DESCRIPTION

TITLE OF INVENTION

COMMUNICATION APPARATUS, CONTROL METHOD FOR COMMUNICATION APPARATUS, AND PROGRAM

TECHNICAL FIELD

[0001] The present invention relates to a communication apparatus that performs wireless communication, a control method for the communication apparatus, and a program.

BACKGROUND ART

[0002] As communication standards relating to wireless LAN (Local Area Network), IEEE (Institute of Electrical and Electronics Engineers) 802.11 series standards are known. The IEEE 802.11 series standards include standards such as IEEE 802.11a/b/g/n/ac/ax/be. In the IEEE 802.11be standard and its successor standards, increasing communication efficiency and throughput and reducing delay by causing a plurality of access point apparatuses (hereinafter also simply referred to as APs) to operate cooperatively have been studied.

[0003] In particular, in 11bn, which is being studied as a successor standard to 11be, or the Ultra High Reliability (UHR) standard, methods for improving the efficiency and reliability of communication are being discussed. As a method for improving efficiency and reliability, C-TDMA has been proposed in which an AP (Sharing AP) that has obtained a TXOP allocates (TXOP Sharing) the TXOP to another AP (Shared AP), thereby enabling communication between the Shared AP and an STA. Furthermore, in order to prevent an STA connected to the Shared AP from overhearing communication for TXOP Sharing by the Sharing AP and setting a communication-disabled period (NAV), a method of sharing a TXOP

cooperatively among a plurality of APs has been proposed. TXOP sharing among a plurality of APs is also called Provisional TXOP.

CITATION LIST

PATENT LITERATURE

[0004] PTL1 Japanese Patent Laid-Open No. 2018-50133

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0005] As described above, as a method for improving efficiency and reliability, there is a method of obtaining a Provisional TXOP. However, a method of notifying a wireless communication apparatus that is a communication partner of parameters used when performing Provisional TXOP is not defined, and there has been a problem in that convenience when executing Provisional TXOP is low.

[0006] In view of the above problem, a purpose of the present invention is to provide a technique for notifying parameters for executing TXOP sharing among a plurality of apparatuses.

SOLUTION TO PROBLEM

[0007] In order to achieve the above purpose, a communication apparatus of the present invention is a communication apparatus capable of wireless communication compliant with an IEEE 802.11 series standard, characterized in that the communication apparatus comprises: a transmission means for transmitting, to another communication apparatus in a transmission opportunity (TXOP) period obtained by the communication apparatus, a wireless frame for executing TXOP sharing among a plurality of apparatuses, in which a TXOP obtained by the communication apparatus is allocated to the other communication

apparatus to obtain a TXOP Sharing period, and a trigger frame for allocating the TXOP to the other communication apparatus, wherein the wireless frame includes at least one of predetermined information by which a maximum duration of the TXOP Sharing period can be specified, and information indicating that the TXOP Sharing period is arranged after the TXOP period obtained by the communication apparatus.

ADVANTAGEOUS EFFECTS OF INVENTION

[0008] According to one aspect of the present invention, a technique for notifying parameters for executing TXOP sharing among a plurality of apparatuses can be provided.

[0009] Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings. Note that the same reference numerals denote the same or like components throughout the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain principles of the invention.

FIG. 1 is a diagram illustrating a configuration of a wireless communication system according to the present embodiment.

FIG. 2 is a diagram illustrating a hardware configuration of a wireless communication apparatus according to the present embodiment.

FIG. 3 is a diagram illustrating a functional configuration of the wireless communication apparatus according to the present embodiment.

FIG. 4 is a diagram illustrating an example of a MAC frame.

FIG. 5A is a diagram illustrating an example of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 5B is a diagram illustrating an example of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 5C is a diagram illustrating an example of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 6 is a diagram illustrating an example of an operation sequence of a first embodiment executed by a Sharing AP, a Shared AP, and an STA connected to the Sharing AP.

FIG. 7 is a diagram illustrating an example of a processing example executed by the Sharing AP.

FIG. 8 is a diagram illustrating an example of a processing example executed by the Shared AP.

FIG. 9A is a diagram illustrating a modification of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 9B is a diagram illustrating a modification of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 9C is a diagram illustrating a modification of an Action frame used for notifying parameters relating to Provisional TXOP.

FIG. 10A is a diagram illustrating an example of an Action frame for performing a TXOP return notification during a Provisional TXOP operation.

FIG. 10B is a diagram illustrating an example of an Action frame for performing a TXOP return notification during a Provisional TXOP operation.

DESCRIPTION OF EMBODIMENTS

[0011] Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the

scope of the claimed invention. Multiple features are described in the embodiments, but limitation is not made to an invention that requires all such features, and multiple such features may be combined as appropriate. Furthermore, in the attached drawings, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.

[0012] (Configuration of Wireless Communication System)

FIG. 1 illustrates a configuration of a wireless communication system according to the present embodiment. A wireless communication system 1 includes an access point apparatus (hereinafter also simply referred to as an AP or an access point) 103 that constructs a wireless communication network 10, and a station apparatus (hereinafter also simply referred to as an STA or a station) 106 as a participant device. In addition, an AP 104 constructs a wireless communication network not illustrated, and an STA 105 participates in the wireless communication network constructed by the AP 104. In addition, a range 20 indicates a range reached by a wireless frame transmitted by the AP 103.

[0013] The APs 103 and 104 and the STAs 105 and 106 are configured to be able to execute wireless communication compliant with the IEEE 802.11bn standard, which is a successor standard to IEEE 802.11be that targets a maximum transmission rate of 46.08 Gbps. Note that IEEE is an abbreviation for Institute of Electrical and Electronics Engineers.

[0014] IEEE 802.11bn lists, as main features, highly reliable communication, low latency (low delay time) communication, and throughput improvement during congestion. A wireless frame communicated under the successor standard is also called a UHR (Ultra High Reliability) PPDU. PPDU is an abbreviation for PLCP Protocol Data Unit, and PLCP is an abbreviation for Physical Layer Convergence Protocol.

[0015] Note that the names IEEE 802.11bn and UHR standard are provided for

convenience based on goals to be achieved by the successor standard and features that are highlights of the standard, and may be changed to different names once formulation of the standard has been completed. Meanwhile, it should be noted that the present Specification and the appended claims are essentially applicable to a successor standard to the IEEE 802.11be standard and to all successor standards.

[0016] Note that although the wireless communication system 1 illustrated in FIG. 1 is described as being configured by one AP and one STA, the numbers of APs and STAs are not limited to this. For example, two or more STAs may be included. At this time, a frequency band or bandwidth of an established link can be changed. In addition, although the APs 103 and 104 and the STAs 105 and 106 are described as supporting communication of a UHR PPDU of the IEEE 802.11bn standard, they are not limited to this. In addition to this, they may support an IEEE 802.11 standard before the IEEE 802.11bn standard. Specifically, the APs 103 and 104 and the STAs 105 and 106 may be configured to support communication of a PPDU of the IEEE 802.11a/b/g/n/ac/ax/be standards or the like.

[0017] Furthermore, the APs 103 and 104 and the STAs 105 and 106 may support other communication standards such as Bluetooth (registered trademark), NFC, UWB, ZigBee, and MBOA in addition to the IEEE 802.11 standard series. Note that UWB is an abbreviation for Ultra Wide Band, and MBOA is an abbreviation for Multi Band OFDM Alliance. In addition, NFC is an abbreviation for Near Field Communication. UWB includes wireless USB, wireless 1394, WiNET, and the like. In addition, they may support a wired communication standard such as a wired local area network (LAN).

[0018] Specific examples of the APs 103 and 104 and the STAs 105 and 106 include a wireless LAN router and a personal computer (PC), but are not limited to these. In addition, the APs 103 and 104 and the STAs 105 and 106 may be

wireless communication apparatuses such as wireless chips capable of executing wireless communication compliant with the IEEE 802.11bn standard. In addition, specific examples of the STAs 105 and 106 include a camera, a tablet, a smartphone, a PC, a mobile phone, a video camera, and a headset, but are not limited to these. In addition, the STAs 105 and 106 may be wireless communication apparatuses such as wireless chips capable of executing wireless communication compliant with the IEEE 802.11bn standard.

[0019] The APs 103 and 104 and the STAs 105 and 106 can communicate at frequencies of a 2.4 GHz band, a 5 GHz band, and a 6 GHz band. A frequency band used by each communication apparatus is not limited to this, and a different frequency band, such as a 60 GHz band, may be used. In addition, the AP 103 and the AP 104 can operate in any of a plurality of bandwidths such as 20 MHz, 40 MHz, 80 MHz, 160 MHz, 320 MHz, and 640 MHz.

[0020] (Configuration of Wireless Communication Apparatus)

FIG. 2 illustrates a hardware configuration example of a wireless communication apparatus (AP and STA). As an example, the wireless communication apparatus includes a storage unit 201, a control unit 202, a functional unit 203, an input unit 204, an output unit 205, a communication unit 206, and an antenna 207. Note that there may be one antenna or a plurality of antennas.

[0021] The storage unit 201 is configured by one or more memories such as a read-only memory (ROM) and a random access memory (RAM), and stores various types of information such as a computer program for performing various operations described later and communication parameters for wireless communication. Note that, as the storage unit 201, in addition to a memory such as a ROM and a RAM, a storage medium such as a flexible disk, a hard disk, or an SSD (Solid State Drive) may be used. Alternatively, as the storage unit 201, in

addition to a memory such as a ROM and a RAM, a storage medium such as an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a nonvolatile memory card, or a DVD may be used. In addition, the storage unit 201 may include a plurality of memories or the like.

[0022] The control unit 202 is configured by, for example, one or more processors such as a central processing unit (CPU) and a micro processing unit (MPU), and controls the AP 103 as a whole by executing a computer program stored in the storage unit 201. Note that the control unit 202 may control the AP 103 as a whole through cooperation between the computer program stored in the storage unit 201 and an OS (Operating System). In addition, the control unit 202 generates data and signals (wireless frames) to be transmitted in communication with another wireless communication apparatus. Note that CPU is an abbreviation for Central Processing Unit, and MPU is an abbreviation for Micro Processing Unit. In addition, the control unit 202 may include a plurality of processors such as multiple core processors, and the wireless communication apparatus as a whole may be controlled by the plurality of processors.

[0023] In addition, the control unit 202 controls the functional unit 203 to execute predetermined processing such as wireless communication, imaging, printing, and projection. The functional unit 203 is hardware for the communication apparatus to execute predetermined processing.

[0024] The input unit 204 receives various operations from a user. The output unit 205 performs various outputs to the user via a monitor screen or a speaker. Here, output by the output unit 205 may be display on a monitor screen, audio output by a speaker, vibration output, or the like. Note that both the input unit 204 and the output unit 205 may be realized by one module such as a touch panel. In addition, the input unit 204 and the output unit 205 may each be integrated with the wireless communication apparatus or may be separate therefrom.

[0025] The communication unit 206 controls wireless communication compliant with the IEEE 802.11bn standard. In addition, the communication unit 206 may control wireless communication compliant with another IEEE 802.11 series standard and wired communication such as a wired LAN in addition to the IEEE 802.11bn standard. The communication unit 206 controls the antenna 207 to transmit and receive signals for wireless communication generated by the control unit 202.

[0026] Note that in a case where the wireless communication apparatus supports an NFC standard, a Bluetooth standard, or the like in addition to the IEEE 802.11bn standard, wireless communication compliant with these communication standards may be controlled. In addition, in a case where the wireless communication apparatus can execute wireless communication compliant with a plurality of communication standards, the wireless communication apparatus may be configured to include, separately, a communication unit and an antenna corresponding to each communication standard. The wireless communication apparatus communicates data such as image data, document data, and video data with another communication apparatus via the communication unit 206. Note that the antenna 207 may be configured as a body separate from the communication unit 206, or may be configured as one module together with the communication unit 206.

[0027] The antenna 207 is an antenna capable of communication in a 2.4 GHz band, a 5 GHz band, and a 6 GHz band. There may be one antenna or a plurality of antennas included in the communication apparatus. In addition, a different antenna may be provided for each frequency band. In addition, in a case where the AP 103 and the AP 104 include a plurality of antennas, the AP 103 and the AP 104 may include communication units 206 corresponding to the respective antennas.

[0028] <Functional Configuration of Wireless Communication Apparatus>

Next, a functional configuration of the wireless communication apparatus (APs 103 and 104 and STAs 105 and 106) will be described with reference to FIG. 3. FIG. 3 is a block diagram illustrating a functional configuration of the wireless communication apparatus in the present embodiment.

[0029] The wireless communication apparatus includes a wireless LAN control unit 301, a frame generation unit 302, a frame analysis unit 303, a UI control unit 304, and a storage unit 305.

[0030] The wireless LAN control unit 301 controls the communication unit 206 and the antenna 207 for transmitting and receiving wireless signals to and from another wireless communication apparatus. Specifically, the wireless LAN control unit 301 cooperates with the frame generation unit 302 and the frame analysis unit 303 to execute communication control of wireless frames in accordance with the IEEE 802.11 series standards.

[0031] The frame generation unit 302 generates a wireless control frame to be transmitted by the wireless LAN control unit 301. The wireless frame includes a preamble field and a data field. A MAC frame such as a management frame, a control frame, or a data frame is stored in the data field. The content of wireless control generated by the frame generation unit 302 may be restricted by settings stored in the storage unit 305. In addition, the content may be changed by user settings from the UI control unit 304.

[0032] Information on the generated frame is sent to the wireless LAN control unit 301 and transmitted to the outside by the communication unit 206 and the antenna 207. In addition, information on a frame received through cooperation of the communication unit 206, the antenna 207, and the wireless LAN control unit 301 is passed to the frame analysis unit 303 and analyzed. When analysis is performed by the frame analysis unit 303, an analysis method may be determined

by settings stored in the storage unit 305.

[0033] The UI control unit 304 is configured to include hardware relating to a user interface such as a touch panel or a button for receiving an operation from an AP to an STA by a user not illustrated, and a program for controlling the hardware. Note that the UI control unit 304 also has a function for presenting information such as display of an image or the like or audio output or the like to the user.

[0034] The storage unit 305 is a storage apparatus that may be configured by a ROM, a RAM, and the like that store programs and data for operating the wireless communication apparatus.

[0035] (Example)

FIG. 4 illustrates an example of a format of a MAC header according to the present example. The MAC header starts with Frame Control 401, followed by fields such as Duration/ID 402 and Address 1. Since the fields from Address 1 onward conform to conventional IEEE 802.11 standards, description thereof is omitted. Frame Control 401 is further configured by several subfields, and includes fields such as Protocol Version 411, Type 412, SubType 413, and ToDS 414 in this order from the beginning. Since the fields from ToDS onward conform to conventional IEEE 802.11 standards, description thereof is omitted.

[0036] By storing predetermined values in Type 412 and SubType 413 included in the Frame Control 401 field, the type of the frame can be indicated. For example, by storing the value “0” in Type 412 and the value “13” in SubType 413, it can be indicated that the MAC frame is an Action frame.

[0037] An example of a Frame Body of an Action frame transmitted by the wireless communication apparatus according to the present embodiment will be described with reference to FIG. 5. As illustrated in FIG. 5, an Action field 500 is roughly configured by a Category field 501 and an Action Details field 502. The

Action field 500 is included in the Frame Body field shown in the format of the MAC header in FIG. 4.

[0038] A value indicating a use of the Action frame is stored in the Category field 501. Here, the value “38” is stored to indicate that the frame is an Action frame used for coordinated time division multiple access (C-TDMA).

[0039] The Action Details field 502 includes a field for indicating specific information about the use of the Action frame specified by the Category field 501. At the beginning of the Action Details field 502, there is a C-TDMA Action field 511 indicating a specific operation type among C-TDMA operations. Here, the value “0” is stored to indicate that, among C-TDMA operations, a notification operation of Provisional TXOP is performed. Here, Provisional TXOP is a communication method in which a wireless communication apparatus having a transmission opportunity (TXOP) allocates the transmission opportunity to another wireless communication apparatus and executes TXOP sharing among a plurality of apparatuses. For example, Provisional TXOP is information shared between a Sharing AP and a Shared AP, and prevents a non-AP STA from setting a NAV and making it impossible for the Shared AP and the non-AP STA to communicate. In this manner, Provisional TXOP is recognized between the Sharing AP and the Shared AP. Therefore, for example, even if a Provisional TXOP notification reaches a non-AP STA under the control of the shared AP, unlike a normal TXOP, a NAV is not set. In the present embodiment, a wireless communication apparatus having a TXOP notifies another wireless communication apparatus that Provisional TXOP is executed within a TXOP period. In addition, as an example of a parameter for executing Provisional TXOP, a maximum length of a TXOP period allocated to another wireless communication apparatus (TXOP Sharing period) is notified. In addition, by including an identifier of wireless communication equipment sharing the TXOP in

a predetermined field such as an Address field or a ToDS field of the MAC header, the Shared AP can identify that the TXOP is shared.

[0040] Following the C-TDMA Action field 511, there is a Provisional TXOP notification element 512, which is an information element (IE) indicating information relating to notification of Provisional TXOP.

[0041] As illustrated in FIG. 5C, the Provisional TXOP notification element 512 is configured by fields of Element ID 521, Length 522, Element ID Extension 523, Provisional TXOP Start time 524, and Provisional TXOP Limit 525 from the beginning.

[0042] A length of the Provisional TXOP notification element 512 is stored in Length 522. In addition, values for indicating that an IE included in the Action frame is this Provisional TXOP notification element are stored in Element ID 521 and Element ID Extension 523. For example, the value "255" may be stored in Element ID 521 and the value "160" may be stored in Element ID Extension 523 to indicate that it is the Provisional TXOP notification element, but the values are not limited to these.

[0043] A start time (start timing) of Provisional TXOP is stored in Provisional TXOP Start time 524.

[0044] The following three patterns are conceivable as definitions of the start time of the Provisional TXOP period. A first pattern is a pattern in which a time point at which a wireless communication apparatus operating as a Sharing TXOP that shares a TXOP has obtained the TXOP is set as the start time of the Provisional TXOP period. In the case of the first pattern, a start time of a period 606 described later with reference to FIG. 6 is the start time of the Provisional TXOP period. In this case, 0 is set in Provisional TXOP Start time 524, or Provisional TXOP Start time 524 is omitted.

[0045] A second pattern is a pattern in which a time point at which the Sharing

TXOP transmits a notification of parameters for executing Provisional TXOP is set as the start time of the Provisional TXOP period. In the case of the second pattern, a transmission time of a Provisional TXOP notification frame 602 described later with reference to FIG. 6 is the start time of the Provisional TXOP period. In this case, transmission timing of a frame including the Provisional TXOP notification element 512 may be set as the start time of the Provisional TXOP period. The transmission timing of the frame may be set in units of microseconds as an offset value from a start time of the currently obtained TXOP. Alternatively, a value of a TSF (Time Synchronization Function) timer at the start time of Provisional TXOP may be set in units of one time unit (TU), that is, in units of 32 microseconds.

[0046] A third pattern is a pattern in which timing at which the Sharing TXOP transmits a trigger frame for allocating the TXOP or timing at which a response to the trigger frame is received is set as the start time of the Provisional TXOP period. The trigger frame is, for example, an MU-RTS (Multi-User Request To Send) TXS (TXOP Sharing) frame, and a response to the trigger frame may be a CTS (Clear To Send) signal. In the case of the third pattern, transmission timing of MU-RTS TXS 603 or a start time of a period 608 described later with reference to FIG. 6 is the start time of the Provisional TXOP period. The MU-RTS TXS frame is one MU-RTS frame that operates as a trigger frame for allocating a TXOP Sharing period.

[0047] A maximum obtainment period of Provisional TXOP is stored in Provisional TXOP Limit 525. The maximum obtainment period of Provisional TXOP may be set from the start time of any of the three patterns described above as a starting point to an end time of a period 609 described later with reference to FIG. 6, in units of microseconds or in units of 1 TU, that is, 32 microseconds. In this manner, by transmitting the maximum duration of Provisional TXOP, the

receiving AP can specify the maximum duration of the TXOP Sharing period. That is, Provisional TXOP Limit 525 need only be information by which the maximum duration of the TXOP Sharing period can be specified, and may have a different format.

[0048] With the frames in FIG. 4 and FIGS. 5A to 5C described above, notification of Provisional TXOP from the AP 103 to the AP 104 is enabled. Note that the configurations and values of the various fields are merely examples, and are not limited to these. For example, the value of Category for indicating an operation relating to C-TDMA may be "50," or the value of C-TDMA Action may be defined as "3." In addition, a field not illustrated may be inserted.

[0049] For example, information indicating whether TXOP Sharing is performed following a TXOP period in which a MAC frame including the Provisional TXOP notification element 512 is transmitted may be added. For example, in a case where a length predefined by a wireless system or a length of a TXOP Sharing period is set by another signal, notifying Provisional TXOP Limit 525 again can be overhead. For this reason, by notifying only information indicating whether TXOP Sharing is performed, it is possible to notify parameters for executing Provisional TXOP while reducing the size of the Action frame.

[0050] Next, with reference to FIG. 6, processing in which the AP 103, which is a wireless communication apparatus, executes TXOP Sharing for sharing an acquired TXOP with the AP 104, and further the AP 104 communicates with the STA 105 during the TXOP Sharing period will be described. That is, the AP 103 is a Sharing AP that shares a TXOP in C-TDMA, and the AP 104 is a Shared AP with which the transmission opportunity is shared.

[0051] The AP 103 that has obtained a TXOP performs a TXOP notification 601 to the AP 104. At this time, as the TXOP period notified by the AP 103, a period until implementation of TXOP Sharing is started is set. The TXOP notification is

implemented, for example, by data transmission or RTS. In this case, the TXOP period can be set in Duration/ID 402 in the MAC frame. In a case where the STA 105 connected to the AP 104 receives the TXOP notification 601 from the AP 103, the STA 105 sets a NAV (Network Allocation Vector) based on the value of Duration/ID 402. The STA 105 in which the NAV has been set is controlled not to transmit a frame. For this reason, since the NAV is released in the TXOP Sharing period 608 following the TXOP period 606, the STA 105 can transmit and receive frames in the TXOP Sharing period.

[0052] The AP 103 transmits the Provisional TXOP notification frame 602 to the AP 104 between transmission of the TXOP notification 601 and transmission of MU-RTS TXS 603. The Provisional TXOP notification frame 602 includes the element described with reference to FIGS. 5A to 5C, and includes information indicating the maximum duration of Provisional TXOP. In the following description, description is given assuming the first pattern described above, in other words that the start time of Provisional TXOP is the timing at which the AP 103 obtained the TXOP. For this reason, the maximum duration of Provisional TXOP is described as being the total time of the TXOP period 606 obtained by the AP 103, the TXOP Sharing period 608, and the period 609 in which the AP 103 continuously performs transmission after return of the TXOP. However, in a case where the start time of Provisional TXOP corresponds to the second or third pattern, the maximum duration of Provisional TXOP may also be changed accordingly. In addition, in a case where return of the TXOP is not performed, the period 609 need not be provided.

[0053] During the TXOP period 606, the AP 103 can perform data communication with an STA 106 connected to the AP 103. This data communication may be before transmission of the Provisional TXOP notification frame 602 or after transmission thereof. Alternatively, data communication may

be performed simultaneously with transmission of the TXOP notification 601. That is, in the TXOP period 606, during a period other than the TXOP Sharing period, the AP 103, which is a TXOP holder, can perform data communication. Meanwhile, in the TXOP Sharing period, the AP 104 with which the TXOP is shared from the TXOP holder can perform data communication.

[0054] Subsequently, when starting TXOP Sharing, the AP 103 transmits MU-RTS TXS 603 to the AP 104. Upon receiving MU-RTS TXS 603, the AP 104 responds by transmitting CTS 604. The AP 103 transmits MU-RTS TXS 603 so that transmission of CTS 604 by the STA is completed during the TXOP period. In other words, MU-RTS TXS 603 is a trigger frame that permits sharing of the TXOP, and CTS 604 is a response message indicating acceptance of sharing of the TXOP in response to MU-RTS TXS 603.

[0055] In the TXOP Sharing period 608, the AP 104 can perform data transmission to the STA 105. Even if the STA 105 has overheard transmission of the AP 103 during the TXOP period 606, since the NAV set upon receiving the TXOP notification 601 is released, the STA 105 can respond to data transmission from the AP 104.

[0056] In addition, the AP 104 transmits a TXOP return notification 605 to the AP 103 when the TXOP Sharing period 608 ends. The TXOP return notification 605 may be implemented, for example, by transmitting a CF (Contention Free)-End frame in which the destination is set to the AP 103. Alternatively, on condition that a time corresponding to the length of the TXOP Sharing period 608 notified by the Provisional TXOP notification frame 602 has elapsed, the TXOP may be implicitly regarded as having been returned. The AP 103 that has received the TXOP return notification 605 can freely perform data communication during the remaining TXOP period 609. In one example, the TXOP Sharing period 608 may be regarded as having ended, and a Provisional TXOP period 607 may be

regarded as having ended, on condition that a time corresponding to the length of the Provisional TXOP period 607 has elapsed.

[0057] Through the above operations, parameters for a Provisional TXOP operation for sharing a TXOP among the AP 103, the AP 104, and the STA 105 can be notified, and the TXOP can be efficiently shared.

[0058] Next, processing examples executed by the Sharing AP and the Shared AP will be described with reference to the flowcharts of FIGS. 7 and 8. FIG. 7 is a flowchart for describing a communication control example executed by the AP 103, which is a wireless communication apparatus operating as the Sharing AP. FIG. 8 is a flowchart for describing an example of communication control executed by the AP 104, which is a wireless communication apparatus operating as the Shared AP. FIG. 7 and FIG. 8 excerpt and illustrate a series of procedures from when the AP 103 obtains a TXOP and performs TXOP Sharing with the AP 104 until when the AP 104 ends the TXOP Sharing. Each process illustrated in the flowchart of FIG. 7 is executed by a processor of the control unit 202 of the AP 103 executing a computer program stored in the storage unit 201. Each process illustrated in the flowchart of FIG. 8 is executed by a processor of the control unit 202 of the AP 104 executing a computer program stored in the storage unit 201. Note that some processes such as transmission and modulation, and reception and decoding in FIG. 7 and FIG. 8 are realized through cooperation of the processor of the control unit 202 of each communication apparatus, the communication unit 206, and an ASIC, DSP, FPGA, and the like of the control unit 202. Note that, in a case where the entity that performs the processing is clearly indicated, the processing is described with the functional units described in FIG. 3 as subjects.

[0059] Communication control of the Sharing AP 103 will be described with reference to FIG. 7. In S701, the control unit 301 determines whether to perform

a Provisional TXOP operation in the obtained TXOP. The control unit 301 of the AP 103 advances the process to S702 in a case where the Provisional TXOP operation is implemented (Yes in S701), and advances the process to S707 in a case where TXOP Sharing is not implemented (No in S701).

[0060] In S702, the control unit 301 of the AP 103 calculates, as a duration of Provisional TXOP, the TXOP Sharing period 608 and times 606 and 609 used for the AP 103 to perform data communication. Note that in a case where the start time of Provisional TXOP corresponds to the second or third pattern described above, the duration of the Provisional TXOP period may be determined to be different.

[0061] In S703, the control unit 301 of the AP 103 cooperates with the frame generation unit 302 to transmit, as the TXOP notification 601, a frame in which the length of the TXOP period 606 until the TXOP Sharing period starts is set in the Duration field.

[0062] In S704, the control unit 301 of the AP 103 cooperates with the frame generation unit 302 to transmit the Provisional TXOP notification frame 602 in which the maximum duration of Provisional TXOP calculated in S702 is set. The maximum duration of Provisional TXOP is the total of the TXOP Sharing period 608 and the periods 606 and 609 used for the AP 103 to perform data communication, as described above. The Provisional TXOP notification frame 602 is, for example, the Action frame described with reference to FIGS. 5A to 5C. In addition, the duration of the Provisional TXOP period is set in Provisional TXOP Limit 525 in FIG. 5C.

[0063] In S705, the control unit 301 of the AP 103 transmits MU-RTS TXS 603, which is a trigger frame for implementing TXOP Sharing. In S706, the control unit 301 of the AP 103 waits without transmitting data until the TXOP return notification 605 is transmitted from the AP 104 or the Provisional TXOP period

set in S704 ends.

[0064] In a case where it is determined in S702 that Provisional TXOP is not implemented (Yes in S702), the control unit 301 of the AP 103 advances the process to S707. In S707, the control unit 301 of the AP 103 cooperates with the frame generation unit 302 to calculate a time required for data transmission, set the calculated time in Duration/ID 402 of a transmission frame, and perform TXOP notification.

[0065] In S708, the control unit 301 of the AP 103 performs data transmission. After S708, the AP 103 does not transmit the Provisional TXOP notification frame 602 and MU-RTS TXS 603 in FIG. 6, and ends the processing illustrated in FIG. 7 without sharing the TXOP.

[0066] Next, communication control of the AP 104 operating as the Shared AP will be described with reference to FIG. 8.

[0067] In S801, by receiving a Provisional TXOP notification from the AP 103, the AP 104 identifies that sharing of a TXOP is performed. In addition, by receiving the Provisional TXOP notification, the AP 104 can specify the maximum duration of the TXOP Sharing period.

[0068] Subsequently, in S802, the AP 104 receives MU-RTS TXS 601 from the AP 103. In S803, the control unit 301 of the AP 104 cooperates with the frame generation unit 302 to respond by transmitting CTS 604. When the response is transmitted in S803, the operation shifts to operation in a TXOP Sharing period in which a transmission opportunity for the AP 104 has been obtained.

[0069] In S804, after waiting for a SIFS time, the control unit 301 of the AP 104 transmits a TXOP notification toward the STA 105 connected to itself. Here, as the time set as the TXOP period, the same value as the length of the TXOP Sharing period 608 is set.

[0070] In S805, the control unit 301 of the AP 104 confirms whether there is data

to be transmitted. In a case where there is data to be transmitted (Yes in S805), the AP 104 advances the process to S806 and transmits data to the STA 105, and in a case where this is not the case (No in S805), advances the process to S808.

[0071] After transmitting the data, in S807, the control unit 301 of the AP 104 determines whether the TXOP Sharing period 608 has ended. In a case where the TXOP Sharing period 608 has not ended, the process returns to S805. In a case where the TXOP Sharing period 608 has ended (Yes in S807), the process advances to S808.

[0072] In S808, the control unit 301 of the AP 104 transmits the TXOP return notification 605 to the AP 103. The TXOP return notification 605 may be implemented, for example, by transmission of a CF-End frame in which the destination is set to the Sharing AP 103. In addition, in a case where the TXOP Sharing period 608 has ended and the process advances to S808, the control unit 301 of the AP 104 may end the TXOP Sharing period without transmitting a CF-End frame.

[0073] As described above, through the processing in FIGS. 6 to 8, parameters for executing Provisional TXOP can be notified from the AP 103 operating as the Sharing AP to the AP 104 operating as the Shared AP. In addition, in the TXOP Sharing period, communication between the AP 104 operating as the Shared AP and the STA 105 connected to the Shared AP becomes possible.

[0074] <Modification 1>

In the example, notification of parameters relating to Provisional TXOP is implemented by a C-TDMA Action frame, but the notification is not limited to this and may be implemented by an Action frame of QoS Action. An example of this case will be described with reference to FIGS. 9A to 9C.

[0075] As illustrated in FIG. 9A, in a QoS Action frame, the value “1” indicating that the Action frame is QoS Action is stored in a Category subfield 901 of the

Action field. As illustrated in FIG. 9B, a QoS Action field 911 indicating specific content of QoS Action is arranged in Action Details 902 following the Category field. The value "9" indicating notification of Provisional TXOP is stored in the QoS Action field 911. Subsequently, a Provisional TXOP Information field 912 in FIG. 9B is arranged.

[0076] In this manner, notification of parameters relating to Provisional TXOP can be performed using the Action frame. Note that the value of the QoS Action field is merely an example, and is not limited to this. For example, the value of the QoS Action field may be "10." In addition, a method of notifying information of Provisional TXOP using the Provisional TXOP Information field 912 has been shown. In one example, the Provisional TXOP notification element 512 described above with reference to FIG. 5C may be arranged instead.

[0077] As illustrated in FIG. 9C, the Provisional TXOP Information field 912 includes Provisional TXOP Start time 921 and a Provisional TXOP Limit subfield 922. Since the contents included in each are the same as the fields of the same names in the Provisional TXOP notification element 512 described above with reference to FIG. 5C, description thereof is omitted.

[0078] <Modification 2>

In the example, the TXOP return notification 605 is performed by a CF-End frame, but the TXOP return notification 605 is not limited to this and may be implemented by an Action frame different from the CF-End frame. For example, the TXOP return notification 605 can be implemented by applying the Action frame for C-TDMA described in FIG. 5.

[0079] FIG. 10 illustrates a configuration example of an Action frame in a case where TXOP return notification is performed using C-TDMA. In this case, a value indicating a use of the Action frame is stored in a Category field 1001. Here, the value "38" is stored to indicate that the frame is an Action frame used

for C-TDMA.

[0080] An Action Details field 1002 includes a field for indicating specific information about the use of the Action frame specified by the Category field. At the beginning of the Action Details field 1002, there is a C-TDMA Action field indicating a specific operation type among C-TDMA operations. Here, the value "1" is stored to indicate that, among C-TDMA operations, TXOP return notification is performed.

[0081] Note that although a modification using the C-TDMA category has been shown, the modification is not limited to this, and return of a TXOP may be notified by an Action frame of QoS Action. In this case, as in Modification 1, the value "1" indicating QoS Action is stored in the Category field, and the value "10" is stored in the QoS Action field to indicate TXOP return notification.

[0082] <Other Embodiments>

In the present embodiment, description has been given assuming that parameters relating to Provisional TXOP are transmitted by an Action frame. However, another frame may be used as long as the frame includes the Provisional TXOP notification element illustrated in FIG. 5C or the Provisional TXOP Information field illustrated in FIG. 9C. For example, parameters relating to Provisional TXOP may be transmitted by a Beacon frame.

[0083] Note that a recording medium storing program code of software for realizing the above-described functions may be supplied to a system or an apparatus, and a computer (CPU, MPU) of the system or apparatus may read out and execute the program code stored in the recording medium. In this case, the program code itself read out from the storage medium realizes the functions of the above-described embodiments, and the storage medium storing the program code constitutes the above-described apparatus.

[0084] As a storage medium for supplying program code, for example, a flexible

disk, a hard disk, an optical disk, a magneto-optical disk, a CD-ROM, a CD-R, a magnetic tape, a nonvolatile memory card, a ROM, a DVD, or the like can be used.

[0085] In addition, not only may the above-described functions be realized by a computer executing the read-out program code, but an OS running on the computer may perform part or all of actual processing based on instructions of the program code and realize the above-described functions. OS is an abbreviation for Operating System.

[0086] Furthermore, the program code read out from the storage medium is written into a memory included in a function expansion board inserted into the computer or a function expansion unit connected to the computer. Then, based on instructions of the program code, a CPU included in the function expansion board or the function expansion unit may perform part or all of actual processing and realize the above-described functions.

[0087] The present invention can be implemented by processing of supplying a program for implementing one or more functions of the above-described embodiments to a system or apparatus via a network or storage medium, and causing one or more processors in the computer of the system or apparatus to read out and execute the program. The present invention can also be implemented by a circuit (for example, an ASIC) for implementing one or more functions.

[0088] The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention. Therefore, to apprise the public of the scope of the present invention, the following claims are made.

[0089] The present application claims priority based on Japanese Patent Application No. 2024-057618 filed on March 29, 2024, the entire contents of which are incorporated herein by reference.

CLAIMS

1. A communication apparatus capable of wireless communication compliant with an IEEE 802.11 series standard, characterized in that the communication apparatus comprises a transmission means for transmitting, to another communication apparatus in a transmission opportunity (TXOP) period obtained by the communication apparatus,

a wireless frame for executing TXOP sharing among a plurality of apparatuses, in which a TXOP obtained by the communication apparatus is allocated to the other communication apparatus to obtain a TXOP Sharing period, and

a trigger frame for allocating the TXOP to the other communication apparatus,

wherein the wireless frame includes at least one of predetermined information by which a maximum duration of the TXOP Sharing period can be specified, and information indicating that the TXOP Sharing period is arranged after the TXOP period obtained by the communication apparatus.

2. The communication apparatus according to claim 1, characterized in that the predetermined information is included in an Information Element.

3. The communication apparatus according to claim 1 or 2, characterized in that the wireless frame is a Beacon frame.

4. The communication apparatus according to any one of claims 1 to 3, characterized in that the wireless frame is an Action frame.

5. The communication apparatus according to claim 4, characterized in that the predetermined information is included in a Frame Body field of the Action frame.

6. The communication apparatus according to any one of claims 1 to 5,

characterized in that the transmission means transmits the wireless frame after transmitting a second wireless frame for obtaining a TXOP.

7. The communication apparatus according to claim 6, characterized in that the second wireless frame includes information by which start timing of the TXOP Sharing period can be specified.

8. The communication apparatus according to claim 7, characterized in that the second wireless frame is an Action frame, and the information by which the start timing of the TXOP Sharing period can be specified is included in a Duration field of the Action frame.

9. The communication apparatus according to any one of claims 1 to 8, characterized in that the communication apparatus further comprises a reception means for receiving a TXOP return notification from the other communication apparatus,

wherein the return notification is an Action frame.

10. The communication apparatus according to any one of claims 1 to 9, characterized in that the wireless frame includes information indicating that the TXOP Sharing period is arranged after the TXOP obtained by the communication apparatus,

wherein the transmission means transmits a third wireless frame including predetermined information by which a maximum duration of the TXOP Sharing period can be specified before the TXOP obtained by the communication apparatus.

11. The communication apparatus according to any one of claims 1 to 10, characterized in that the trigger frame is an MU-RTS (Multi-User Request To Send) trigger frame.

12. A communication apparatus capable of wireless communication compliant with an IEEE 802.11 series standard, characterized in that the communication

apparatus comprises: a reception means for receiving, from another communication apparatus in a transmission opportunity (TXOP) period obtained by the other communication apparatus,

a wireless frame for executing TXOP sharing among a plurality of apparatuses, in which a TXOP obtained by the other communication apparatus is allocated from the other communication apparatus as a TXOP Sharing period, and

a trigger frame for allocating the TXOP to the communication apparatus in the transmission opportunity (TXOP) obtained by the other communication apparatus; and

a transmission means for transmitting a CTS (Clear To Send) frame as a response to receiving the trigger frame,

wherein the wireless frame includes at least one of predetermined information by which a maximum duration of the TXOP Sharing period can be specified, and information indicating that the TXOP Sharing period is arranged after the TXOP period obtained by the communication apparatus.

13. A control method executed by a communication apparatus capable of wireless communication compliant with an IEEE 802.11 series standard, the method comprising: transmitting, to another communication apparatus in a transmission opportunity (TXOP) period obtained by the communication apparatus,

a wireless frame for executing TXOP sharing among a plurality of apparatuses, in which a TXOP obtained by the communication apparatus is allocated to the other communication apparatus to obtain a TXOP Sharing period, and

a trigger frame for allocating the TXOP to the other communication apparatus,

wherein the wireless frame includes at least one of predetermined

information by which a maximum duration of the TXOP Sharing period can be specified, and information indicating that the TXOP Sharing period is arranged after the TXOP period obtained by the communication apparatus.

14. A control method executed by a communication apparatus capable of wireless communication compliant with an IEEE 802.11 series standard, the method comprising: receiving, from another communication apparatus in a transmission opportunity (TXOP) period obtained by the other communication apparatus,

a wireless frame for executing TXOP sharing among a plurality of apparatuses, in which a TXOP obtained by the other communication apparatus is allocated from the other communication apparatus as a TXOP Sharing period, and

a trigger frame for allocating the TXOP to the communication apparatus in a TXOP obtained by the other communication apparatus; and

transmitting a CTS (Clear To Send) frame as a response to receiving the trigger frame,

wherein the wireless frame includes at least one of predetermined information by which a maximum duration of the TXOP Sharing period can be specified, and information indicating that the TXOP Sharing period is arranged after the TXOP period obtained by the communication apparatus.

15. A program for causing a computer to function as the communication apparatus according to any one of claims 1 to 12.