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(54) **Title:** METHODS, DEVICES AND COMPUTER STORAGE MEDIA FOR COMMUNICATION

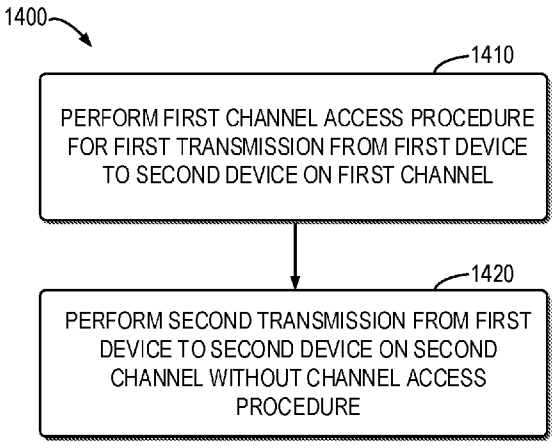

FIG. 14

(57) **Abstract:** Embodiments of the present disclosure relate to methods, devices and computer storage media for communication. The method comprises performing a first channel access procedure for a first transmission from a first device to a second device on a first channel and performing a second transmission from the first device to the second device on a second channel without a channel access procedure.

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METHODS, DEVICES AND COMPUTER STORAGE MEDIA FOR COMMUNICATION

TECHNICAL FIELD

[0001] Embodiments of the present disclosure generally relate to the field of telecommunication, and in particular, to methods, devices and computer storage media for channel occupancy in millimeter wave bands.

BACKGROUND

[0002] Mobile communication involves the transmissions between a terminal device and a network device. Before performing transmission(s), the terminal device or the network device may evaluate the availability of a channel for performing transmissions with channel access procedures, such as a Listen-before-Talk (LBT) mechanism or a clear channel assessment (CCA), to improve the transmission performance. Work is ongoing to introduce enhancements to achieve more flexible channel access procedures.

SUMMARY

[0003] In general, example embodiments of the present disclosure provide methods, devices and computer storage media for channel occupancy in millimeter wave bands.

[0004] In a first aspect, there is provided a method. The method comprises performing a first channel access procedure for a first transmission from a first device to a second device on a first channel and performing a second transmission from the first device to the second device on a second channel without a channel access procedure.

[0005] In a second aspect, there is provided a method. The method comprises obtaining first COT sharing information associated with a first channel on which a first transmission from a first device to a second device is received; and performing, based on the first COT sharing information and without a first channel access procedure, a fourth transmission from the second device to the first device on a second channel on which a second transmission from the first device to the second device is received.

[0006] In a third aspect, there is provided a method. The method comprises performing, a fourth transmission from a second device to a first device on a second channel

independent of first COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel and a second transmission from the first device to the second device being received on the second channel, no channel access procedure being required on the second channel.

[0007] In a fourth aspect, there is provided a method. The method comprises obtaining first COT sharing information associated with a first channel on which a first transmission from a first device to a second device is received; and in accordance with a determination that a channel access procedure is required before a fourth transmission from the second device to the first device on a fourth channel, performing the fourth transmission on the fourth channel based on the first COT sharing information, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received.

[0008] In a fifth aspect, there is provided a method. The method comprises in accordance with a determination that a channel access procedure is required for a fourth transmission from a second device to a first device on a fourth channel, performing the fourth transmission on the fourth channel independent of first COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received, no channel access procedure being required on the second channel.

[0009] In a sixth aspect, there is provided a first device. The first device comprises a processor and a memory. The memory is coupled to the processor and stores instructions thereon. The instructions, when executed by the processor, cause the first device to perform the method according to the first aspect of the present disclosure.

[0010] In a seventh aspect, there is provided a second device. The second device comprises a processor and a memory. The memory is coupled to the processor and stores instructions thereon. The instructions, when executed by the processor, cause the second device to perform the method according to the second aspect of the present disclosure.

[0011] In an eighth aspect, there is provided a second device. The second device comprises a processor and a memory. The memory is coupled to the processor and stores instructions thereon. The instructions, when executed by the processor, cause the second

device to perform the method according to the third aspect of the present disclosure.

[0012] In a ninth aspect, there is provided a second device. The second device comprises a processor and a memory. The memory is coupled to the processor and stores instructions thereon. The instructions, when executed by the processor, cause the second device to perform the method according to the fourth aspect of the present disclosure.

[0013] In a tenth aspect, there is provided a second device. The second device comprises a processor and a memory. The memory is coupled to the processor and stores instructions thereon. The instructions, when executed by the processor, cause the second device to perform the method according to the fifth aspect of the present disclosure.

[0014] In an eleventh aspect, there is provided a computer readable medium having instructions stored thereon. The instructions, when executed on at least one processor, cause the at least one processor to perform the method according to any of the first, the second, the third, the fourth and the fifth aspects.

[0015] It is to be understood that the summary section is not intended to identify key or essential features of embodiments of the present disclosure, nor is it intended to be used to limit the scope of the present disclosure. Other features of the present disclosure will become easily comprehensible through the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Through the more detailed description of some embodiments of the present disclosure in the accompanying drawings, the above and other objects, features and advantages of the present disclosure will become more apparent, wherein:

[0017] FIG. 1 illustrate an example communication network in which embodiments of the present disclosure can be implemented;

[0018] FIG. 2 illustrates a signaling chart for a process of channel occupancy according to some example embodiments of the present disclosure;

[0019] FIGs. 3A-3D illustrate time diagrams for the channel occupancy according to some example embodiments of the present disclosure;

[0020] FIGs. 4A-4D illustrate time diagrams for the channel occupancy according to some example embodiments of the present disclosure;

[0021] FIGs. 5A-5C illustrate time diagrams for the channel occupancy according to some

example embodiments of the present disclosure;

[0022] FIGs. 6A-6C illustrate time diagrams for the channel occupancy according to some example embodiments of the present disclosure;

[0023] FIGs. 7-13 illustrate time diagrams for the channel occupancy according to some example embodiments of the present disclosure;

[0024] FIG. 14 illustrates a flowchart of an example method of the channel occupancy in accordance with some embodiments of the present disclosure;

[0025] FIG. 15 illustrates a flowchart of an example method of the channel occupancy in accordance with some embodiments of the present disclosure;

[0026] FIG. 16 illustrates a flowchart of an example method of the channel occupancy in accordance with some embodiments of the present disclosure;

[0027] FIG. 17 illustrates a flowchart of an example method of the channel occupancy in accordance with some embodiments of the present disclosure;

[0028] FIG. 18 illustrates a flowchart of an example method of the channel occupancy in accordance with some embodiments of the present disclosure; and

[0029] FIG. 19 is a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure.

[0030] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0031] Principle of the present disclosure will now be described with reference to some example embodiments. It is to be understood that these embodiments are described only for the purpose of illustration and help those skilled in the art to understand and implement the present disclosure, without suggesting any limitation as to the scope of the disclosure. The disclosure described herein can be implemented in various manners other than the ones described below.

[0032] In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

[0033] References in the present disclosure to "one embodiment," "an embodiment," "an example embodiment," and the like indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an example embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0034] It shall be understood that although the terms "first" and "second" etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish functionalities of various elements. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms.

[0035] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of example embodiments. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises", "comprising", "has", "having", "includes" and/or "including", when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

[0036] As used herein, the term "communication network" refers to a network following any suitable communication standards, such as fifth generation (5G) systems, Long Term Evolution (LTE), LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), High-Speed Packet Access (HSPA), Narrow Band Internet of Things (NB-IoT) and so on. Furthermore, the communications between a terminal device and a network device in the communication network may be performed according to any suitable generation communication protocols, including, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the future fifth generation (5G) new radio (NR) communication protocols, and/or any other protocols either currently known or to be developed in the future. Embodiments of the present disclosure may be applied in various communication systems.

Given the rapid development in communications, there will of course also be future type communication technologies and systems with which the present disclosure may be embodied. It should not be seen as limiting the scope of the present disclosure to only the aforementioned system.

[0037] As used herein, the term "network device" refers to a node in a communication network via which a terminal device accesses the network and receives services therefrom. The network device may refer to a base station (BS) or an access point (AP), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR Next Generation NodeB (gNB), a Remote Radio Unit (RRU), a radio header (RH), a remote radio head (RRH), a relay, a low power node such as a femto, a pico, and so forth, depending on the applied terminology and technology.

[0038] The term "terminal device" refers to any end device that may be capable of wireless communication. By way of example rather than limitation, a terminal device may also be referred to as a communication device, user equipment (UE), a Subscriber Station (SS), a Portable Subscriber Station, a Mobile Station (MS), or an Access Terminal (AT). The terminal device may include, but not limited to, a mobile phone, a cellular phone, a smart phone, voice over IP (VoIP) phones, wireless local loop phones, a tablet, a wearable terminal device, a personal digital assistant (PDA), portable computers, desktop computer, image capture terminal devices such as digital cameras, gaming terminal devices, music storage and playback appliances, vehicle-mounted wireless terminal devices, wireless endpoints, mobile stations, laptop-embedded equipment (LEE), laptop-mounted equipment (LME), USB dongles, smart devices, wireless customer-premises equipment (CPE), an Internet of Things (IoT) device, a watch or other wearable, a head-mounted display (HMD), a vehicle, a drone, a medical device and applications (e.g., remote surgery), an industrial device and applications (e.g., a robot and/or other wireless devices operating in an industrial and/or an automated processing chain contexts), a consumer electronics device, a device operating on commercial and/or industrial wireless networks, and the like. The terminal device may also correspond to Mobile Termination (MT) part of the integrated access and backhaul (IAB) node (a.k.a. a relay node). In the following description, the terms "terminal device", "communication device", "terminal", "user equipment" and "UE" may be used interchangeably.

[0039] Although functionalities described herein can be performed, in various example embodiments, in a fixed and/or a wireless network node, in other example embodiments,

functionalities may be implemented in a user equipment apparatus (such as a cell phone or tablet computer or laptop computer or desktop computer or mobile IoT device or fixed IoT device). This user equipment apparatus can, for example, be furnished with corresponding capabilities as described in connection with the fixed and/or the wireless network node(s), as appropriate. The user equipment apparatus may be the user equipment and/or or a control device, such as a chipset or processor, configured to control the user equipment when installed therein. Examples of such functionalities include the bootstrapping server function and/or the home subscriber server, which may be implemented in the user equipment apparatus by providing the user equipment apparatus with software configured to cause the user equipment apparatus to perform from the point of view of these functions/nodes.

[0040] The term "circuitry" used herein may refer to hardware circuits and/or combinations of hardware circuits and software. For example, the circuitry may be a combination of analog and/or digital hardware circuits with software/firmware. As a further example, the circuitry may be any portions of hardware processors with software including digital signal processor(s), software, and memory (memories) that work together to cause an apparatus, such as a terminal device or a network device, to perform various functions. In a still further example, the circuitry may be hardware circuits and or processors, such as a microprocessor or a portion of a microprocessor, that requires software/firmware for operation, but the software may not be present when it is not needed for operation. As used herein, the term circuitry also covers an implementation of merely a hardware circuit or processor(s) or a portion of a hardware circuit or processor(s) and its (or their) accompanying software and/or firmware.

[0041] FIG. 1 shows an example communication network 100 in which embodiments of the present disclosure can be implemented. The network 100 includes a network device 120 and terminal devices 110-1, 110-2..., 110-N served by the network device 120. The serving area of the network device 120 is called as a cell 102. The terminal devices 110-1, 110-2..., 110-N may be collectively referred to as "terminal device 110".

[0042] It is to be understood that the number of network devices and terminal devices is only for the purpose of illustration without suggesting any limitations. The communication network 100 may include any suitable number of network devices and terminal devices adapted for implementing embodiments of the present disclosure.

[0043] In the communication network 100, the network device 120 can communicate/transmit data and control information to the terminal device 110 and the terminal device 110 can also communicate/transmit data and control information to the network device 120. A link from the network device 120 to the terminal device 110 is referred to as a downlink (DL), while a link from the terminal device 110 to the network device 120 is referred to as an uplink (UL). DL may comprise one or more logical channels, including but not limited to a Physical Downlink Control Channel (PDCCH) and a Physical Downlink Shared Channel (PDSCH). UL may comprise one or more logical channels, including but not limited to a Physical Uplink Control Channel (PUCCH) and a Physical Uplink Shared Channel (PUSCH).

[0044] Depending on the communication technologies, the network 100 may be a Code Division Multiple Access (CDMA) network, a Time Division Multiple Address (TDMA) network, a Frequency Division Multiple Access (FDMA) network, an Orthogonal Frequency-Division Multiple Access (OFDMA) network, a Single Carrier-Frequency Division Multiple Access (SC-FDMA) network or any others. Communications discussed in the network 100 may use conform to any suitable standards including, but not limited to, NR, Long Term Evolution (LTE), LTE-Evolution, LTE-Advanced (LTE-A), Wideband Code Division Multiple Access (WCDMA), Code Division Multiple Access (CDMA), CDMA2000, and Global System for Mobile Communications (GSM) and the like. Furthermore, the communications may be performed according to any generation communication protocols either currently known or to be developed in the future. Examples of the communication protocols include, but not limited to, the first generation (1G), the second generation (2G), 2.5G, 2.75G, the third generation (3G), the fourth generation (4G), 4.5G, the fifth generation (5G) communication protocols. The techniques described herein may be used for the wireless networks and radio technologies mentioned above as well as other wireless networks and radio technologies. For clarity, certain aspects of the techniques are described below for LTE, and LTE terminology is used in much of the description below.

[0045] As used herein, the term "channel" may refer to a carrier or a part of a carrier consisting of a contiguous set of resource blocks (RBs) on which a channel access procedure is performed in shared spectrum.

[0046] As used herein, the term "channel access procedure" may refer to a procedure based on sensing that evaluates the availability of a channel for performing transmissions.

The basic unit for sensing may be a sensing slot with a sensing slot duration T_{sl}. For example, the sensing slot duration T_{sl} may be considered to be idle if an eNB/gNB or a UE senses the channel during the sensing slot duration, and determines that the detected power for at least certain duration within the sensing slot duration (such as 4μs) is less than energy detection threshold X_{thresh}. Otherwise, the sensing slot duration T_{sl} may be considered to be busy.

[0047] As used herein, the term "LBT", "Category 4 (Cat4) LBT", "Category 2 (Cat2) LBT", "clear channel assessment (CCA)" or "enhanced clear channel assessment (eCCA)" may refer to the channel access procedure described above. For example, the Cat 4 LBT procedure may be similar to the Type 1 UL/DL channel access procedure or Clear Channel Access (CCA). As a further example, the Cat 2 LBT procedure may be similar to the Type 2/2A/2B/2C UL/DL channel access procedures.

[0048] As used herein, the term "channel occupancy" may refer to transmission(s) on channel(s) by eNB/gNB/UE(s) after performing the corresponding channel access procedures.

[0049] As used herein, the term "Channel Occupancy Time (COT)" may refer to the total time for which eNB/gNB/UE and any eNB/gNB/UE(s) sharing the channel occupancy perform transmission(s) on a channel after an eNB/gNB/UE performs the corresponding channel access procedures described above. For example, for determining a Channel Occupancy Time, if a transmission gap is less than or equal to certain duration (such as 25μs), the gap duration is counted in the channel occupancy time. A channel occupancy time may be shared for transmission between an eNB/gNB and the corresponding UE(s).

[0050] If a gNB shares a channel occupancy initiated by a UE using the channel access procedures described above on a channel, the gNB may transmit a transmission that follows a UL transmission on scheduled resources or a PUSCH transmission on configured resources by the UE after a gap. If the gap is up to a duration (such as 16us), the gNB can transmit the transmission on the channel without/after performing a kind of channel access procedure described above. Otherwise, if the gap is greater than a duration (such as 16us), the gNB can transmit the transmission on the channel after performing another kind of channel access procedure described above.

[0051] For regions where LBT is not mandated, gNB indicates to the UE this gNB-UE connection is operating in LBT mode or no-LBT mode. For a frequency range in mmWave

band under corresponding regulation in a certain region, the indication of operation mode may be per UE, per cell or per beam, and carried as part of system information, L1 signalling or dedicated RRC signalling in an implicit or explicit way. The system information can be MIB and/or SIB1.

[0052] Furthermore, an gNB/UE can access multiple channels on which scheduled transmission(s) are performed; as well as the case that multiple UEs are scheduled by the gNB on different channels, respectively. For the channel(s) in no-LBT mode, the gNB/UE can access the channel(s) with a kind of LBT procedure (such as Cat 2 LBT) or directly access the channel(s) without performing LBT procedure in advance. For the channels in LBT mode, the gNB/UE can access the channels based on one of the Type A procedure or Type B procedure. The gNB/UE can perform independent eCCA for each channel in the Type A procedure. In Type B procedure, the gNB/UE may identify a primary channel and perform eCCA on the primary channel, while perform LBT procedure(s) in parallel with fixed sensing interval (such as Cat2 LBT) for other channels in the last sensing slot to align the ending position of LBT procedure on primary channel with that of LBT procedure(s) on other channels.

[0053] The frequency domain granularity for LBT procedure at gNB/UE can be channel bandwidth or a predefined frequency domain unit. It is referred to as LBT bandwidth.

[0054] When transmission bandwidth in LBT mode is greater than an LBT bandwidth, the gNB/UE can simultaneously perform multiple LBT procedures over non-overlapping frequency bands to cover the transmission bandwidth. Multiple LBT procedures can share the same LBT parameter (such as random number, backoff counter) for determining transmission deferring, or apply different LBT parameters respectively.

[0055] A predefined parameter N is the maximum number of serial LBT procedure(s) over the same LBT bandwidth (could be channel or carrier) prior to a successful LBT. If N is greater than one, the parameter for different LBT procedure(s) may be different.

[0056] Therefore, it is to be studied how to design a mechanism for channel occupancy initiating and channel occupancy time sharing between a gNB and a UE considering wide band operation on multiple bands with different LBT operating modes in mmWave shared spectrum.

[0057] Based on the above-mentioned problem of channel occupancy by considering wide band operation on multiple bands wherein a gNB/eNB and/or UE(s) are operating in

different modes, the present disclosure focuses on the transmission over multiple independent frequency bands or channels wherein a gNB/eNB and/or UE(s) are operating in different operating modes (LBT mode or no-LBT mode), deals with corresponding channel occupancy initiating and subsequent channel occupancy sharing between gNB and UE. From the perspective of UE, based on different operating modes, the entire frequency range for intended transmission can be divided into two parts which are referred to as a first band part (hereinafter may also be referred to as a band part A) for the frequency range wherein a UE are operating in LBT mode and a second band part (hereinafter may also be referred to as a band part B) for the frequency range wherein a UE is operating in no-LBT mode, respectively.

[0058] In the solution of the present invention, a first device performs a first CCA procedure for a first transmission from a first device to a second device on a first channel. The first device may also perform a second transmission to the second device on a second channel without performing a CCA.

[0059] In this way, a mechanism of channel occupancy initiating and channel occupancy time sharing between a gNB/eNB and a UE considering wide band operation on multiple bands wherein a eNB/gNB and a UE are operating indifferent LBT modes on mmWave band(s) can be proposed to achieve a flexible and effective channel occupancy.

[0060] Principle and implementations of the present disclosure will be described in detail below with reference to FIGs. 2-13.

[0061] Reference is now made to FIG. 2, which illustrates a signaling chart for a process 200 of channel occupancy according to some example embodiments of the present disclosure. The process 200 may involve a first device 210 and second device 220. In some scenarios, the first device 210 can be considered as the terminal device 110 as shown in FIG. 1 while the second device can be considered as the network device 120 as shown in FIG. 1. In some other scenarios, the first device 210 can be considered as the network device 120 as shown in FIG. 1 while the second device can be considered as the terminal device 110 as shown in FIG. 1.

[0062] As shown in FIG. 2, the first device 210 may perform 2010 multiple transmissions on a plurality of channels between the first device 210 and the second device 220. The plurality of channels may transverse a wide frequency range. To initiating the transmission, a CCA (for example LBT) procedure may be required on some of the

plurality of channels. On the other of plurality of channels, the transmission can also be initiated without the CCA.

[0063] In the example of the transmission on the channels over band part A, assuming band part A consists of a set of an integer number of LBT bandwidths. The first device 210 may perform single Cat 4/2 LBT or multiple independent Cat 4/2 LBTs in parallel depending on the bandwidth of band part A and LBT bandwidth. Alternatively, the terminal device 210 may firstly perform single Cat 4 LBT on selected primary LBT bandwidth, and the perform single/multiple Cat 2 LBT on the other LBT bandwidth(s) in the last the sensing slot within Cat 4 LBT, so that the ending points of Cat 4 LBT on primary channel and Cat2 LBT(s) on other channel(s) are aligned.

[0064] For example, the first device 210 may perform a first CCA procedure for a first transmission to the second device 220 on a first channel. For example, the first device 210 may perform a second CCA procedure for a third transmission to the second device 220 on a third channel. In some embodiments, the first device 210 may perform a Type A CCA procedure. That is, the first device 210 may perform independent eCCA for each channel. Alternatively, the first device 210 may perform a Type B CCA procedure. That is, the first device 210 may identify a primary channel (for example the first channel) and perform eCCA on the primary channel, while perform LBT procedure(s) in parallel with fixed sensing interval (such as Cat2 LBT or any other suitable LBT) for other channels in the last sensing slot to align the ending position of LBT procedure on primary channel with that of LBT procedure(s) on other channels.

[0065] The first device 210 also performs a second transmission to the second device 220 on a second channel without a CCA. It is to be understood that the first device 210 may perform more transmission(s) to the second device 220 other than the first, second and the third transmission. Details for the transmission(s) from the first device 210 to the second device 220 may be described with respect to FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C.

[0066] FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C show time diagrams of examples of the channel occupancy for transmission(s) from the first device 210 to the second device 220 according to the present disclosure.

[0067] For example, the first device 210 may perform UL transmissions in the FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C. It is to be understood that the first device 210 may also perform DL transmissions.

[0068] The UL transmission can be scheduled uplink transmissions, such as PUSCH, Msg3 of the random access procedure, SRS and so on. In the scenario where the first device performs the UL transmission, the first device 210 may receive downlink control information (DCI) wherein the UL grant for each channel is indicated. Each of uplink grants for multiple channels wherein a UE is operating in LBT mode or no-LBT mode may indicate corresponding time/frequency domain resources assignments, UL LBT type, transmission starting position, and other information for uplink transmission within a subframe. These indication information also may be indicated by dedicated RRC signaling. The first device 210 may fully or partly align the different starting positions of transmissions on multiple channels according to UL grants or RRC signalling. Alternatively, the first device 210 may transmit the transmission on each channel independently. The configurable combination of channels wherein an eNB/gNB and/or a UE are operating in same or different mode (LBT mode or no-LBT mode) may be used as at least the partly basis to determine whether and how to align the different channels.

[0069] In some embodiments, the first device 210 may applies a deferral prior to the UL transmission, and then performs the UL transmission over band part B and all or a subset of band part A (subject to the allowance of LBT(s) on band part A), the information of aligning position and COTs across different band parts are included in UL transmission. As used herein, the term "deferral" refers to a duration between the start point of the first transmission (i.e., the transmission with CCA procedure) and the start point of the second transmission (i.e., the transmission without CCA procedure).

[0070] In some embodiments, the first device 210 may start the second transmission over band part B at a time position when the first CCA procedure for the first transmission over band part A is completed. That is, the deferral over band part B lasts until at least a frequency band or a transmission channel in band part A is sensed to be idle of busy before an intended transmission.

[0071] As shown in FIGs. 3A and 3B, the first device 210 performs a first CCA (for example, a Cat 4 LBT) procedure 301 for the first transmission on LBT bandwidth 1 in band part A. The first device 210 may also perform a second CCA procedure 303 for a third transmission on LBT bandwidth 2 in band part A.

[0072] The first device 210 starts the second transmission 320 over band part B at a time position when any of the first CCA procedure 301 and the second CCA 303 is completed,

regardless of the success of the CCA. For example, in the case where the first CCA procedure 301 is successful, the first device 210 may start the second transmission at a same time with the starting of the first transmission 310, as shown in FIG. 3A. The same time may be referred to as a same slot/symbol boundary. In the case where the first CCA procedure 301 fails, the first device 210 may start the second transmission after determining the first CCA procedure fails, as shown in FIG. 3B. In the case where the first CCA procedure 301 and the second CCA 303 fail, the first device 210 may also start the second transmission after determining the first CCA procedure fails, as shown in FIG. 3D.

[0073] In some embodiments, the first device 210 may start the second transmission at a time position when more than one first CCA procedures are completed. As shown in the example of FIG. 3C, the first device 210 may start the second transmission over band part B when two CCA procedures 303 and 304 are completed.

[0074] The first CCA procedure and the second CCA procedure may use same or different CCA parameters (such as LBT parameters). That is, the duration of the first CCA procedure and the second CCA procedure may be the same or different. In the examples of FIGs. 3A-3D, the duration of the first CCA procedure and the duration of the second CCA procedure are different. It is to be understood that in some example embodiments, the durations of the first and second CCA procedures may be the same.

[0075] In some embodiments, the deferral over band part B and band part A (if any) last until each frequency range or transmission channel in band part A is sensed to be idle or busy for intended transmission. That is, the first device 210 may start the second transmission when each CCA procedure in band part A is completed (successful or unsuccessful). FIGs. 4A-4D shows some example transmission(s) with this kind of deferral.

[0076] The first CCA procedure and the second CCA procedure may be of the same type or different types. In the examples of FIG. 4B and 4C, the first CCA procedure 401 and the second CCA procedure 403 are of the same type (i.e., Cat 4 LBT). In these two examples, the first device 210 may start the second transmission 420 when the first CCA procedure 401 and the second CCA procedure 403 both are completed (successful or unsuccessful). Although in the examples of 4B and 4C, one CCA procedure is successful and another CCA procedure fails, it is to be understood that in other examples, the first and second CCA procedures may be both successful or both unsuccessful. The first CCA

procedure and the second CCA procedure of the same type may use same or different CCA parameters (such as LBT parameters). In the example of FIG. 4B, the first CCA procedure and the second CCA procedure use different LBT parameters, thus have different durations. In the example of FIG. 4C, the first and second CCA procedures use the same LBT parameters thus have the same duration.

[0077] FIG. 4D shows the first CCA procedure and the second CCA procedure of different types. As shown, the first CCA procedure is a Cat 2 LBT procedure while the second CCA procedure is a Cat 4 LBT procedure. In this example, the first device 210 may start the second transmission 420 over band part B when both the first and the second CCA procedures 401 and 403 are completed (both successful, or both unsuccessful, or one successful and one unsuccessful) over band part A.

[0078] In some embodiments, as shown in FIG. 4A, the first device 210 may perform more than first CCA procedures for the first transmission. For example, the first CCA procedure is initially a Cat 4 LBT procedure 401 and then changed to a Cat 2 LBT procedure 402. In this case, the first device 210 may start the second transmission 420 over band part B when both the first CCA procedure 401 and 402 and the second CCA procedure 403 are completed (both successful, or both unsuccessful, or one successful and one unsuccessful) over band part A.

[0079] In some embodiments, the first device 210 may perform the second transmission without deferral. For example, the first device 210 may perform scheduled transmission over band part B directly, and perform transmission over band part A according to the result of corresponding LBT procedure(s). That is, the first device 210 may start the second transmission independent of the first transmission. Asynchronous transmissions across band part A and band part B with different starting position may be achieved in the end, the information of relative starting position and COTs across different band parts are included in transmission. FIGs. 5A-5C and 6A-6C show several examples of performing second transmission independent of the first transmission.

[0080] As shown in FIGs. 5A-5C, the first device 210 performs the first CCA procedure 501 (for example, Cat 4 LBT procedure as shown in FIG. 5) over bandwidth 1 in band part A and performs the second CCA procedure 503 (for example, Cat 4 LBT procedure as shown in FIG. 5) over bandwidth 2 in band part A. The first device 210 may perform the second transmission 520 over the band part B according to a scheduled starting position.

The first device 210 may perform the first transmission 510 and/or the third transmission 511 over band part A according to the result of corresponding CCA procedures.

[0081] In addition or alternatively, the first device 210 may apply a deferral prior to the first transmission over band part A until each component carriers or transmission channels in band part A is sensed to be idle or busy for intended transmission. Then, according to LBT result for each LBT bandwidth, the first device 210 may perform multiple concurrent transmissions over different channels or different carriers in band part A. As shown in FIGs. 6A-6C, the first device 210 performs a first CCA procedure 601 over LBT bandwidth 1 in band part A and performs a second CCA procedure 603 over LBT bandwidth 2 in band part A. The first and second CCA procedures may be of the same type (as shown in examples of FIG. 6A and FIG. 6C), or of different types (as shown in example FIG. 6B). In the examples of FIG. 6A and FIG. 6C, the first device 210 may use different LBT parameters (as shown in example of FIG. 6A) or use the same LBT parameters (as shown in example of FIG. 6C). In these examples as shown in FIGs. 6A-6C, the first device 210 may perform the first transmission 610 on the LBT bandwidth 1 in band part A and/or the third transmission 611 on the LBT bandwidth 2 in band part A based on the respective results of the first and the second CCA procedures when both the first and the second CCA procedures are completed. The first device 210 may start the second transmission 620 independent of the first transmission and/or the third transmissions.

[0082] Reference is now back to FIG. 2, the second device 220 performs 2020 transmission(s) to the first device 210. For example, for the first device 210 and the second device 220 sharing the same operating modes over band part A and band part B, if the LBT result(s) on all or a subset of band part A (in a granularity of LBT bandwidth) for the first device 210's transmission (for example, DL transmission if the first device 210 is referred to as the network device 120, or UL transmission if the first device 210 is referred to the terminal device 110) is successful, then the second device 220 may share the remaining first device 210-initiated COT over all or a subset of band part A, and proceed with transmission (for example, UL transmission if the second device 220 is referred to the terminal device 110, or DL transmission if the second device 220 is referred to the network device 120) over all or a subset of band part B and band part A together.

[0083] In some embodiments, the second device 220 obtains first COT sharing information associated with a first channel on which a first transmission from a first device to a second device is received. Then, the second device 220 performs, based on the first

COT sharing information and without a first CCA procedure, a fourth transmission from the second device 220 to the first device 210 on a second channel on which a second transmission from the first device 210 to the second device 220 is received.

[0084] For the channel occupancy initiated by first device 210, the second device 220 may determine certain LBT bandwidth(s) in band part A as potential frequency resources for transmission, based on COT indication information initiated by the first device 210. The example of COT indication information may include but not limited to time and frequency domain resources for the second device 220 to sharing the COT in a LBT bandwidth granularity. In the case that the first device 210 is referred to a terminal device 210 and the second device 220 is referred to a network device 220, the COT indication information may be implicitly or explicitly carried in UL transmission (such as UCI and/or DMRS signals in PUCCH/PUSCH and so on).

[0085] The second device 220 may then apply one or multiple deferrals regarding the transmission on these LBT bandwidth(s) to keep the transmission over band part A (subject to the allowance of potential Cat 2 like LBT(s) on the LBT bandwidth(s) for the transmission) aligned with fourth transmission over band part B. Further, an aligned transmission over all or a subset of band part A and band part B may be transmitted by the second device 220 through sharing at least all or a subset of the common remaining COT initiated by the first device 210. Details for the aligned transmission performed by the second device 220 will be described with respect to FIGs. 7-8.

[0086] In the example that the second device 220 perform a CCA procedure for a transmission to the first device 210 over LBT bandwidth 1 in band part A, and perform the fourth transmission to the first device 210 over band part B without performing CCA procedure, the second device 220 may perform the fourth transmission during a time interval aligned with a first remaining COT initiated by the first device 210 for the first transmission (from the first device 210 to the second device 220), the first remaining COT being determined by the first COT sharing information.

[0087] In addition or alternatively, in some example embodiments, the second device 220 may further obtain second COT sharing information associated with the third channel. In the third channel, the third transmission from the first device 210 to the second device 220 is received. In this situation, the second device 220 may perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT

initiated by the first device 210 for the first transmission and a second remaining COT initiated by the first device 210 for the third transmission. The first remaining COT is determined by the first COT sharing information and the second remaining COT is determined by the second COT sharing information.

[0088] FIG. 7 shows an example of fourth transmission according to the present disclosure. In the example of FIG. 7, the first device 210 may be referred to the terminal device 110, and the second device 220 may be referred to the network device 120. As shown in FIG. 7, the first device 210 performs a first CCA procedure 701 (for example, a Cat 4 LBT procedure as shown in FIG. 7) over LBT bandwidth 1 in band part A, and performs a second CCA procedure 702 (for example, a Cat 4 LBT procedure as shown in FIG. 7) over LBT bandwidth 2 in band part A. The first device 210 does not perform CCA procedure over band part B. The first device 210 performs the first and third transmissions 710 and 711 over the LBT bandwidth 1 and 2 in band part A, respectively at the time position where both the first and second CCA procedures are successful. The first device 210 performs the second transmission 720 over band part B at the time position where both first and second CCA procedures are successful. It is to be understood that the first, second and third transmissions performed by the first device 210 may be performed at other time position determined by any process described with respect to 3A-3D, 4A-4D, 5A-5C and 6A-6C above.

[0089] After that, the second device 220 may perform the fourth transmission 721 over band part B and perform a fifth transmission 712 over LBT bandwidth 1 in part A and/or a sixth transmission 713 over LBT bandwidth 2 in part A at a same time position as shown in FIG. 7. The fourth, fifth and sixth transmissions may be referred to as aligned transmissions. As shown in the example of FIG. 7, the aligned DL transmissions over all or a subset of band part A and band part B may be transmitted by the second device 220 (for example, the network device 120) though sharing at least all or a subset of the common remaining COT initiated by the first device 210 (for example, the terminal device 110). The common remaining COT initiated by the first device 210 is the overlapped part after the end of the first, second and third transmissions among different COTs which are obtained through LBT procedures for these transmissions on multiple LBT bandwidths. As shown in FIG. 7, the common remaining COT is the overlapped part after the end of the UL transmission among different COTs obtained through LBT procedures for UL transmission on multiple LBT bandwidths. The frequency resources corresponding to

these LBT bandwidths may be used by the second device 220 (the network device 120) for DL transmission.

[0090] FIG. 8 shows another example of transmission(s) performed by the second device according to the present disclose. Similar to FIG. 7, the first device 210 may be referred to the terminal device 110, and the second device 220 may be referred to the network device 120. The first device 210 performs a first CCA procedure 801 (for example, a Cat 4 LBT procedure as shown in FIG. 8) over LBT bandwidth 1 in band part A, and performs a second CCA procedure 802 (for example, a Cat 4 LBT procedure as shown in FIG. 8) over LBT bandwidth 2 in band part A. The first device 210 does not perform CCA procedure over band part B. The first device 210 performs the first transmission 810 over the LBT bandwidth 1 in band part A after the first CCA procedure is successful and performs the third transmission 811 over the LBT bandwidth 2 in band part A after the second CCA procedure is successful. The first device 210 performs the third transmission 820 over band part B independent with the first and third transmissions. It is to be understood that the first, second and third transmissions performed by the first device 210 may be performed at other time position determined by any process described with respect to FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C above.

[0091] The second device 220 (for example, the network device 210) may determine certain LBT bandwidth(s) in band part A as potential frequency resources for DL transmission. The second device 220 then apply one or multiple truncations regarding the UL transmission on these LBT bandwidth(s) to keep the DL transmission over band part A (subject to the allowance of potential Cat 2 like LBT(s) on the LBT bandwidth(s) for DL transmission) aligned with DL transmission over band part B.

[0092] Further, an aligned DL transmission over all or a subset of band part A and band part B may be transmitted by the second device 220 through sharing at least all or a subset of the common remaining initiated COT initiated by the first device 210. As shown in FIG. 8, the second device 220 may perform the fourth transmission 821 over band part B and perform a fifth transmission 812 over LBT bandwidth 1 in part A and/or a sixth transmission 813 over LBT bandwidth 2 in part A at a same time position as shown in FIG. 7. The fourth, fifth and sixth transmissions may be referred to as aligned transmissions. As shown, to align the starting position of the fourth, fifth and sixth transmissions, a part of the third transmission 815 is truncated. That is, the DL transmission under both LBT mode and no-LBT mode are aligned and transmitted over all or a subset of band part A and

band part B.

[0093] It is to be understood that in the case where the first device is referred to a network device 120 and the second device 220 is referred to a terminal device 110, the second device 220 may perform similar processed with the processed with respect to FIGs. 7-8.

[0094] Aligned transmission performed by the second device 220 has been discussed with respect to FIGs. 7-8. From now on, it will describe independent transmission performed by the second device 220. In some embodiments, the second device 220 performs a fourth transmission to the first device 210 on a second channel independent of first COT sharing information associated with a first channel. A first transmission from the first device 210 to the second device 220 is received on the first channel, and a second transmission from the first device 210 to the second device 220 is received on the second channel. CCA procedure prior to the transmission is not necessary for the transmission in the second channel.

[0095] In some embodiments, the second device 220 may further receive a third transmission from the first device 210 on a third channel. The second device 220 may perform the fourth transmission independent of both the first COT sharing information and second COT sharing information associated with the third channel. The first device 210 and the second device 220 share the same operation modes over band part A and band part B. The second device 220 may perform transmission over all or a subset of band part A (subject to the allowance of potential Cat 2 like LBT(s) on the LBT bandwidth(s) for transmission) and band part B independently to achieve multiple independent transmissions.

[0096] For the band part B, after a potential switching gap between transmissions performed by the first device 210 and the second device 220, the second device 220 may directly perform corresponding transmission over all or a subset of band part B. The potential switching gap is less than the switching gap between transmissions by the first device 210 and the second device 220 shown in FIG. 7 or FIG. 8. Details about this kind of independent transmission performed by the second device will be described with respect to FIGs. 9-10 as below.

[0097] As shown in FIG. 9, the first device may be referred to as a terminal device 110, and the second device may be referred to as a network device 120. The first device 210 performs UL transmissions in any way described with respect to FIGs. 3A-3D, 4A-4D,

5A-5C and 6A-6C above. For example, as shown in FIG. 9, the first device 210 performs a first CCA procedure 901 over LBT bandwidth 1 in band part A and transmits the first transmission 910 in LBT bandwidth 1 after the first CCA procedure is successful. The first device 210 performs a second CCA procedure 902 over LBT bandwidth 2 in band part A and transmits the third transmission 911 in LBT bandwidth 2 after the second CCA procedure is successful. The first device 210 performs the second transmission 920 over band part B without CCA procedure. The second device 220 may perform DL transmission over LBT bandwidth 1 and/or LBT bandwidth 2 (subject to the allowance of potential Cat 2 like LBT(s) on the corresponding bandwidth) through sharing all or a subset of remaining COT initiated by the first device 210 based on COT indication information. The COT is obtained by the first device 210 with successful LBT for UL transmission on the corresponding bandwidth. The COT indication information may comprise at least time and frequency domain resources for the second device 220 to sharing the COT in a LBT bandwidth granularity. The COT indication information is implicitly or explicitly carried in UL transmission (such as UCI and/or DMRS signal in PUSCH/PUCCH and so on).

[0098] As shown in FIG. 9, the second device 220 may perform the fourth transmission 921 after a potential switching gap (which is quite short) with the second transmission over band part B. The second device 220 may perform CCA procedures (for example, Cat 2 LBT procedure) over LBT bandwidth 1 and 2 in band part A. In addition or alternatively, the starting point of the CCA procedures performed by the second device 220 may be aligned. As shown, to align the starting position of the fifth and sixth transmissions 912 and 913, a part of the third transmission 915 is truncated. If the first transmission 910 over LBT bandwidth 1 in band part A will not reach the starting point of the CCA procedures, a deferral performed and the CCA procedures will be aligned.

[0099] In addition or alternatively, in some example embodiments, the second device 220 may perform a fifth transmission to the first device 210 on the first channel and a sixth transmission to the first device 210 on the third channel during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information. FIG. 10 shows an example of aligned fifth and sixth transmission performed

by the second device 220.

[00100] In the example of FIG. 10, the first device 210 may be referred to as a terminal device 110, and the second device 220 may be referred to as a network device 120. Similar to FIG. 9, the second device 220 may perform a fourth transmission 1021 after a potential switching gap (which is quite short) with the second transmission 1020 performed by the first device 210 over band part B. The second device 220 may perform CCA procedures (for example, Cat 2 LBT procedure) over LBT bandwidth 1 and 2 in band part A. The second device 220 may perform fifth and sixth transmissions 1012 and 1013 over LBT bandwidth 1 and 2 in band part A, respectively if the CCA procedures (for example, Cat 2 LBT as shown in FIG 10) over these bandwidths is successful. The second device 220 may apply one or multiple truncations/deferrals regarding the DL/UL transmission on these LBT bandwidth(s) to keep the DL transmission over each LBT bandwidth(subject to the allowance of potential Cat 2 like LBT on this bandwidth for DL transmission) aligned with the DL transmission(s) over the other bandwidth(s) in band part A. By doing so, the transmissions over each LBT bandwidth may be aligned with the DL transmission(s) over the other bandwidth(s) in band part A.

[00101] It is to be understood that in the case where the first device is referred to as a network device 120 and the second device 220 is referred to as a terminal device 110, the second device 220 may perform similar processed with the processed with respect to FIGs. 9-10.

[00102] FIGs. 7-10 above shows several examples of transmission performed by the second device 220 where the second device 220 and the first device 210 have the same operating mode for frequency resources in band part A and band part B. In some other embodiments, the second device 220 and the first device 210 may have the different operating modes (LBT mode or no-LBT mode) for frequency resources in band part A and band part B, or there is a mode switching for frequency resources in band part A and/or band part B. Examples of transmission with a mode switching will be described in details with respect to the FIGs. 11-13 as below.

[00103] In some embodiments, the second device 220 obtains first COT sharing information associated with a first channel on which a first transmission from a first device 210 to the second device 220 is received. The second device 220 may determine whether a CCA procedure is required for a fourth transmission from the second device 220 to the

first device 210 on a fourth channel. In accordance with a determination that a CCA procedure is required for the fourth transmission, the second device 220 performs the fourth transmission on the fourth channel based on the first COT sharing information. The fourth channel belongs to a same frequency range with a second channel on which a second transmission from the first device 210 to the second device 20 is received.

[00104] From the perspective of the second device 220, the entire frequency range for intended transmission can be divided into two parts which are referred to as band part A' for the frequency range wherein a eNB/gNB or a UE is operating in LBT mode and band part B' for the frequency range wherein a eNB/gNB or a UE is operating in no-LBT mode, respectively. The intersection (in a granularity of LBT bandwidth) of band part A and A' is referred to as band part A&A'. The frequency resources (in a granularity of LBT bandwidth) in band part A' but not in band part A is referred to as band part sA'.

[00105] There can exist a switching gap between UL and DL transmission wherein a Cat 2 like LBT procedure may be potentially performed by the second device 220 over all or a subset (in a LBT bandwidth granularity) of the LBT bandwidth(s) in band part A&A'.

[00106] For example, in the case that the first device comprises a terminal device 110 and the second device 220 comprises a network device 120, the subsequent DL transmission over band part A&A' is subject to the allowance of LBT performed by a second device's at the UL to DL switching gap and limited in corresponding remaining COT initiated by the first device 210. For band part sA', Cat 4/2 like LBT may be performed by the second device 220 prior to the DL transmission over this part of frequency resources. The subsequent DL transmission over all or a subset of band part As' is subject to a second device 220's LBT allowance on LBT bandwidth(s) and limited in corresponding COT initiated by the second device 220.

[00107] In some embodiments, the second device 220 may perform a third CCA procedure for the fourth transmission to initiate a COT for the fourth transmission. The second device 220 may further perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device 210 for the first transmission and the COT for the fourth transmission. The first remaining COT is determined by the first COT sharing information.

[00108] The second device 220 may perform a fifth transmission to the first device 210 on a fifth channel without the CCA procedure during a time interval aligned with a first

remaining COT initiated by the first device 210 for the first transmission. The fifth channel belongs to the same frequency range with the second channel. The first remaining COT is determined by the first COT sharing information.

[00109] The second device 220 may further determine whether a third transmission from the first device 210 to the second device 220 is received on a third channel within a COT initiated by the first device 210 for the third transmission. In accordance with a determination that the third transmission is received on the third channel, the second device 220 may perform a sixth transmission to the first device 210 on a sixth channel without the CCA procedure during a time interval aligned with a first remaining COT initiated by the first device 210 for the first transmission. The first remaining COT is determined by the first COT sharing information.

[00110] FIG. 11 shows an example of such fourth transmission during an aligned time interval. For the UE-initiated channel occupancy wherein the UL transmission is performed in a way described with respect to FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C above, based on UE-initiated COT indication information(such as time and frequency domain resources for gNB to sharing the UE-initiated COT in a LBT bandwidth granularity) implicitly or explicitly carried in UL transmission(such as UCI and/or DMRS signal in PUSCH/PUCCH and so on), the gNB can determine certain LBT bandwidth(s) in band part A&A' as part of potential frequency resources for DL transmission.

[00111] Then, the gNB can jointly apply one or multiple deferrals and/or truncation regarding the DL/UL transmission over these LBT bandwidth(s) in band part A&A', band part sA' and band part B' prior to the DL transmission to keep the DL transmission over all or a subset of band part A&A' and band part sA' (subject to the allowance of potential Cat 2/4 LBT(s) on the LBT bandwidth(s) for DL transmission) aligned with DL transmission over all or a subset of band part B'.

[00112] Further, a fully aligned DL transmission over all or a subset of band part A' and band part B' can be transmitted by the gNB through sharing at least all or a subset of the common UL and DL COT. The common UL and DL COT is the overlapped part between common remaining UE-initiated COT and gNB-initiated COT(s) obtained by LBT procedure(s) on LBT bandwidth(s) in band part sA' for DL transmission.

[00113] As shown in FIG 11, the first device 210 performs a first CCA procedure 1101 over LBT bandwidth 1 in band part A and transmits the first transmission 1110 in LBT

bandwidth 1 after the first CCA procedure is successful. The first device 210 performs a second CCA procedure 1102 over LBT bandwidth 2 in band part A and transmits the third transmission 1111 in LBT bandwidth 2 after the second CCA procedure is successful. The first device 210 performs the second transmission 1120 over band part B without CCA procedure.

[00114] The LBT operating mode of an eNB/gNB and/or a UE may be switched for some band part. In the bandwidth B', which is associated with the LBT bandwidth 1 in band part A, the CCA may not be required for a fifth transmission 1112 initiated from the second device 220. In the band part sA', which is a part of the band part B, the CCA 1103 may be required for the fourth transmission 1122.

[00115] For the transmission by an eNB/gNB or a UE in the bandwidth A&A', the LBT operating mode of eNB/gNB or UE is not switched and therefore the sixth transmission in the bandwidth A&A' may use the remaining COT initiated by the first device 210 for the third transmission 1111. The seventh transmission on the bandwidth B', which is a part of bandwidth B, may be performed with the CCA procedure in advance. As shown, for all transmission to be initiated from the second device, the second device 220 may perform these transmissions aligned with each other. The time interval for performing theses transmissions can be determined based on the overlapping portion between the remaining COT initiated by the first device 210 for the third transmission 1111 and the COT initiated by the second device for the fourth transmission 1122.

[00116] In some embodiments, the second device 220 determines whether a CCA is required for a fourth transmission to a first device 210 on a fourth channel. In accordance with a determination that a CCA is required for the fourth transmission, the second device 220 performs the fourth transmission on the fourth channel independent of first COT sharing information associated with a first channel. A first transmission from the first device 210 to the second device 220 is received on the first channel. The fourth channel belongs to a same frequency range with a second channel on which a second transmission from the first device 210 to the second device 220 is received. CCA procedure in advance is not required for the transmission on the second channel.

[00117] The second device 220 may perform a fifth transmission to the first device 210 on a fifth channel without the CCA procedure independent of the first COT sharing information. The fifth channel belongs to the same frequency range with the second

channel.

[00118] For the UE-initiated channel occupancy wherein the UL transmission is performed in a way described with respect to FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C above, a gNB can deal with DL transmissions over band part A&A', band part sA' and band part B' independently.

[00119] For band part A&A', based on UE-initiated COT indication such as time and frequency domain resources for gNB to sharing the UE-initiated COT (in a LBT bandwidth granularity) implicitly or explicitly carried in UL transmission (such as UCI and/or DMRS signal in PUSCH/PUCCH and so on), the gNB can determine certain LBT bandwidth(s) in band part A&A' as part of potential frequency resources for DL transmission. If the bandwidth of potential frequency resources is greater than LBT bandwidth, the gNB can jointly apply one or multiple deferrals and/or truncations regarding the UL transmission on these LBT bandwidth(s) in band part A&A' to keep the DL transmissions over band part A&A' (subject to the allowance of potential Cat 2 like LBT(s) on the LBT bandwidth(s) at the UL to DL switching gap) aligned with each other. An aligned DL transmission over all or a subset of band part A&A' can be transmitted by the gNB through sharing at least all or a subset of the common remaining UE-initiated COT.

[00120] For the frequency resources in band part sA', according to the bandwidth of sA', one or multiple simultaneous Cat 2/4 LBTs can be performed by gNB on single or multiple LBT bandwidths. With the same LBT parameters, DL transmission(s) (subject to the allowance of potential Cat2/4 LBT(s) at the UL to DL switching gap) over all or a subset of band part sA' can be aligned with each other. An aligned DL transmission over all or a subset of band part sA' can be transmitted by the gNB through sharing at least all or a subset of the common gNB-initiated COT.

[00121] For the band part B', after a potential switching gap between UL and DL transmission, a gNB can directly perform corresponding DL transmission over all or a subset of band part B'.

[00122] FIG. 12 shows examples for such transmission according to the present disclosure.

[00123] As shown in FIG 12, the first device 210 performs a first CCA procedure 1201 over LBT bandwidth 1 in band part A and transmits the first transmission 1210 in LBT bandwidth 1 after the first CCA procedure is successful. The first device 210 performs a second CCA procedure 1202 over LBT bandwidth 2 in band part A and transmits the third

transmission 1211 in LBT bandwidth 2 after the second CCA procedure is successful. The first device 210 performs the second transmission 1220 over band part B without CCA procedure.

[00124] The LBT operating mode of an eNB/gNB and/or a UE may be switched in some band part. In the band part sA', which is a part of the band part B, the CCA 1203 may be required for the fourth transmission 1222 and the CCA 1204 may be required for the fifth transmission 1223.

[00125] For the bandwidth A&A' wherein the LBT operating mode of gNB/eNB and UE is not switched, the sixth transmission 1212 in the bandwidth A&A' may use the remaining COT initiated by the first device 210 for the first transmission 1210 and the seventh transmission 1213 in the bandwidth A&A' may use the remaining COT initiated by the first device 210 for the third transmission 1211. The sixth and the seventh transmissions can be aligned with each other. The time interval for performing the sixth and the seventh transmissions can be determined based on the overlapping portion between the remaining COT initiated by the first device 210 for the first transmission 1210 and the remaining COT initiated by the first device 210 for the third transmission 1211.

[00126] In the band part sA', the fourth and the fifth transmissions can be aligned with each other. The time interval for performing the fourth and the fifth transmissions can be determined based on the overlapping portion between the COT initiated by the second device 220 for the fourth transmission 1222 and the COT initiated by the second device 220 for the fifth transmission 1223.

[00127] In the bandwidth B', which is a part of bandwidth B, the eight transmission 1221 can be performed without CCA. The eight transmission can be independent of any time interval for the fourth, fifth, sixth and seventh transmission

[00128] For the UE-initiated channel occupancy wherein the UL transmission is performed in a way described with respect to FIGs. 3A-3D, 4A-4D, 5A-5C and 6A-6C above, based on UE-initiated COT indication information(such as time and frequency domain resources for gNB to sharing the UE-initiated COT in a LBT bandwidth granularity) implicitly or explicitly carried in UL transmission(such as UCI and/or DMRS signal in in PUSCH/PUCCH and so on) , the gNB can determine certain LBT bandwidth(s) in band part A&A' as part of potential frequency resources for DL transmission.

[00129] For the UE-initiated channel occupancy wherein the UL transmission is performed

in a way of Case 0-1, gNB can perform DL transmission over all or a subset of band part A'(subject to the allowance of potential Cat2/4 LBT(s) on the LBT bandwidth(s) in band part A' at the UL to DL switching gap.) and band part B' independently.

[00130] For the band part B', after a potential switching gap between UL and DL transmission, a gNB can directly perform corresponding DL transmission over all or a subset of band part B'.

[00131] FIG. 13 shows examples for such transmission according to the present disclosure.

[00132] As shown in FIG 13, the first device 210 performs a first CCA procedure 1301 over LBT bandwidth 1 in band part A and transmits the first transmission 1310 in LBT bandwidth 1 after the first CCA procedure is successful. The first device 210 performs a second CCA procedure 1302 over LBT bandwidth 2 in band part A and transmits the third transmission 1311 in LBT bandwidth 2 after the second CCA procedure is successful. The first device 210 performs the second transmission 1320 over band part B without CCA procedure.

[00133] The LBT operating modes for a gNB/eNB and/or a UE may be switched in some band part. In the band part sA', which is a part of the band part B, the CCA 1303 may be required for the fourth transmission 1322.

[00134] For the bandwidth A&A' wherein the LBT operating mode of a eNB/gNB or a UE is not switched, the sixth transmission 1312 in the bandwidth A&A' may use the remaining COT initiated by the first device 210 for the first transmission 1310 and the seventh transmission 1313 in the bandwidth A&A' may use the remaining COT initiated by the first device 210 for the third transmission 1311. In the bandwidth B', which is a part of bandwidth B, the eight transmission 1321 can be performed without CCA.

[00135] As shown, the fourth, sixth, seventh and eight transmissions can be performed by the second device independent with each other.

[00136] With the solution of the present disclosure, a mechanism of channel occupancy initiating and channel occupancy time sharing between a gNB and a UE with different LBT operating modes on multiple frequency ranges or channels in mmWave band can be proposed to achieve a flexible and effective channel occupancy.

[00137] FIG. 14 illustrates a flowchart of an example method 1400 in accordance with some embodiments of the present disclosure. The method 1400 can be implemented at a

first device 210 as shown in FIG. 2. It is to be understood that the method 1400 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard. For the purpose of discussion, the method 1400 will be described from the perspective of the first device 210 with reference to FIG. 2.

[00138] At block 1410, the first device 210 performs a first channel access procedure for a first transmission from the first device 210 to a second device 220 on a first channel.

[00139] At block 1420, the first device 210 performs a second transmission to the second device 220 on a second channel without a channel access procedure.

[00140] In some embodiments, the first device may start the second transmission at a time position when the first channel access procedure for the first transmission is completed.

[00141] In some embodiments, the first device may start the second transmission at a same time with a starting of the first transmission.

[00142] In some embodiments, the first device may perform a second channel access procedure for a third transmission from the first device to the second device on a third channel; and start the second transmission at the time position when at least one of the following: the first channel access procedure for the first transmission is completed, or the second channel access procedure for the third transmission is completed.

[00143] In some embodiments, the first device may perform a second channel access procedure for a third transmission from the first device to the second device on a third channel; and start the second transmission independent of both the first and the third transmissions.

[00144] In some embodiments, the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

[00145] FIG. 15 illustrates a flowchart of an example method 1500 in accordance with some embodiments of the present disclosure. The method 1500 can be implemented at a second device 220 as shown in FIG. 2. It is to be understood that the method 1500 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard. For the purpose of discussion, the

method 1500 will be described from the perspective of the second device 220 with reference to FIG. 2.

[00146] At block 1510, the second device 220 obtains first COT sharing information associated with a first channel on which a first transmission from a first device 210 to a second device 220 is received.

[00147] At block 1520, the second device 220 performs, based on the first COT sharing information and without a first channel access procedure, a fourth transmission from the second device 210 to the first device 210 on a second channel on which a second transmission from the first device 210 to the second device 220 is received.

[00148] In some embodiments, the second device may perform the fourth transmission during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

[00149] In some embodiments, if the second device determines that a third transmission from the first device to the second device on a third channel is received, the second device may obtain second COT sharing information associated with the third channel and perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

[00150] In some embodiments, the second device may perform a fifth transmission from the second device to the first device on the first channel and a sixth transmission from the second device to the first device on the third channel during the overlapping portion.

[00151] In some embodiments, the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

[00152] FIG. 16 illustrates a flowchart of an example method 1600 in accordance with some embodiments of the present disclosure. The method 1600 can be implemented at a second device 220 as shown in FIG. 2. It is to be understood that the method 1600 may include additional blocks not shown and/or may omit some blocks as shown, and the scope

of the present disclosure is not limited in this regard. For the purpose of discussion, the method 1600 will be described from the perspective of the second device 220 with reference to FIG. 2.

[00153] At block 1610, the second device 220 performs, a fourth transmission to a first device 210 on a second channel independent of first COT sharing information associated with a first channel. A first transmission from the first device 210 to the second device 220 is received on the first channel and a second transmission from the first device 210 to the second device 220 is received on the second channel. The channel access procedure is not required for the transmission by the first device and/or the second device on the second channel.

[00154] In some embodiments, if the second device determines that a third transmission from the first device to the second device is received on a third channel, the second device may perform the fourth transmission independent of both the first COT sharing information and second COT sharing information associated with the third channel.

[00155] In some embodiments, the second device may perform a fifth transmission from the second device to the first device on the first channel and a sixth transmission from the second device to the first device on the third channel during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

[00156] In some embodiments, the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

[00157] FIG. 17 illustrates a flowchart of an example method 1700 in accordance with some embodiments of the present disclosure. The method 1700 can be implemented at a second device 220 as shown in FIG. 2. It is to be understood that the method 1700 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard. For the purpose of discussion, the method 1700 will be described from the perspective of the second device 220 with

reference to FIG. 2.

[00158] At block 1710, the second device 220 obtains first COT sharing information associated with a first channel on which a first transmission from a first device 210 to the second device 220 is received.

[00159] At block 1720, the second device 220 determines whether a channel access procedure is required for a fourth transmission. In accordance with a determination that a channel access procedure is required before the fourth transmission, the process 1700 proceeds to block 1730.

[00160] At block 1730, the second device 220 performs the fourth transmission on the fourth channel based on the first COT sharing information. The fourth channel belongs to a same frequency range with a second channel on which a second transmission from the first device 210 to the second device 220 is received.

[00161] In some embodiments, the second device may perform a third channel access procedure for the fourth transmission to initiate a COT for the fourth transmission; and perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and the COT for the fourth transmission, the first remaining COT being determined by the first COT sharing information.

[00162] In some embodiments, the second device may perform a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the fifth channel belonging to the same frequency range with the second channel, the first remaining COT being determined by the first COT sharing information.

[00163] In some embodiments, if the second device determines that a third transmission from the first device to the second device is received on a third channel within a COT initiated by the first device for the third transmission, the second device may perform a sixth transmission from the second device to the first device on a sixth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

[00164] In some embodiments, the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the

first frequency range and the second frequency range can be located at a same carrier or at different carriers.

[00165] FIG. 18 illustrates a flowchart of an example method 1800 in accordance with some embodiments of the present disclosure. The method 1800 can be implemented at a second device 220 as shown in FIG. 2. It is to be understood that the method 1800 may include additional blocks not shown and/or may omit some blocks as shown, and the scope of the present disclosure is not limited in this regard. For the purpose of discussion, the method 1800 will be described from the perspective of the second device 220 with reference to FIG. 2.

[00166] At block 1810, the second device 220 determines whether a channel access procedure is required for a fourth transmission. In accordance with a determination that a channel access procedure is required for the fourth transmission, the process 1700 proceeds to block 1820.

[00167] At block 1820, the second device 220 performs the fourth transmission on the fourth channel independent of first COT sharing information associated with a first channel. A first transmission from the first device 210 to the second device 220 is received on the first channel. The fourth channel belongs to a same frequency range with a second channel on which a second transmission from the first device 210 to the second device 220 is received. The channel access procedure is not required for the transmission by the first device and/or the second device on the second channel.

[00168] In some embodiments, the second device may perform a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure independent of the first COT sharing information, the fifth channel belonging to the same frequency range with the second channel.

[00169] In some embodiments, the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

[00170] Details for channel occupancy in millimeter wave bands according to the present disclosure have been described with reference to FIGs. 1-18. Now an example implementation of the first device 210 will be discussed below. In some embodiments, the first device 210 comprises circuitry configured to: perform a first channel access procedure

for a first transmission from the first device 210 to a second device 220 on a first channel and perform a second transmission to the second device 220 on a second channel without a channel access procedure.

[00171] In some embodiments, the first device 210 comprises circuitry configured to start the second transmission at a time position when the first channel access procedure for the first transmission is completed.

[00172] In some embodiments, the first device 210 comprises circuitry configured to start the second transmission at a same time with a starting of the first transmission.

[00173] In some embodiments, the first device 210 comprises circuitry configured to perform a second channel access procedure for a third transmission from the first device to the second device on a third channel; and start the second transmission at the time position when at least one of the following: the first channel access procedure for the first transmission is completed, or the second channel assessment procedure for the third transmission is completed.

[00174] In some embodiments, the first device 210 comprises circuitry configured to perform a second channel access procedure for a third transmission from the first device to the second device on a third channel; and start the second transmission independent of both the first and the third transmissions.

[00175] Now an example implementation of the second device 220 will be discussed below. In some embodiments, the second device 220 comprises circuitry configured to: obtain first COT sharing information associated with a first channel on which a first transmission from a first device 210 to a second device 220 is received and perform, based on the first COT sharing information and without a first channel access procedure, a fourth transmission from the second device 210 to the first device 210 on a second channel on which a second transmission from the first device 210 to the second device 220 is received.

[00176] In some embodiments, the second device 220 comprises circuitry configured to perform the fourth transmission during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

[00177] In some embodiments, the second device 220 comprises circuitry configured to in accordance with a determination that a third transmission from the first device to the second device on a third channel is received, obtain second COT sharing information associated

with the third channel and perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

[00178] In some embodiments, the second device 220 comprises circuitry configured to perform a fifth transmission from the second device to the first device on the first channel and a sixth transmission from the second device to the first device on the third channel during the overlapping portion.

[00179] In some embodiments, the second device 220 comprises circuitry configured to: perform, a fourth transmission to a first device 210 on a second channel independent of first COT sharing information associated with a first channel. A first transmission from the first device 210 to the second device 220 is received on the first channel and a second transmission from the first device 210 to the second device 220 is received on the second channel. The channel access procedure is not required for the transmission by the first device and the second device on the second channel.

[00180] In some embodiments, the second device 220 comprises circuitry configured to in accordance with a determination that a third transmission from the first device to the second device is received on a third channel, perform the fourth transmission independent of both the first COT sharing information and second COT sharing information associated with the third channel.

[00181] In some embodiments, the second device 220 comprises circuitry configured to perform a fifth transmission from the second device to the first device on the first channel and a sixth transmission from the second device to the first device on the third channel during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

[00182] In some embodiments, the second device 220 comprises circuitry configured to obtain first COT sharing information associated with a first channel on which a first

transmission from a first device 210 to the second device 220 is received and in accordance with a determination that a channel access procedure is required before a fourth transmission from the second device to the first device on a fourth channel, perform the fourth transmission on the fourth channel based on the first COT sharing information, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received.

[00183] In some embodiments, the second device 220 comprises circuitry configured to perform a third channel access procedure for the fourth transmission to initiate a COT for the fourth transmission; and perform the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and the COT for the fourth transmission, the first remaining COT being determined by the first COT sharing information.

[00184] In some embodiments, the second device 220 comprises circuitry configured to perform a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the fifth channel belonging to the same frequency range with the second channel, the first remaining COT being determined by the first COT sharing information.

[00185] In some embodiments, the second device 220 comprises circuitry configured to in accordance with a determination that a third transmission from the first device to the second device is received on a third channel within a COT initiated by the first device for the third transmission, the second device may perform a sixth transmission from the second device to the first device on a sixth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

[00186] In some embodiments, the second device 220 comprises circuitry configured to in accordance with a determination that a channel access procedure is required for a fourth transmission from a second device to a first device on a fourth channel, perform the fourth transmission on the fourth channel independent of first COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel, the fourth channel belonging to a same frequency range with a

second channel on which a second transmission from the first device to the second device is received, the channel access procedure is not required for the transmission on the second channel.

[00187] In some embodiments, the second device 220 comprises circuitry configured to perform a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure independent of the first COT sharing information, the fifth channel belonging to the same frequency range with the second channel.

[00188] FIG. 19 is a simplified block diagram of a device 1900 that is suitable for implementing embodiments of the present disclosure. The device 1900 can be considered as a further example implementation of the network device 120 or the terminal device 110 as shown in FIG. 1. Accordingly, the device 1900 can be implemented at or as at least a part of the network device 120 or the terminal device 110.

[00189] As shown, the device 1900 includes a processor 1910, a memory 1920 coupled to the processor 1910, a suitable transmitter (TX) and receiver (RX) 1940 coupled to the processor 1910, and a communication interface coupled to the TX/RX 1940. The memory 1910 stores at least a part of a program 1930. The TX/RX 1940 is for bidirectional communications. The TX/RX 1940 has at least one antenna to facilitate communication, though in practice an Access Node mentioned in this application may have several ones. The communication interface may represent any interface that is necessary for communication with other network elements, such as X2 interface for bidirectional communications between eNBs, S1 interface for communication between a Mobility Management Entity (MME)/Serving Gateway (S-GW) and the eNB, Un interface for communication between the eNB and a relay node (RN), or Uu interface for communication between the eNB and a terminal device.

[00190] The program 1930 is assumed to include program instructions that, when executed by the associated processor 1910, enable the device 1900 to operate in accordance with the embodiments of the present disclosure, as discussed herein with reference to FIGs. 2 to 18. The embodiments herein may be implemented by computer software executable by the processor 1910 of the device 1900, or by hardware, or by a combination of software and hardware. The processor 1910 may be configured to implement various embodiments of the present disclosure. Furthermore, a combination of the processor 1910 and memory 1920 may form processing means 1950 adapted to implement various embodiments of the

present disclosure.

[00191] The memory 1920 may be of any type suitable to the local technical network and may be implemented using any suitable data storage technology, such as a non-transitory computer readable storage medium, semiconductor based memory devices, magnetic memory devices and systems, optical memory devices and systems, fixed memory and removable memory, as non-limiting examples. While only one memory 1920 is shown in the device 1900, there may be several physically distinct memory modules in the device 1900. The processor 1910 may be of any type suitable to the local technical network, and may include one or more of general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 1900 may have multiple processors, such as an application specific integrated circuit chip that is slaved in time to a clock which synchronizes the main processor.

[00192] Generally, various embodiments of the present disclosure may be implemented in hardware or special purpose circuits, software, logic or any combination thereof. Some aspects may be implemented in hardware, while other aspects may be implemented in firmware or software which may be executed by a controller, microprocessor or other computing device. While various aspects of embodiments of the present disclosure are illustrated and described as block diagrams, flowcharts, or using some other pictorial representation, it will be appreciated that the blocks, apparatus, systems, techniques or methods described herein may be implemented in, as non-limiting examples, hardware, software, firmware, special purpose circuits or logic, general purpose hardware or controller or other computing devices, or some combination thereof.

[00193] The present disclosure also provides at least one computer program product tangibly stored on a non-transitory computer readable storage medium. The computer program product includes computer-executable instructions, such as those included in program modules, being executed in a device on a target real or virtual processor, to carry out the process or method as described above with reference to FIGs. 2-18. Generally, program modules include routines, programs, libraries, objects, classes, components, data structures, or the like that perform particular tasks or implement particular abstract data types. The functionality of the program modules may be combined or split between program modules as desired in various embodiments. Machine-executable instructions for program modules may be executed within a local or distributed device. In a distributed

device, program modules may be located in both local and remote storage media.

[00194] Program code for carrying out methods of the present disclosure may be written in any combination of one or more programming languages. These program codes may be provided to a processor or controller of a general purpose computer, special purpose computer, or other programmable data processing apparatus, such that the program codes, when executed by the processor or controller, cause the functions/operations specified in the flowcharts and/or block diagrams to be implemented. The program code may execute entirely on a machine, partly on the machine, as a stand-alone software package, partly on the machine and partly on a remote machine or entirely on the remote machine or server.

[00195] The above program code may be embodied on a machine readable medium, which may be any tangible medium that may contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device. The machine readable medium may be a machine readable signal medium or a machine readable storage medium. A machine readable medium may include but not limited to an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples of the machine readable storage medium would include an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[00196] Further, while operations are depicted in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and parallel processing may be advantageous. Likewise, while several specific implementation details are contained in the above discussions, these should not be construed as limitations on the scope of the present disclosure, but rather as descriptions of features that may be specific to particular embodiments. Certain features that are described in the context of separate embodiments may also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment may also be implemented in multiple embodiments separately or in any suitable sub-combination.

[00197] Although the present disclosure has been described in language specific to structural features and/or methodological acts, it is to be understood that the present disclosure defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

WHAT IS CLAIMED IS:

1. A method comprising:

performing a first channel access procedure for a first transmission from a first device to a second device on a first channel; and

performing a second transmission from the first device to the second device on a second channel without a channel access procedure.

2. The method of Claim 1, wherein performing the second transmission comprises:

starting the second transmission at a time position when the first channel access procedure for the first transmission is completed.

3. The method of Claim 1, wherein performing the second transmission comprises:

starting the second transmission at a same time with a starting of the first transmission.

4. The method of Claim 1, wherein performing the second transmission comprises:

starting the second transmission independent of the first transmission.

5. The method of Claim 1, wherein performing the second transmission comprises:

performing a second channel access procedure for a third transmission from the first device to the second device on a third channel; and

starting the second transmission at the time position when at least one of the following:

the first channel access procedure for the first transmission is completed, or

the second channel assessment procedure for the third transmission is completed.

6. The method of Claim 1, wherein performing the second transmission comprises:

performing a second channel access procedure for a third transmission from the first device to the second device on a third channel; and

starting the second transmission independent of both the first and the third transmissions.

7. The method of Claim 1, wherein the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

8. A method comprising:

obtaining first Channel Occupancy Time, COT, sharing information associated with a first channel on which a first transmission from a first device to a second device is received; and

performing, based on the first COT sharing information and without a channel access procedure, a fourth transmission from the second device to the first device on a second channel on which a second transmission from the first device to the second device is received.

9. The method of Claim 8, wherein performing the fourth transmission comprises:

performing the fourth transmission during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

10. The method of Claim 8, wherein performing the fourth transmission comprises:

in accordance with a determination that a third transmission from the first device to the second device on a third channel is received, obtaining second COT sharing information associated with the third channel; and

performing the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

11. The method of Claim 10, further comprising:

performing a fifth transmission from the second device to the first device on the

first channel and a sixth transmission from the second device to the first device on the third channel during the overlapping portion.

12. The method of Claim 8, wherein the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

13. A method comprising:

performing, a fourth transmission from a second device to a first device on a second channel independent of first Channel Occupancy Time, COT, sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel and a second transmission from the first device to the second device being received on the second channel, a channel access procedure being required on the second channel.

14. The method of Claim 13, wherein performing the fourth transmission comprises:

in accordance with a determination that a third transmission from the first device to the second device is received on a third channel, performing the fourth transmission independent of both the first COT sharing information and second COT sharing information associated with the third channel.

15. The method of Claim 14, further comprising:

performing a fifth transmission from the second device to the first device on the first channel and a sixth transmission from the second device to the first device on the third channel during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and a second remaining COT initiated by the first device for the third transmission, the first remaining COT being determined by the first COT sharing information and the second remaining COT being determined by the second COT sharing information.

16. The method of Claim 13, wherein the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range,

and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

17. A method comprising:

obtaining first Channel Occupancy Time, COT, sharing information associated with a first channel on which a first transmission from a first device to a second device is received; and

in accordance with a determination that a channel access procedure is required before a fourth transmission from the second device to the first device on a fourth channel, performing the fourth transmission on the fourth channel based on the first COT sharing information, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received, a channel access procedure being required on the second channel.

18. The method of Claim 17, wherein performing the fourth transmission comprises:

performing a third channel access procedure for the fourth transmission to initiate a COT for the fourth transmission;

performing the fourth transmission during a time interval aligned with an overlapping portion between a first remaining COT initiated by the first device for the first transmission and the COT for the fourth transmission, the first remaining COT being determined by the first COT sharing information.

19. The method of Claim 17, further comprising:

performing a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the fifth channel belonging to the same frequency range with the second channel, the first remaining COT being determined by the first COT sharing information.

20. The method of Claim 17, further comprising:

in accordance with a determination that a third transmission from the first device to the second device is received on a third channel within a COT initiated by the first device for the third transmission, performing a sixth transmission from the second device to the

first device on a sixth channel without the channel access procedure during a time interval aligned with a first remaining COT initiated by the first device for the first transmission, the first remaining COT being determined by the first COT sharing information.

21. The method of Claim 17, wherein the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

22. A method comprising:

in accordance with a determination that a channel access procedure is required for a fourth transmission from a second device to a first device on a fourth channel, performing the fourth transmission on the fourth channel independent of first Channel Occupancy Time, COT, COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received, a channel access procedure being not required on the second channel.

23. The method of Claim 22, further comprising:

performing a fifth transmission from the second device to the first device on a fifth channel without the channel access procedure independent of the first COT sharing information, the fifth channel belonging to the same frequency range with the second channel.

24. The method of Claim 22, wherein the first channel is associated with a first frequency range and the second device channel is associated with a second frequency range, and wherein the first frequency range and the second frequency range can be located at a same carrier or at different carriers.

25. A first device, comprising:

a processor configured to:

perform a first channel access procedure for a first transmission from the first device to a second device on a first channel; and

perform a second transmission from the first device to the second device on a second channel without a channel access procedure.

26. A second device, comprising:

a processor configured to:

obtain first COT sharing information associated with a first channel on which a first transmission from the first device to the second device is received; and

perform, based on the first COT sharing information and without a first channel access procedure, a fourth transmission from the second device to the first device on a second channel on which a second transmission from the first device to the second device is received.

27. A second device, comprising:

a processor configured to:

perform, a fourth transmission from the second device to a first device on a second channel independent of first COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel and a second transmission from the first device to the second device being received on the second channel, a channel access procedure being not required on the second channel.

28. A second device, comprising:

a processor configured to:

obtain first COT sharing information associated with a first channel on which a first transmission from a first device to the second device is received; and

in accordance with a determination that a channel access procedure is required for a fourth transmission from the second device to the first device on a fourth channel, perform the fourth transmission on the fourth channel based on the first COT sharing information, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received, a channel access procedure being not required on the second channel.

29. A second device, comprising:

a processor configured to:

in accordance with a determination that a channel access procedure is required for a fourth transmission from the second device to a first device on a fourth channel, perform the fourth transmission on the fourth channel independent of first COT sharing information associated with a first channel, a first transmission from the first device to the second device being received on the first channel, the fourth channel belonging to a same frequency range with a second channel on which a second transmission from the first device to the second device is received, a channel access procedure being not required on the second channel.

30. A non-transitory computer readable medium comprising program instructions for causing an apparatus to perform at least the method of any of claims 1-7, the method of any of claims 8-12, the method of any of claims 13-16, the method of any of claims 17-21 and the method of any of claims 22-24.

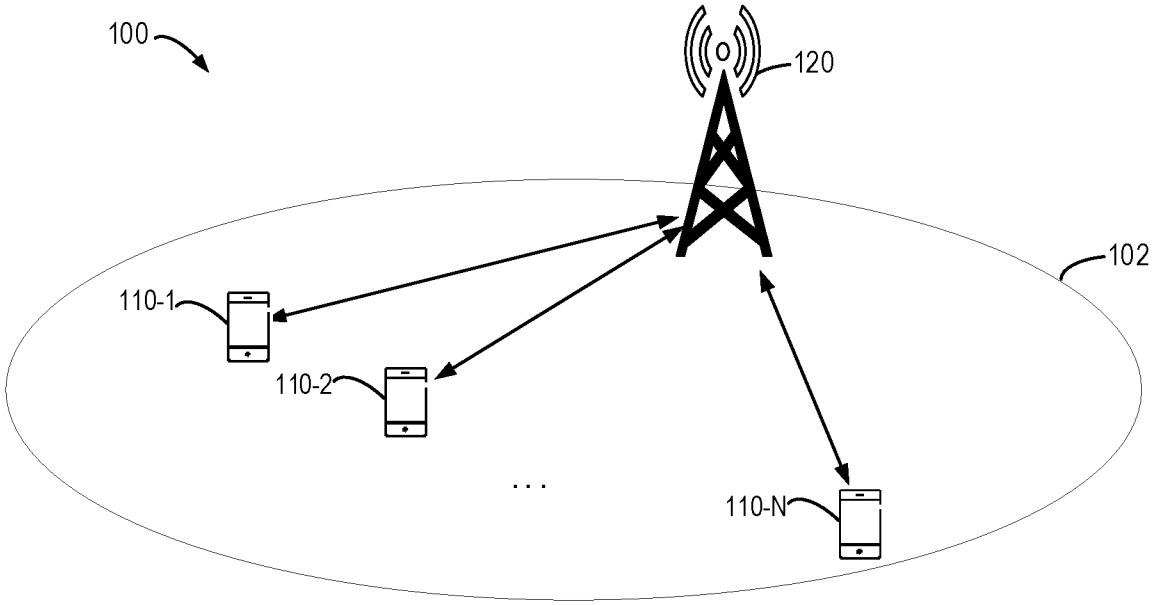

FIG. 1

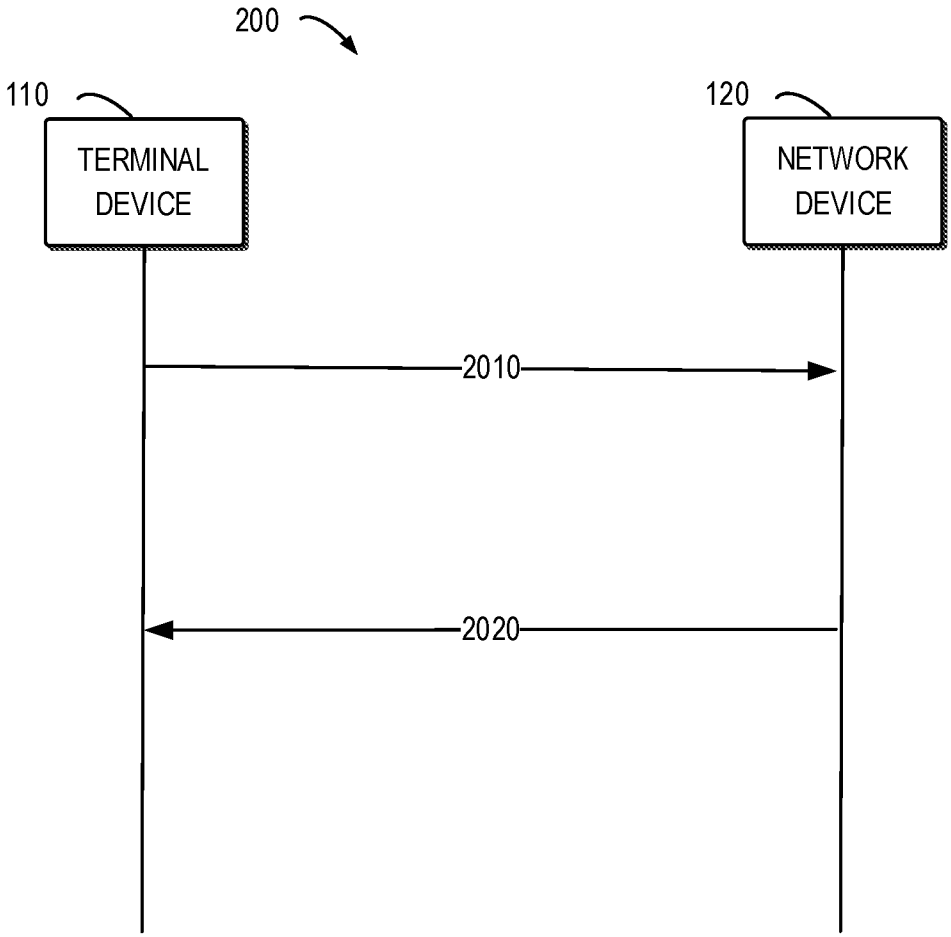

FIG. 2

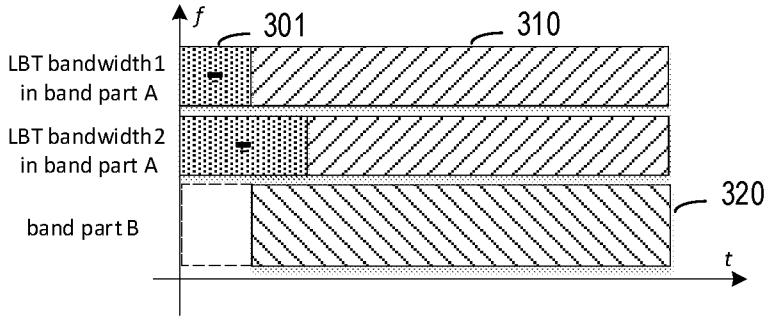

FIG. 3A

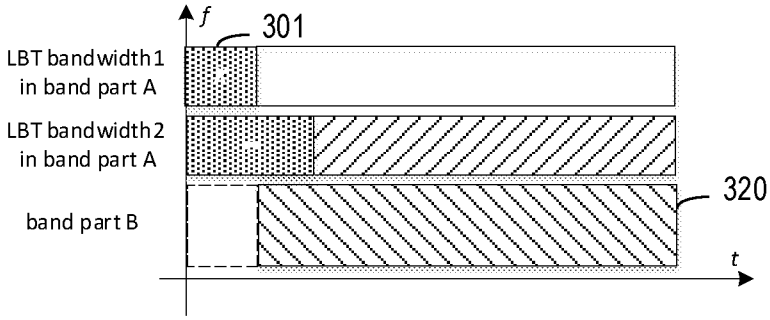

FIG. 3B

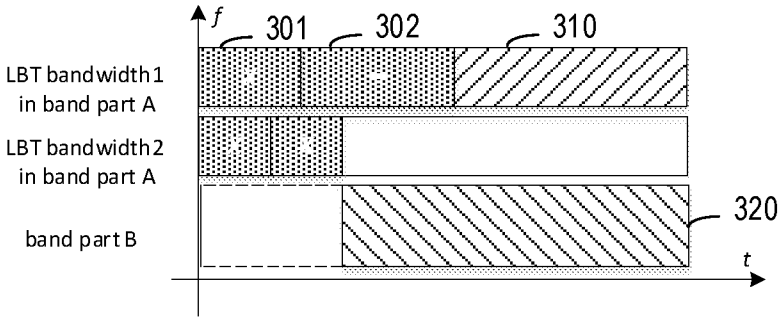

FIG. 3C

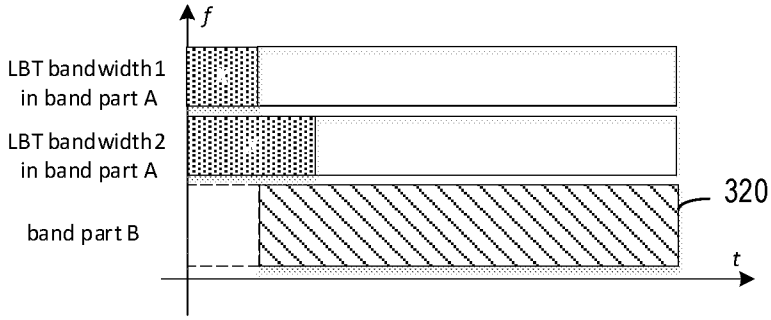

FIG. 3D

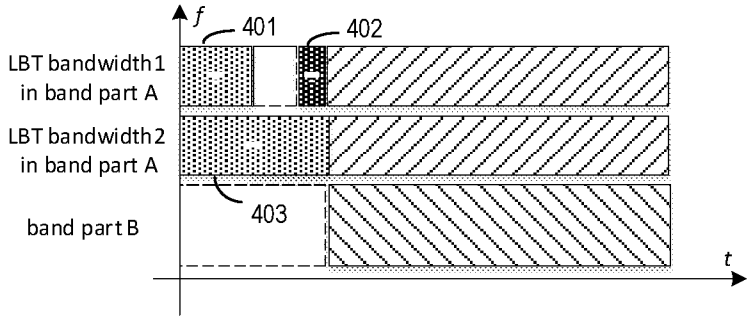

FIG. 4A

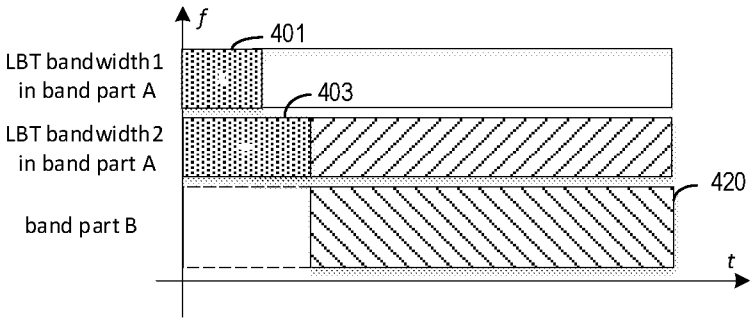

FIG. 4B

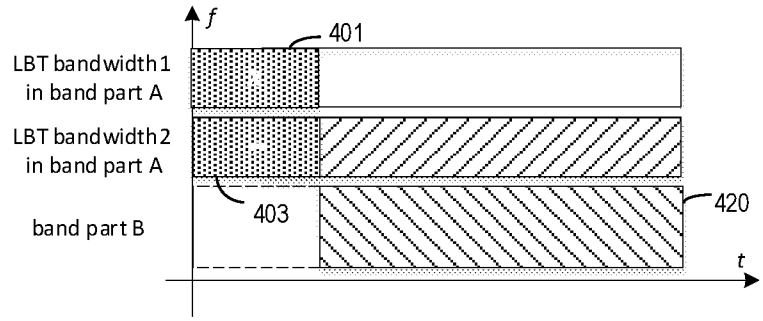

FIG. 4C

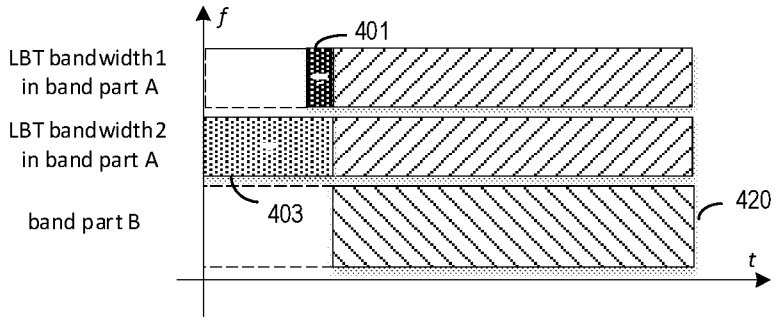

FIG. 4D

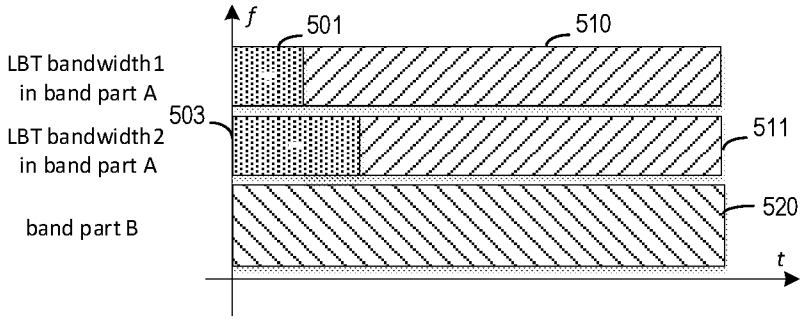

FIG. 5A

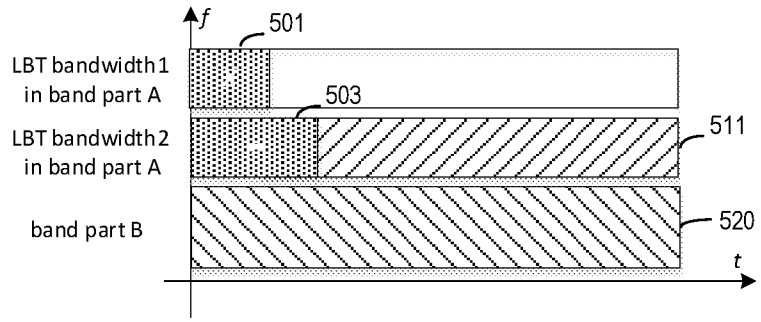

FIG. 5B

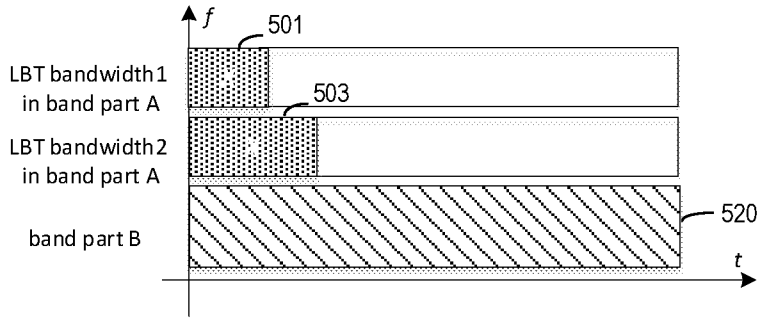

FIG. 5C

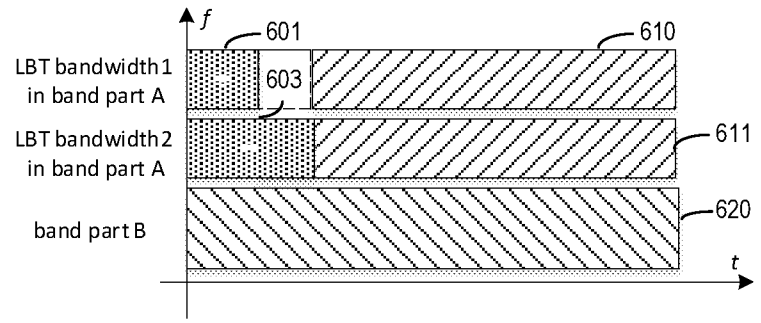

FIG. 6A

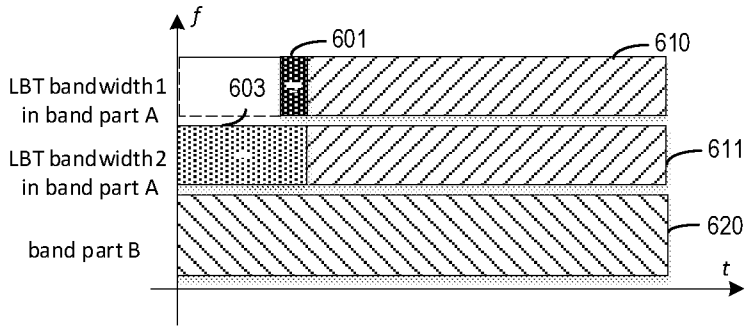

FIG. 6B

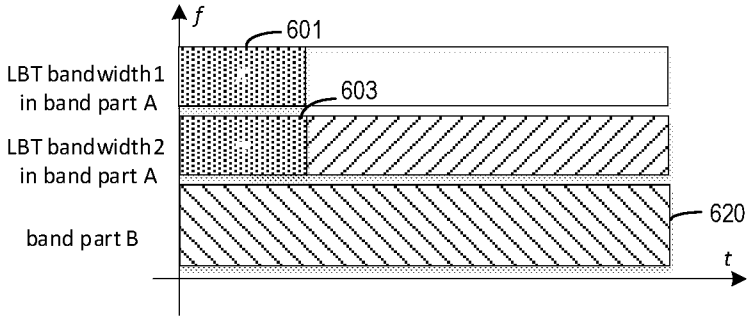

FIG. 6C

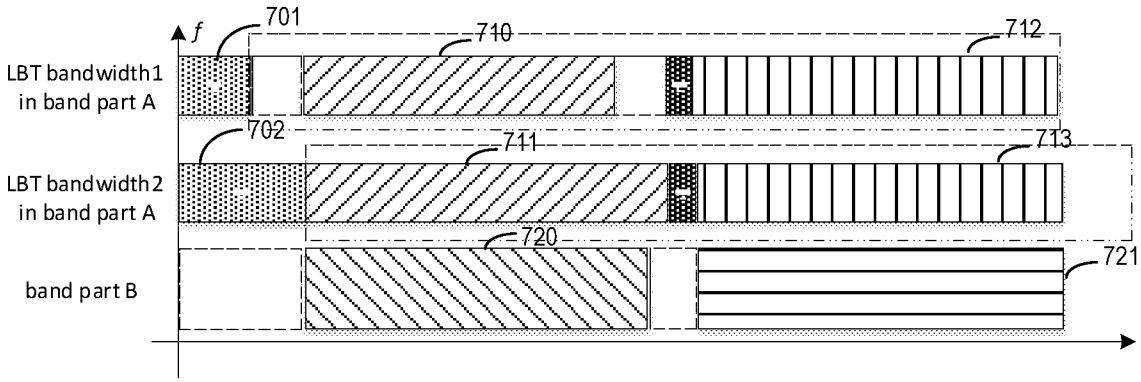

FIG. 7

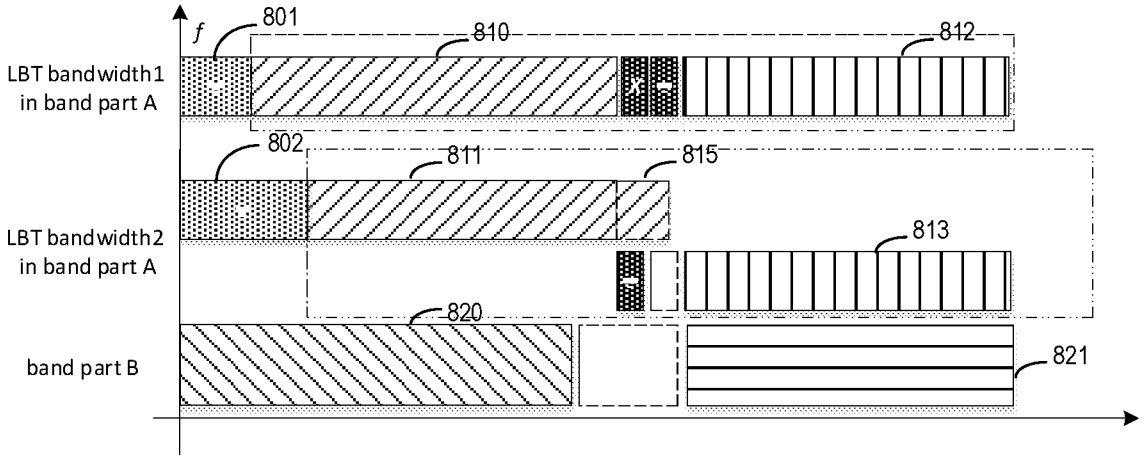

FIG. 8

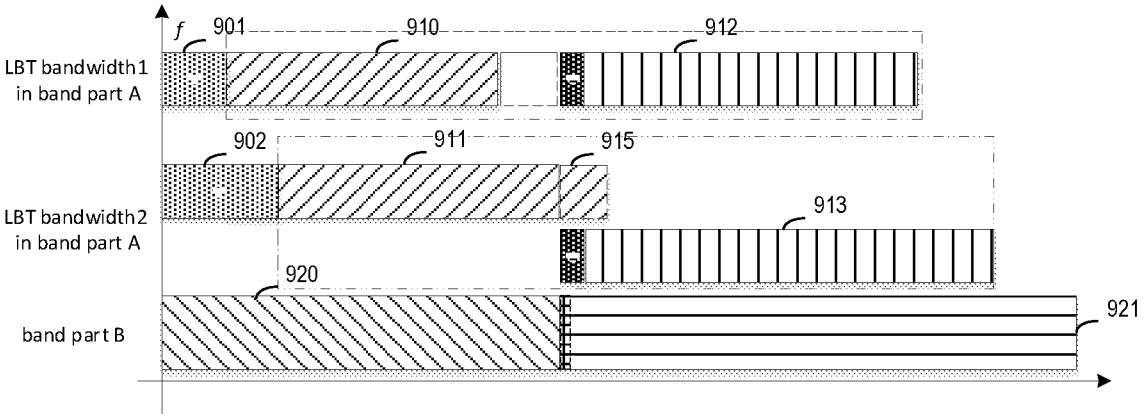

FIG. 9

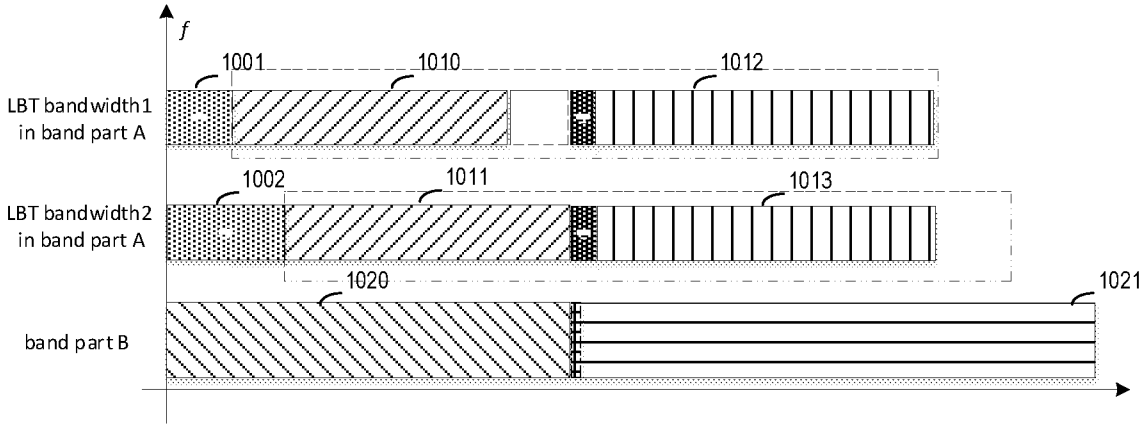

FIG. 10

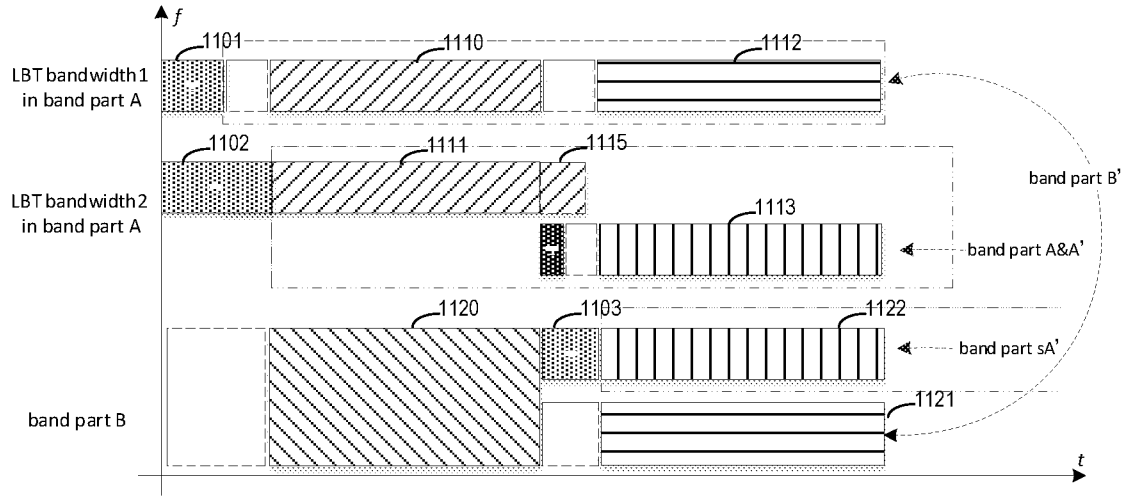
f
1101
1110
1112
LBT bandwidth 1 in band part A
1102
1111
1115
band part B'
LBT bandwidth 2 in band part A
1113
band part A&A'
1120
1103
1122
band part sA'
band part B
1121
t

FIG. 11

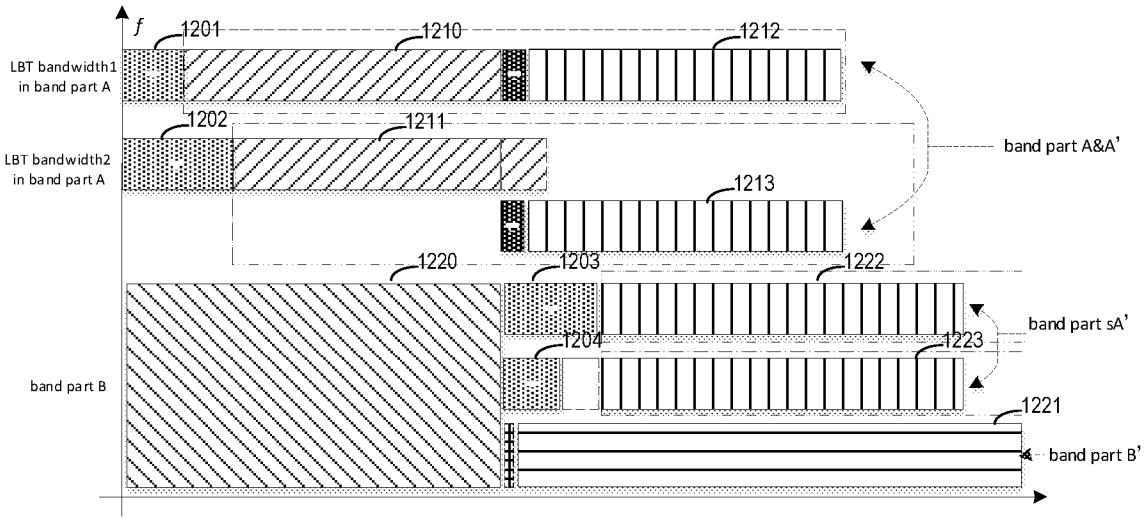
f
1201
1210
1212
LBT bandwidth 1 in band part A
1202
1211
band part A&A'
LBT bandwidth 2 in band part A
1213
1220
1203
1222
band part sA'
1204
1223
band part B
1221
band part B'

FIG. 12

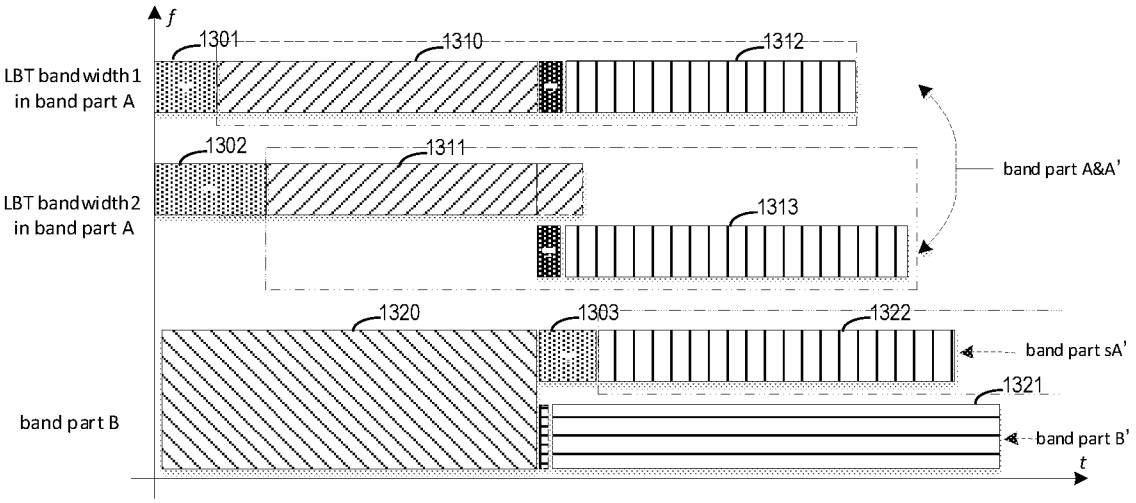
f
1301
1310
1312
LBT bandwidth1 in band part A
1302
1311
band part A&A'
LBT bandwidth2 in band part A
1313
1320
1303
1322
band part sA'
1321
band part B
band part B'
t

FIG. 13

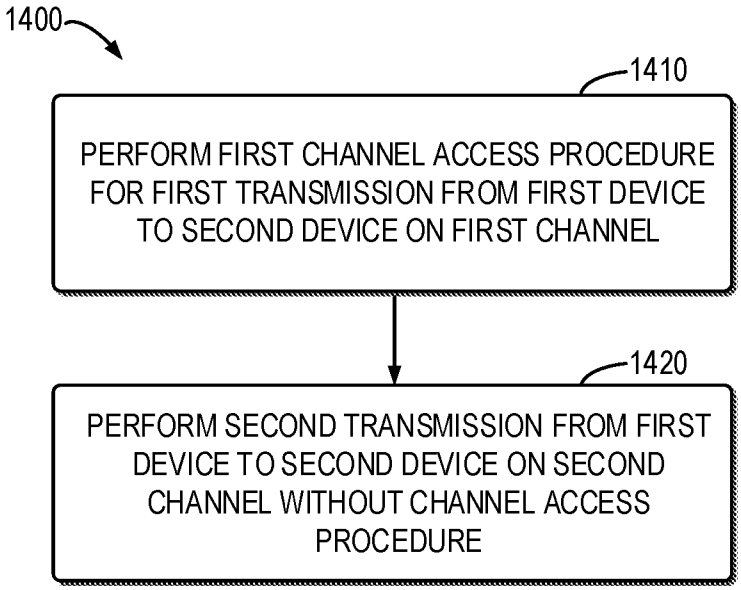
1400
1410
PERFORM FIRST CHANNEL ACCESS PROCEDURE FOR FIRST TRANSMISSION FROM FIRST DEVICE TO SECOND DEVICE ON FIRST CHANNEL
1420
PERFORM SECOND TRANSMISSION FROM FIRST DEVICE TO SECOND DEVICE ON SECOND CHANNEL WITHOUT CHANNEL ACCESS PROCEDURE

FIG. 14

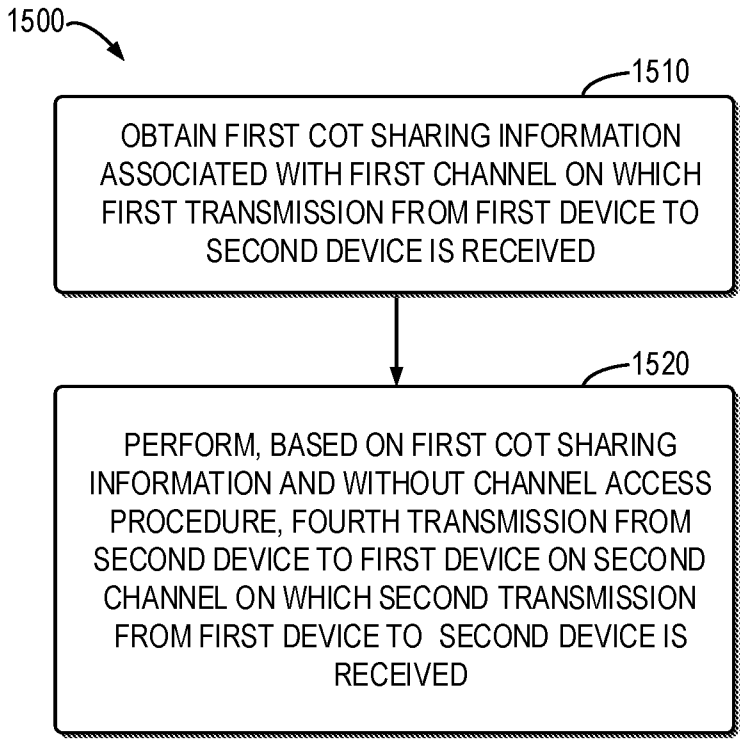
1500
1510
OBTAIN FIRST COT SHARING INFORMATION ASSOCIATED WITH FIRST CHANNEL ON WHICH FIRST TRANSMISSION FROM FIRST DEVICE TO SECOND DEVICE IS RECEIVED
1520
PERFORM, BASED ON FIRST COT SHARING INFORMATION AND WITHOUT CHANNEL ACCESS PROCEDURE, FOURTH TRANSMISSION FROM SECOND DEVICE TO FIRST DEVICE ON SECOND CHANNEL ON WHICH SECOND TRANSMISSION FROM FIRST DEVICE TO SECOND DEVICE IS RECEIVED

FIG. 15

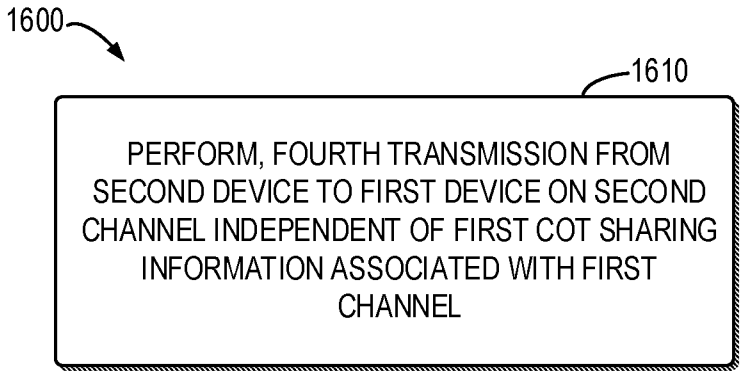
1600
1610
PERFORM, FOURTH TRANSMISSION FROM SECOND DEVICE TO FIRST DEVICE ON SECOND CHANNEL INDEPENDENT OF FIRST COT SHARING INFORMATION ASSOCIATED WITH FIRST CHANNEL

FIG. 16

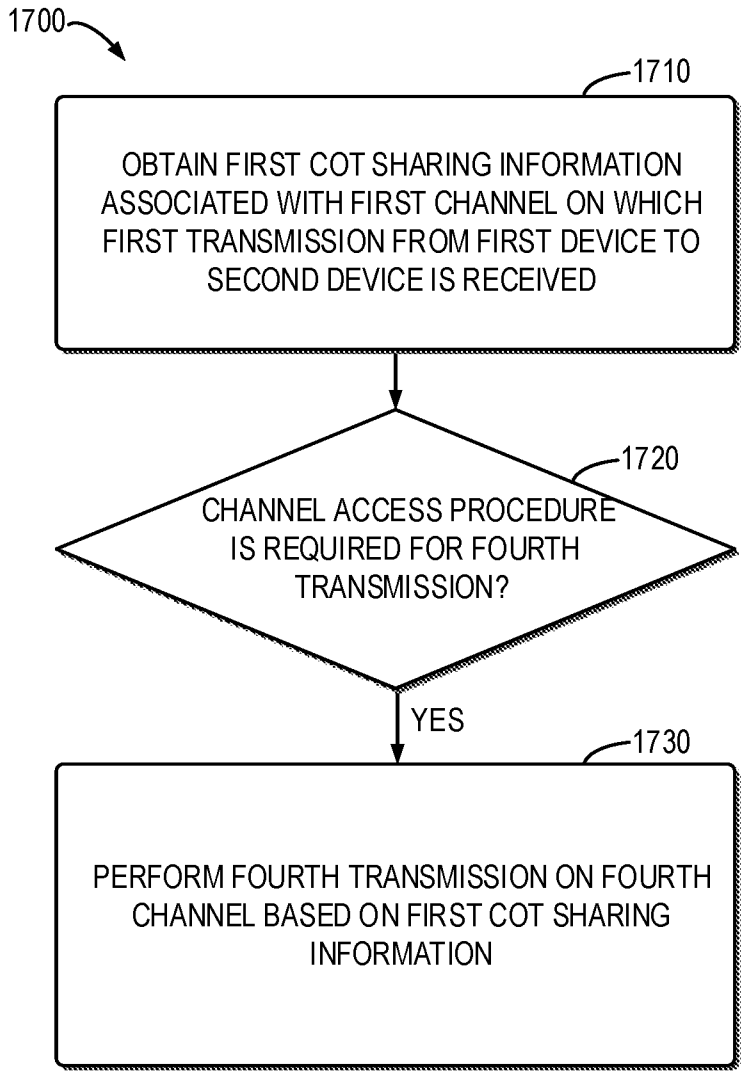
1700
1710
OBTAIN FIRST COT SHARING INFORMATION ASSOCIATED WITH FIRST CHANNEL ON WHICH FIRST TRANSMISSION FROM FIRST DEVICE TO SECOND DEVICE IS RECEIVED
1720
CHANNEL ACCESS PROCEDURE IS REQUIRED FOR FOURTH TRANSMISSION?
YES
1730
PERFORM FOURTH TRANSMISSION ON FOURTH CHANNEL BASED ON FIRST COT SHARING INFORMATION

FIG. 17

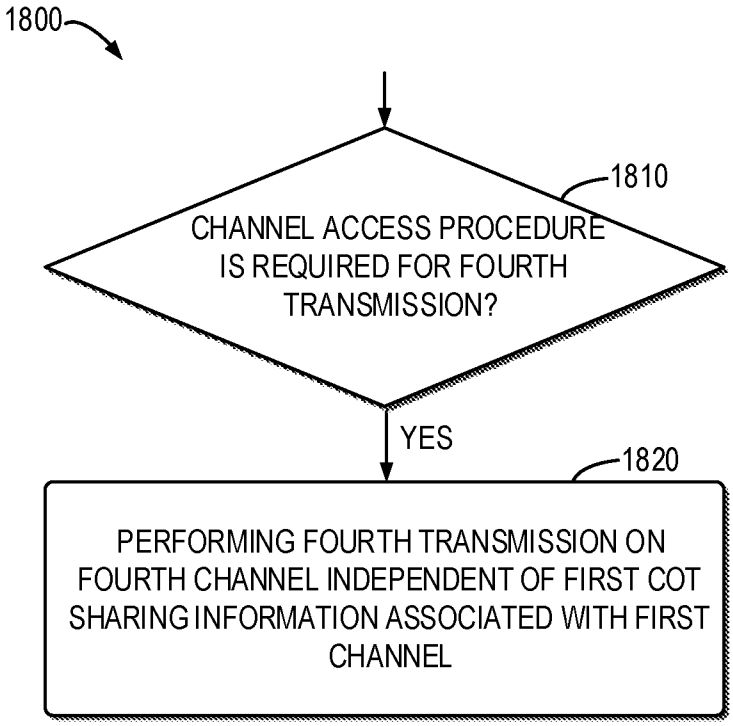
1800
1810
CHANNEL ACCESS PROCEDURE IS REQUIRED FOR FOURTH TRANSMISSION?
YES
1820
PERFORMING FOURTH TRANSMISSION ON FOURTH CHANNEL INDEPENDENT OF FIRST COT SHARING INFORMATION ASSOCIATED WITH FIRST CHANNEL

FIG. 18

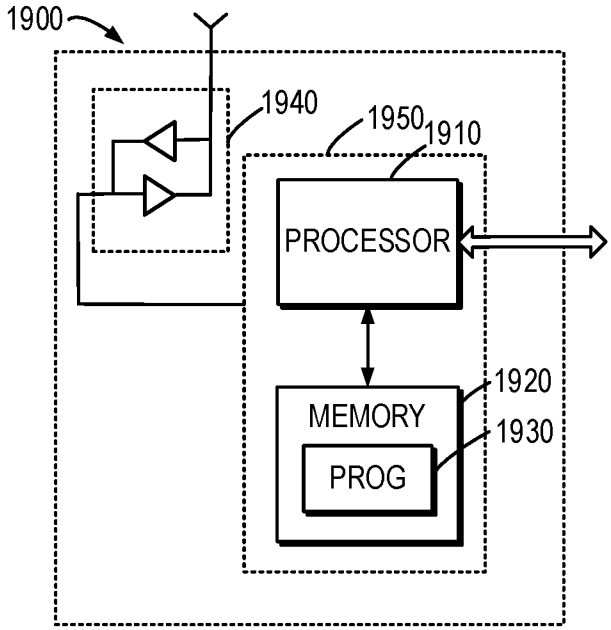
1900
1940
1950
1910
PROCESSOR
1920
MEMORY
1930
PROG

FIG. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/102554

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/02(2009.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04B; H04L

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

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

CNTXT; CNKI; ENTXT; 3GPP; IEEE:channel access, procedure, shar+ information, channel occupancy time, COT, first, second, transmi+, channel, without, no, none, not

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2021035502 A1 (LENOVO BEIJING LTD.) 04 March 2021 (2021-03-04) the description, paragraphs10-11	1,25,30
A	WO 2021093893 A1 (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP. LTD.) 20 May 2021 (2021-05-20) the whole document	1-30
A	WO 2021093190 A1 (ZTE CORP.) 20 May 2021 (2021-05-20) the whole document	1-30
A	CN 112655271 A (GUANGDONG OPPO MOBILE TELECOMMUNICATIONS CORP. LTD.) 13 April 2021 (2021-04-13) the whole document	1-30
A	Moderator Ericsson. "3GPP TSG-RAN WG1 Meeting #105-e Tdoc R1- 2106048" *Summary#5 - Enhancements for IIOT/URLLC on Unlicensed Band,* 28 May 2021 (2021-05-28), sections 2-5	1-30

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
21 February 2022	**28 February 2022**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing** **100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **WU,Zhibiao** Telephone No. **86-（010）-62411320**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/102554

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
WO 2021035502 A1	04 March 2021	None	
WO 2021093893 A1	20 May 2021	None	
WO 2021093190 A1	20 May 2021	None	
CN 112655271 A	13 April 2021	None	