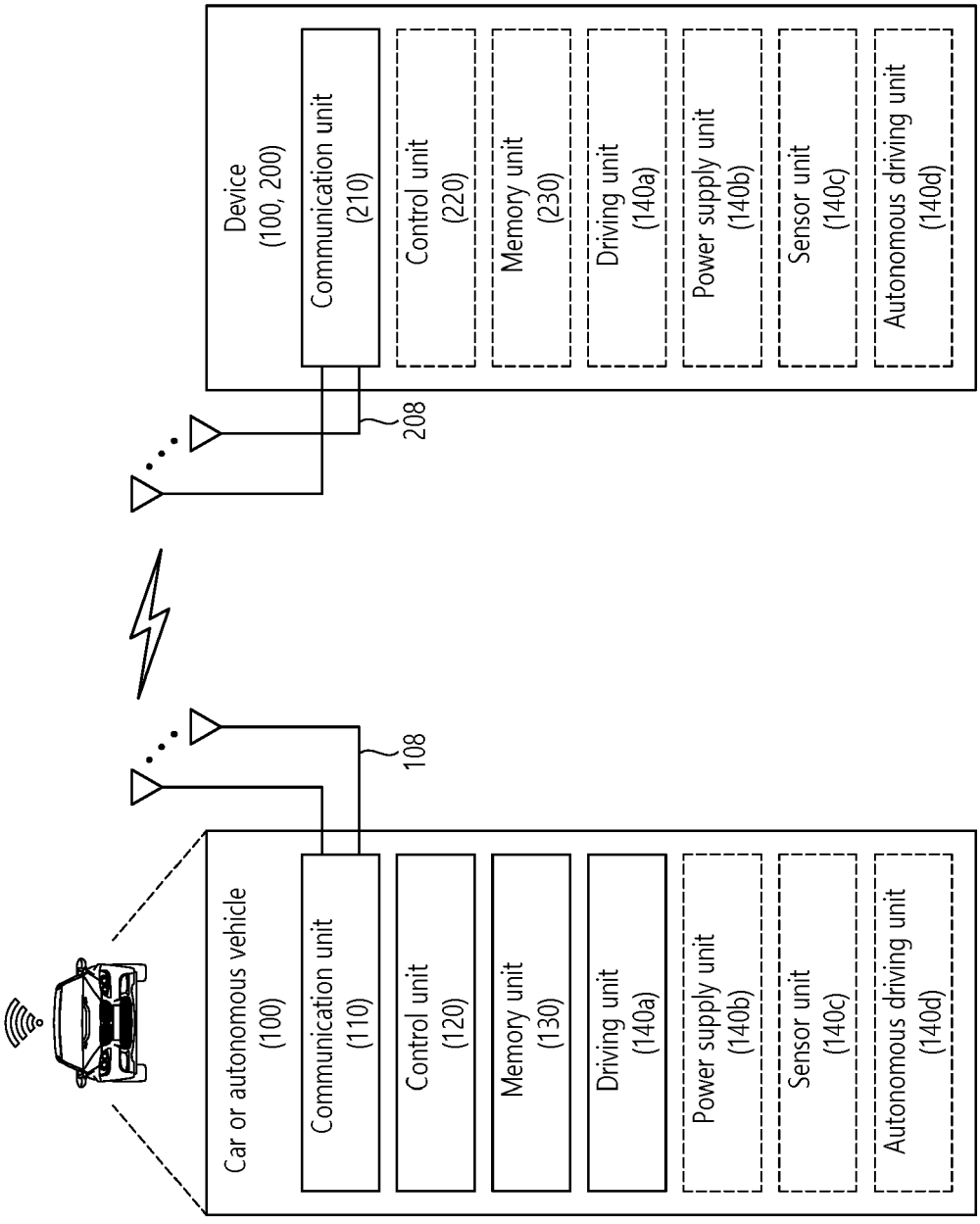

100
140a
Power supply unit
108
110
120
130
Communication unit
Control unit
Memory unit
140c
I/O unit
Display
Interface unit
140d
140b

FIG. 22


Car or autonomous vehicle (100)
Communication unit (110)
Control unit (120)
Memory unit (130)
Driving unit (140a)
Power supply unit (140b)
Sensor unit (140c)
Autonomous driving unit (140d)
108
208
Device (100, 200)
Communication unit (210)
Control unit (220)
Memory unit (230)
Driving unit (140a)
Power supply unit (140b)
Sensor unit (140c)
Autonomous driving unit (140d)

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EUROPEAN SEARCH REPORT

Application Number
EP 23 16 1055

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2020/314953 A1 (LIN GUAN-YU [TW]) 1 October 2020 (2020-10-01) * paragraphs [0001] - [0010], [0020] - [0050] *	1-15	INV. H04W72/02 H04W92/18
X A	US 2022/061095 A1 (XUE YISHENG [US] ET AL) 24 February 2022 (2022-02-24) * paragraphs [0005] - [0010], [0030] - [0050], [0060] - [0080], [0090] - [0110]; figures 13-14 *	1-3,14,15 4-13	
			TECHNICAL FIELDS SEARCHED (IPC)
			H04W

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	7 July 2023	Ranaivoarison, L

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07-07-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2020314953 A1	01-10-2020	CN 112020892 A	01-12-2020
		TW 202042587 A	16-11-2020
		US 2020314953 A1	01-10-2020
		WO 2020192758 A1	01-10-2020
US 2022061095 A1	24-02-2022	US 2022061095 A1	24-02-2022
		WO 2022039852 A1	24-02-2022

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