[0061] Based on the foregoing technical solution, the multi-link device (for example, the first device) may flexibly select the number of spatial streams of the link based on a requirement. In addition, information about the operating mode information is notified to the second device, for example, spatial streams of links of the second device are notified, or bandwidth of the links may be further notified. In this way, the second device can perform communication based on the determined communication parameter.

[0062] With reference to the third aspect or the fourth aspect, in some implementations, a frame structure of the fifth configuration information includes a spatial stream SS allocation SS field and a link identifier ID field, and the SS allocation field is used to carry allocation information of a spatial stream.

[0063] The SS allocation field is used to carry the allocation information of the spatial stream. In other words, the SS allocation field may carry allocation information of all spatial streams allocated to all links.

[0064] The link ID field may carry identification information of the link, that is, indicate the links to which the spatial streams are allocated.

[0065] Based on the foregoing technical solution, information about the link allocated to the spatial stream can be learned.

[0066] With reference to the third aspect or the fourth aspect, in some implementations, a frame structure of the fifth configuration information includes an SS allocation field and a link bitmap field, and the SS allocation field is used to carry allocation information of a spatial stream.

[0067] The SS allocation field is used to carry the allocation information of the spatial stream. In other words, the SS allocation field may carry allocation information of all spatial streams allocated to all links.

[0068] The link bitmap field may indicate the links to which the spatial streams are allocated.

[0069] Based on the foregoing technical solution, the links to which the spatial streams are allocated can be learned by using a bitmap.

[0070] With reference to the third aspect or the fourth aspect, in some implementations, a frame structure of the fifth configuration information includes a link ID field and a number of spatial streams NSS field, and the link ID field and the NSS field respectively indicate an identifier of a link and a number of allocated spatial streams.

waste of resources.

[00156] Optionally, the first configuration or the second configuration may include one or more communication parameters.

[00157] For example, the communication parameter may include a link ID. By using the link ID, the first device may determine a communication link, or in other words, determining a link on which communication is performed, to perform communication on the determined link. This improves communication performance. In addition, the communication parameters may further include a number of spatial streams of the link, bandwidth of the link, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode. The first device may perform communication based on the communication parameters.

[00158] The following describes manners of determining the first configuration and the second configuration.

[00159] (1) First configuration

[00160] Manner 1: One or more stations of the first device separately send information about the first configuration to one or more stations of the second device.

[00161] In other words, the one or more stations of the first device separately send the configuration information to the one or more stations of the second device, to separately indicate an operating parameter of each station of the first device.

[00162] Manner 2: One station of the first device sends information about the first configuration to one station of the second device.

[00163] In other words, the one station of the first device sends the configuration information to the one station of the second device, to indicate an operating parameter of each station on the plurality of links of the first device.

[00164] The operating parameter may include the link ID. In addition, operating parameters may further include operating bandwidth, an NSS, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode.

[00165] For example, the first configuration may be carried in existing signaling. For example, the first configuration may be carried in an OMI control information field, or carried in an extremely high throughput (extremely high throughput, EHT) operation element (EHT operation element).

device on the links ends, so that the first device may disable the links.

[00250] It should be understood that the more data field is merely an example for description, and this embodiment of this application is not limited thereto. For example, a field may be redefined in the data frame as the third field.

[00251] Method 2: Whether sending of the data by the second device ends is determined based on control information carried by the second device in the data frame.

[00252] For example, the control information is carried in a fourth field. In this case, it may be determined, based on a value of the fourth field, whether sending of the data by the second device ends.

[00253] The fourth field may be, for example, a multi-link more data (multi-link more data) field, and a name of the fourth field does not limit the protection scope of embodiments of this application.

[00254] Optionally, the first device may determine, based on the value of the fourth field, whether sending of the data by the second device ends. It is assumed that a value of the fourth field may be a third value or a fourth value, and the third value and the fourth value are different. For example, when the value of the fourth field is the third value, it indicates that sending of the data by the second device ends, so that the first device may restore the second configuration for use; or when the value of the fourth field is the fourth value, it indicates that sending of the data by the second device does not end, so that the first device continues to use the first configuration. For example, the third value is 0, and the fourth value is 1; or the third value is 1, and the fourth value is 0.

[00255] For example, the fourth field may be a newly defined field, or may be an existing field. This is not limited herein.

[00256] For example, the fourth field may be carried at a physical layer, for example, carried in a signaling field of a physical layer preamble; or may be carried in media access control (media access control, MAC), for example, carried in a MAC header (header). For example, the fourth field is carried in the MAC. For example, the fourth field may be carried in an OMI field or a command and status (command and status, CAS) field. For another example, a new control information type may be defined to carry the fourth field. For example, the new control information type is defined in a high efficiency (high efficiency, HE) variant of a high throughput (high throughput, HT) control field (HE variant of HT Control field) to carry the fourth field.

structure may further include a quantity of links (number of links).

[00299] For example, the link profile may include a link ID and a number of spatial streams (namely, a number of spatial streams of a link, or both of a Tx NSS and an Rx NSS that may be indicated by using one parameter). Alternatively, bandwidth (namely, bandwidth of the link, for example, maximum bandwidth of the link) may be further included.

[00300] In still another possible design, the information about the third configuration may be carried by using a frame structure shown in FIG. 9.

[00301] Different from FIG. 8, in the frame structure shown in FIG. 9, a number of spatial streams of each link may include a Tx NSS and an Rx NSS.

[00302] It should be understood that the frame structures shown in FIG. 8 and FIG. 9 are merely examples for description. This is not limited in this embodiment of this application. For example, the frame structure may include more fields or fewer fields.

[00303] Based on the foregoing case 2, the first device may switch from performing communication by using the second configuration to performing communication by using the third configuration. In addition, the second device may recommend, to the first device based on an actual communication requirement, a configuration parameter, namely, the third configuration, for transmitting a data frame. This can improve data transmission performance.

[00304] Case 3: The first device uses, for communication, a fourth configuration obtained after the third configuration is adjusted.

[00305] It may be understood that, in the case 3, in the second communication mode, the first device may switch from the second configuration to the fourth configuration.

[00306] The following provides description by using an example with reference to a method 1000 shown in FIG. 10.

[00307] 1010: The first device performs communication by using the second configuration.

[00308] 1020: A second device sends information about the third configuration to the first device by using a first parameter.

[00309] In other words, the second device sends a configuration recommendation frame to the first device. The first parameter indicates a parameter supported by the second configuration.

[00310] For the third configuration, refer to the description in the case 2. Details are not described herein again.

[00311] 1030: The first device determines the fourth configuration based on the third

[00354] It is assumed that there are a maximum of 16 spatial streams, and the spatial streams may be allocated to a maximum of four links. After calculation, there may be at least 576 allocation schemes. Therefore, 10 bits may be used to distinguish each allocation scheme. As shown in FIG. 13, the link ID 1, the link ID 2, the link ID 3, and the link ID 4 are identification information of links, that is, indicate the links to which the spatial streams are allocated. If a number of allocated links is less than 4, a special link identifier, for example, a dummy link identifier (dummy link ID), may also indicate that link indication is complete. For example, when the special link identifier is all 1s (that is, a value of each bit is 1), it indicates that the link indication is complete.

[00355] Design 2: The frame structure may include an SS allocation field and a link bitmap (bitmap) field.

[00356] The SS allocation field may carry allocation information of a spatial stream. In other words, the SS allocation field may carry allocation information of all spatial streams allocated to all links.

[00357] The link bitmap field may indicate the links to which the spatial streams are allocated.

[00358] FIG. 14 shows a possible frame structure. As shown in FIG. 14, the frame structure may include the SS allocation field and the link bitmap field. The frame structure shown in FIG. 14 is used as an example, and 16 bits may indicate allocation of spatial streams. Specifically, each of the 16 bits may indicate a link to which a corresponding spatial stream is allocated. For example, if a value of a corresponding bit is the same as a value of a previous bit, it indicates that the spatial stream is allocated to a same link; if the value of the corresponding bit is different from the value of the previous bit, the spatial stream is allocated to a next link.

[00359] For example, as shown in FIG. 15, a value of the SS allocation field is 0000110101000001111. It is assumed that it starts from a link 1, it indicates that a link indicated by each of first four bits is allocated to the link 1 (that is, a value of each of the first four bits is 0), a link indicated by each of the following four bits is allocated to a link 2 (that is, a value of each of the following four bits is 1), a link indicated by each of the following four bits is allocated to a link 3 (that is, a value of each of the following four bits is 0), and a link indicated by each of last four bits is allocated to a link 4 (that is, a value of each of the following four bits is 0).

[00360] The link bitmap field may indicate the link to which the spatial stream is allocated. It is assumed that a total quantity of links is 8, and the SS allocation field allocates all spatial streams to four links (as shown in FIG. 15). In this case, a length of the link bitmap field is 8 bits, and values of four bits are 1, which correspond to four links to which the spatial streams are allocated.

second communication mode includes the first configuration and a second configuration. Under the first configuration, the first device can perform communication on N links, under the second configuration, the first device can perform communication on M links, M is an integer greater than 1 or equal to 1, N is an integer greater than 2 or equal to 2, and N is greater than M.

[00380] In an example, the transceiver unit 1710 is further configured to receive a second message from the second device, where the second message is a response message or an acknowledgment message for the first message; and the processing unit 1720 is further configured to switch the communication mode.

[00381] In still another example, when the communication apparatus 1700 is in the second communication mode, the transceiver unit 1710 is further configured to perform communication by using the second configuration; or the transceiver unit 1710 is further configured to switch between the first configuration and the second configuration for communication.

[00382] In still another example, when the communication apparatus 1700 is in the second communication mode, the transceiver unit 1710 is further configured to perform communication by using the second configuration; the transceiver unit 1710 is further configured to receive a radio frame from the second device; the processing unit 1720 is further configured to switch to the first configuration; and the transceiver unit 1710 is further configured to transmit data to the second device by using the first configuration.

[00383] In still another example, when the communication apparatus 1700 is in the second communication mode, the transceiver unit 1710 is further configured to perform communication by using the second configuration; the transceiver unit 1710 is further configured to receive information about a third configuration from the second device; the processing unit 1720 is further configured to switch to the third configuration based on the information about the third configuration; and the transceiver unit 1710 is further configured to transmit data to the second device by using the third configuration.

[00384] In still another example, when the communication apparatus 1700 is in the second communication mode, the transceiver unit 1710 is further configured to perform communication by using the second configuration; the transceiver unit 1710 is further configured to receive information about a third configuration from the second device; the processing unit 1720 is further configured to switch to a fourth configuration based on the information about the third configuration, where the fourth configuration is determined based on the third configuration; and

the second device in FIG. 3 to FIG. 16 according to embodiments of this application. The communication apparatus 1700 may include units configured to perform the methods performed by the second device in FIG. 3 to FIG. 16. In addition, the units in the communication apparatus 1700 and the foregoing other operations and/or functions are separately used to implement corresponding procedures in FIG. 3 to FIG. 16.

[00408] For example, when the communication apparatus 1700 is configured to perform the method 300 in FIG. 3, the transceiver unit 1710 may be configured to perform step 310 in the method 300.

[00409] For another example, when the communication apparatus 1700 is configured to perform the method 600 in FIG. 6, the transceiver unit 1710 may be configured to perform steps 610, 620, 630, 601, 602, and 605 in the method 600.

[00410] For another example, when the communication apparatus 1700 is configured to perform the method 700 in FIG. 7, the transceiver unit 1710 may be configured to perform steps 710, 720, and 730 in the method 700.

[00411] For another example, when the communication apparatus 1700 is configured to perform the method 1000 in FIG. 10, the transceiver unit 1710 may be configured to perform steps 1010, 1020, 1040, and 1060 in the method 1000.

[00412] For another example, when the communication apparatus 1700 is configured to perform the method 1100 in FIG. 11, the transceiver unit 1710 may be configured to perform steps 1110 and 1120 in the method 1100.

[00413] It should be understood that a specific process in which the units perform the foregoing corresponding steps is described in detail in the foregoing method embodiments. For brevity, details are not described herein again.

[00414] The processing unit 1720 in the foregoing embodiment may be implemented by at least one processor or a processor-related circuit. The transceiver unit 1710 may be implemented by a transceiver or a transceiver-related circuit. The transceiver unit 1710 may also be referred to as a communication unit or a communication interface. The storage unit may be implemented by using at least one memory.

[00415] As shown in FIG. 18, an embodiment of this application further provides a communication apparatus 1800. The communication apparatus 1800 includes a processor 1810. The processor 1810 is coupled to a memory 1820. The memory 1820 is configured to store a

[00447] It should be understood that FIG. 20 is merely an example instead of a limitation. The second device including the transceiver unit and the processing unit may not depend on the structure shown in FIG. 20.

[00448] When the communication apparatus 2000 is a chip, the chip includes a transceiver unit and a processing unit. The transceiver unit may be an input/output circuit or a communication interface. The processing unit is a processor, a microprocessor, or an integrated circuit integrated on the chip. Certainly, the communication apparatus 2000 may alternatively be a chip system or a processing system, a device in which the communication apparatus 2000 is installed can implement the methods and the functions in embodiments of this application. For example, the processing unit 2020 may be a chip system or a processing circuit in a processing system, to control a device in which the chip system or the processing system is installed. The processing unit 2020 may further be coupled to a storage unit, and invoke instructions in the storage unit, so that the device can implement the methods and the functions in embodiments of this application. The transceiver unit 2010 may be an input/output circuit in the chip system or the processing system, to output information processed by the chip system, or input to-be-processed data or signaling information into the chip system for processing. The communication apparatus 2000 may be, for example, a Wi-Fi chip. Therefore, an apparatus in which the chip is installed can communicate with another device by using the 802.11 protocol.

[00449] An embodiment of this application further provides a computer-readable storage medium. The computer-readable storage medium stores computer instructions used to implement the method performed by the first device or the method performed by the second device in the foregoing method embodiments.

[00450] For example, when the computer program is executed by a computer, the computer is enabled to implement the method performed by the first device or the method performed by the second device in the foregoing method embodiments.

[00451] An embodiment of this application further provides a computer program product including instructions. When the instructions are executed by a computer, the computer is enabled to implement the method performed by the first device or the method performed by the second device in the foregoing method embodiments.

[00452] An embodiment of this application further provides a communication system. The communication system includes the first device and the second device in the foregoing

CLAIMS

What is claimed is:

1. A communication mode switching method, comprising:

sending, by a first device, a first message to a second device, wherein the first message is used to notify the second device that the first device switches a communication mode, and the switching a communication mode comprises: switching from a first communication mode to a second communication mode, or switching from the second communication mode to the first communication mode; and

switching, by the first device, from the first communication mode to the second communication mode, or switching, by the first device, from the second communication mode to the first communication mode, wherein

the first communication mode comprises a first configuration, the second communication mode comprises the first configuration and a second configuration, under the first configuration, the first device can perform communication on N links, under the second configuration, the first device can perform communication on M links, M is an integer greater than 1 or equal to 1, N is an integer greater than 2 or equal to 2, and N is greater than M.

2. The method according to claim 1, wherein

the first device switches the communication mode after receiving a second message from the second device, wherein the second message is a response message or an acknowledgment message for the first message.

3. The method according to claim 1 or 2, wherein when the first device is in the second communication mode,

the first device performs communication by using the second configuration, or

the first device switches between the first configuration and the second configuration for communication.

4. The method according to any one of claims 1 to 3, wherein when the first device is in the second communication mode, the first device performs communication by using the second configuration; and

the method further comprises:

after receiving a radio frame from the second device, switching, by the first device, to the first

configuration, and transmitting data to the second device by using the first configuration.

5. The method according to any one of claims 1 to 4, wherein the method further comprises:

performing, by the first device, communication by using the second configuration after the data transmission ends.

6. The method according to claim 5, wherein the transmitting, by the first device, data to the second device by using the first configuration comprises:

receiving, by the first device, a data frame from the second device on T links, wherein T is an integer greater than 1 or equal to 1; and

the method further comprises:

comprising, by the data frame on each of the T links, a more data field, wherein the more data field in the data frame on a link indicates whether data transmission on the corresponding link ends, and the first device determines, based on the more data field on each link, whether the data transmission ends; or

comprising, by the data frame, a multi-link more data field, wherein the multi-link more data field indicates whether data transmission on the T links ends, and the first device determines, based on the multi-link more data field, whether the data transmission ends.

7. The method according to any one of claims 1 to 6, wherein the method further comprises:

sending, by the first device, indication information to a station of the second device, wherein the indication information comprises information about the first configuration or information about the second configuration, and

the indication information indicates configuration information of each station on one or more links of the first device.

8. The method according to any one of claims 1 to 7, wherein

the information about the first configuration or the information about the second configuration comprises one or more pieces of the following information:

an identifier of a link, a number of spatial streams of the link, bandwidth of the link, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode.

9. A communication mode switching method, comprising:

receiving, by a second device, a first message from a first device, wherein the first message is used to notify the second device that the first device switches a communication mode, and the

switching a communication mode comprises: switching from a first communication mode to a second communication mode, or switching from the second communication mode to the first communication mode; and

determining, by the second device, a communication mode to which the first device switches, wherein

the first communication mode comprises a first configuration, the second communication mode comprises the first configuration and a second configuration, under the first configuration, the first device can perform communication on N links, under the second configuration, the first device can perform communication on M links, M is an integer greater than 1 or equal to 1, N is an integer greater than 2 or equal to 2, and N is greater than M.

10. The method according to claim 9, wherein the method further comprises:

receiving, by the second device, indication information from the first device, wherein the indication information comprises information about the first configuration or information about the second configuration; and

determining, by the second device, configuration information of each station on one or more links of the first device based on the indication information.

11. The method according to claim 9 or 10, wherein

the information about the first configuration or the information about the second configuration comprises one or more pieces of the following information:

an identifier of a link, a number of spatial streams of the link, bandwidth of the link, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode.

12. A communication mode switching method, comprising:

receiving, by a first device, a radio frame from a second device, wherein the radio frame indicates the first device to perform link configuration switching; and

the first device switches from performing communication by using a second configuration to performing communication by using a first configuration, wherein

under the first configuration, the first device can perform communication on N links, under the second configuration, the first device can perform communication on M links, M is an integer greater than 1 or equal to 1, N is an integer greater than 2 or equal to 2, and N is greater than M.

13. The method according to claim 12, wherein the first device is in a multi-link spatial

multiplexing power save mode, and the multi-link spatial multiplexing power save mode comprises:

performing, by the first device, communication by using the second configuration, or

switching, by the first device, between the first configuration and the second configuration for communication.

14. The method according to claim 12 or 13, wherein the method further comprises:

after data transmission between the first device and the second device by using the first configuration ends, switching, by the first device, to the second configuration for communication.

15. The method according to any one of claims 12 to 14, wherein before the receiving, by a first device, a radio frame from a second device, the method further comprises:

sending, by the first device, a first message to the second device, wherein the first message is used to notify the second device that the first device enters the multi-link spatial multiplexing power save mode.

16. The method according to claim 15, wherein the method further comprises:

after receiving a second message from the second device, switching, by the first device, to the multi-link spatial multiplexing power save mode, wherein

the second message is a response message or an acknowledgment message for the first message.

17. The method according to any one of claims 12 to 16, wherein the performing communication, by the first device, with the second device by using a first configuration comprises:

receiving, by the first device, a data frame from the second device on T links, wherein T is an integer greater than 1 or equal to 1; and

the method further comprises:

comprising, by the data frame on each of the T links, a more data field, wherein the more data field in the data frame on the link indicates whether data transmission on the corresponding link ends, and the first device determines, based on the more data field on each link, whether the data transmission ends; or

comprising, by the data frame, a multi-link more data field, wherein the multi-link more data field indicates whether data transmission on the T links ends, and the first device determines, based on the multi-link more data field, whether the data transmission ends.

18. The method according to any one of claims 12 to 17, wherein the method further

comprises:

sending, by the first device, indication information to a station of the second device, wherein the indication information comprises information about the first configuration or information about the second configuration, and

the indication information indicates configuration information of each station on one or more links of the first device.

19. The method according to any one of claims 12 to 18, wherein

the information about the first configuration or the information about the second configuration comprises one or more pieces of the following information:

an identifier of a link, a number of spatial streams of the link, bandwidth of the link, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode.

20. The method according to any one of claims 15 to 19, wherein

the first message comprises a control field, wherein the control field comprises a first field, the first field is used to notify the second device that whether the first device enters the multi-link spatial multiplexing power save mode, and the value of the first field is the first value is used to indicate the first device enters the multi-link spatial multiplexing power save mode.

21. A communication mode switching method, comprising:

generating, by a second device, a radio frame, wherein the radio frame indicates a first device to perform link configuration switching, and the link configuration switching comprises: switching from performing communication by using a second configuration to performing communication by using a first configuration; and

sending, by the second device, the radio frame to the first device, wherein

under the first configuration, the second device can communicate with the first device on N links, under the second configuration, the second device can communicate with the first device on M links, M is an integer greater than 1 or equal to 1, N is an integer greater than 2 or equal to 2, and N is greater than M.

22. The method according to claim 21, wherein the first device is in a multi-link spatial multiplexing power save mode, and the multi-link spatial multiplexing power save mode comprises:

performing, by the second device, communication by using the second configuration, or

switching, by the second device, between the first configuration and the second configuration for communication.

23. The method according to claim 21 or 22, wherein before the generating, by a second device, a radio frame, the method further comprises:

receiving, by the second device, a first message from the first device, wherein the first message is used to notify the second device that the first device enters the multi-link spatial multiplexing power save mode.

24. The method according to claim 23, wherein the method further comprises:

after the second device sends a second message to the first device, switching, by the first device, to the multi-link spatial multiplexing power save mode, wherein

the second message is a response message or an acknowledgment message for the first message.

25. The method according to any one of claims 21 to 24, wherein the performing communication, by the first device, with the second device by using a first configuration comprises:

sending, by the second device, a data frame to first device on T links, wherein T is an integer greater than 1 or equal to 1; and

the method further comprises:

comprising, by the data frame on each of the T links, a more data field, wherein the more data field in the data frame on the link indicates whether data transmission on the corresponding link ends, and the first device determines, based on the more data field on each link, whether the data transmission ends; or

comprising, by the data frame, a multi-link more data field, wherein the multi-link more data field indicates whether data transmission on the T links ends, and the first device determines, based on the multi-link more data field, whether the data transmission ends.

26. The method according to any one of claims 21 to 25, wherein the method further comprises:

receiving, by the second device, indication information sent by the first device, wherein the indication information comprises information about the first configuration or information about the second configuration; and

the indication information indicates configuration information of each station on one or more links of the first device.

27. The method according to any one of claims 21 to 26, wherein

the information about the first configuration or the information about the second configuration comprises one or more pieces of the following information:

an identifier of a link, a number of spatial streams of the link, bandwidth of the link, whether to support uplink multi-user transmission, and whether to support an extended-range transmission mode.

28. The method according to any one of claims 23 to 27, wherein

the first message comprises a control field, wherein the control field comprises a first field, the first field is used to notify the second device that whether the first device enters the multi-link spatial multiplexing power save mode, and the value of the first field is the first value is used to indicate the first device enters the multi-link spatial multiplexing power save mode.

29. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program or instructions, and the computer program or instructions are used to implement the method according to any one of claims 1 to 28.

30. A communication apparatus, wherein the communication apparatus is configured to perform the method according to any one of claims 1 to 28.