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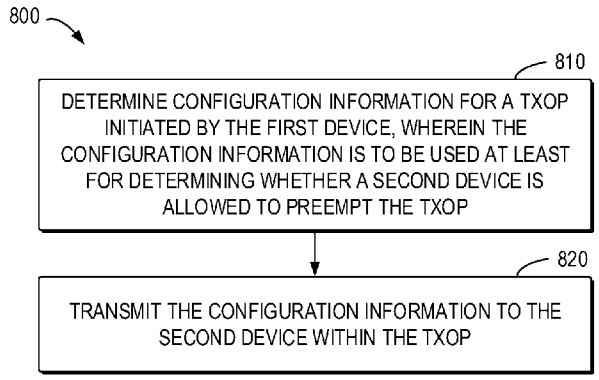

Fig. 8

(57) Abstract: Embodiments of the present disclosure relate to a proactive grant for preemption. In an aspect, a first device determines configuration information for a transmission opportunity (TXOP) initiated by the first device. The configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP. The first device transmits the configuration information to the second device within the TXOP. In this way, low latency data frame transmission can be improved by preempting a TXOP under a preemption grant.

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CONFIGURATION INFORMATION FOR DETERMINING WHETHER TO PREEMPT

FIELD

[0001] Various example embodiments relate to the field of communications and in particular, to devices, methods, apparatuses, and a computer readable medium relating to configuration information for determining whether to preempt.

BACKGROUND

[0002] Recently, the institute of electrical and electronic engineers (IEEE) 802.11 Working Group has formed a new Study Group (SG) to define a project for new physical (PHY) and media access control (MAC) technologies to further increase the reliability and throughput of 802.11 wireless local area networks (WLANs). Latency improvement is one of the main requirements in the ultra-high reliability (UHR) Group as described in the approved motion for UHR SG formation and in the project authorization request (PAR).

[0003] Several new features are developed to support low latency data frame transmission. These features include multi-link operation (MLO), restricted target wake time (R-TWT) and the MLO stream classification service (MSCS) based quality of service (QoS) signaling mechanism. Combining R-TWT with the MSCS based QoS signaling on 802.11be device can achieve a bounded latency of less than 25ms. However, it still can't meet the requirements of the industrial applications that require latencies of less than tens of milliseconds to a few milliseconds. To schedule a low latency data frame transmission, preemption solutions are under discussion.

SUMMARY

[0004] In general, example embodiments of the present disclosure provide a solution related to a proactive grant for preemption.

[0005] In a first aspect, there is provided a first device. The first device comprises at least one processor and at least one memory storing instructions that, when executed by the at least one processor, cause the first device at least to: determine configuration information for a transmission opportunity (TXOP) initiated by the first device, wherein the configuration information is to be used at least for determining whether a second device is

allowed to preempt the TXOP; and transmit the configuration information to the second device within the TXOP.

[0006] In a second aspect, there is provided a second device. The second device comprises at least one processor and at least one memory storing instructions that, when executed by the at least one processor, cause the second device at least to: receive, from a first device, configuration information for a TXOP initiated by the first device; determine, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and dependent on determining to preempt the TXOP for the data frame transmission, transmit or receive the data frame transmission within the TXOP.

[0007] In a third aspect, there is provided a method. The method comprises: determining, at a first device, configuration information for a TXOP initiated by the first device, wherein the configuration information is to be used for determining whether a second device is allowed to preempt the TXOP; and transmitting the configuration information to the second device within the TXOP.

[0008] In a fourth aspect, there is provided a method. The method comprises: receiving, at a second device and from a first device, configuration information for a TXOP initiated by the first device; determining, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and dependent on determining to preempt the TXOP for the data frame transmission, transmitting or receiving the data frame transmission within the TXOP.

[0009] In a fifth aspect, there is provided an apparatus. The apparatus comprises means for determining, at a first device, configuration information for a TXOP initiated by the first device, wherein the configuration information is to be used for determining whether a second device is allowed to preempt the TXOP; and means for transmitting the configuration information to the second device within the TXOP.

[0010] In a sixth aspect, there is provided an apparatus. The apparatus comprises means for receiving, at a second device and from a first device, configuration information for a TXOP initiated by the first device; means for determining, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and means for dependent on determining to preempt the TXOP for the data frame transmission, transmitting or receiving the data frame transmission within the TXOP.

[0011] In a seventh aspect, there is provided a non-transitory computer readable medium

comprising program instructions for causing an apparatus to perform at least the method according to any one of the above third to fourth aspects.

[0012] In an eighth aspect, there is provided a computer program product comprising program instructions for performing at least the method according to any one of the above third to fourth aspects.

[0013] In a ninth aspect, there is provided a computer program comprising instructions, which, when executed by an apparatus, cause the apparatus to perform at least the method according to any one of the above third to fourth aspects.

[0014] In an tenth aspect, there is provided a first device. The first device comprises: determining circuitry configured to determine configuration information for a TXOP initiated by the first device, wherein the configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP; and transmitting circuitry configured to transmit the configuration information to the second device within the TXOP.

[0015] In an eleventh aspect, there is provided a second device. The second device comprises: receiving circuitry configured to receive, from a first device, configuration information for a TXOP initiated by the first device; determining circuitry configured to determine, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and transmitting circuitry configured to, dependent on determining to preempt the TXOP for the data frame transmission, transmit the data frame transmission within the TXOP, or receiving circuitry configured to, dependent on determining to preempt the TXOP for the data frame transmission, receive the data frame transmission within the TXOP.

[0016] 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

[0017] Some example embodiments will now be described with reference to the accompanying drawings, in which:

[0018] Fig. 1A illustrates an example communication system in which embodiments of

the present disclosure may be implemented;

[0019] Fig. 1B illustrates a schematic diagram illustrating a preemption case for a low latency data frame transmission;

[0020] Fig. 1C illustrates a schematic diagram illustrating a delay issue that may be caused in a preemption case for a low latency data frame transmission;

[0021] Fig. 2 illustrates an example signaling chart of an example process according to some embodiments of the present disclosure;

[0022] Fig. 3 illustrates an example signaling chart of an exemplary proactive preemption grant process according to some embodiments of the present disclosure;

[0023] Fig. 4 illustrates a schematic diagram illustrating a preemption grant configuration according to some embodiments of the present disclosure;

[0024] Fig. 5 illustrates a schematic diagram illustrating another preemption grant configuration according to some embodiments of the present disclosure;

[0025] Fig. 6 illustrates a schematic diagram illustrating a further preemption grant configuration according to some embodiments of the present disclosure;

[0026] Fig. 7 illustrates a schematic diagram illustrating a still further preemption grant configuration according to some embodiments of the present disclosure;

[0027] Fig. 8 illustrates a schematic diagram illustrating a method implemented at a first device according to some other embodiments of the present disclosure;

[0028] Fig. 9 illustrates a schematic diagram illustrating a method implemented at a second device according to some other embodiments of the present disclosure;

[0029] Fig. 10 illustrates a simplified block diagram of a device that is suitable for implementing embodiments of the present disclosure; and

[0030] Fig. 11 illustrates a block diagram of an example computer readable medium in accordance with some embodiments of the present disclosure.

[0031] Throughout the drawings, the same or similar reference numerals represent the same or similar element.

DETAILED DESCRIPTION

[0032] Principles 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.

[0033] 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.

[0034] 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 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.

[0035] 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 one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term "and/or" includes any and all combinations of one or more of the listed terms.

[0036] 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. As used herein, "at least one of the following: <a list of two or more elements>" and "at least one of <a list of two or more elements>"

and similar wording, where the list of two or more elements are joined by "and" or "or", mean at least any one of the elements, or at least any two or more of the elements, or at least all the elements.

[0037] As used in this application, the term "circuitry" may refer to one or more or all of the following:

(a) hardware-only circuit implementations (such as implementations in only analog and/or digital circuitry) and

(b) combinations of hardware circuits and software, such as (as applicable):

(i) a combination of analog and/or digital hardware circuit(s) with software/firmware and

(ii) any portions of hardware processor(s) with software (including digital signal processor(s)), software, and memory(ies) that work together to cause an apparatus, such as a mobile phone or server, to perform various functions) and

(c) hardware circuit(s) and or processor(s), such as a microprocessor(s) or a portion of a microprocessor(s), that requires software (e.g., firmware) for operation, but the software may not be present when it is not needed for operation.

[0038] This definition of circuitry applies to all uses of this term in this application, including in any claims. As a further example, as used in this application, the term circuitry also covers an implementation of merely a hardware circuit or processor (or multiple processors) or portion of a hardware circuit or processor and its (or their) accompanying software and/or firmware. The term circuitry also covers, for example and if applicable to the particular claim element, a baseband integrated circuit or processor integrated circuit for a mobile device or a similar integrated circuit in server, a cellular network device, or other computing or network device.

[0039] As used herein, the term "communication network" refers to a network following any suitable communication standards, such as WLAN, 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 fifth generation (5G), the future sixth generation (6G) communication protocols, and/or any other protocols either currently known or to be developed in the future, wireless local network communication protocols such as IEEE 802.11 and the like 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.

[0040] 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 an access point (AP) or a base station (BS), for example, a node B (NodeB or NB), an evolved NodeB (eNodeB or eNB), a NR NB (also referred to as a 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. In the following description, the terms "network device", "network (NW)," "AP" may be used interchangeably.

[0041] 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 station (STA), 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 (loT) 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. In the following description, the terms "terminal device", "communication device", "terminal", "user equipment" ,"UE" and "STA" may be used interchangeably.

[0042] As used herein, the term "AP device" may refer to a device via which to access any wired or wireless network. For example, the wired or wireless network may be a broadband network, the Internet, a local area network, a metropolitan area network, a mobile communication network, or the like. For convenience, AP devices are also referred to as AP stations or APs herein. The AP device may support, for example, the Wi-Fi protocol or any other known or future-developed similar protocols. For example, the AP device may be a wireless router, a terminal device with a router function, a network device with a router function, and so on.

[0043] As used herein, the term "TXOP holder" may refer to a device that initiates a TXOP to communicate with other device(s) within the TXOP. For example, the device may sense a channel and get the TXOP in a listen before talk (LBT) procedure. The TXOP holder can be also referred to as an initiating device. As used herein, the term "non-TXOP holder" may refer to a device that communicates with a TXOP holder or other device(s) within a TXOP initiated by the TXOP holder. The non-TXOP holder can be also referred to as a responding device.

[0044] 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 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.

[0045] Principles and implementations of the present disclosure will be described in detail

below with reference to the figures. Fig. 1A illustrates an example communication system 100 in which embodiments of the present disclosure may be implemented. The system 100 includes an STA 110 and an AP 120. The system 100 may also include an STA 130. In some embodiments, the STA 110 may initiate a TXOP to communicate with the AP 120. In this case, the STA 110 is the TXOP holder and the AP 120 is the non-TXOP holder. Alternatively, the AP 120 may be the TXOP holder and the STA 110 may be the non-TXOP holder.

[0046] It is to be understood that the number of AP and STA and their connections are only for the purpose of illustration without suggesting any limitations. The system 100 may include any suitable number of AP and STA adapted for implementing embodiments of the present disclosure.

[0047] Communications in the communication system 100 may be implemented according to any proper communication protocol(s), comprising, but not limited to, wireless local network communication protocols such as IEEE 802.11 and the like, cellular communication protocols, and/or any other protocols currently known or to be developed in the future. Moreover, the communication may utilize any proper wireless communication technology, comprising but not limited to: Code Division Multiple Access (CDMA), Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Frequency Division Duplex (FDD), Time Division Duplex (TDD), Multiple-Input Multiple-Output (MIMO), Orthogonal Frequency Division Multiple (OFDM), Discrete Fourier Transform spread OFDM (DFT-s-OFDM) and/or any other technologies currently known or to be developed in the future.

[0048] To schedule a low latency data frame transmission, preemption solutions are under discussion. One possible case is to preempt the ongoing transmission or TXOP by the non-TXOP holder, i.e., in case of low latency data frame buffered at a non-TXOP holder, the low latency data frame can be transmitted before the current TXOP is end.

[0049] Fig. 1B illustrates a schematic diagram 150 illustrating a preemption case for a low latency data frame transmission. As illustrated in Fig.1B, the non-TXOP holder (i.e., AP) can transmit a low latency data frame to another device (i.e., STA2) by preempting current TXOP initiated by the TXOP holder (i.e., STA1).

[0050] For example, as shown in Fig. 1B, STA1 as a TXOP holder may transmit a request to send (RTS) frame 151 to AP and the AP may transmit a clear to send (CTS) frame 152 to

the STA1 as a response. Then STA1 may transmit non-low latency data 153 to the AP. Low latency data for STA2 may arrive at time A at the AP STA1 while the STA1 is transmitting the non-low latency data 153 to the AP. To transmit the low latency data frame to STA2, the AP may need to preempt the TXOP initiated by the STA1. The AP may terminate the transmission of the non-low latency data by transmitting a block acknowledgment (BA) frame 154 to the STA1. Then, the AP may transmit the low latency data 155 to the STA2 within the STA1's TXOP. The STA2 may transmit a BA frame 156 to the AP upon reception of the low latency data. The STA1 may continue transmission of the non-low latency data 157 to the AP in remaining time of the STA1's TXOP.

[0051] For this case, the AP needs to schedule a low-latency data frame transmission by preempting the ongoing transmission or preempting the TXOP initiated by a STA. For the preemption operation, an open issue is that the STA may also buffer low-latency data frames for transmission within its TXOP, and the TXOP preemption proposal will be unfair and unfriendly to the STA.

[0052] Fig. 1C which illustrates a schematic diagram 180 illustrating a delay issue that may be caused in a preemption case for a low latency data frame transmission. As illustrated in Fig. 1C, when the STA1 is transmitting data frame to the AP within its TXOP, low-latency data frames are buffered at both the AP and the STA1. If the AP interrupts the ongoing transmission from STA1 and schedules the low latency data frame transmission 155 to the STA2 using the STA1's TXOP, and results in that the STA1 cannot transmit the low-latency data frame 158 to the AP in time, which would cause a higher delay issue for the low-latency data frame transmission for STA1.

[0053] Another open issue is that the AP may be not allowed to preempt the TXOP initiated by other device for low-latency data frame transmission. As an example, according to European Telecommunication Standards Institute (ETSI) regulation rule that Responding Device Channel Access Mechanism in 5GHz unlicensed band shown below, a Responding Device may perform transmissions on the current operating channel for the remaining Channel Occupancy Time (i.e., TXOP) after it received a transmission grant from an associated initiating device (i.e., TXOP holder). That means that the AP shall receive a transmission grant from the STA for the preemption operation so that it can schedule a low latency data frame transmission within the TXOP initiated by the STA.

Table 1: Responding Device Channel Access Mechanism

4.2.7.3.2.7 Responding Device Channel Access Mechanism
Clause 4.2.7.3.2.6, step 6) b) describes the possibility whereby an *Initiating Device* grants an authorization to one or more associated *Responding Devices* to transmit on the current *Operating Channel.* A *Responding Device* that receives such a grant shall follow the procedure described in step 1) to step 3): 1) A *Responding Device* that received a transmission grant from an associated *Initiating Device* may proceed with transmissions on the current *Operating Channel.* a) The *Responding Device* may proceed with such transmissions without performing a *Clear Channel Assessment* (CCA) if these transmissions are initiated at most 16 μs after the last transmission by the *Initiating Device* that issued the grant. b) The *Responding Device* that does not proceed with such transmissions within 16 μs after the last transmission from the *Initiating Device* that issued the grant, shall perform a *Clear Channel Assessment* (CCA) on the *Operating Channel* during a single observation slot within a 25 μs period ending immediately before the granted transmission time. If energy was detected with a level above the *ED Threshold* defined in clause 4.2.7.3.2.5, the *Responding Device* shall proceed with step 3). Otherwise, the *Responding Device* shall proceed with step 2). 2) The *Responding Device* may perform transmissions on the current *Operating Channel* for the remaining *Channel Occupancy Time*. The *Responding Device* may have multiple transmissions on this *Operating Channel* provided that the gap in between such transmissions does not exceed 16 μs. When the transmissions by the *Responding Device* are completed the *Responding Device* shall proceed with step 3). *3)* The transmission grant for the *Responding Device* is withdrawn.

[0054] In view of the above and other aspects, embodiments of the present disclosure provide a proactive grant solution for preemption operation within a TXOP. In the solution, a first device as a TXOP holder determines a configuration information for a TXOP initiated by the first device. The configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP. Then, the first device transmits the configuration information to the second device within the TXOP. The second device determines, dependent on the configuration information, whether to preempt

the TXOP for a data frame transmission. Dependent on determining to preempt the TXOP for the data frame transmission, the second device transmits or receives the data frame transmission within the TXOP. In this way, low latency data frame transmission can be improved by preempting a TXOP under a preemption grant from the TXOP holder. Thus, the TXOP holder can determine whether the preemption operation is allowed considering certain conditions, e.g., data frame type/QoS (i.e., latency or priority) of itself.

[0055] Fig. 2 illustrates an example signaling chart illustrating an example process 200 according to some embodiments of the present disclosure. The process 200 may involve a first device 201 and a second device 202. The first device 201 may be a TXOP holder, e.g., one of the STA 110 or the AP 120 as shown in Fig. 1A. The second device 202 may be a non-TXOP holder, e.g., the other one of the AP 120 or the STA 110 as shown in Fig. 1A.

[0056] As shown in Fig. 2, the second device 202 as a non-TXOP holder may transmit 210 an indication 211 to the first device 201 as a TXOP holder. The indication 211 may be used for configuring the first device 201 to support a proactive grant for preempting a TXOP initiated by the first device 201. The first device 201 may receive the indication 211.

[0057] With reference to Fig. 2, the first device 201 determines 213 configuration information for a TXOP initiated by the first device 201. The configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP. Then, the first device 201 transmits 214 the configuration information 215 to the second device 202 within the TXOP.

[0058] Upon receiving 216 the configuration information 215, the second device 202 determines 217 whether to preempt the TXOP for a data frame transmission dependent on the configuration information. If the second device 202 determines to preempt the TXOP for the data frame transmission, the second device 202 transmits or receives the data frame transmission within the TXOP.

[0059] In some embodiments, the first device 201 may determine the configuration information dependent on at least one of a QoS status and priority of at least one buffered data frame at the first device 201. For example, if a low latency data frame is to be transmitted by the first device 201 within the TXOP, the first device 201 may determine the configuration information to indicate that the second device 202 is not allowed to preempt

the TXOP. If no low latency data frame is to be transmitted by the first device within the TXOP, the first device 201 may determine the configuration information to indicate that the second device 202 is allowed to preempt the TXOP.

[0060] The first device 201 may transmit the configuration information via a field in an existing frame. For example, the configuration information can be carried in a header of one or more PPDU frame with the TXOP. Alternatively or in addition, the first device 201 may transmit the configuration information via a frame designed for transmitting the configuration information.

[0061] If the configuration information indicates that the second device 202 is allowed to preempt the TXOP, the second device 202 may further determine whether to preempt the TXOP. For example, if a priority of the data frame transmission is higher than the priority threshold, the second device 202 may determine to preempt the TXOP. If the priority is lower than or equal to the priority threshold, the second device 202 may determine not to preempt the TXOP. In some embodiments, if a latency of the data frame transmission is longer than the latency threshold, the second device 202 may determine to preempt the TXOP. If the latency is shorter than or equal to the latency threshold, the second device 202 may determine not to preempt the TXOP.

[0062] In the case that a low latency data frame arrives at the first device 201 within the TXOP, e.g., after the transmission of the configuration information, the first device 201 may transmit other configuration information (e.g., second configuration information) to the second device 202 to indicate that the second device 202 is not allowed to preempt the TXOP. The second device 202 may determine whether to preempt the TXOP dependent on the latest configuration information.

[0063] The configuration information (as well as the second configuration information) may comprise an indication of whether the second device 202 is allowed to preempt the TXOP. Alternatively or in addition, the configuration information may comprise a priority threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information may comprise a latency threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information may comprise one or more device identifiers (IDs) of devices that are allowed to preempt the TXOP. In some embodiments, the first device 201 may broadcast the configuration information to the one or more devices.

[0064] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an inter frame space (IFS). In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA frame transmission. In some embodiments, the preemption occasion may allow the second device 202 to terminate the PPDU frame transmission within the TXOP.

[0065] If the second device 202 determines to preempt the TXOP for the data frame transmission, it may transmit the data frame transmission to the first device 201 or a third device starting from the preemption occasion. Alternatively or in addition, the second device 202 may transmit a trigger to the third device for the data frame transmission starting from the preemption occasion and receive the data frame transmission from the third device.

[0066] On the first device 201 side, the first device 201 may monitor whether there is a frame transmission from the second device 202 starting from the preemption occasion. If the frame transmission is detected, the first device 201 may terminate an ongoing transmission within the TXOP. If it fails to detect the frame transmission, the first device 201 may continue the ongoing transmission within the TXOP after the preemption occasion.

[0067] To monitor whether there is a frame transmission from the second device 202 starting from the preemption occasion, the first device 201 may perform energy detection (ED). For example, the first device 201 may detect energy within the preemption occasion, and compare the detected energy with a threshold. If the detected energy level is lower than the ED threshold, the channel is considered idle and thus data transmission is allowed for the first device 201. Alternatively or in addition, the first device 201 may perform signal detection within the preemption occasion. For example, the first device 201 may detect preamble or/and MAC header to detect whether a data transmission is performed by the second device 202.

[0068] In some embodiments, the preemption occasion may be not applied. For example, the configuration information may do not indicate a preemption occasion, and the preemption occasion may be not pre-configured or pre-defined. In this case, if the second

device 202 determines to preempt the TXOP, the second device 202 may transmit an indication for early terminating an ongoing transmission within the TXOP to the first device 201. Then, the second device 202 can transmit the data frame transmission within the TXOP to the first device 201 or a third device, or receive the data frame transmission within the TXOP from the third device. The indication may be transmitted via, e.g., a BA frame or a new frame. Upon receiving the indication for early terminating an ongoing transmission within the TXOP, the first device 201 can terminate the ongoing transmission within the TXOP.

[0069] With the process 200, a proactive grant solution for preemption operations within a TXOP is provided. In the solution, the TXOP holder can determine whether the preemption operation is allowed considering certain conditions. Low latency data frame transmission can be improved by preempting a TXOP under a preemption grant from the TXOP holder. It is to be noted that the above process 200 is merely an example, and may have additional or less operations. It is also to be noted that operations of the above process 200 may be carried out separately or in any suitable combination.

[0070] Fig. 3 illustrates an example signaling chart of an exemplary proactive preemption grant process 300 according to some embodiments of the present disclosure. The process 300 can be an example of the process 200 as shown in Fig. 2. The process 300 may involve the first device 201 and the second device 202 as shown in Fig. 2 and a third device 203. The third device 203 may be a STA that communicates with at least one of the first device 201 and the second device 202.

[0071] In process 300, the TXOP holder (e.g., the first device 201) can proactively determine whether to provide a preemption grant to a non-TXOP holder (e.g., the second device 202). Only if the non-TXOP holder obtains the preemption grant from the TXOP holder, it will be allowed to preempt the current TXOP and schedule a buffered low latency frame transmission within the remaining TXOP.

[0072] As shown in Fig. 3, at 310, the first device 201 as a TXOP holder can be set or/pre-configured by the second device 202 as a non-TXOP holder to support the proactive grant feature on preemption operation. At 311, after the first device 201 initiates a TXOP, it can determine whether it's allowed the second device 202 to preempt the current TXOP. The determination can be made at least based on a QoS status or priority of the buffered data frame locally.

[0073] In an embodiment, if the first device 201 needs to transmit low-latency traffic within the TXOP, it doesn't allow the second device 202 to preempt the current TXOP; otherwise, it allows the second device 202 to preempt the current TXOP. In another embodiment, the first device 201 allows the second device 202 to preempt the current TXOP based on the configured priority threshold, e.g., if the priority of low latency data frame buffered at the second device 202 is higher than a configured priority threshold (which can be determined based on one of the buffered data frames with highest priority), the first device 201 allows the second device 202 to preempt the current TXOP; otherwise, the second device 202 will not be allowed to preempt the current TXOP.

[0074] In a further embodiment, the first device 201 allows the second device 202 to preempt the current TXOP based on the configured latency threshold, e.g., if the maximum latency boundary at the second device 202 is higher than a configured latency threshold, the first device 201 allows the second device 202 to preempt the current TXOP; otherwise, the second device 202 will not be allowed to preempt the current TXOP.

[0075] At 312, the first device 201 transmits a preemption grant configuration to the second device 202 via a frame within the TXOP. The preemption grant configuration can include a preemption allowed indication, which is to indicate whether the second device 202 is allowed to preempt the current TXOP for low latency data frame transmission. Alternatively or in addition, the preemption grant configuration can include the priority and/or latency threshold; if presented, the first device 201 grants the second device 202 to preempt the current TXOP conditionally at least based on the priority/latency threshold. Alternatively or in addition, the preemption grant configuration can include a preemption occasion.

[0076] The first device 201 may indicate a preemption occasion that allow the preemption occurred after the current PPDU frame exchange, e.g., after PPDU or BA frame transmission, or allow to terminal the current PPDU frame exchange. The preemption occasion can be an xIFS, such as a Short Inter Frame Space (SIFS), a Point Coordination Function (PCF) Interframe Space (PIFS), a Distributed Coordination Function (DCF) Interframe Space (DIFS), an Extended Interframe Space (EIFS), etc. Alternatively or in addition, the preemption grant configuration can include one or more device IDs of devices that are allowed to preempt the TXOP. The preemption grant configuration can be transmitted through a new frame, or a field carried in a frame (e.g., a PHY header of a PPDU frame), details will be elaborated with reference to Figs. 4-7 later.

[0077] Continuing to refer to Fig. 3, at 313, if there is a low latency data frame buffered, the second device 202 determines whether to preempt the current TXOP for the low latency data frame transmission based on the preemption grant configuration set by current TXOP holder.

[0078] In an embodiment, the second device 202 can preempt the current TXOP if at least one of the following conditions is met: the preemption grant configuration indicates the second device 202 can preempt the current TXOP; and/or the priority and/or latency of low latency frame buffered at the second device 202 meet the priority and/or latency threshold if configured by the first device 201. The second device 202 would make the decision based on the latest received preemption grant configuration.

[0079] As shown in Fig. 3, there are two cases about how to preempt the TXOP for transmitting the low latency data frame transmission. In case 1, a preemption occasion is presented in the preemption configuration or pre-configured/pre-defined. At 314, under the precondition that the second device 202 meet the preemption condition mentioned above, once the first device 201 finishes a PPDU frame exchange, e.g., receive a BA frame for the PPDU receiver, the second device 202 schedules the low latency data frame transmission within the remaining TXOP to the first device 201 or the third device 203 based on indicative of the preemption occasion. In an embodiment, the second device 202 preempts the ongoing transmissions during an xIFS time after receiving a PPDU frame from the first device 201 or transmitting a BA frame to the first device 201.

[0080] At 315, if the first device 201 monitors a frame transmission from the second device 202 starting from the preemption occasion, it terminates ongoing transmission within the TXOP; otherwise, it continues the ongoing transmission(s) within the TXOP after the preemption occasion.

[0081] In case 2, a preemption occasion isn't presented in the preemption grant configuration or pre-configured/pre-defined. At 316, if the second device 202 is allowed to preempt and finishes reception of a PPDU frame from the first device 201, the second device 202 sends an early termination indication to the first device 201 through a frame.

[0082] In an embodiment, the indication can be signaled through a BA frame or be signaled through an action/control frame in another link for the case of multiple link operation. At 317, upon receiving the early termination indication, the first device 201 terminates ongoing transmission within the TXOP. At 318, the second device 202

schedules the low latency data frame transmission within the remaining TXOP to the first device 201 or the third device 203.

[0083] With the process 300, the TXOP holder can determine whether the preemption operation is allowed considering certain conditions. Low latency data frame transmission can be improved by preempting a TXOP under a preemption grant from the TXOP holder. It is to be noted that the above process 300 is merely an example, and may have additional or less operations. It is also to be noted that operations of the above process 500 may be carried out separately or in any suitable combination.

[0084] Some examples for the preemption operation will be described in details with reference to Figs. 4-7 below. Fig. 4 illustrates a schematic diagram 400 illustrating a preemption grant configuration according to some embodiments of the present disclosure. In Fig. 4, STA1 (e.g., the first device 201 as shown in Figs. 2 and 3) is the TXOP holder, AP (e.g., the second device as shown in Figs. 2 and 3) and STA2 (e.g., the third device as shown in Fig. 3) are non-TXOP holders.

[0085] As shown in Fig.4, STA1 initiates a TXOP for communication with AP. STA1 may transmit an RTS frame 401 to AP and the AP may transmit a CTS frame 402 to STA1 as a response. After STA1 initiates the TXOP, it can determine the preemption grant configuration based on QoS (e.g., priority) of buffered data frames. If there is not low latency data buffered at STA1, it may indicate in the preemption grant configuration through the header of PPDU frame 403 that the current TXOP is allowed to be preempted for low latency data frame transmission.

[0086] When the low latency data frame for STA2 arrives at time A at AP, it can transmit an early termination indication to STA1 through the BA frame 404 after STA1 finishes a PPDU frame transmission. After that, STA1 may terminate the ongoing transmission and AP can schedule low latency frame transmission 405 within the remaining TXOP for STA2. After AP finishes the low latency frame transmission 405, STA2 can transmit a BA frame 406 to AP.

[0087] Fig. 5 illustrates a schematic diagram 500 illustrating another preemption grant configuration according to some embodiments of the present disclosure. In Fig. 5, similarly, STA1 (e.g., the first device 201 as shown in Figs. 2 and 3) is the TXOP holder, AP (e.g., the second device as shown in Figs. 2 and 3) and STA2 (e.g., the third device as shown in Fig. 3) are non-TXOP holders.

[0088] As shown in Fig. 5, after RTS frame 501 to AP and CTS frame 502, multiple PPDU frames 503, 505 and 507 can be transmitted within a TXOP, and a preemption grant configuration can be carried in a header of per PPDU. Ba frames 504, 506 and 508 are responses to PPDU frames 503, 505 and 507, respectively. Based on the data frame buffered at STA1, STA1 can update the preemption configuration frame by frame.

[0089] As an example, the preemption grant configuration carried in PPDU#1 may indicate that the current TXOP can be preempted. However, as the low latency data frame arrives at time A during transmission of PPDU#1, the preemption grant configuration carried in PPDU#2/3 will indicate that the current TXOP can't be preempted. Therefore, AP can't transmit an early termination indication to STA1 after STA1 finishes transmission of PPDU#2 even if the low latency data for STA2 arrives at AP.

[0090] Fig. 6 illustrates a schematic diagram 600 illustrating a further preemption grant configuration according to some embodiments of the present disclosure. In this embodiment, assuming that a preemption occasion is indicated through the preemption configuration or (pre-)configured/defined, which is an xIFS after the PPDU frame transmission from the TXOP holder (e.g., STA1). If the low latency data frame is buffered at AP, AP can preempt the TXOP for low latency data frame transmission starting from the PPDU.

[0091] In Fig. 6, STA1 initiates a TXOP to transmit data to the AP. STA1 may transmit an RTS frame 601 to AP and the AP may transmit a CTS frame 602 to STA1 as a response. As there is no low latency data buffered at the STA1, it can transmit a preemption configuration through the header of the PPDU frame 603 which indicates the AP allow to preempt its TXOP and transmit low latency data 605 during an xIFS time 604 following the PPDU transmission.

[0092] As illustrated in Fig. 6 (a), AP could schedule a low latency data frame transmission 605 staring from the configured preemption occasion (i.e., the configured xIFS 604) following the PPDU frame transmission 603 from STA1 if AP buffered a low latency data frame for STA2. After AP finishes the low latency frame transmission 605, STA2 can transmit a BA frame 606 to AP. As STA1 detects the low latency data frame transmission from AP starting from the preemption occasion (i.e., the configured xIFS 604), it would terminate the ongoing transmission within the TXOP.

[0093] As illustrated in Fig. 6 (b), if there was no low latency data frame buffered at AP, it

could transmit a BA frame 607 in response to reception of the PPDU#1 frame 603 and continue to receive data from the STA1 although it has got preemption grant from the STA1. As the STA1 doesn't detect the low latency data frame transmission from the AP starting from the preemption occasion (i.e., the configured xIFS 604), it can continue the ongoing transmission (i.e., PPDU#2) 608 within the TXOP. After STA1 finishes the low latency frame transmission 608, AP can transmit a BA frame 609 to AP.

[0094] Fig. 7 illustrates a schematic diagram 700 illustrating a still further preemption grant configuration according to some embodiments of the present disclosure. Similar to Fig. 6, a preemption occasion will be (pre-)configured for preemption operation. However, the preemption occasion can be different from that in Fig. 6. For example, the preemption occasion in Fig. 6 starts from the end of a PPDU frame transmission from the TXOP holder, while in Fig. 7, the preemption occasion starts from the end of a BA frame in response to a PPDU frame transmission from the TXOP holder.

[0095] In some embodiments of the present disclosure, the TXOP holder can specify any occasion for the non-TXOP holder to preempt the TXOP. If an xIFS is configured for the non-TXOP holder to preempt the TXOP, the length of the xIFS can be configurable.

[0096] With reference to Fig. 7, STA1 initiates a TXOP to transmit data to the AP. As there is no low latency data buffered at STA1, it can transmit a preemption configuration through the header of the PPDU frame 603 which indicates AP can preempt its TXOP and transmit low latency data during an xIFS time 604 following the PPDU transmission. Upon receiving the PPDU frame transmission from STA1, AP would first transmit a BA frame 609 in response to reception of the PPDU frame and schedule a low latency data frame transmission 605 starting from the configured preemption occasion (i.e., the configured xIFS 604) following the BA frame transmission 609.

[0097] Fig. 8 illustrates a schematic diagram illustrating a method 800 implemented at a first device according to some other embodiments of the present disclosure. For the purpose of discussion, the method 800 will be described from the perspective of the first device 201 as shown in, e.g., Figs. 2 and 3. In some other embodiments, the first device 201 can also be the STA1 in Figs. 4-7.

[0098] As shown in Fig. 8, at block 810, the first device 201 determines configuration information for a TXOP initiated by the first device 201. The configuration information is to be used at least for determining whether a second device 202 is allowed to preempt the

TXOP. At block 820, the first device 201 transmits the configuration information to the second device 202 within the TXOP.

[0099] In some embodiments, prior to determining the configuration information, the first device 201 may receive an indication for configuring the first device to support a proactive grant for preempting the TXOP.

[00100] In some embodiments, the first device 201 may determine the configuration information dependent on at least one of a QoS status and priority of at least one buffered data frame at the first device 201.

[00101] For example, if a low latency data frame is to be transmitted by the first device 201 within the TXOP, the first device 201 may determine the configuration information to indicate that the second device 202 is not allowed to preempt the TXOP. If no low latency data frame is to be transmitted by the first device within the TXOP, the first device 201 may determine the configuration information to indicate that the second device 202 is allowed to preempt the TXOP.

[00102] The first device 201 may transmit the configuration information via a field in an existing frame. Alternatively or in addition, the first device 201 may transmit the configuration information via a frame designed for transmitting the configuration information.

[00103] In some embodiments, the configuration information is first configuration information and indicates that the second device is allowed to preempt the TXOP; if a low latency data frame arrives at the first device 201 within the TXOP, the first device 201 may transmit second configuration information within the TXOP to indicate that the second device is not allowed to preempt the TXOP.

[00104] In some embodiments, the configuration information and the second configuration information may comprise an indication of whether the second device 202 is allowed to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise a priority threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise a latency threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise one or more device IDs of devices that are allowed to preempt the TXOP.

[00105] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an IFS. In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA frame transmission. In some embodiments, the preemption occasion may allow the second device 202 to terminate the PPDU frame transmission within the TXOP.

[00106] In some embodiments, dependent on detecting a frame transmission from the second device starting from the preemption occasion, the first device 201 may terminate an ongoing transmission within the TXOP. Alternatively, dependent on failing to detect the frame transmission, the first device 201 may continue the ongoing transmission within the TXOP after the preemption occasion.

[00107] In some embodiments, the configuration information may do not indicate a preemption occasion, and the preemption occasion may be not pre-configured or pre-defined. If the second device 202 is allowed to preempt the TXOP, the first device 201 may receive, from the second device 202, an indication for early terminating an ongoing transmission within the TXOP. Dependent on receiving the indication, the first device 201 may terminate the ongoing transmission within the TXOP.

[00108] In some embodiments, the first device may be one of an STA or an AP, and the second device may be one of an STA or an AP.

[00109] Fig. 9 illustrates a schematic diagram illustrating a method 900 implemented at a second device according to some other embodiments of the present disclosure. For the purpose of discussion, the method 900 will be described from the perspective of the second device 202 as shown in, e.g., Figs. 2 and 3. In some other embodiments, the second device 202 can also be the AP in Figs. 4-7.

[00110] As shown in Fig. 9, at block 910, the second device 202 receives, from the first device 201, configuration information for a TXOP initiated by the first device. At block 920, the second device 202 determines, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission. At block 930, dependent on determining to preempt the TXOP for the data frame transmission, the second device 202 transmits or receives the data frame transmission within the TXOP.

[00111] In some embodiments, the configuration information may be received via a field in an existing frame. Alternatively or in addition, the configuration information may be received via a frame designed for receiving the configuration information.

[00112] In some embodiments, prior to receiving the configuration information, the second device 202 may transmit, to the first device 201, an indication for configuring the first device to support a proactive grant for preempting the TXOP.

[00113] In some embodiments, the configuration information is first configuration information, and the second device 202 may receive second configuration information for the TXOP before receiving the first configuration information. Moreover, the second device 202 may determine whether to preempt the TXOP dependent on the first configuration information.

[00114] In some embodiments, the configuration information and the second configuration information may comprise an indication of whether the second device 202 is allowed to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise a priority threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise a latency threshold for the second device to determine whether to preempt the TXOP. Alternatively or in addition, the configuration information and the second configuration information may comprise one or more device IDs of devices that are allowed to preempt the TXOP.

[00115] In some embodiments, the second device 202 is allowed to preempt the TXOP, and dependent on determining that a priority of the data frame transmission is higher than the priority threshold, the second device 202 may determine to preempt the TXOP. Alternatively, dependent on determining that the priority is lower than or equal to the priority threshold, the second device 202 may determine not to preempt the TXOP.

[00116] In some embodiments, the second device 202 is allowed to preempt the TXOP, and dependent on determining that a latency of the data frame transmission is longer than the latency threshold, the second device 202 may determine to preempt the TXOP. Alternatively, dependent on determining that the latency is shorter than or equal to the latency threshold, the second device 202 may determine not to preempt the TXOP.

[00117] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the

preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an IFS. In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA frame transmission. In some embodiments, the preemption occasion may allow the second device 202 to terminate the PPDU frame transmission within the TXOP.

[00118] In some embodiments, if the second device 202 determines to preempt the TXOP for the data frame transmission, it may transmit the data frame transmission to the first device 201 or a third device starting from the preemption occasion. Alternatively or in addition, the second device 202 may transmit a trigger to the third device for the data frame transmission starting from the preemption occasion and receive the data frame transmission from the third device.

[00119] In some embodiments, the configuration information may do not indicate a preemption occasion, and the preemption occasion may be not pre-configured or pre-defined. In this case, if the second device 202 determines to preempt the TXOP, the second device 202 may transmit an indication for early terminating an ongoing transmission within the TXOP to the first device 201. Then, the second device 202 can transmit the data frame transmission within the TXOP to the first device 201 or a third device, or receive the data frame transmission within the TXOP from the third device.

[00120] In some embodiments, the first device may be one of an STA or an AP, and the second device may be one of an STA or an AP.

[00121] In some embodiments, an apparatus capable of performing any of the method 800 (for example, the first device 201) may comprise means for performing the respective steps of the method 800. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00122] In some embodiments, the apparatus comprises: means for determining, at a first device, configuration information for a TXOP initiated by the first device, wherein the configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP; and means for transmitting the configuration information to the second device within the TXOP.

[00123] In some embodiments, the apparatus further comprises means for: prior to determining the configuration information, receiving an indication for configuring the first

device to support a proactive grant for preempting the TXOP.

[00124] In some embodiments, the means for determining configuration information comprises means for determining configuration information dependent on at least one of a QoS status and priority of at least one buffered data frame at the first device.

[00125] In some embodiments, the means for determining configuration information comprises means for: dependent on determining that a low latency data frame is to be transmitted by the first device within the TXOP, determining the configuration information to indicate that the second device is not allowed to preempt the TXOP; or dependent on determining that no low latency data frame is to be transmitted by the first device within the TXOP, determining the configuration information to indicate that the second device is allowed to preempt the TXOP.

[00126] In some embodiments, the configuration information is transmitted via a field in an existing frame. Alternatively or in addition, the configuration information is transmitted via a frame designed for transmitting the configuration information.

[00127] In some embodiments, the configuration information is first configuration information and indicates that the second device is allowed to preempt the TXOP; the apparatus further comprises means for: dependent on determining that a low latency data frame arrives at the first device within the TXOP, transmitting second configuration information within the TXOP to indicate that the second device is not allowed to preempt the TXOP.

[00128] In some embodiments, the configuration information and the second configuration information each comprise at least one of the following: an indication of whether the second device is allowed to preempt the TXOP; a priority threshold for the second device to determine whether to preempt the TXOP; a latency threshold for the second device to determine whether to preempt the TXOP; or one or more device IDs of devices that are allowed to preempt the TXOP.

[00129] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an IFS. In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA

frame transmission. In some embodiments, the preemption occasion may allow the second device to terminate the PPDU frame transmission within the TXOP.

[00130] In some embodiments, the apparatus further comprises means for: dependent on detecting a frame transmission from the second device starting from the preemption occasion, terminating an ongoing transmission within the TXOP; or dependent on failing to detect the frame transmission, continuing the ongoing transmission within the TXOP after the preemption occasion.

[00131] In some embodiments, the configuration information may do not indicate a preemption occasion, and the preemption occasion may be not pre-configured or pre-defined. The apparatus further comprises means for: receiving, from the second device, an indication for early terminating an ongoing transmission within the TXOP; and dependent on receiving the indication, terminating the ongoing transmission within the TXOP.

[00132] In some embodiments, the first device may be one of an STA or an AP, and the second device may be one of an STA or an AP.

[00133] In some embodiments, the apparatus further comprises means for performing other steps in some embodiments of the method 800. In some embodiments, the means comprises at least one processor and at least one memory including computer program code, the at least one memory and computer program code configured to, with the at least one processor, cause the performance of the apparatus.

[00134] In some embodiments, an apparatus capable of performing any of the method 900 (for example, the second device 202) may comprise means for performing the respective steps of the method 900. The means may be implemented in any suitable form. For example, the means may be implemented in a circuitry or software module.

[00135] In some embodiments, the apparatus comprises: means for receiving, at a second device from a first device, configuration information for a TXOP initiated by the first device; determine, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and dependent on determining to preempt the TXOP for the data frame transmission, transmit or receive the data frame transmission within the TXOP.

[00136] In some embodiments, the apparatus further comprises means for: prior to receiving the configuration information, transmitting, to the first device, an indication for

configuring the first device to support a proactive grant for preempting the TXOP.

[00137] In some embodiments, the configuration information is received via a field in an existing frame. Alternatively or in addition, the configuration information is received via a frame designed for transmitting the configuration information.

[00138] In some embodiments, the configuration information is first configuration information, and the apparatus further comprises means for: receiving second configuration information for the TXOP before receiving the first configuration information; and determining whether to preempt the TXOP dependent on the first configuration information.

[00139] In some embodiments, the configuration information and the second configuration information each comprise at least one of the following: an indication of whether the second device is allowed to preempt the TXOP; a priority threshold for the second device to determine whether to preempt the TXOP; a latency threshold for the second device to determine whether to preempt the TXOP; or one or more device IDs of devices that are allowed to preempt the TXOP.

[00140] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an IFS. In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA frame transmission. In some embodiments, the preemption occasion may allow the second device to terminate the PPDU frame transmission within the TXOP.

[00141] In some embodiments, the second device is allowed to preempt the TXOP and the means for determining whether to preempt the TXOP comprises means for: dependent on determining that a priority of the data frame transmission is higher than the priority threshold, determine to preempt the TXOP; or dependent on determining that the priority is lower than or equal to the priority threshold, determine not to preempt the TXOP.

[00142] In some embodiments, the second device is allowed to preempt the TXOP and the means for determining whether to preempt the TXOP comprises means for: dependent on determining that a latency of the data frame transmission is longer than the latency threshold, determine to preempt the TXOP; or dependent on determining that the latency is

shorter than or equal to the latency threshold, determine not to preempt the TXOP.

[00143] In some embodiments, the configuration information may indicate a preemption occasion for starting preemption within the TXOP. Alternatively or in addition, the preemption occasion is pre-configured or pre-defined. In some embodiments, the preemption occasion may be within a time window. The time window may comprise an IFS. In some embodiments, the preemption occasion may be after a PPDU frame transmission. Alternatively or in addition, the preemption occasion may be after a BA frame transmission. In some embodiments, the preemption occasion may allow the second device to terminate the PPDU frame transmission within the TXOP.

[00144] In some embodiments, the means for transmitting the data frame transmission comprises means for: transmitting, to the first device or a third device, the data frame transmission starting from the preemption occasion. In some embodiments, the means for receiving the data frame transmission comprises means for: transmitting, to the third device, a trigger for the data frame transmission starting from the preemption occasion; and receiving, from the third device, the data frame transmission.

[00145] In some embodiments, the configuration information may do not indicate a preemption occasion, and the preemption occasion may be not pre-configured or pre-defined. The apparatus further comprises means for: dependent on determining to preempt the TXOP, transmitting, to the first device, an indication for early terminating an ongoing transmission within the TXOP; and transmitting the data frame transmission within the TXOP to the first device or a third device, or receive the data frame transmission within the TXOP from the third device.

[00146] In some embodiments, the second device may be one of an STA or an AP, and the first device may be one of an STA or an AP.

[00147] Fig. 10 is a simplified block diagram of a device 1000 that is suitable for implementing embodiments of the present disclosure. The device 1000 may be provided to implement the communication device, for example the first device 201, or the second device 202 as shown in Figs. 2 and 3. As shown, the device 1000 includes one or more processors 1010, one or more memories 1020 coupled to the processor 1010, and one or more communication modules 1040 coupled to the processor 1010.

[00148] The communication module 1040 is for bidirectional communications. The communication module 1040 has at least one antenna to facilitate communication. The

communication interface may represent any interface that is necessary for communication with other network elements.

[00149] The processor 1010 may be of any type suitable to the local technical network and may include one or more of the following: general purpose computers, special purpose computers, microprocessors, digital signal processors (DSPs) and processors based on multicore processor architecture, as non-limiting examples. The device 1000 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.

[00150] The memory 1020 may include one or more non-volatile memories and one or more volatile memories. Examples of the non-volatile memories include, but are not limited to, a Read Only Memory (ROM) 1024, an electrically programmable read only memory (EPROM), a flash memory, a hard disk, a compact disc (CD), a digital video disk (DVD), and other magnetic storage and/or optical storage. Examples of the volatile memories include, but are not limited to, a random access memory (RAM) 1022 and other volatile memories that will not last in the power-down duration.

[00151] A computer program 1030 includes computer executable instructions that are executed by the associated processor 1010. The program 1030 may be stored in the ROM 1020. The processor 1010 may perform any suitable actions and processing by loading the program 1030 into the RAM 1020.

[00152] The embodiments of the present disclosure may be implemented by means of the program 1030 so that the device 1000 may perform any process of the disclosure as discussed with reference to Figs. 2 to 9. The embodiments of the present disclosure may also be implemented by hardware or by a combination of software and hardware.

[00153] In some embodiments, the program 1030 may be tangibly contained in a computer readable medium which may be included in the device 1000 (such as in the memory 1020) or other storage devices that are accessible by the device 1000. The device 1000 may load the program 1030 from the computer readable medium to the RAM 1022 for execution. The computer readable medium may include any types of tangible non-volatile storage, such as ROM, EPROM, a flash memory, a hard disk, CD, DVD, and the like. Fig. 11 shows an example of the computer readable medium 1100 in form of CD or DVD. The computer readable medium has the program 1030 stored thereon.

[00154] 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 representations, it is to be understood that the block, apparatus, system, technique or method 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.

[00155] 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 method 800 or the method 900 as described above with reference to Figs. 8 and 9. 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.

[00156] 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.

[00157] In the context of the present disclosure, the computer program codes or related data may be carried by any suitable carrier to enable the device, apparatus or processor to perform various processes and operations as described above. Examples of the carrier include a signal, computer readable medium, and the like.

[00158] The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer 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 computer 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. The term "non-transitory," as used herein, is a limitation of the medium itself (i.e., tangible, not a signal) as opposed to a limitation on data storage persistency (e.g., RAM vs. ROM).

[00159] 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.

[00160] Although the present disclosure has been described in languages 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 first device comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the first device at least to:

determine configuration information for a transmission opportunity (TXOP) initiated by the first device, wherein the configuration information is to be used at least for determining whether a second device is allowed to preempt the TXOP; and

transmit the configuration information to the second device within the TXOP.

2. The first device of claim 1, wherein the first device is further caused to:

prior to determining the configuration information, receive an indication for configuring the first device to support a proactive grant for preempting the TXOP.

3. The first device of claim 1 or 2, wherein the first device is caused to determine the configuration information dependent on at least one of a quality of service (QoS) status and priority of at least one buffered data frame at the first device.

4. The first device of any of claims 1-3, wherein the first device is caused to determine the configuration information by at least one of the following:

dependent on determining that a low latency data frame is to be transmitted by the first device within the TXOP, determining the configuration information to indicate that the second device is not allowed to preempt the TXOP; or

dependent on determining that no low latency data frame is to be transmitted by the first device within the TXOP, determining the configuration information to indicate that the second device is allowed to preempt the TXOP.

5. The first device of any of claims 1-4, wherein the configuration information is transmitted via at least one of the following:

a field in an existing frame; or

a frame designed for transmitting the configuration information.

6. The first device of any of claims 1-5, wherein the configuration information is first configuration information and indicates that the second device is allowed to preempt the TXOP, and the first device is further caused to:

dependent on determining that a low latency data frame arrives at the first device within the TXOP, transmit second configuration information within the TXOP to indicate that the second device is not allowed to preempt the TXOP.

7. The first device of claim 6, wherein the configuration information and the second configuration information each comprise at least one of the following:

an indication of whether the second device is allowed to preempt the TXOP;

a priority threshold for the second device to determine whether to preempt the TXOP;

a latency threshold for the second device to determine whether to preempt the TXOP; or

one or more device identifiers (IDs) of devices that are allowed to preempt the TXOP.

8. The first device of any of claims 1-7, wherein:

the configuration information indicates a preemption occasion for starting preemption within the TXOP; or

the preemption occasion is pre-configured or pre-defined.

9. The first device of claim 8, wherein at least one of the following:

the preemption occasion is within a time window;

the preemption occasion is after a physical protocol data unit (PPDU) frame transmission;

the preemption occasion is after a block acknowledgment (BA) frame transmission; or

the preemption occasion allows the second device to terminate the PPDU frame transmission within the TXOP.

10. The first device of claim 9, wherein the time window comprises an inter frame space (IFS).

11. The first device of claim 8, wherein the first device is further caused to:

dependent on detecting a frame transmission from the second device starting from the preemption occasion, terminate an ongoing transmission within the TXOP; or

dependent on failing to detect the frame transmission, continue the ongoing transmission within the TXOP after the preemption occasion.

12. The first device of any of claims 1-7, wherein the configuration information does not indicate a preemption occasion, the preemption occasion is not pre-configured or pre-defined, and the second device is allowed to preempt the TXOP, and wherein the first device is further caused to:

receive, from the second device, an indication for early terminating an ongoing transmission within the TXOP; and

dependent on receiving the indication, terminate the ongoing transmission within the TXOP.

13. The first device of any of claims 1-12, wherein the first device is one of a station (STA) or an access point (AP), and the second device is one of an STA or an AP.

14. A second device comprising:

at least one processor; and

at least one memory storing instructions that, when executed by the at least one processor, cause the second device at least to:

receive, from a first device, configuration information for a transmission opportunity (TXOP) initiated by the first device;

determine, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and

dependent on determining to preempt the TXOP for the data frame transmission, transmit or receive the data frame transmission within the TXOP.

15. The second device of claim 14, the second device is further caused to:

prior to receiving the configuration information, transmit, to the first device, an indication for configuring the first device to support a proactive grant for preempting the TXOP.

16. The second device of claim 14 or 15, wherein the configuration information is received via at least one of the following:

a field in an existing frame; or

a frame designed for receiving the configuration information.

17. The second device of any of claims 14-16, wherein the configuration information is first configuration information, and the second device is further caused to:

receive second configuration information for the TXOP before receiving the first configuration information; and

determine whether to preempt the TXOP dependent on the first configuration information.

18. The second device of claim 17, wherein the configuration information and the second configuration information each comprise at least one of the following:

an indication of whether the second device is allowed to preempt the TXOP;

a priority threshold for the second device to determine whether to preempt the TXOP;

a latency threshold for the second device to determine whether to preempt the TXOP; or

one or more device identifiers (IDs) of devices that are allowed to preempt the TXOP.

19. The second device of claim 18, wherein the second device is allowed to preempt the TXOP, and the second device is caused to determine whether to preempt the TXOP by:

dependent on determining that a priority of the data frame transmission is higher than the priority threshold, determine to preempt the TXOP; or

dependent on determining that the priority is lower than or equal to the priority threshold, determine not to preempt the TXOP.

20. The second device of claim 18 or 19, wherein the second device is allowed to preempt the TXOP, and the second device is caused to determine whether to preempt the TXOP by:

dependent on determining that a latency of the data frame transmission is longer than the latency threshold, determine to preempt the TXOP; or

dependent on determining that the latency is shorter than or equal to the latency threshold, determine not to preempt the TXOP.

21. The second device of any of claims 14-18, wherein:

the configuration information indicates a preemption occasion for starting preemption within the TXOP; or

the preemption occasion is pre-configured or pre-defined.

22. The second device of claim 21, wherein at least one of the following:

the preemption occasion is within a time window;

the preemption occasion is after a physical protocol data unit (PPDU) frame transmission;

the preemption occasion is after a block acknowledgment (BA) frame transmission; or

the preemption occasion allows the second device to terminate the PPDU frame transmission.

23. The second device of claim 22, wherein the time window comprises an inter frame space (IFS).

24. The second device of claim 22, wherein:

the second device is caused to transmit the data frame transmission by:

transmitting, to the first device or a third device, the data frame transmission starting from the preemption occasion; or

the second device is caused to receive the data frame transmission by:

transmitting, to the third device, a trigger for the data frame transmission starting from the preemption occasion; and

receiving, from the third device, the data frame transmission.

25. The second device of any of claims 14-20, wherein the configuration information does not indicate a preemption occasion, and the preemption occasion is not pre-configured or pre-defined, and wherein the second device is further caused to:

dependent on determining to preempt the TXOP, transmit, to the first device, an indication for early terminating an ongoing transmission within the TXOP; and

transmit the data frame transmission within the TXOP to the first device or a third device, or receive the data frame transmission within the TXOP from the third device.

26. The second device of any of claims 14-25, wherein the first device is one of a station (STA) or an access point (AP), and the second device is one of an STA or an AP.

27. A method comprising:

determining, at a first device, configuration information for a transmission opportunity (TXOP) initiated by the first device, wherein the configuration information is to be used for determining whether a second device is allowed to preempt the TXOP; and

transmitting the configuration information to the second device within the TXOP.

28. A method comprising:

receiving, at a second device and from a first device, configuration information for a transmission opportunity (TXOP) initiated by the first device;

determining, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and

dependent on determining to preempt the TXOP for the data frame transmission, transmitting or receiving the data frame transmission within the TXOP.

29. An apparatus comprising:

means for determining, at a first device, configuration information for a transmission opportunity (TXOP) initiated by the first device, wherein the configuration information is to be used for determining whether a second device is allowed to preempt the TXOP; and

means for transmitting the configuration information to the second device within the TXOP.

30. An apparatus comprising:

means for receiving, at a second device and from a first device, configuration information for a transmission opportunity (TXOP) initiated by the first device;

means for determining, dependent on the configuration information, whether to preempt the TXOP for a data frame transmission; and

means for dependent on determining to preempt the TXOP for the data frame

transmission, transmitting or receiving the data frame transmission within the TXOP.

31. A computer readable medium comprising program instructions that, when executed by an apparatus, cause the apparatus to perform at least one of the methods of claims 27 and 28.

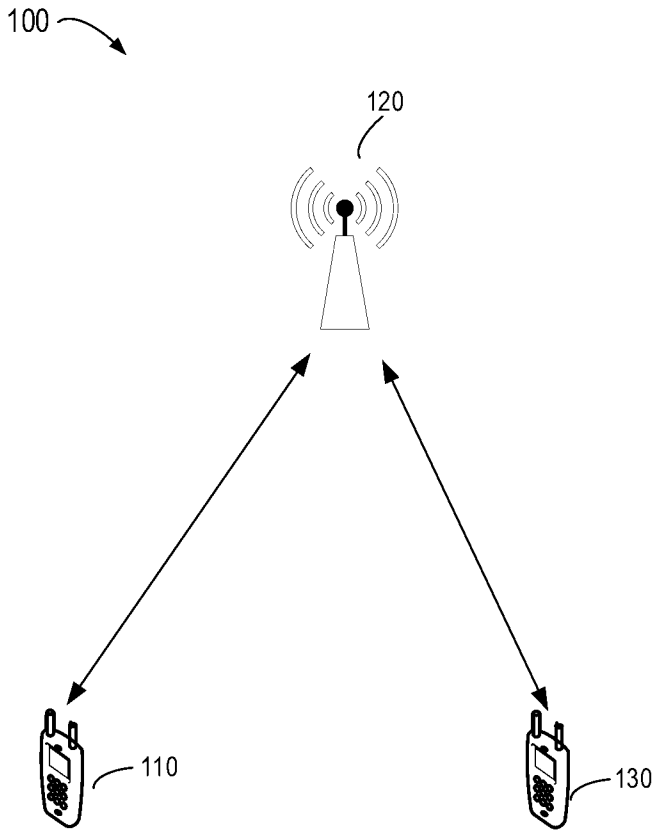

Fig. 1A

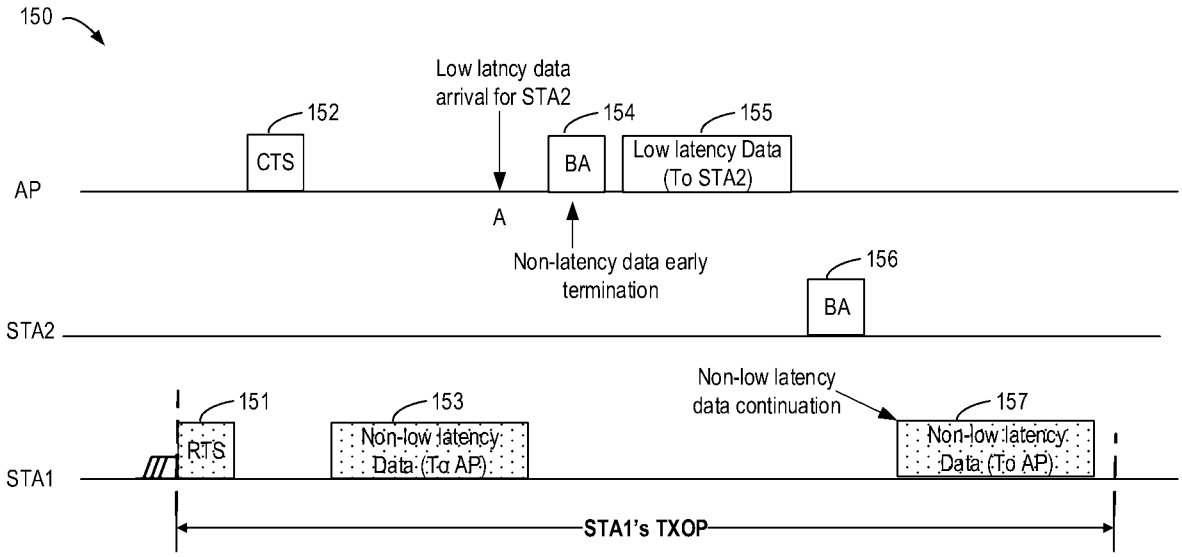
150
Low latncy data arrival for STA2
152
154
155
CTS
BA
Low latency Data (To STA2)
AP
A
Non-latency data early termination
156
BA
STA2
Non-low latency data continuation
151
153
157
RTS
Non-low latency Data (To AP)
Non-low latency Data (To AP)
STA1
STA1's TXOP

Fig. 1B

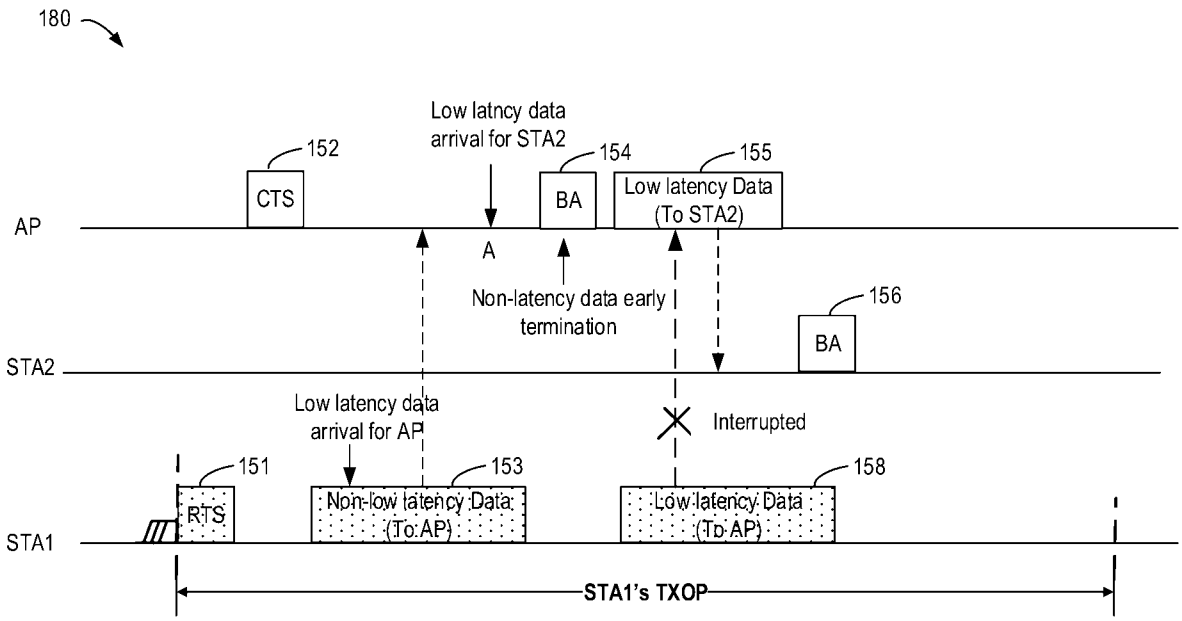
180
Low latncy data arrival for STA2
152
154
155
CTS
BA
Low latency Data (To STA2)
AP
A
Non-latency data early termination
156
BA
STA2
Low latency data arrival for AP
Interrupted
151
153
158
RTS
Non-low latency Data (To AP)
Low latency Data (To AP)
STA1
STA1's TXOP

Fig. 1C

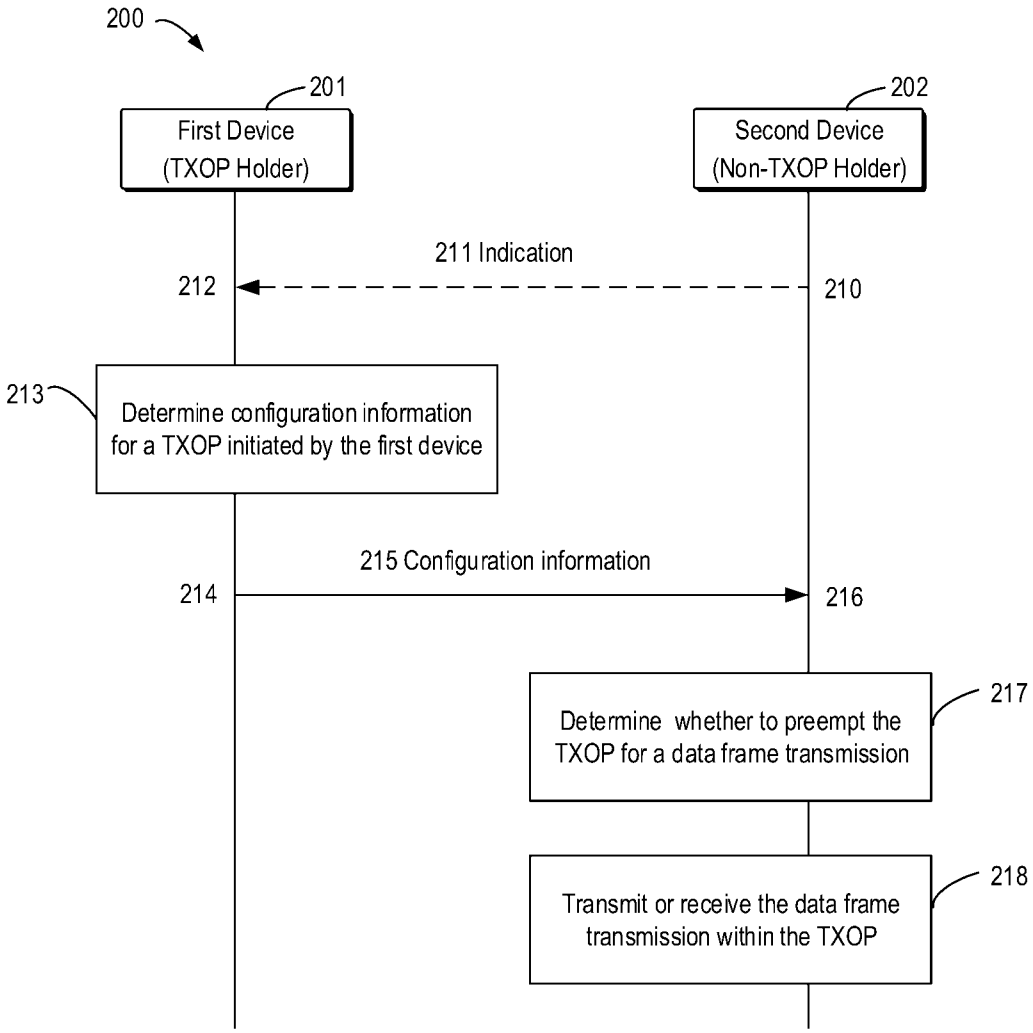
200
201
First Device
(TXOP Holder)
202
Second Device
(Non-TXOP Holder)
211 Indication
212
210
213
Determine configuration information
for a TXOP initiated by the first device
215 Configuration information
214
216
217
Determine whether to preempt the
TXOP for a data frame transmission
218
Transmit or receive the data frame
transmission within the TXOP

Fig. 2

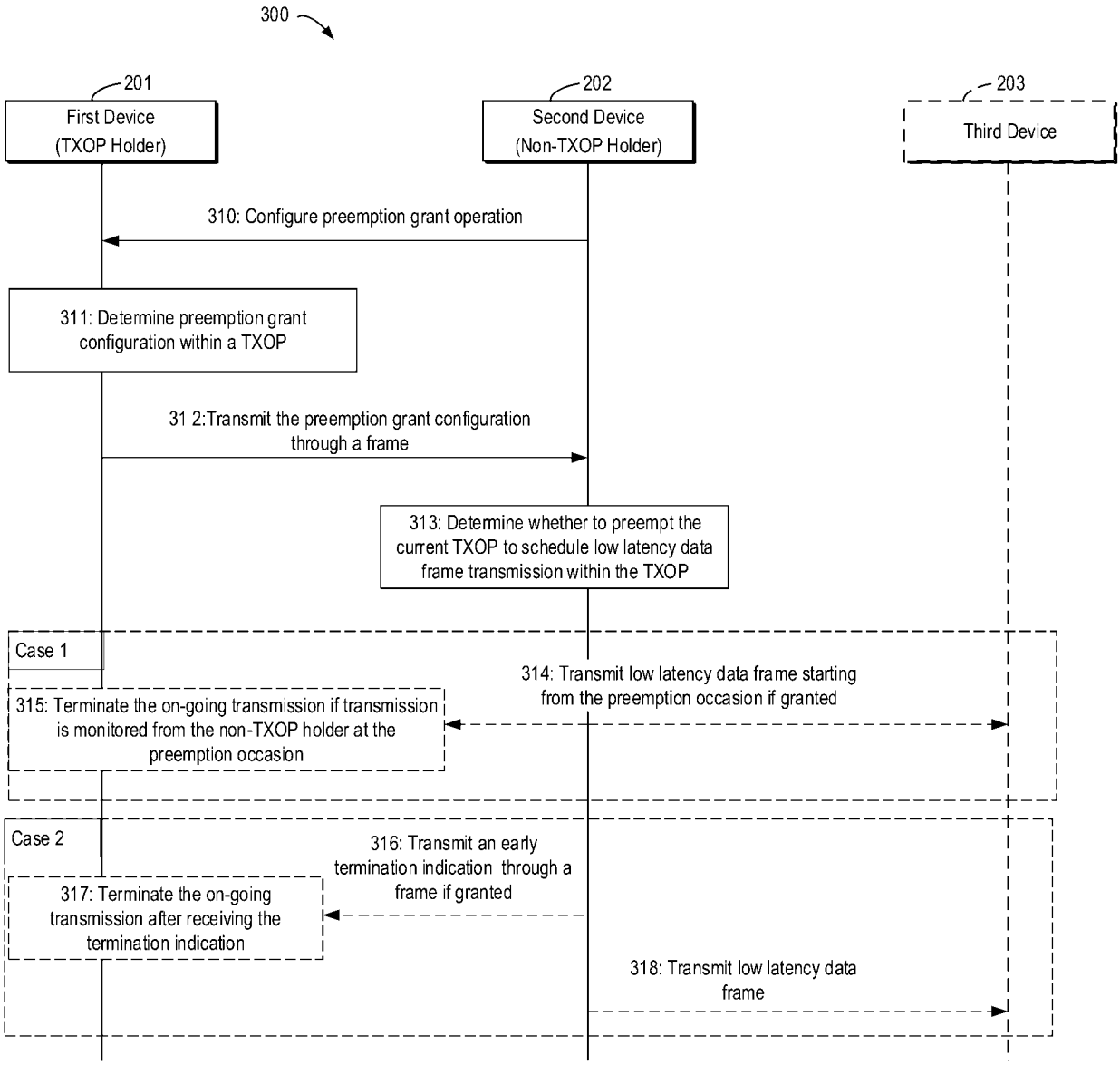
300
201
First Device
(TXOP Holder)
202
Second Device
(Non-TXOP Holder)
203
Third Device
310: Configure preemption grant operation
311: Determine preemption grant configuration within a TXOP
31 2:Transmit the preemption grant configuration through a frame
313: Determine whether to preempt the current TXOP to schedule low latency data frame transmission within the TXOP
Case 1
314: Transmit low latency data frame starting from the preemption occasion if granted
315: Terminate the on-going transmission if transmission is monitored from the non-TXOP holder at the preemption occasion
Case 2
316: Transmit an early termination indication through a frame if granted
317: Terminate the on-going transmission after receiving the termination indication
318: Transmit low latency data frame

Fig. 3

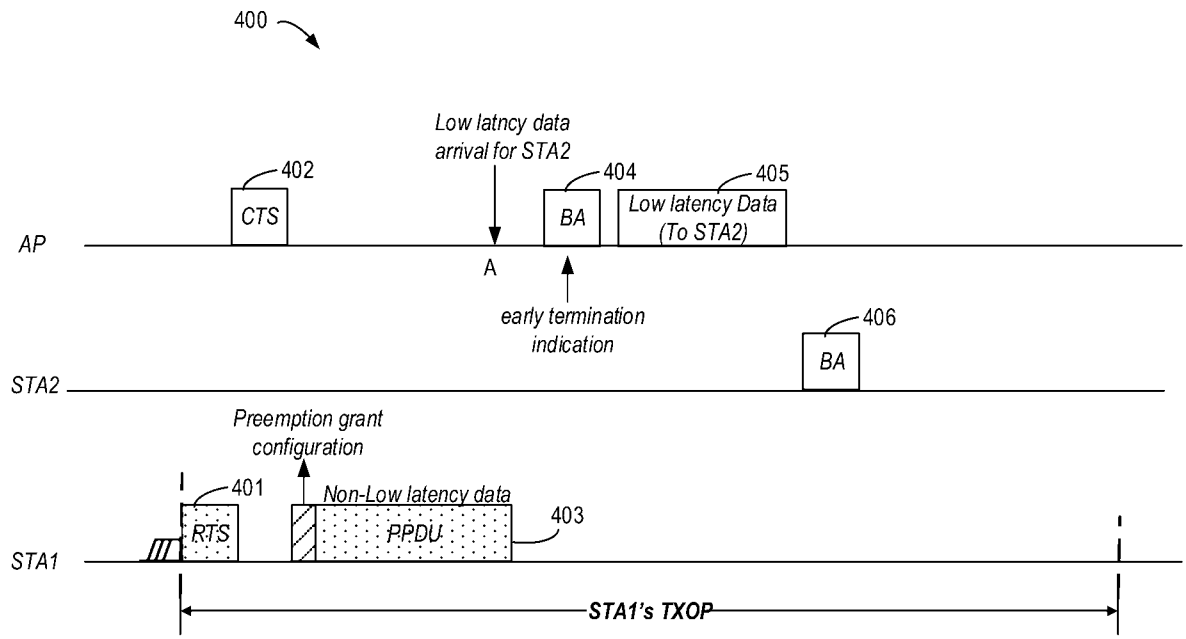
400
Low latncy data arrival for STA2
402
404
405
CTS
BA
Low latency Data (To STA2)
AP
A
early termination indication
406
BA
STA2
Preemption grant configuration
401
Non-Low latency data
403
RTS
PPDU
STA1
STA1's TXOP

Fig. 4

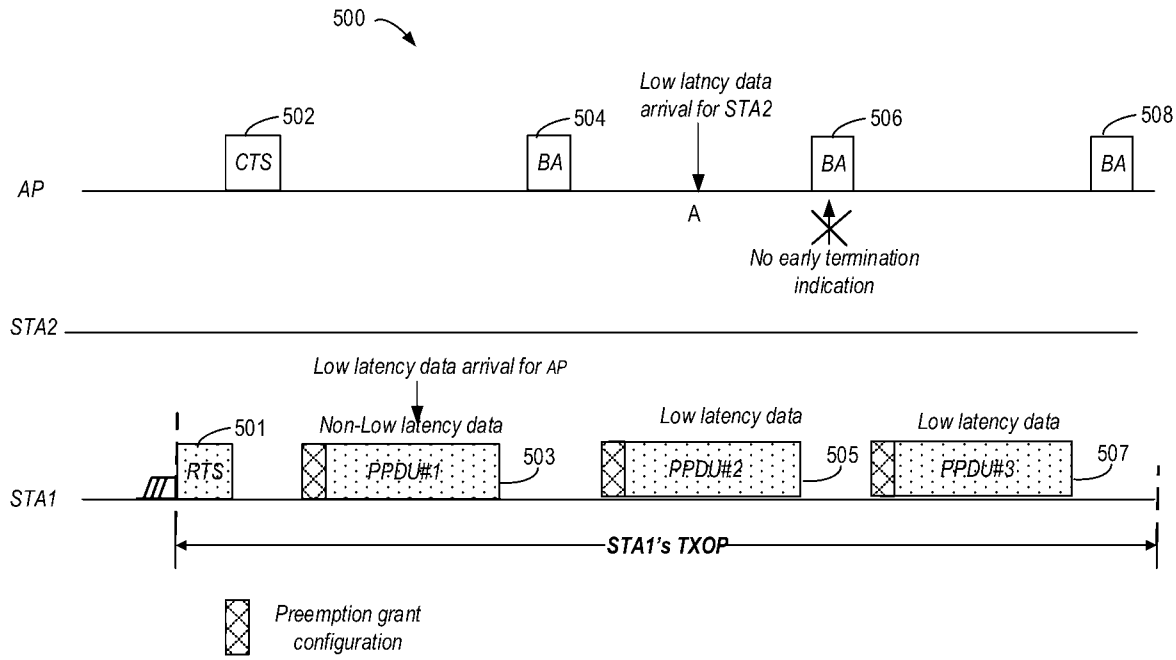
500
Low latncy data arrival for STA2
502
504
506
508
CTS
BA
BA
BA
AP
A
No early termination indication
STA2
Low latency data arrival for AP
501
Non-Low latency data
Low latency data
Low latency data
503
505
507
RTS
PPDU#1
PPDU#2
PPDU#3
STA1
STA1's TXOP
Preemption grant configuration

Fig. 5

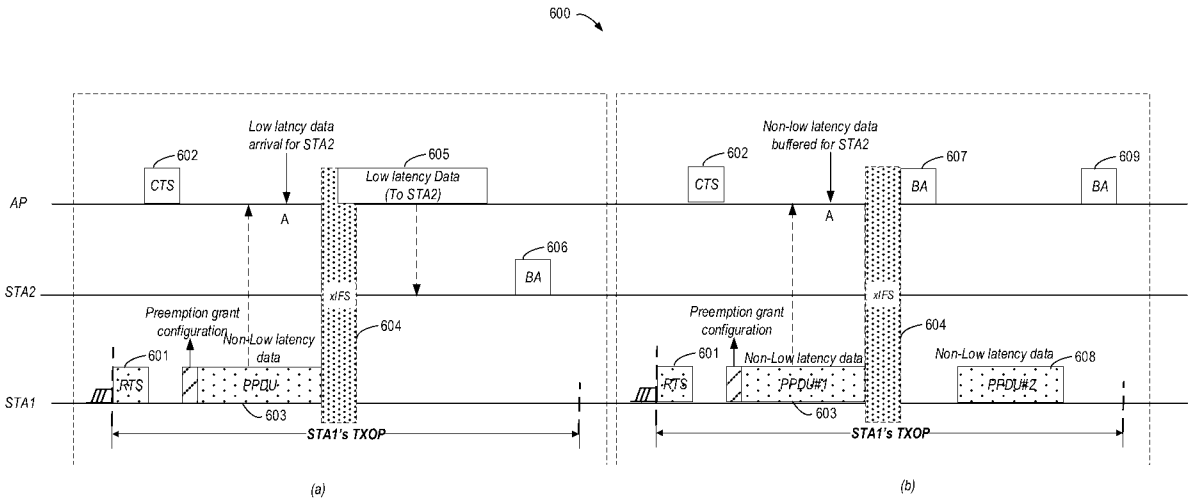
600
AP
STA2
STA1
CTS
602
Low latncy data arrival for STA2
A
605
Low latency Data (To STA2)
606
BA
xIFS
Preemption grant configuration
Non-Low latency data
601
RTS
PPDU
604
603
STA1's TXOP
(a)
Non-low latency data buffered for STA2
607
609
PPDU#1
608
PPDU#Z
(b)

Fig. 6

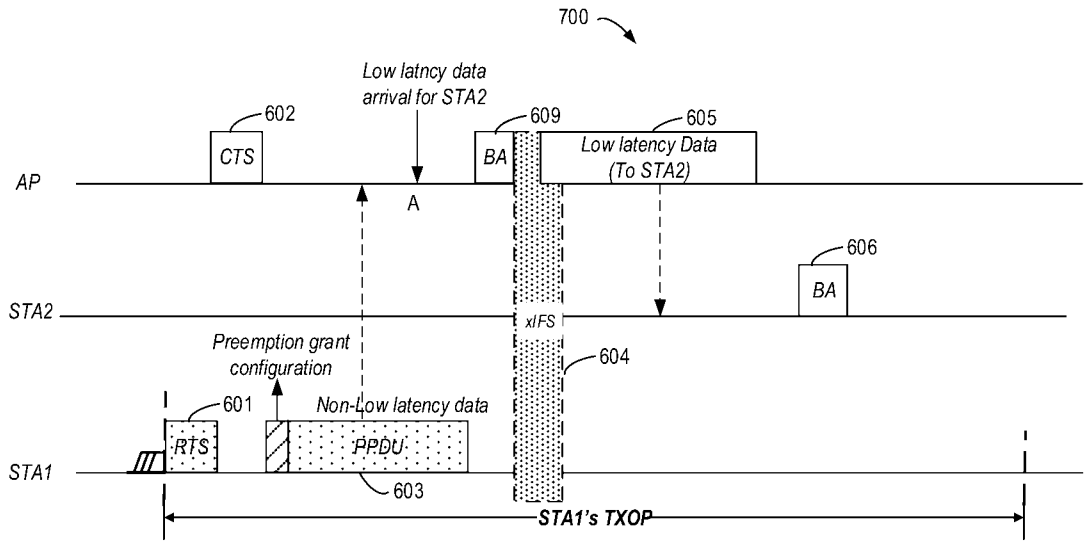
700
AP
STA2
STA1
CTS
602
Low latncy data arrival for STA2
A
609
BA
605
Low latency Data (To STA2)
606
xIFS
Preemption grant configuration
604
601
Non-Low latency data
RTS
PPDU
603
STA1's TXOP

Fig. 7

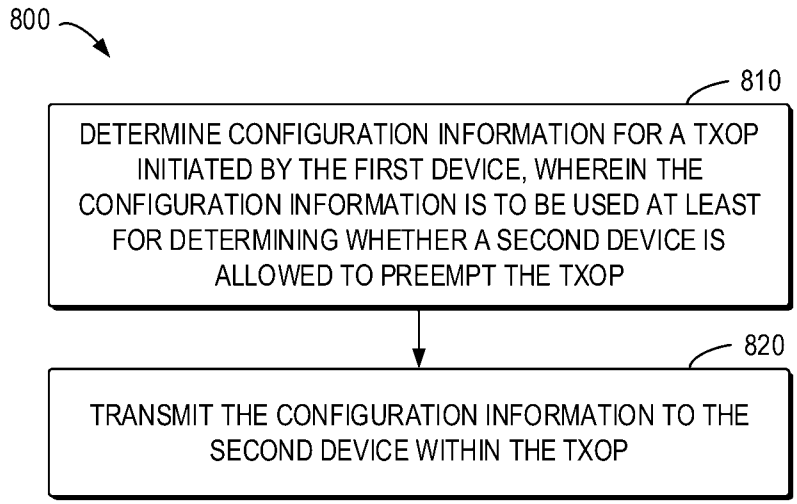
800
810
DETERMINE CONFIGURATION INFORMATION FOR A TXOP INITIATED BY THE FIRST DEVICE, WHEREIN THE CONFIGURATION INFORMATION IS TO BE USED AT LEAST FOR DETERMINING WHETHER A SECOND DEVICE IS ALLOWED TO PREEMPT THE TXOP
820
TRANSMIT THE CONFIGURATION INFORMATION TO THE SECOND DEVICE WITHIN THE TXOP

Fig. 8

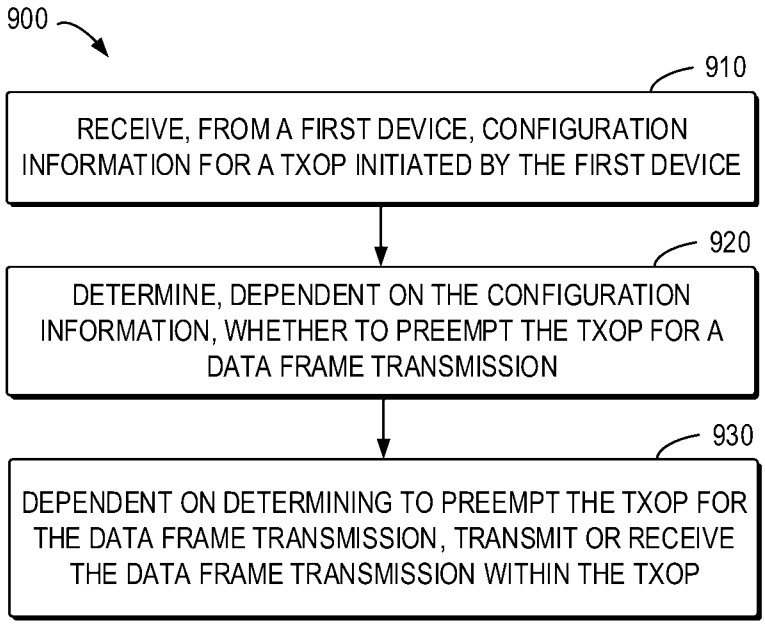
900
910
RECEIVE, FROM A FIRST DEVICE, CONFIGURATION INFORMATION FOR A TXOP INITIATED BY THE FIRST DEVICE
920
DETERMINE, DEPENDENT ON THE CONFIGURATION INFORMATION, WHETHER TO PREEMPT THE TXOP FOR A DATA FRAME TRANSMISSION
930
DEPENDENT ON DETERMINING TO PREEMPT THE TXOP FOR THE DATA FRAME TRANSMISSION, TRANSMIT OR RECEIVE THE DATA FRAME TRANSMISSION WITHIN THE TXOP

Fig. 9

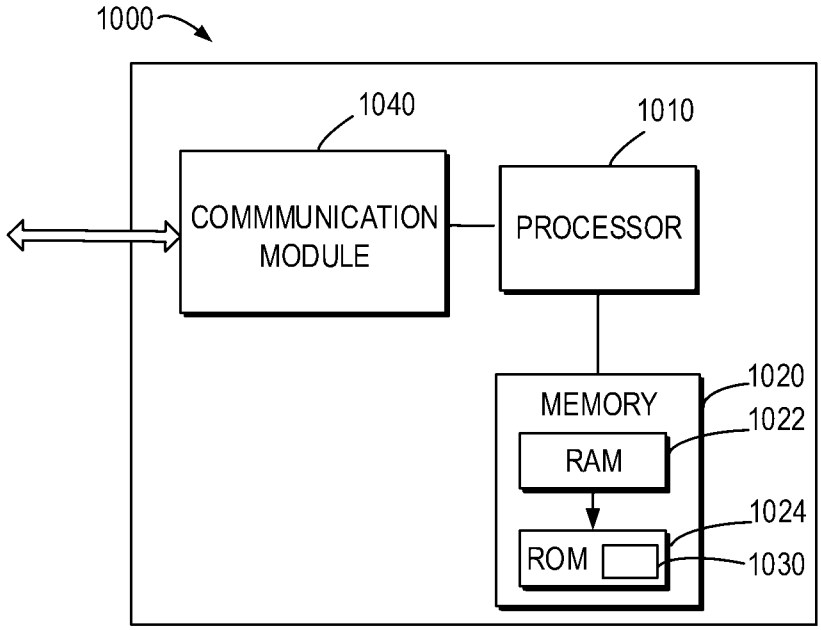
1000
1040
1010
COMMMUNICATION MODULE
PROCESSOR
MEMORY
1020
1022
RAM
1024
ROM
1030

Fig. 10

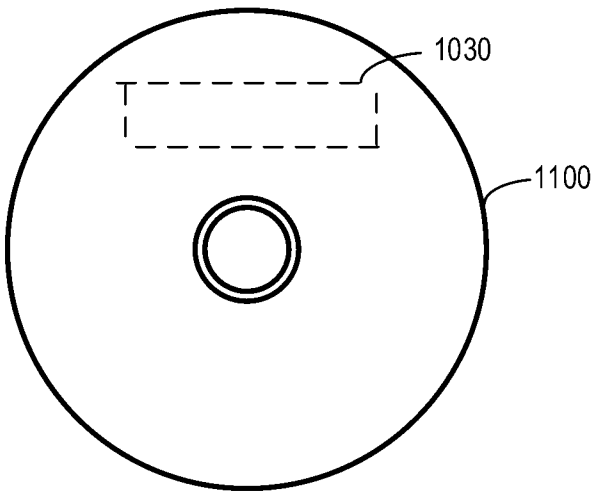
1030
1100

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2023/100247

A. CLASSIFICATION OF SUBJECT MATTER

H04W 72/0446(2023.01)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)

IPC: H04W

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, VCN, ENTXT, DWPI: transmission w opportunity, TXOP, AP, STA, preempt+, QoS, priority, configure+, proactive, latency, allow+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 114828280 A (HUAWEI TECHNOLOGIES CO., LTD.) 29 July 2022 (2022-07-29) description, paragraphs [0144]-[0250]	1-31
A	CN 114430575 A (HUAWEI TECHNOLOGIES CO., LTD.) 03 May 2022 (2022-05-03) the whole document	1-31
A	WO 2023072584 A1 (SONY GROUP CORPORATION et al.) 04 May 2023 (2023-05-04) the whole document	1-31
A	US 2021084667 A1 (INTEL CORPORATION) 18 March 2021 (2021-03-18) the whole document	1-31

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
05 December 2023	**12 December 2023**

Name and mailing address of the ISA/CN	Authorized officer
CHINA NATIONAL INTELLECTUAL PROPERTY ADMINISTRATION **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China**	**LV,Miao** Telephone No. **(+86) 010-53961742**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2023/100247

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 114828280 A	29 July 2022	None	
CN 114430575 A	03 May 2022	WO 2022089508 A1	05 May 2022
WO 2023072584 A1	04 May 2023	None	
US 2021084667 A1	18 March 2021	None	