standard control field is 10, it indicates that the first frame is a frame of an EHT variant; or when a value of the standard control field is 11, it indicates that the first frame is a frame of a ranging variant. Alternatively, when a value of the standard control field is 00, it indicates that the first ~~NDPA~~ frame is a frame of a VHT variant; when a value of the standard control field is 01, it indicates that the first ~~NDPA~~ frame is a frame of an HE variant; when a value of the standard control field is 10, it indicates that the first ~~NDPA~~ frame is a frame of a ranging variant; or when a value of the standard control field is 11, it indicates that the first ~~NDPA~~ frame is a frame of an EHT variant.

[0034] Optionally, the third field includes a standard control field including bits of a ranging field and an HE field in the sounding dialog token field, and one or more bits in a station information field. When a value of the standard control field is 00, it indicates that the first frame is a frame of a VHT variant or a frame of an EHT variant; when a value of the standard control field is 01, it indicates that the first frame is a frame of an HE variant; when a value of the standard control field is 10, it indicates that the first frame is a frame of a ranging variant; or when a value of the standard control field is 11, it indicates that the first frame is invalid or reserved for future use. When the value of the standard control field is 00, it indicates that the first frame is the frame of the VHT variant or the frame of the EHT variant. Therefore, distinguishing may be further performed based on one or more bits in the station information field.

[0035] In an example, one bit in the station information field may be occupied, and the bit is used to further indicate whether the first frame is a frame of a VHT variant or a frame of an EHT variant.

[0036] For example, a new disambiguation field may be set in the station information field. When a value of the disambiguation field is 0, it indicates that the first frame is a frame of a VHT variant; or when a value of the disambiguation field is 1, it indicates that the first frame is a frame of an EHT variant. Alternatively, when a value of the disambiguation field is 1, it indicates that the first frame is a frame of a VHT variant; or when a value of the disambiguation field is 0, it indicates that the first frame is a frame of an EHT variant.

[0037] For another example, one bit in an association identifier field may be used to further indicate whether the first frame is a frame of a VHT variant or a frame of an EHT variant. When a value of the bit is 0, it indicates that the first frame is a frame of a VHT variant; or when a value of the bit is 1, it indicates that the first frame is a frame of an EHT variant. Alternatively, when a value of the bit is 1, it indicates that the first frame is a frame of a VHT variant; or when a value

accompanying drawings.

[00217] The technical solutions of embodiments of this application may be applied to various communication systems, such as a wireless local area network (wireless local area network, WLAN) communication system, a global system for mobile communications (global system of mobile communication, GSM) system, a code division multiple access (code division multiple access, CDMA) system, a wideband code division multiple access (wideband ~~5~~ code division multiple access, WCDMA) system, a general packet radio service (general packet radio service, GPRS) system, a long term evolution (long term evolution, LTE) system, an LTE frequency division duplex (frequency division duplex, FDD) system, LTE time division duplex (time division duplex, TDD), a universal mobile telecommunications system (universal mobile telecommunication system, UMTS), a worldwide interoperability for microwave access (worldwide interoperability for microwave access, WiMAX) communication system, and a 5th generation (5th generation, ~~10~~ 5G) system or new radio (new radio, NR).

[00218] The following is used as an example for description. Only a WLAN system is used as an example below to describe an application scenario in embodiments of this application and a method in embodiments of this application.

[00219] Specifically, embodiments of this application may be applied to a wireless local area network (wireless local area network, WLAN), and embodiments of this application may be applied to any protocol in the IEEE 802.11 series protocols currently used in a WLAN. The WLAN may include one or more basic service sets (basic service set, BSS), and network nodes in the basic service set include an AP and a STA.

[00220] Specifically, in embodiments of this application, an initiating device and a responding device may be user stations (STA) in the WLAN. The user station may also be referred to as a system, a subscriber unit, an access terminal, a mobile station, a mobile, a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless communication device, a user agent, a user apparatus, or user equipment (user equipment, UE). The STA may be a cellular phone, a cordless phone, a session initiation protocol (session initiation protocol, SIP) phone, a wireless local loop (wireless local loop, WLL) station, a personal digital assistant (personal digital assistant, PDA), a handheld device having a wireless local area network (for example, Wi-Fi) communication function, a wearable device, a computing device, or another processing device connected to a wireless modem.

is assumed that there is one primary AP (primary ~~maser~~ AP) and one or more secondary APs (secondary ~~slave~~ AP) among a plurality of APs participating in D-MIMO transmission. The primary AP first sends a secondary trigger (slave trigger) frame to the secondary AP. After receiving the secondary trigger frame, the secondary AP estimates a carrier frequency offset (carrier frequency offset, CFO) and the like. Then, the primary AP and the secondary AP simultaneously send an NDPA to a STA, to indicate the STA to prepare for channel sounding. Then, the primary AP sends a secondary trigger frame to the secondary AP again. After receiving the secondary trigger frame, the secondary AP estimates a CFO and the like again and estimates a reference channel, so that the secondary AP performs pre-correction before the secondary AP sends an NDP, to synchronize with the primary AP. Finally, the primary AP and the secondary AP send an NDP packet to the STA simultaneously. The STA is not shown in FIG. 6. After receiving the NDPAs, the STA learns that the STA is to participate in channel sounding. After receiving the NDPs, the STA performs channel estimation. Similar to the procedures in FIG. 4 and FIG. 5, in a subsequent procedure, the STA feeds back a beamforming report to each of the primary AP and the secondary AP.

[00233] The NDPA frame, the NDP frame, the trigger frame, and the beamforming report frame in FIG. 4 to FIG. 6 may be shown in FIG. 7, FIG. 8, FIG. 9, and FIG. 10, respectively.

[00234] FIG. 7 shows a frame structure of an NDPA frame. The frame structure shown in FIG. 7 is a frame structure of an NDPA frame in IEEE 802.11ax. The NDPA frame in IEEE 802.11ax is also referred to as a high efficiency (high efficient, HE) NDPA frame. The NDPA frame inherits a type and a subtype of a very high throughput (very high throughput, VHT) NDPA frame, and uses a reserved bit in a sounding dialog token (sounding dialog token) field to distinguish between the VHT NDPA and the HE NDPA. Compared with that in the VHT NDPA, a station information field in the HE NDPA frame is extended to four bytes, and partial bandwidth information (Partial BW Info) is introduced to indicate a resource used by the STA to feed back channel state information. A resource unit (resource unit, RU) start index (start index) to an RU end index (end index) may indicate a segment of contiguous RUs. In addition, a number of grouping (number of grouping, Ng) is used to indicate that Ng subcarriers are grouped into one group. All of the group of subcarriers only need to feed back channel state information, to reduce feedback compression. A codebook size (codebook size) is used to indicate quantization precision. Different precision corresponds to different overheads.

[00235] FIG. 8 shows a frame structure of an NDP frame. As shown in FIG. 8, the NDP frame

includes a non-high-throughput short training field (non-high-throughput short training field, L-STF), a non-high-throughput long training field (non-high-throughput long training field, L-LTF), a non-high-throughput signal field (non-high-throughput signal field, L-SIG), an extremely high throughput short training field (extremely high throughput short training field, EHT-STF), an extremely high throughput long training field (extremely high throughput long training field, EHT-LTF~~SIG~~), an extremely high throughput signal field (extremely high throughput signal field, EHT-SIG), and a packet extension field.

[00236] FIG. 9 shows a frame structure of a trigger frame. The frame structure shown in FIG. 9 is a trigger frame of a beamforming report poll (beamforming report poll, BFRP) variant. The trigger frame is one of a plurality of trigger frame variants, and is used to trigger a plurality of STAs to simultaneously feed back a beamforming report. As shown in (a) in FIG. 9, a frame format of the trigger frame includes a common field and a user information list, and (b) in FIG. 9 shows content included in one piece of user information in the user information list.

[00237] FIG. 10 shows a frame structure of a beamforming report frame. A frame carrying channel state information in IEEE 802.11ax is referred to as a high efficiency compressed beamforming and channel state information report (HE compressed beamforming and CQI report) frame, which includes an HE MIMO control field and a beamforming report field. FIG. 10 shows an HE MIMO control field. In some embodiments, in addition to feeding back CSI, the high efficiency compressed beamforming and channel state information report frame in IEEE 802.11ax may further feed back CQI including only a signal-to-noise ratio. It should be noted that, in this application, the CSI and the CQI are not specifically distinguished below, and are collectively referred to as CSI.

[00238] It can be learned from the foregoing content that more channel state feedback information is required if larger bandwidth and more spatial streams are introduced. This causes higher feedback overheads.

[00239] Therefore, how to reduce channel state information feedback overheads becomes an urgent problem to be resolved.

[00240] To resolve the foregoing problem, this application provides a channel sounding method and apparatus, to reduce channel state information feedback overheads.

[00241] The following describes in detail the technical solutions provided in this application with reference to the accompanying drawings. Embodiments of this application may be applied to

[00349] As shown in FIG. 25, an apparatus 2500 includes a processing unit 2510 and a transceiver unit 2520. The apparatus 2500 is configured to implement the functions of the first communication device or the second communication device in any one of the foregoing method embodiments.

[00350] When the apparatus 2500 is configured to implement the functions of the first communication device in the method embodiments, the transceiver unit 2520 is configured to send a first frame to the second communication device, where the first frame is used to indicate the second communication device to perform channel sounding on a part of antennas of the first communication device. The transceiver unit 2520 is further configured to send a second frame to the second communication device, where the second frame is used by the second communication device to perform channel sounding on the part of antennas. The transceiver unit 2520 is further configured to receive a third frame from the second communication device, where the third frame is used to indicate a result of performing channel sounding on the part of antennas.

[00351] Alternatively, the transceiver unit 2520 is configured to send a first frame to the second communication device, where the first frame is used to indicate the second communication device to perform channel sounding on a part of communication devices in a communication device group to which the first communication device belongs. The transceiver unit 2520 is further configured to send a second frame to the second communication device, where the second frame is used by the second communication device to perform channel sounding on the part of communication devices. The transceiver unit 2520 is further configured to receive a third frame from the second communication device, where the third frame is used to indicate a result of performing channel sounding on the part of communication devices.

[00352] When the apparatus 2500 is configured to implement the functions of the second communication device in the method embodiments, the transceiver unit 2520 is configured to receive a first frame from the first communication device, where the first frame is used to indicate the second communication device to perform channel sounding on a part of antennas of the first communication device. The transceiver unit 2520 is further configured to receive a second frame sent by the first communication device, where the second frame is used by the second communication device to perform channel sounding on the part of antennas. The processing unit 2510 is configured to perform channel sounding on the part of antennas based on the second frame. The transceiver unit 2520 is further configured to send~~, by the second communication device,~~ a

third frame to the first communication device, where the third frame is used to indicate a result of performing channel sounding on the part of antennas.

[00353] Alternatively, the transceiver unit 2520 is configured to receive a first frame from the first communication device, where the first frame is used to indicate the second communication device to perform channel sounding on a part of communication devices in a communication device group to which the first communication device belongs. The transceiver unit 2520 is further configured to receive a second frame sent by the first communication device, where the second frame is used by the second communication device to perform channel sounding on the part of communication devices. The processing unit 2510 is configured to perform channel sounding on the part of communication devices based on the second frame. The transceiver unit 2520 is further configured to send~~, by the second communication device,~~ a third frame to the first communication device, where the third frame is used to indicate a result of performing channel sounding on the part of communication devices.

[00354] For more detailed description about the processing unit 2510 and the transceiver unit 2520, refer to related description in the method embodiments directly. Details are not described herein again.

[00355] As shown in FIG. 26, an apparatus 2600 includes a processor 2610 and an interface circuit 2620. The processor 2610 and the interface circuit 2620 are coupled to each other. It may be understood that the interface circuit 2620 may be a transceiver or an input/output interface. Optionally, the apparatus 2600 may further include a memory 2630, configured to store instructions executed by the processor 2610, store input data required by the processor 2610 to run instructions, or store data generated after the processor 2610 runs instructions.

[00356] When the apparatus 2600 is configured to implement the foregoing methods, the processor 2610 is configured to perform functions of the processing unit ~~2610~~2510, and the interface circuit 2620 is configured to perform functions of the transceiver unit ~~2620~~2520.

[00357] When the apparatus is a chip used in the first communication device, the chip implements the functions of the first communication device in the foregoing method embodiments. The chip receives information from another module (for example, a radio frequency module or an antenna) of the first communication device, where the information is sent by the second communication device to the first communication device. Alternatively, the chip sends information to another module (for example, a radio frequency module or an antenna) of the first

communication device, where the information is sent by the first communication device to the second communication device.

[00358] When the apparatus is a chip used in the second communication device, the chip implements the functions of the second communication device in the foregoing method embodiments. The chip receives information from another module (for example, a radio frequency module or an antenna) of the second communication device~~a network device~~, where the information is sent by the first communication device to the second communication device. Alternatively, the chip sends information to another module (for example, a radio frequency module or an antenna) of the second communication device, where the information is sent by the second communication device to the first communication device.

[00359] It should be noted that the processor in embodiments of this application may be a central processing unit (Central Processing Unit, CPU), may be another general-purpose processor, a digital signal processor (Digital Signal Processor, DSP), an application-specific integrated circuit (Application Specific Integrated Circuit, ASIC), a field programmable gate array (Field Programmable Gate Array, FPGA), or another programmable logic device, a transistor logic device, a hardware component, or any combination thereof. The general-purpose processor may be a microprocessor or any conventional processor.

[00360] The method steps in embodiments of this application may be implemented by using hardware, or may be implemented by executing software instructions by the processor. The software instructions may include a corresponding software module. The software module may be stored in a random access memory (Random Access Memory, RAM), a flash memory, a read-only memory (Read-Only Memory, ROM), a programmable read-only memory (Programmable ROM, PROM), an erasable programmable read-only memory (Erasable PROM, EPROM), an electrically erasable programmable read-only memory (Electrically EPROM, EEPROM), a register, a hard disk drive, a removable hard disk, a CD-ROM, or any other form of storage medium well-known in the art. For example, a storage medium is coupled to the processor, so that the processor can read information from the storage medium and can write information into the storage medium. Certainly, the storage medium may be a component of the processor. The processor and the storage medium may be located in an ASIC. In addition, the ASIC may be located in a network device or a terminal device. Certainly, the processor and the storage medium may alternatively exist in a network device or a terminal device as discrete components.

CLAIMS

What is claimed is:

1. A channel sounding method, comprising:

sending, by a first communication device, a first frame to a second communication device, wherein the first frame is used to indicate the second communication device to perform channel sounding on a part of antennas of the first communication device;

sending, by the first communication device, a second frame to the second communication device, wherein the second frame is used by the second communication device to perform channel sounding on the part of antennas; and

receiving, by the first communication device, a third frame from the second communication device, wherein the third frame is used to indicate a result of performing channel sounding on the part of antennas.

2. The method according to claim 1, wherein before the receiving, by the first communication device, a third frame from the second communication device, the method further comprises:

sending, by the first communication device, a fourth frame to the second communication device, wherein the fourth frame is used to indicate the second communication device to send the third frame to the first communication device.

3. The method according to claim 1 or 2, wherein before the sending, by a first communication device, a first frame to a second communication device, the method further comprises:

sending, by the first communication device, a training frame to the second communication device, wherein the training frame is used to perform channel sounding on all the antennas of the first communication device;

receiving, by the first communication device, a feedback frame from the second communication device; and

determining, by the first communication device, the part of antennas based on the feedback frame.

4. The method according to claim 3, wherein before the sending, by the first communication device, a training frame to the second communication device, the method further comprises:

sending, by the first communication device, a pre-training frame to the second communication device, wherein the pre-training frame is used to indicate the second

communication device to perform channel sounding on all the antennas of the first communication device.

5. The method according to claim 3 or 4, wherein before the receiving, by the first communication device, a feedback frame from the second communication device, the method further comprises:

sending, by the first communication device, a trigger frame to the second communication device, wherein the trigger frame is used to indicate the second communication device to send the feedback frame to the first communication device.

6. The method according to any one of claims 1 to 5, wherein the first frame comprises a first field, wherein the first field is used to indicate a part of panels of the first communication device, and the part of antennas comprises an antenna corresponding to the part of panels.

7. The method according to any one of claims 1 to 5, wherein the first frame comprises a first field, wherein the first field is used to carry an antenna index, and the antenna index is used to indicate the part of antennas.

8. The method according to claim 6 or 7, wherein the first frame further comprises a second field, wherein the second field is used to indicate that the first field is used to indicate a part of panels of the first communication device or carry an antenna index.

9. The method according to any one of claims 1 to 8, wherein the first frame comprises a third field, wherein the third field is used to indicate that the first frame is a frame of an extremely high throughput EHT variant.

10. The method according to any one of claims 1 to 8, wherein the first frame is a null data packet announcement (NDPA) frame, and the first frame comprises a third field, wherein the third field comprises a standard control field; and

when a value of the standard control field is 00, it indicates that the first frame is a frame of a very high throughput (VHT) variant;

when a value of the standard control field is 01, it indicates that the first frame is a frame of a high efficiency (HE) variant;

when a value of the standard control field is 10, it indicates that the first frame is a frame of a ranging (Ranging) variant; or

when a value of the standard control field is 11, it indicates that the first frame is a frame of an extremely high throughput (EHT) variant.

11. The method according to any one of claims 1 to 10, wherein the second frame comprises an extremely high throughput (EHT) signal field, an EHT short training field, and an EHT long training field, wherein the part of antennas corresponds to at least two antenna panels, the second frame comprises at least two second subframes, and the EHT long training field in the second subframe comprises a long training field of an antenna corresponding to one of the at least two antenna panels.

12. A channel sounding method, comprising:

receiving, by a second communication device, a first frame from a first communication device, wherein the first frame is used to indicate the second communication device to perform channel sounding on a part of antennas of the first communication device;

receiving, by the second communication device, a second frame sent by the first communication device, wherein the second frame is used by the second communication device to perform channel sounding on the part of antennas;

performing, by the second communication device, channel sounding on the part of antennas based on the second frame; and

sending, by the second communication device, a third frame to the first communication device, wherein the third frame is used to indicate a result of performing channel sounding on the part of antennas.

13. The method according to claim 12, wherein before the sending, by the second communication device, a third frame to the first communication device, the method further comprises:

receiving, by the second communication device, a fourth frame sent by the first communication device, wherein the fourth frame is used to indicate the second communication device to send the third frame to the first communication device.

14. The method according to claim 12 or 13, wherein before the receiving, by a second communication device, a first frame from a first communication device, the method further comprises:

receiving, by the second communication device, a training frame from the first communication device, wherein the training frame is used to perform channel sounding on all the antennas of the first communication device; and

sending, by the second communication device, a feedback frame to the first communication

device, so that the first communication device determines the part of antennas based on the feedback frame.

15. The method according to claim 14, wherein before the receiving, by the second communication device, a training frame from the first communication device, the method further comprises:

receiving, by the second communication device, a pre-training frame sent by the first communication device, wherein the pre-training frame is used to indicate the second communication device to perform channel sounding on all the antennas of the first communication device.

16. The method according to claim 14 or 15, wherein before the sending, by the second communication device, a feedback frame to the first communication device, the method further comprises:

receiving, by the second communication device, a trigger frame from the first communication device, wherein the trigger frame is used to indicate the second communication device to send the feedback frame to the first communication device.

17. The method according to any one of claims 12 to 16, wherein the first frame comprises a first field, wherein the first field is used to indicate a part of panels of the first communication device, and the part of antennas comprises an antenna corresponding to the part of panels.

18. The method according to any one of claims 12 to 16, wherein the first frame comprises a first field, wherein the first field is used to carry an antenna index, and the antenna index is used to indicate the part of antennas.

19. The method according to claim 17 or 18, wherein the first frame further comprises a second field, wherein the second field is used to indicate that the first field is used to indicate a part of panels of the first communication device or carry an antenna index.

20. The method according to any one of claims 12 to 19, wherein the first frame comprises a third field, wherein the third field is used to indicate that the first frame is a frame of an extremely high throughput (EHT) variant.

21. The method according to any one of claims 12 to 19, wherein the first frame is a null data packet announcement (NDPA) frame, and the first frame comprises a third field, wherein the third field comprises a standard control field; and

when a value of the standard control field is 00, it indicates that the first frame is a frame of

a very high throughput (VHT) variant;

when a value of the standard control field is 01, it indicates that the first frame is a frame of a high efficiency (HE) variant;

when a value of the standard control field is 10, it indicates that the first frame is a frame of a ranging (Ranging) variant; or

when a value of the standard control field is 11, it indicates that the first frame is a frame of an extremely high throughput (EHT) variant.

22. The method according to any one of claims 12 to 21, wherein the second frame comprises an extremely high throughput (EHT) signal field, an EHT short training field, and an EHT long training field, wherein the part of antennas corresponds to at least two antenna panels, the second frame comprises at least two second subframes, and the EHT long training field in the second subframe comprises a long training field of an antenna corresponding to one of the at least two antenna panels.

23. A channel sounding apparatus, comprising:

a memory, configured to store computer instructions; and

a processor, configured to execute the computer instruction stored in the memory, to enable the channel sounding apparatus to perform the method according to any one of claims 1 to 11, or enable the channel sounding apparatus to perform the method according to any one of claims 12 to 22.

24. A computer-readable storage medium, configured to store computer instructions, wherein when the computer instructions are executed by a computer, the computer is enabled to perform the method according to any one of claims 1 to 11, or the computer is enabled to perform the method according to any one of claims 12 to 22.

25. A communication system, comprising a first channel sounding apparatus and a second channel sounding apparatus, wherein the first channel sounding apparatus is configured to perform the method according to any one of claims 1 to 11, and the second channel sounding apparatus is configured to perform the method according to any one of claims 12 to 22.

26. A computer program product, comprising instructions, wherein when the instructions are executed by a computer, the computer is enabled to perform the method according to any one of claims 1 to 11, or the computer is enabled to perform the method according to any one of claims 12 to 22.