MULTI-LINK DEVICE COMMUNICATION METHOD, COMMUNICATION APPARATUS, CHIP, COMPUTER-READABLE STORAGE MEDIUM, AND COMPUTER PROGRAM PRODUCT

[0001] This application claims priority to Chinese Patent Application No. 202410266240.X, filed with the China National Intellectual Property Administration on March 7, 2024 and entitled "MULTI-LINK DEVICE COMMUNICATION METHOD, COMMUNICATION APPARATUS, CHIP, COMPUTER-READABLE STORAGE MEDIUM, AND COMPUTER PROGRAM PRODUCT", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the communication field, and in particular, to a multi-link device communication method, a communication apparatus, a chip, a computer-readable storage medium, and a computer program product.

BACKGROUND

[0003] Wireless local area network (wireless local area network, WLAN) roaming or wireless fidelity (wireless fidelity, Wi-Fi) roaming means a process in which a wireless terminal or a station (station, STA) moves from one access point (access point, AP) to another AP, that is, the wireless terminal or the STA moves from one basic service set (basic service set, BSS) to another BSS for access. WLAN roaming or Wi-Fi roaming means that the STA can move arbitrarily in Wi-Fi networks that belong to a same extended service set (extended service set, ESS), for example, switch from one BSS to another BSS in the same ESS. WLAN roaming or Wi-Fi roaming includes roaming of the STA and roaming of a non-access point multi-link device (non-AP multi-link device, non-AP MLD), that is, the non-AP MLD switches from one access point multi-link device (AP multi-link device, AP MLD) to another AP MLD.

[0004] A roaming mechanism defined in a current protocol does not support resumable packet transmission. In other words, problems of packet loss and an excessively long transmission interruption time occur in a roaming process, resulting in poor user experience. How to improve user roaming experience is a problem to be resolved currently.

SUMMARY

[0005] Embodiments of this application disclose a multi-link device communication method, a communication apparatus, a chip, a computer-readable storage medium, and a computer program product, to implement roaming that supports resumable packet transmission.

[0006] According to a first aspect, an embodiment of this application provides a multi-link device communication method. The method is applied to a non-access point multi-link device (non-AP multi-link device, non-AP MLD), and the method includes: generating a request frame, where the request frame is used to request to roam to a target AP MLD, the request frame includes first indication information, and the first indication information is used to determine the target AP MLD; and sending the request frame to a first AP MLD.

[0007] In this embodiment of this application, the non-AP MLD sends the request frame to the first AP MLD, where the request frame is used to request to roam to the target AP MLD, so that the first AP MLD implements, in a manner such as context transfer, that transmission of the non-AP MLD is not interrupted in a process in which the non-AP MLD roams to the target AP MLD, that is, implements roaming that supports resumable packet transmission. This can reduce packet loss and improve user roaming experience.

[0008] In a possible implementation, the first indication information indicates the target AP MLD, or the first indication information is a wildcard (wildcard) basic service set identifier (basic service set identifier, BSSID).

[0009] In this implementation, the first indication information indicates the target AP MLD, so that the first AP MLD can learn of an AP MLD to which the non-AP MLD roams. The first indication information is the wildcard BSSID, so that the first AP MLD determines a specific AP MLD to which the non-AP MLD roams.

[0010] In a possible implementation, the request frame further includes one or more pieces of second indication information, each piece of second indication information indicates one first link, and the first link is a link that the non-AP MLD requests the target AP MLD to establish. Alternatively, the request frame further includes second indication information, the second indication information indicates a first link, and the first link includes one or more links that the non-AP MLD requests the target AP MLD to establish.

[0011] In this implementation, the request frame further includes the one or more pieces of second indication information, which may indicate the link that the non-AP MLD requests the target AP MLD to establish.

[0012] In a possible implementation, the request frame further includes at least one of third indication information and a parameter used to establish one or more first links, and the third

indication information indicates a primary link in the one or more first links.

[0013] In this implementation, the third indication information indicates the primary link in the one or more first links, so that the target AP MLD learns of the primary link that the non-AP MLD requests to establish. The request frame further includes a parameter used to establish the one or more first links, so that the parameter for establishing the first link can be determined more quickly.

[0014] In a possible implementation, the request frame further includes fourth indication information, and the fourth indication information indicates a link status of the first link after a response frame is received.

[0015] In this implementation, the fourth indication information indicates the link status of the first link after the response frame is received, to facilitate data transmission between the non-AP MLD and a current AP MLD and between the non-AP MLD and the target AP MLD.

[0016] In a possible implementation, the link status includes enable and disable, or the link status includes an awake state and a doze state.

[0017] In a possible implementation, the request frame further includes timeout information, and the timeout information is used to determine a validity time for feeding back a response frame corresponding to the request frame.

[0018] In this implementation, the request frame further includes the timeout information, and the timeout information is used to determine the validity time for feeding back the response frame corresponding to the request frame. This can avoid long-time waiting of the non-AP MLD, and avoid affecting roaming experience.

[0019] In a possible implementation, the request frame is a link reconfiguration request frame.

[0020] In this implementation, an advantage of reusing the link reconfiguration request frame is that the first AP MLD can be triggered to perform context transfer when the link is established with the target AP MLD. This can reduce signaling overheads while reducing interaction for switching to the target AP MLD.

[0021] In a possible implementation, the method further includes: receiving a response frame from the first AP MLD, where the response frame includes fifth indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to the first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a basic service set (basic service set, BSS) critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

[0022] In this implementation, the fifth indication information indicates the status code and/or the critical update count value corresponding to the first link, so that the non-AP MLD can learn

whether the request for establishing the first link is accepted and/or whether the BSS critical parameter of the AP on the first link needs to be updated.

[0023] In a possible implementation, the response frame further includes sixth indication information, and the sixth indication information indicates the target AP MLD.

[0024] In a possible implementation, the response frame is a link reconfiguration response frame.

[0025] In this implementation, the link reconfiguration response frame is reused, so that signaling overheads can be reduced.

[0026] According to a second aspect, an embodiment of this application provides a multi-link device communication method. The method is applied to a first AP MLD, and the method includes: receiving a request frame from a non-AP MLD, where the request frame is used to request to roam to a target AP MLD, the request frame includes first indication information, and the first indication information is used to determine the target AP MLD; and transferring a context to the target AP MLD. An objective of transferring the context is for the non-AP MLD to roam to the target AP MLD. In other words, transferring the context is used for the non-AP MLD to roam to the target AP MLD. For example, the context is used to configure an MLD MAC sublayer.

[0027] In this embodiment of this application, the context is transferred to the target AP MLD, so that the non-AP MLD can roam to the target AP MLD. The context is transferred to the target AP MLD, so that transmission of the non-AP MLD is not interrupted in a process in which the non-AP MLD roams to the target AP MLD, that is, roaming that supports resumable packet transmission is implemented. This can reduce packet loss and improve user roaming experience.

[0028] In a possible implementation, the context includes a block acknowledgment (Block ACK, BA) session-related parameter and/or a security-related parameter.

[0029] In this implementation, if the context includes the BA session-related parameter, the context is transferred to the target AP MLD, to reduce or avoid packet loss of the non-AP MLD in a roaming process and improve user roaming experience. If the context includes the security-related parameter, the target AP MLD can implement encryption and decryption-related operations, to improve data security.

[0030] In a possible implementation, the first indication information indicates the target AP MLD, or the first indication information is a wildcard BSSID.

[0031] In a possible implementation, the request frame further includes one or more pieces of second indication information, each piece of second indication information indicates one first link, and the first link is a link that the non-AP MLD requests the target AP MLD to establish.

[0032] In a possible implementation, the request frame further includes at least one of third indication information and a parameter used to establish one or more first links, and the third

indication information indicates a primary link in the one or more first links.

[0033] In a possible implementation, the request frame further includes fourth indication information, and the fourth indication information indicates a link status of the first link after a response frame is received.

[0034] In a possible implementation, the link status includes enable and disable, or the link status includes an awake state and a doze state.

[0035] In a possible implementation, the request frame further includes timeout information, and the timeout information is used to determine a validity time for feeding back a response frame corresponding to the request frame.

[0036] In a possible implementation, the request frame is a link reconfiguration request frame.

[0037] In a possible implementation, the method further includes: sending a response frame to the non-AP MLD, where the response frame includes fifth indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to the first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a basic service set BSS critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

[0038] In this implementation, the response frame is sent to the non-AP MLD, so that the non-AP MLD can learn of the status code and/or the critical update count value corresponding to the first link.

[0039] In a possible implementation, the response frame further includes sixth indication information, and the sixth indication information indicates the target AP MLD.

[0040] In a possible implementation, the request frame further includes the fourth indication information, the fourth indication information indicates the link status of the first link after the response frame is received, and the first link is a link that the non-AP MLD requests the target AP MLD to establish; and after the sending the response frame to the non-AP MLD, the method further includes:

when the link status of the first link is a disabled state or a doze state, sending a remaining data packet in a transmission queue to the non-AP MLD, where the transmission queue includes a data packet to be sent to the non-AP MLD; and when a last sequence number SN associated with the non-AP MLD on the first AP MLD is refreshed or times out, sending link deletion information to the non-AP MLD, where the link deletion information indicates the non-AP MLD to delete a link of the first AP MLD. Sending link deletion information to the non-AP MLD may be replaced with: sending link disabling information to the non-AP MLD, where the link disabling information indicates the non-AP MLD to disable a link between the non-AP MLD

and the first AP MLD. Alternatively, sending link deletion information to the non-AP MLD may be replaced with: sending link doze information to the non-AP MLD, where the link doze information indicates the non-AP MLD to configure (switch) a link between the non-AP MLD and the first AP MLD to the doze state.

[0041] In this implementation, when the link status of the first link is the disabled state or the doze state, the remaining data packet in the transmission queue is sent to the non-AP MLD, so that the non-AP MLD receives complete downlink data from the first AP MLD.

[0042] In a possible implementation, the response frame is a link reconfiguration response frame.

[0043] For the possible implementations of the second aspect, refer to the possible implementations of the first aspect.

[0044] For technical effects brought by the possible implementations of the second aspect, refer to the descriptions of the technical effects brought by the possible implementations of the first aspect.

[0045] According to a third aspect, an embodiment of this application provides a communication apparatus. The communication apparatus has a function of implementing behavior in the method embodiment according to the first aspect. The communication apparatus may be a terminal device, or may be a component (for example, a processor, a chip, or a system on chip) of the terminal device, or may be a logic module or software that can implement all or a part of functions of the terminal device. For example, the communication apparatus is a second access point. The function of the communication apparatus may be implemented by hardware, or may be implemented by hardware executing corresponding software. The hardware or the software includes one or more modules or units corresponding to the foregoing function. In a possible implementation, the communication apparatus includes a transceiver module and a processing module. The processing module is configured to generate a request frame, where the request frame is used to request to roam to a target AP MLD, the request frame includes first indication information, and the first indication information is used to determine the target AP MLD. The transceiver module is configured to send the request frame to a first AP MLD.

[0046] In a possible implementation, the transceiver module is further configured to receive a response frame from the first AP MLD, where the response frame includes fifth indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to a first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a BSS critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

[0047] For the possible implementations of the third aspect, refer to the possible implementations of the first aspect.

[0048] For technical effects brought by the possible implementations of the third aspect, refer to the descriptions of the technical effects of the possible implementations of the first aspect.

[0049] According to a fourth aspect, an embodiment of this application provides another communication apparatus. The communication apparatus has a function of implementing behavior in the method embodiment according to the second aspect. The communication apparatus may be a network device, or may be a component (for example, a processor, a chip, or a system on chip) of the network device, or may be a logical module or software that can implement all or a part of functions of the network device. For example, the communication apparatus is a second access point. The function of the communication apparatus may be implemented by hardware, or may be implemented by hardware executing corresponding software. The hardware or the software includes one or more modules or units corresponding to the foregoing function. In a possible implementation, the communication apparatus includes a transceiver module and a processing module. The transceiver module is configured to receive a request frame from a non-AP MLD, where the request frame is used to request to roam to a target AP MLD, the request frame includes first indication information, and the first indication information is used to determine the target AP MLD. The processing module is configured to transfer a context to the target AP MLD. For example, the processing module is configured to transfer the context to the target AP MLD in response to the request frame.

[0050] In a possible implementation, the transceiver module is further configured to send a response frame to the non-AP MLD, where the response frame includes fifth indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to a first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a BSS critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

[0051] In a possible implementation, the request frame further includes fourth indication information, the fourth indication information indicates a link status of a first link after a response frame is received, and the first link is a link that the non-AP MLD requests the target AP MLD to establish. The transceiver module is further configured to: when the link status of the first link is a disabled state or a doze state, send a remaining data packet in a transmission queue to the non-AP MLD, where the transmission queue includes a data packet to be sent to the non-AP MLD; and when a last sequence number SN associated with the non-AP MLD on a first AP MLD is refreshed or times out, send link deletion information to the non-AP MLD, where the link deletion

information indicates the non-AP MLD to delete a link of the first AP MLD.

[0052] For possible implementations of the fourth aspect, refer to the possible implementations of the second aspect.

[0053] For technical effects brought by the possible implementations of the fourth aspect, refer to the descriptions of the technical effects of the possible implementations of the second aspect.

[0054] According to a fifth aspect, an embodiment of this application provides another communication apparatus. The communication apparatus includes one or more processors, and the one or more processors are configured to process data and/or signaling, to implement the method according to the first aspect or the second aspect.

[0055] Optionally, the communication apparatus further includes a memory. The memory stores a computer program or instructions. When the computer program or the instructions are executed by the processor, the communication apparatus is caused to perform the method according to the first aspect or the second aspect. For example, the communication apparatus may be a chip, the processor is a processing unit in the chip, and the memory is a random access memory or a cache in the chip.

[0056] In this embodiment of this application, in a process of performing the method, a process of sending information (or a signal) in the method may be understood as a process of outputting information according to the computer program or the instructions of the processor. When the information is output, the processor outputs the information to a transceiver, so that the transceiver transmits the information. After the information is output by the processor, other processing may be further performed on the information before the information arrives at the transceiver. Similarly, when the processor receives input information, the transceiver receives the information, and inputs the information into the processor. Further, after the transceiver receives the information, other processing may be performed on the information before the information is input into the processor.

[0057] Operations such as sending and/or receiving related to the processor may be generally understood as outputting based on the computer program or instructions of the processor, unless otherwise specified, or if the operations do not conflict with actual functions or internal logic of the operations in the related descriptions.

[0058] In an implementation process, the processor may be a processor specially configured to perform these methods, or may be a processor, for example, a general-purpose processor, that executes the computer program or the instructions in the memory to perform these methods. For example, the processor may be further configured to execute a program stored in the memory. When the program is executed, the communication apparatus is caused to perform the method according to any one of the first aspect or the possible implementations of the first aspect.

[0059] In a possible implementation, the memory is located outside the communication

apparatus. In a possible implementation, the memory is located inside the communication apparatus.

[0060] In a possible implementation, the processor and the memory may alternatively be integrated into one device. In other words, the processor and the memory may alternatively be integrated together.

[0061] In a possible implementation, the communication apparatus further includes the transceiver. The transceiver is configured to receive a signal, send a signal, or the like.

[0062] According to a sixth aspect, this application provides another communication apparatus. The communication apparatus includes a processing circuit and an interface circuit. The interface circuit is configured to obtain data or output data. The processing circuit is configured to perform the method according to the first aspect or the second aspect.

[0063] According to a seventh aspect, this application provides a computer-readable storage medium. The computer-readable storage medium stores a computer program, the computer program includes program instructions, and when the program instructions are executed, a computer is caused to perform the method according to the first aspect or the second aspect.

[0064] According to an eighth aspect, this application provides a computer program product. The computer program product includes a computer program, the computer program includes program instructions, and when the program instructions are executed, a computer is caused to perform the method according to the first aspect or the second aspect.

[0065] According to a ninth aspect, this application provides a chip, including a communication interface and a processor. The communication interface is configured to receive and send a signal of the chip. The processor is configured to execute a computer program or instructions, so that a communication apparatus including the chip performs the method according to the first aspect or the second aspect.

[0066] According to a tenth aspect, an embodiment of this application provides a communication system, including the communication apparatus according to any one of the third aspect or the possible implementations of the third aspect, and the communication apparatus according to any one of the fourth aspect or the possible implementations of the fourth aspect.

BRIEF DESCRIPTION OF DRAWINGS

[0067] FIG. 1 is a diagram of a roaming scenario to which embodiments of this application are applicable;

[0068] FIG. 2 shows an example of a diagram of a structure of a multi-link device according to an embodiment of this application;

[0069] FIG. 3 shows an example of a diagram of a structure of multiple links between multi-link devices according to an embodiment of this application;

[0070] FIG. 4 is a diagram of a format of a basic multi-link element;

[0071] FIG. 5 is a diagram of a format of a reconfiguration multi-link element (Reconfiguration Multi-link element);

[0072] FIG. 6 is a diagram of a connection manner between a multi-link AP and a multi-link STA according to an embodiment of this application;

[0073] FIG. 7 is a diagram of an architecture of a communication system according to an embodiment of this application;

[0074] FIG. 8 shows an example of a reconfiguration status list;

[0075] FIG. 9 shows an example of group key data;

[0076] FIG. 10 shows a KDE format according to an embodiment of this application;

[0077] FIG. 11-1 shows an MLO GTK KDE format according to an embodiment of this application;

[0078] FIG. 11-2 shows an MLO IGTK KDE format according to an embodiment of this application;

[0079] FIG. 11-3 shows an MLO BIGTK KDE format according to an embodiment of this application;

[0080] FIG. 12 shows a format of an OCI element according to an embodiment of this application;

[0081] FIG. 13 is a diagram of a BA session establishment procedure according to an embodiment of this application;

[0082] FIG. 14 is a flowchart of a multi-link device communication method according to an embodiment of this application;

[0083] FIG. 15 shows an example of a frame structure of a request frame according to an embodiment of this application;

[0084] FIG. 16 shows an example of a frame structure of another request frame according to an embodiment of this application;

[0085] FIG. 17 shows an example of a frame structure of a response frame according to an embodiment of this application;

[0086] FIG. 18 is a flowchart of another multi-link device communication method according to an embodiment of this application;

[0087] FIG. 19 is a flowchart of another multi-link device communication method according to an embodiment of this application;

[0088] FIG. 20 is a block diagram of a communication apparatus 10 according to an

embodiment of this application;

[0089] FIG. 21 is a diagram of another communication apparatus 20 according to an embodiment of this application; and

[0090] FIG. 22 is a diagram of a system on chip 30 according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0091] Terms "first," "second," and various numbers (for example, "#1" and "#2") in the specification, claims, and accompanying drawings of this application are merely used to distinguish between different objects, but are not used to describe a specific sequence. It may be understood that various numbers in embodiments of this application are merely used for differentiation for ease of description, and are not used to limit the scope of embodiments of this application. Sequence numbers of the following processes do not mean an execution sequence. The execution sequence of the processes should be determined based on functions and internal logic of the processes, and should not constitute any limitation on an implementation process of embodiments of this application. In addition, terms such as "include" and "have" and any other variants thereof are intended to cover non-exclusive inclusion. For example, processes, methods, systems, products, or devices that include a series of steps or units are not limited to listed steps or units, but instead, optionally further include steps or units that are not listed, or optionally further include other steps or units inherent to these processes, methods, products, or devices.

[0092] "Embodiments" mentioned herein mean that specific features, structures, or characteristics described in combination with the embodiments may be included in at least one embodiment of this application. The phrase shown in various locations in this specification may not necessarily refer to a same embodiment, and is not an independent or optional embodiment exclusive from another embodiment. It may be understood explicitly and implicitly by a person skilled in the art that embodiments described in this specification may be combined with other embodiments. Some steps in embodiments described in this specification may be used as an independent embodiment. In this application, naming of a message (frame) is merely used to distinguish between different messages (frames), and should not be construed as a limitation. In other words, a name of any message or frame in this application may be replaced with another name. This is not limited in this application.

[0093] Terms used in the following embodiments of this application are merely intended to describe specific embodiments, but are not intended to limit this application. The terms "one", "a", "an", "the", and "this" of singular forms used in this specification and the appended claims of this

application are also intended to include plural forms, unless otherwise specified in the context clearly. It should also be understood that the term "and/or" used in this application means and includes any or all possible combinations of one or more listed items. For example, "A and/or B" may represent three cases: Only A exists, only B exists, and both A and B exist, where A and B may be singular or plural. The term "multiple" used in this application means two or more. In the text descriptions of this application, the character "/" usually indicates an "or" relationship between associated objects.

[0094] It may be understood that in embodiments of this application, "B corresponding to A" indicates that there is a correspondence between A and B, and B may be determined based on A. However, it should be further understood that determining (or generating) B based on (or according to) A does not mean that B is determined (or generated) only based on (or according to) A, and B may alternatively be determined (or generated) based on (or according to) A and/or other information.

[0095] It should be understood that in this application, an indication includes a direct indication (also referred to as an explicit indication) and an implicit indication. Directly indicating information A means including the information A. Implicitly indicating the information A means indicating the information A by directly indicating information B and based on a correspondence between the information A and the information B. The correspondence between the information A and the information B may be predefined, prestored, pre-burned, or preconfigured.

[0096] It should be understood that in this application, that information C is used to determine information D includes that the information D is determined based on the information C alone, and also includes that the information D is determined based on the information C and other information. In addition, that the information C is used to determine the information D may further include an indirect determining case. For example, the information D is determined based on information E, and the information E is determined based on the information C.

[0097] In embodiments of this application, the term such as "example" or "for example" is used to represent giving an example, an illustration, or a description. Any embodiment or design scheme described as an "example" or "for example" in this application should not be explained as being more preferred or having more advantages than another embodiment or design scheme. To be precise, use of the words such as "example" or "for example" is intended to present a relative concept in a specific manner.

[0098] In addition, in embodiments of this application, that "a network element A sends information A to a network element B" may be understood as that a destination of the information A or an intermediate network element in a transmission path between the network element A and a destination is the network element B, and may include directly or indirectly sending the

information to the network element B. That "the network element B receives the information A from the network element A" may be understood as that a source of the information A or an intermediate network element in a transmission path from a source is the network element A, and may include directly or indirectly receiving the information from the network element A. Information may undergo necessary processing, for example, a format change, between a source for sending the information and a destination. However, the destination may understand valid information from the source. Similar descriptions in this application may be understood similarly, and details are not described herein.

[0099] In some of the accompanying drawings related to the structure of the message (frame) in embodiments of this application, an example of a length of a field in the message is provided. It should be understood that the length of the field shown in the accompanying drawings in embodiments of this application is merely an example. During actual application, a length of any field may change. In the accompanying drawings related to the structure of the message (frame) in embodiments of this application, locations of the fields are not limited.

[00100] In some of the accompanying drawings related to the structure of the message in embodiments of this application, an example of a name of a field in the message is provided. It should be understood that the name of the field shown in the accompanying drawings in embodiments of this application is merely an example. During actual applications, a name of any field may change.

[00101] In some of the accompanying drawings related to the structure of the message in embodiments of this application, a length of a field in a message is 0 or variable (variable), which indicates that the field is an optional field. In other words, when the message does not include the field, the length of the field is 0. If the length of the field is variable (variable), it indicates that the length of the field is uncertain. In an actual design process, other indication information may indicate a specific length of the field, or a receiver and a transmitter may negotiate the length of the field in advance, or the length of the field is predefined, or when receiving the message that carries the field, a receiver can determine the length of the field based on other auxiliary information and parse the message. A manner of determining a specific length of a field whose length is variable is not limited in this application. The following does not repeatedly describe the length of the variable-length field in the message.

[00102] The technical solutions provided in embodiments of this application may be applied to a WLAN system, for example, Wi-Fi. For example, a method provided in embodiments of this application may be applied to the IEEE protocols such as IEEE 802.11be/Wi-Fi 7/EHT, IEEE 802.11bn/UHR/Wi-Fi 8, IEEE Integrated mmWave/integrated millimeter wave/IMMW, IEEE 802.15/ultra-wideband (ultra-wideband, UWB), or IEEE 802.11bf/sensing. This application may

also support the NearLink/SparkLink standard. The technical solutions provided in embodiments of this application may be further applied to a UWB technology-based wireless personal area network (wireless personal area network, WPAN). For example, the method provided in embodiments of this application may be applied to IEEE 802.15 series protocols such as 802.15.4a, 802.15.4z, 802.15.4ab, or a future-generation UWB WPAN protocol, which are not enumerated herein. The technical solutions provided in embodiments of this application may be further applied to the following communication systems, for example, an internet of things (internet of things, IoT) system, a vehicle to everything (vehicle to X, V2X) system, and a narrowband internet of things (narrowband internet of things, NB-IoT) system, may be applied to a device in the internet of vehicles, an internet of things node, a sensor, and the like in the internet of things (IoT, internet of things), a smart camera, a smart remote control, and a smart water/electricity meter in smart home, a sensor in smart city, and the like, or may be further applied to a long term evolution (long term evolution, LTE) system, a 5th-generation (5th-generation, 5G) communication system, a new communication system emerging in future communication development, and the like.

[00103] The WLAN system can provide high-speed and low-latency transmission. With continuous evolution of WLAN application scenarios, the WLAN system is to be used in more scenarios or industries, for example, the internet of things industry, the internet of vehicles industry, the banking industry, enterprise offices, stadiums, exhibition halls, concert halls, hotel rooms, dormitories, wards, classrooms, supermarkets, squares, streets, production workshops, and warehousing. Certainly, a device (for example, an access point or a station) that supports WLAN communication or sensing may be a sensor node (for example, a smart water meter, a smart electricity meter, or a smart air detection node) in smart city, a smart device (for example, a smart camera, a projector, a display, a television, a speaker, a refrigerator, or a washing machine) in smart home, a node in the internet of things, an entertainment terminal (for example, an augmented reality (augmented reality, AR) wearable device or a virtual reality (virtual reality, VR) wearable device), a smart device (for example, a printer, a projector, a loudspeaker, or a speaker) in smart office, an internet of vehicles device in the internet of vehicles, infrastructure (for example, a vending machine, a self-service navigation console of a supermarket, a self-service cash register device, or a self-service ordering machine) in a daily life scenario, a device in a large stadium or music venue, or the like. For example, the access point and the station each may be a device used in the internet of vehicles, an internet of things node, a sensor, or the like in the internet of things, a smart camera, a smart remote control, and a smart water/electricity meter in smart home, a sensor in smart city, or the like.

[00104] Although embodiments of this application mainly use a WLAN as an example, especially a network applied to IEEE 802.11 series standards, for example, a system supporting

Wi-Fi 7 that may also be referred to as extremely high throughput (extremely high throughput, EHT), and for another example, a system supporting Wi-Fi 8 that may also be referred to as ultra high reliability (ultra high reliability, UHR) or ultra high reliability and throughput (ultra high reliability and throughput, UHRT). However, a person skilled in the art easily understands that aspects in embodiments of this application may be extended to other networks using various standards or protocols, for example, Bluetooth (Bluetooth), a high performance radio LAN (high performance radio LAN, HIPERLAN) (a wireless standard similar to the IEEE 802.11 standard, and mainly used in Europe), a wide area network (WAN), or other networks known or developed in the future.

[00105] The foregoing communication system to which this application is applicable is merely an example for description, and the communication system to which this application is applicable is not limited thereto. This applies throughout and will not be repeated below.

[00106] The method provided in this application is mainly applied to a roaming scenario. The roaming scenario includes at least two access point (access point, AP) multi-link devices (MLD) and at least one non-access point (Non-AP) MLD. FIG. 1 is a diagram of a roaming scenario to which embodiments of this application are applicable. In the roaming scenario shown in FIG. 1, when a non-AP MLD associated with an AP MLD 1 moves from coverage of the AP MLD 1 to coverage of an AP MLD 2, the non-AP MLD establishes an association relationship with the AP MLD 2. For example, a STA 1 of the non-AP MLD is associated with an AP 1 of the AP MLD 2, and a STA 2 of the non-AP MLD is associated with an AP 2 of the AP MLD 2. FIG. 1 is merely an example. A quantity of non-AP MLDs and a quantity of AP MLDs in the roaming scenario are not limited.

[00107] A key technology of the Institute of Electrical and Electronics Engineers (institute of electrical and electronics engineers, IEEE) 802.11be (which in Wi-Fi Alliance, is referred to as Wi-Fi 7, and is also referred to as an extremely high throughput (extremely high throughput, EHT) standard) is a multi-link (multi-link) technology. Correspondingly, the multi-link technology requires a multi-link device (multi-link device, MLD) for support. The MLD is a device that supports (has) multi-link simultaneous transmission. In embodiments of this application, a device that simultaneously supports multiple links and supports the IEEE 802.11 standard is referred to as a multi-link device. The MLD may have a capability of simultaneously establishing multiple links. For example, the multi-link device may be an AP MLD, or may be a non-AP MLD, for example, a station multi-link device (station MLD, STA MLD). It should be noted that the foregoing names of the multi-link device are merely examples, and do not constitute any limitation on the protection scope of this application. For example, the AP MLD may also be referred to as a multi-link AP. Alternatively, with development of communication technologies, the AP MLD may

have other names. Examples are not enumerated for description herein.

[00108] In the IEEE 802.11be (Wi-Fi 7) protocol, the MLD may simultaneously use multiple links. In a possible implementation, the MLD has multiple radio frequency modules, and may separately operate on different frequency bands. For example, frequency bands on which the MLD operates may be all or a part of 2.4 GHz, 5 GHz, 6 GHz, and high-frequency 60 GHz. When a spacing between channels on which two radio frequency modules in one MLD operate is large enough, the two radio frequency modules do not interfere with each other and may operate independently. If simultaneous transmitting on one link and simultaneous receiving on the other link are supported for any two links, it is considered as supporting a simultaneous transmitting and receiving (simultaneous transmitting and receiving, STR) capability between the two links. Otherwise, it is considered as non-simultaneous transmitting and receiving (Non-STR) between the two links. The multi-link device includes one or more affiliated stations (affiliated STA). The affiliated STA is a logic station and may operate on one link. The affiliated station may be an access point (Access Point, AP) or a non-access point station (non-Access Point Station, non-AP STA). For ease of description, in this application, a multi-link device whose affiliated station is an AP may be referred to as a multi-link AP, a multi-link AP device, or an AP multi-link device (AP multi-link device), and a multi-link device whose affiliated station is a non-AP STA may be referred to as a multi-link STA, a multi-link STA device, or a STA multi-link device (STA multi-link device). For ease of description, that "the multi-link device includes an affiliated STA" is also briefly described as that "the multi-link device includes a STA" in embodiments of this application.

[00109] It should be noted that the multi-link device includes multiple logical stations, and each logical station operates on one link, but the multiple logical stations are allowed to operate on a same link. A link identifier mentioned below represents one station operating on one link. In other words, if there is more than one station on one link, more than one link identifier is needed to represent the more than one station. A link mentioned below sometimes also represents a station operating on the link.

[00110] During data transmission between a multi-link AP device and a multi-link STA, a link identifier may be used to identify a link or a station on a link. Before communication, the multi-link AP device and the multi-link STA device may negotiate or communicate with each other about a correspondence between a link identifier and a link or a station on a link. Therefore, during data transmission, there is no need to transmit a large amount of signaling information to indicate a link or a station on the link, provided that a link identifier is carried. This reduces signaling overheads and improves transmission efficiency.

[00111] In an example, when the multi-link AP device establishes a BSS, a management frame sent by the multi-link AP device, for example, a beacon (beacon) frame, carries an element

including multiple link identifier information fields, and each link identifier information field may indicate a correspondence between a link identifier and a station operating on a link. Each link identifier information field includes a link identifier, and further includes one or more of a medium access control (medium access control, MAC) address, an operating class, and a channel number, where one or more of the MAC address, the operating class, and the channel number may indicate a link. In another example, in a multi-link association establishment process, the multi-link AP device negotiates multiple link identifier information fields with the multi-link station device. In subsequent communication, the multi-link AP device or the multi-link station device uses a link identifier to represent a station in the multi-link device, and the link identifier may further represent one or more attributes of a MAC address of the station, an operating class, and a channel number. The MAC address may also be replaced with an association identifier of the associated multi-link AP device.

[00112] If multiple stations operate on one link, the link identifier (which is a numeric ID) represents an operating class and a channel number of the link, and also represents an identifier of a station operating on the link, for example, a MAC address or an AID of the station.

[00113] The multi-link device may implement wireless communication according to 802.11 series protocols. For example, a station complying with an extremely high throughput (Extremely High Throughput, EHT), or a station complying with 802.11be or compatible with 802.11be implements communication with another device. Certainly, the another device may be a multi-link device, or may not be a multi-link device.

[00114] The non-AP MLD in this application may be a wireless communication chip, a wireless sensor, or a wireless communication terminal, for example, a user terminal, a user apparatus, an access apparatus, a subscriber station, a subscriber unit, a mobile station, a user agent, and a user device that support a Wi-Fi communication function. The user terminal may include various handheld devices, vehicle-mounted devices, wearable devices, internet of things (internet of things, IoT) devices, or compute devices that have a wireless communication function, or another processing device connected to a wireless modem, user equipment (user equipment, UE) in various forms, a mobile station (mobile station, MS), a terminal (terminal), terminal equipment (terminal equipment), a portable communication device, a handheld device, a portable compute device, an entertainment device, a game device or system, a global positioning system device, or any other appropriate device configured to perform network communication via a wireless medium. In addition, the non-AP MLD may support the 802.11be standard or a next-generation standard of 802.11be, for example, a WLAN standard such as Wi-Fi 8. The non-AP MLD may also support multiple WLAN standards such as 802.11ax, 802.11ac, 802.11n, 802.11g, 802.11b, and 802.11a.

[00115] The AP MLD in embodiments of this application may be an apparatus that is deployed

in a wireless communication network to provide a wireless communication function for a non-AP associated with the AP MLD. The AP MLD is mainly deployed at home, in a building, and in a campus, with a typical coverage radius of tens of meters to hundreds of meters. Certainly, the AP MLD may also be deployed outdoors. The AP MLD is equivalent to a bridge that connects a wired network and a wireless network. The AP MLD is mainly used to connect various wireless network clients together and then connect the wireless network to the Ethernet. Specifically, the AP MLD may be a communication device with a Wi-Fi chip, for example, a base station, a router, a gateway, a repeater, a communication server, a switch, or a bridge. The base station may include a macro base station, a micro base station, a relay station, and the like in various forms. In addition, the AP MLD may support the 802.11be standard or a next-generation standard of 802.11be, for example, a WLAN standard such as Wi-Fi 8. The AP MLD may also support WLAN standards such as 802.11ax, 802.11ac, 802.11n, 802.11g, 802.11b, and 802.11a.

[00116] A MAC layer of the MLD is divided into an MLD upper MAC sublayer (MLD Upper MAC sublayer) and an MLD lower MAC sublayer (MLD lower MAC sublayer). Each affiliated station included in the MLD has a respective medium access control (medium access control, MAC) address (address). A MAC address of each affiliated station may be referred to as a low (low)-MAC address, and the MLD has one upper (upper)-MAC address. The low-MAC address corresponds to the MLD lower MAC sublayer, and the upper MAC address corresponds to the MLD upper MAC sublayer. FIG. 2 shows an example of a diagram of a structure of a multi-link device according to an embodiment of this application. As shown in FIG. 2, affiliated stations of an AP MLD include an AP 1 and an AP 2. A low (low)-MAC address (corresponding to an MLD lower MAC sublayer 1) of the AP 1 is a MAC address #1, and a low-MAC address (corresponding to an MLD lower MAC sublayer 2) of the AP 2 is a MAC address #2. The AP MLD further has an upper (upper)-MAC address, which is referred to as an MLD MAC address. The low (low)-MAC address of the AP 1 may be a MAC address of a link associated with (supported by) the AP 1, and the low (low)-MAC address of the AP 2 may be a MAC address of a link associated with the AP 2.

[00117] To facilitate understanding of the technical solutions in embodiments of this application, the following first briefly describes technologies that may be used in embodiments of this application.

[00118] (1) Multi-link establishment: An AP MLD and a non-AP MLD may establish a multi-link connection through signaling exchange on any link. FIG. 3 shows an example of a diagram of a structure of multiple links between multi-link devices according to an embodiment of this application. As shown in FIG. 3, an AP MLD includes an AP 1 and an AP 2. The AP 1 includes an AP 1 physical layer (physical layer, PHY), AP 1 low-MAC (that is, an MLD lower MAC sublayer),

and MLD high-MAC (that is, an MLD upper MAC sublayer). The AP 2 includes an AP 2 PHY, AP 2 low-MAC, and MLD high-MAC. The AP 1 and the AP 2 share MLD high-MAC. A non-AP MLD includes a STA 1 and a STA 2. The STA 1 includes a STA 1 PHY, STA 1 low-MAC, and MLD high-MAC. The STA 2 includes a STA 2 PHY, STA 2 low-MAC, and MLD high-MAC. The STA 1 and the STA 2 share MLD high-MAC. The AP 1 is connected to the STA 1 through a link 1, and the AP 2 is connected to the STA 2 through a link 2. FIG. 3 is merely an example. A quantity of APs included in the AP MLD, a quantity of STAs included in the non-AP MLD, and a quantity of links between the AP MLD and the non-AP MLD are not limited.

[00119] The non-AP MLD may perform a multi-link establishment operation on one link to simultaneously establish an association with multiple links of the AP MLD. In a possible implementation, when the multiple links are established, an association between the non-AP MLD and the AP MLD may be established through an association process. With reference to FIG. 3, a multi-link establishment procedure may include the following steps. Step (1): The non-AP MLD sends an association request (Association Request) frame on the link 1, where the association request frame carries STA-side information of the link 1 and STA-side information of the link 2. For example, the association request frame may carry a multi-link element (Multi-link element) field, and the multi-link element field carries information about the non-AP MLD and information about a station in the non-AP MLD. Step (2): The AP MLD sends an association response (Association Response) frame on the link 1, where the association response frame carries AP-side information of the link 1, and further carries AP-side information of the link 2, so that the STA 1 and the STA 2 in the non-AP MLD respectively establish an association (or complete an association) with the AP 1 and the AP 2 in the AP MLD. In the multi-link establishment procedure, a link (for example, the link 1) on which the association request/response frame is exchanged is referred to as a transmitted link (Transmitted Link), and correspondingly, another link (for example, the link 2) is referred to as a non-transmitted link (Non-transmitted Link).

[00120] To carry non-AP MLD-related information in an existing association request frame, the IEEE 802.11be protocol defines a basic multi-link element (Basic Multi-link element), which carries MLD-related information in an inheritance manner, similar to a multi-basic service set identifier (BSS identifier, BSSID) element (Multi-BSS identifier element) in the existing protocol. A BSS is short for a basic service set (Basic service set). In a possible implementation, the basic multi-link element includes a multi-link control (Multi-Link Control) field, a common information (Common Info) field, and a link information (Link Info) field. The common info field carries common information of multiple stations in an MLD and information about the MLD. The link info field carries information about a station on each link in the MLD, for example, a per-STA profile shown in FIG. 4. For example, the per-STA profile (Per-STA Profile) includes a subelement

ID (Subelement ID), a length (Length), STA control (STA Control), STA information (STA Info), and a STA profile (STA Profile). FIG. 4 is a diagram of a format of a basic multi-link element. For meanings of fields in FIG. 4, refer to the existing protocol. Details are not described herein. The multi-link control field carries a type of a multi-link element (for example, multiple variants such as a basic variant (Basic variant), a reconfiguration variant (Reconfiguration variant), and a probe request variant (Probe Request variant) are defined currently), and a presence bitmap (Presence Bitmap) field, which is indication information indicating specific fields that do not appear. The inheritance manner means that a corresponding element is carried in the per-STA profile only when content of the corresponding element of a corresponding link in the per-STA profile is different from content of a corresponding element of a corresponding link in a frame body (frame body). If content of corresponding elements is the same, the corresponding element does not need to be repeatedly carried in the per-STA profile.

[00121] FIG. 5 is a diagram of a format of a reconfiguration multi-link element (Reconfiguration Multi-link element). As shown in FIG. 5, the reconfiguration multi-link element includes a multi-link control (Multi-Link Control) field, a common information (Common Info) field, and a link information (Link Info) field. For example, the multi-link control field includes a type, a presence bitmap, and reserved. For example, a per-STA profile (Per-STA Profile) includes a subelement ID (Subelement ID), a length (Length), STA control (STA control), and STA information (STA info). The STA control field may include a link identifier (link identifier, ID), a complete profile (complete profile), a STA MAC address present (STA MAC address present), a removal timer present (removal timer present), an operation parameters present (Operation parameters present), and reserved. The STA information may include at least one of a STA information length (STA Info Length), a STA MAC address (STA MAC Address), an AP removal timer (AP Removal Timer), and operation parameters (Operation Parameters). For meanings of fields in FIG. 5, refer to the existing protocol. Details are not described herein.

[00122] (2) MLD MAC layer unicast data plane architecture: A MAC layer of the MLD may be divided into an MLD upper MAC sublayer (MLD Upper MAC sublayer, which may be briefly referred to as a high-MAC layer) and an MLD lower MAC sublayer (MLD lower MAC sublayer, which may be briefly referred to as a low-MAC layer). Affiliated APs in a same AP MLD share one MLD upper MAC sublayer, and each affiliated AP has a respective MLD lower MAC sublayer, as shown in FIG. 6 below. FIG. 6 is a diagram of a connection manner between a multi-link AP and a multi-link STA according to an embodiment of this application. The 802.11 standard focuses on 802.11 PHY and MAC layer parts in a multi-link device. Therefore, FIG. 6 shows only an example of the PHY and the MAC layer.

[00123] As shown in FIG. 6, the multi-link device (for example, the multi-link AP and the multi-

link STA) may include the PHY (for example, a PHY #1, a PHY #2, and a PHY #n shown in FIG. 6) and the MAC layer. The physical layer may be used to process a physical layer signal, and the MAC layer may be used to process a MAC layer signal. Further, the MAC layer may be divided into one high-MAC (high-MAC) layer (for example, high-MAC shown in FIG. 6) and multiple low-MAC (low-MAC) layers (for example, low-MAC #1 and low-MAC #2 to low-MAC #n shown in FIG. 6). As shown in FIG. 6, multiple APs included in the multi-link AP are independent of each other at the low-MAC layer and the PHY, and share the high-MAC layer. Multiple STAs included in the multi-link STA are independent of each other at the low-MAC layer and the PHY, and share the high-MAC layer. The high-MAC layer is separately connected to the multiple low-MAC layers. In other words, the high-MAC layer is shared by multiple links. For example, the high-MAC layer includes the following functions: When the MLD sends data, the high-MAC layer may implement one or more of the following functions: allocation of a sequence number (sequence number, SN) and a packet number (packet number, PN) of a MAC service data unit (MAC service data unit, MSDU), MAC protocol data unit (MAC protocol data unit, MPDU) encryption, mapping from a traffic identifier (Traffic identifier, TID) to a link (TID-to-link), and the like. When the MLD receives data, the high-MAC layer may implement one or more of the following functions: block acknowledgment scoreboard maintenance, duplicate detection, MPDU decryption, packet reordering, replay attack detection, and the like.

[00124] In FIG. 6, in the multi-link AP, the PHY #1 layer, the low-MAC #1 layer, and the high-MAC layer may be considered as an AP #1; the PHY #2 layer, the low-MAC #2 layer, and the high-MAC layer may be considered as an AP #2; ...; and the PHY #n layer, the low-MAC #n layer, and the high-MAC layer may be considered as an AP #n. In other words, it may be understood that the multi-link AP includes n AP entities. A similar case exists in the multi-link STA. To be specific, the high-MAC layer in the multi-link STA is also shared by multiple links. The PHY #1 layer, the low-MAC #1 layer, and the high-MAC layer are considered as a STA #1; the PHY #2 layer, the low-MAC #2 layer, and the high-MAC layer are considered as a STA #2; ...; and the PHY #n layer, the low-MAC #n layer, and the high-MAC layer are considered as a STA #n. In other words, it may be understood that the multi-link STA includes n STA entities. As shown in FIG. 6, the PHY #1 of the AP #1 in the multi-link AP and the PHY #1 of the STA #1 in the multi-link STA operate on a same channel, and the AP #1 in the multi-link AP communicates with the STA #1 in the multi-link STA on a link (a link #1 shown in FIG. 6); the PHY #2 of the AP #2 in the multi-link AP and the PHY #2 of the STA #2 in the multi-link STA operate on another same channel, and the AP #2 in the multi-link AP communicates with the STA #2 in the multi-link STA on a link (a link #2 shown in FIG. 6); and the PHY #n of the AP #n in the multi-link AP and the PHY #n of the STA #n in the multi-link STA operate on another same channel, and the AP #n in the multi-link AP

communicates with the STA #n in the multi-link STA on a link (a link #n shown in FIG. 6).

[00125] For example, the high-MAC layer or the low-MAC layer may be implemented by a processor in a system on chip of the multi-link device, or may be implemented by a different software processing module in a system on chip. Examples are not listed in embodiments of this application. It may be understood that FIG. 6 may be understood as division of the multi-link device into functional modules. The modules shown in FIG. 6 may be implemented in a form of hardware, or may be implemented in a form of software functional modules, or the like. The PHY and the MAC layer shown in FIG. 6 may be understood as logical function division, and another division manner may be used during actual implementation. n shown in FIG. 6 may be equal to 1, or n is an integer greater than 1, or the like.

[00126] For the multi-link device, in addition to a respective MAC address (MAC address) on each link, each multi-link device further has one MLD MAC address (MLD MAC address). The architecture shown in FIG. 6 is used as an example. The high-MAC layer may be uniquely identified by a corresponding MLD MAC address, and the low-MAC layer may be uniquely identified by a MAC address corresponding to a link. For example, the low-MAC #1 and the low-MAC #2 may respectively correspond to MAC addresses of respective links. For example, the multi-link device in embodiments of this application may be a single-antenna device, or may be a multi-antenna device. For example, the multi-link device may be a device with more than two antennas. A quantity of antennas included in the multi-link device is not limited in embodiments of this application.

[00127] In a possible implementation, all links in a same MLD share a pairwise transient key (pairwise transient key, PTK), but each link has a respective group temporal key (group temporal key, GTK), integrity group temporal key (integrity group temporal key, IGTK), and beacon integrity group temporal key (beacon integrity group temporal key, BIGTK).

[00128] (3) Non-collocated AP MLD (Non-collocated AP MLD) or referred to as roaming AP MLD (Roaming AP MLD) architecture: Currently, the IEEE 802.11be is discussing a new AP MLD architecture, which is referred to as the non-collocated AP MLD. The non-collocated AP MLD may also be referred to as a logical AP MLD (logical AP MLD), and a collocated AP MLD may also be referred to as a physical AP MLD (physical AP MLD). A possible deployment form of the non-collocated AP MLD architecture is as follows: An MLD upper MAC sublayer and an MLD lower MAC sublayer of an AP MLD are not in a same device, and communicate with each other in a wired manner, as shown in FIG. 7 below. FIG. 7 is a diagram of an architecture of a communication system according to an embodiment of this application. The architecture shown in FIG. 7 includes a UHR system, an EHT system, and a system before EHT (for example, referred to as pre-EHT). It may be understood that lines, dashed lines, or the like with different thicknesses

shown in FIG. 7 are used to represent different transmission paths. Generally, an interface between an upper layer (which may also be referred to as a higher layer, for example, a radio resource control (radio resource control, RRC) layer) and a MAC layer may be referred to as a MAC service access point (service access point, SAP) (for example, a MAC SAP 1 to a MAC SAP 7 shown by seven black dots in FIG. 7). A MAC address may uniquely identify a MAC SAP. It may be understood that a representation manner (for example, representation by using a black dot) and a representation location (for example, a location of the black dot) of the MAC SAP shown in FIG. 7 are merely examples, and should not be construed as a limitation on embodiments of this application.

[00129] In an example, because data of a pre-EHT STA is associated with an affiliated AP, all data related to the pre-EHT STA needs to be received and sent via a MAC SAP (for example, the MAC SAP 1, the MAC SAP 3, the MAC SAP 4, and the MAC SAP 6 shown in FIG. 7) of the corresponding affiliated AP. As shown in FIG. 7, for data from the pre-EHT STA or data sent to the pre-EHT STA, an AP may process the data via a non-MLD upper MAC layer (for example, the MAC SAP 1, the MAC SAP 3, the MAC SAP 4, and the MAC SAP 6 shown in FIG. 7).

[00130] In another example, because data of an EHT non-AP MLD is associated with a collocated AP MLD, all data related to the EHT non-AP MLD needs to be received and sent via a MAC SAP (for example, the MAC SAP 2 and the MAC SAP5 shown in FIG. 7) of the corresponding collocated AP MLD. As shown in FIG. 7, for data from the EHT non-AP MLD or data sent to the EHT non-AP MLD, a collocated AP MLD may perform data processing via an AP MLD upper MAC sublayer (for example, the MAC SAP 2 and the MAC SAP5 shown in FIG. 7) and then perform data processing via an AP MLD lower MAC sublayer. Each AP MLD lower MAC sublayer may correspond to one PHY. For example, for a collocated AP MLD A, each AP MLD lower MAC sublayer sequentially corresponds to a PHY 1 (which may also be referred to as a link 1 or a PHY corresponding to the link1), ..., and a PHY N (which may also be referred to as a link N or a PHY corresponding to the link N). For a collocated AP MLD B, each AP MLD lower MAC sublayer may sequentially correspond to a PHY 1 (which may also be referred to as a link 1 or a PHY corresponding to the link 1), ..., and a PHY M (which may also be referred to as a link M or a PHY corresponding to the link M). A and B are used to distinguish between different collocated AP MLDs, and M and N are both positive integers.

[00131] In still another example, because data of a UHR non-AP MLD is associated with a non-collocated AP MLD, all data related to the UHR non-AP MLD needs to be received and sent via a MAC SAP (for example, the MAC SAP 7 shown in FIG. 7) of the corresponding non-collocated AP MLD. As shown in FIG. 7, for data from the UHR non-AP MLD or data sent to the UHR non-AP MLD, the non-collocated AP MLD processes the data via an AP MLD upper MAC sublayer,

and then forwards processed data to the outside or a corresponding collocated AP MLD via the MAC SAP 7. The collocated AP MLD delivers the data to a module related to TID-to-link mapping or link aggregation.

[00132] For example, function division of a non-collocated AP MLD upper MAC sublayer and a non-collocated AP MLD lower MAC sublayer may depend on whether a traffic identifier (traffic identifier, TID) is allowed to be mapped to links of different collocated AP MLDs. For example, when a traffic identifier (traffic identifier, TID) is allowed to be mapped to links of different collocated AP MLDs, a block acknowledgment (block ACK, BA) session of the TID needs to be maintained at the non-collocated AP MLD upper MAC sublayer, and the session may be refreshed based on BA information fed back by a corresponding collocated AP MLD.

[00133] It may be understood that an AP MLD upper MAC sublayer function block may be placed in a collocated AP MLD, or may be placed in an access point controller, or the like. A manner of setting the non-collocated AP MLD upper MAC sublayer is not limited in embodiments of this application. An AP MLD upper MAC sublayer and an AP MLD lower MAC sublayer may communicate with each other by using a network cable or another technology. For example, the non-collocated AP MLD may be understood as an AP MLD including multiple collocated AP MLDs. Alternatively, the non-collocated AP MLD may be understood as a device configured to centrally or uniformly manage (or control) multiple collocated AP MLDs.

[00134] The relationship between a MAC address of an MLD and a MAC address of a link affiliated with the MLD shown in FIG. 2 is used as an example. In this case, there is also a similar relationship between a non-collocated AP MLD and a collocated AP MLD. For example, each non-collocated AP MLD has a non-collocated MLD MAC address (for example, the non-collocated AP MLD upper MAC sublayer shown in FIG. 7), an MLD MAC address of a collocated AP MLD affiliated with the non-collocated AP MLD, and a MAC address of a link affiliated with the collocated AP MLD. It may be understood that the non-collocated MLD MAC address may be understood as a MAC address of the AP MLD upper MAC sublayer shown in FIG. 7 (for example, the MAC address of the AP MLD upper MAC sublayer may identify the MAC SAP 7), and n collocated AP MLDs affiliated with a non-collocated AP MLD may also be considered as that the non-collocated AP MLD includes the n collocated AP MLDs, or the non-collocated AP MLD corresponds to the n collocated AP MLDs, or the like.

[00135] It may be understood that the relationship between a non-collocated AP MLD and a collocated AP MLD may be described differently with progress of the standard. Therefore, the descriptions of the relationship between the non-collocated AP MLD and the collocated AP MLD are not limited in embodiments of this application.

[00136] In the non-collocated AP MLD architecture, a UHR non-AP MLD with a roaming

requirement may be associated with a UHR non-collocated AP MLD, an EHT non-AP MLD can be associated with only an AP MLD, and a pre-EHT STA can be associated with only an affiliated AP. When the UHR non-AP MLD associated with the UHR non-collocated AP MLD moves from coverage of one AP MLD to coverage of another AP MLD, and the two AP MLDs are affiliated with the UHR non-collocated AP MLD, a link may be added and a group key of the added link may be allocated to implement uninterrupted data transmission during roaming without updating a PTK or performing reassociation.

[00137] It should be noted that the non-collocated AP MLD architecture is sometimes referred to as a roaming (Roaming) AP MLD architecture, meaning that the AP MLD architecture is proposed to improve roaming performance of the non-AP MLD.

[00138] However, no agreement has been reached on a specific implementation (deployment) form of the non-collocated AP MLD architecture currently. It is considered that if the MLD upper MAC sublayer and the MLD lower MAC sublayer of the non-collocated AP MLD are deployed at different locations, a communication delay between the MLD upper MAC sublayer and the MLD lower MAC sublayer is very large, resulting in poor data transmission performance in this implementation form. Therefore, another possible deployment form of the non-collocated AP MLD architecture is proposed. To be specific, the MLD upper MAC sublayer and the MLD lower MAC sublayer of the non-collocated AP MLD needs to be deployed in a same device, and the MLD upper MAC sublayer of the non-collocated AP MLD moves from one AP MLD to another AP MLD as the non-AP MLD moves, that is, the MLD upper MAC sublayer is transferred through the context (Context). Context transfer herein may include information such as a parameter of the MLD upper MAC sublayer needed for data sending and receiving, and a PTKSA. An advantage of this deployment form is that the MLD upper MAC sublayer and the MLD lower MAC sublayer are always in the same device, and a communication delay between the MLD upper MAC sublayer and the MLD lower MAC sublayer is very small. For ease of description, the former deployment form is referred to as a deployment form I, and the latter deployment form is referred to as a deployment form II.

[00139] (4) BSS parameter critical update (BSS Parameter Critical Update): To prevent a client (such as a STA) from having to parse content of a beacon (Beacon) frame each time, the existing protocol defines a BSS parameter critical update mechanism. In this mechanism, an AP maintains a critical update count value (critical update counter), and the critical update count value is carried in a beacon frame. The STA locally stores a previous critical update counter. If the local critical update counter is different from the critical update counter carried in the current beacon frame, it is considered that a BSS parameter changes, and content of the beacon frame is further parsed. If a value of the local critical update counter is the same as that of the critical update counter carried

in the current beacon frame, it is considered that a BSS parameter does not change, and content of the beacon frame does not need to be parsed. The protocol defines specific elements whose changes in content are defined as critical updates (critical Update). When the content of the elements changes, a critical update value is added.

[00140] (5) Link reconfiguration request/response (Link Reconfiguration Request/Response) frame: Currently, the IEEE 802.11be draft defines a multi-link reconfiguration operation, to allow a non-AP MLD to add or delete one or more links without reassociation when the non-AP MLD is associated with a current AP MLD. In the multi-link reconfiguration operation, a PTK does not need to be updated, and only per-link (per-link) key information such as a GTK/IGTK/BIGTK needs to be negotiated for an added link. Specifically, the multi-link reconfiguration operation is completed by using a link reconfiguration request/response. Specific frame formats are shown in Table 1 and Table 2 below.

Table 1 Multi-link reconfiguration request frame

Order	Information
1	Category (category)
2	Protected EHT action (protected EHT action) frame
3	Dialog token (dialog token)
4	Reconfiguration multi-link element (reconfiguration multi-link element)
5	OCI element (operating channel information element)

[00141] For meanings of the fields in Table 1, refer to the existing protocol. When the complete profile subfield in the reconfiguration multi-link element is set to 1, the per-STA profile carries all fields and elements in the (re)association request frame.

Table 2 Multi-link reconfiguration response frame

Order	Information
1	Category (category)
2	Protected EHT action (protected EHT action) frame
3	Dialog token (dialog token)
4	Count (count)
5	Reconfiguration status list (reconfiguration status list)
6	Group key data (group key data)
7	OCI element (operating channel information element)

Order	Information
8	Basic multi-link element (basic multi-link element)

[00142] In Table 2, the count indicates a quantity of reconfiguration status tuple (Reconfiguration Status Tuple) fields in the reconfiguration status list. The reconfiguration status list indicates a status code of a corresponding link, and a format of the reconfiguration status list is shown in FIG. 8. The group key data (Group Key Data) field carries group key data, and a format of the multicast key data is shown in FIG. 9. FIG. 8 shows an example of a reconfiguration status list. As shown in FIG. 8, the reconfiguration status list includes multiple reconfiguration status tuple fields, each reconfiguration status tuple field includes a link identifier (link identifier, ID) and a status code, and each reconfiguration status tuple field indicates a status of a link.

[00143] FIG. 9 shows an example of group key data. As shown in FIG. 9, the group key data includes a key data length (Key Data Length) subfield and a key data (Key Data) subfield, and the key data length indicates a length of key data. For meanings of the fields in Table 2, refer to the existing protocol. The key data subfield contains one or more multi-link operation (multi-link operation, MLO) key data encapsulations (key data encapsulation, KDE) for group keys corresponding to added links (The Key Data subfield contains one or more MLO KDEs for group keys corresponding to added links). Each MLO KDE is encapsulated using the KDE format shown in FIG. 10 (Each MLO KDE is encapsulated using the KDE format shown in Figure 10). FIG. 10 shows a KDE format according to an embodiment of this application. For each added link, an MLO GTK KDE (MLO GTK KDE format) defined in FIG. 11-1, an MLO IGTK KDE (MLO IGTK KDE format) defined in FIG. 11-2, and an MLO BIGTK KDE (MLO BIGTK KDE) defined in FIG. 11-3 are included (For each added link, an MLO GTK KDE is included as defined in Figure 11-1 (MLO GTK KDE format), an MLO IGTK KDE is included as defined in Figure 11-2 (MLO IGTK KDE format), and an MLO BIGTK KDE is included as defined in Figure 11-3 (MLO BIGTK KDE)). FIG. 11-1 shows an MLO GTK KDE format according to an embodiment of this application. FIG. 11-2 shows an MLO IGTK KDE format according to an embodiment of this application. FIG. 11-3 shows an MLO BIGTK KDE format according to an embodiment of this application. Refer to FIG. 10. When the data type is only the MLO GTK KDE, the data field is shown in FIG. 11-1. Refer to FIG. 10. When the data type is only the MLO IGTK KDE, the data field is shown in FIG. 11-2. Refer to FIG. 10. When the data type is only the MLO BIGTK KDE, the data field is shown in FIG. 11-3.

[00144] The operating channel information (Operating Channel Information, OCI) element indicates operating channel information, and a format of the OCI element is shown in FIG. 12. FIG. 12 shows a format of an OCI element according to an embodiment of this application.

[00145] (6) Block acknowledgment (Block ACK) session establishment: In a multi-link scenario, a block acknowledgment session needs to be established before multi-link aggregation transmission is used. The 802.11n protocol defines a BA mechanism, and the BA mechanism is to aggregate multiple "acknowledgments (acknowledgment)" into one frame to improve channel efficiency. The BA mechanism is started by exchanging an add block acknowledgment (add BA, ADDBA) request (request) frame and an ADDBA response (response) frame. Specifically, a BA session establishment procedure is shown in FIG. 13. FIG. 13 is a diagram of a BA session establishment procedure according to an embodiment of this application. Refer to FIG. 13. The BA session establishment procedure includes: A data transmitter (originator) (briefly referred to as a "transmitter") sends an ADDBA request frame to a data receiver (recipient) (briefly referred to as a "receiver"), and the receiver returns an ADDBA response frame to the transmitter. Through the foregoing procedure, a BA mechanism (or a "BA session") between the transmitter and the receiver is successfully established. Then, the transmitter sends multiple medium access control protocol data units (MAC protocol data unit, MPDU) to the receiver. The multiple MPDUs sent by the transmitter to the receiver are aggregated into one aggregate medium access control protocol data unit (aggregate MPDU, A-MPDU). The transmitter sends a BA request (BA request, BAR) frame to the receiver. The receiver returns a BA frame to the transmitter, to acknowledge receiving statuses of all the MPDUs in the A-MPDU sent by the transmitter. The transmitter or the receiver may send a DELBA to terminate a block acknowledgment session corresponding to a TID.

[00146] Currently, there are two BA mechanisms: a full-state BA mechanism and a partial state BA mechanism. The former needs to maintain a scoreboard status during an entire BA session. Therefore, the receiver needs to maintain all active BA session statuses, which causes heavy load on the receiver. The latter only needs to buffer a recently active BA session status, which can ensure that a memory used to store the BA status can be repeatedly used by different BA sessions, and can implement backward compatibility with the full-state BA mechanism.

[00147] A block acknowledgment session established between two stations has a specific traffic identifier (traffic identifier, TID) and is used only for unidirectional data transmission from the originator to the responder. For example, for downlink data transmission, only an AP can initiate BA session establishment. For uplink data transmission, only a STA can initiate BA session establishment. Specifically, the originator establishes a BA session for a TID by exchanging an ADDBA request/response frame with the STA. The originator or the responder may send a DELBA to terminate a block acknowledgment session corresponding to a TID.

[00148] The block acknowledgment session of the transmitter includes one or more of the following parameters:

a TID;

an SN (sequence number) allocated to each MSDU, a block acknowledgment policy, whether MSDU aggregation is allowed, whether fragmentation is allowed, and whether an HE fragmentation operation is supported;

WinStart_O (window start location) and WinSize_O (window size) of a send buffer; and

a sending success or failure state and a quantity of retransmissions of each MPDU in a window.

[00149] The block acknowledgment session of the receiver includes one or more of the following parameters:

a TID;

a block acknowledgment policy, whether MSDU aggregation is allowed, whether fragmentation is allowed, and whether an HE fragmentation operation (HE fragmentation operation) is supported;

a scoreboard bitmap of the receiver, WinStart_R (window start location), and WinSize_R (window size), where the scoreboard bitmap is used to record specific MSDUs successfully received; and

WinStart_B (window start location) and WinSize_B (window size) of a receive reordering buffer. The receive reordering buffer is used to buffer a received MSDU, because a MAC layer needs to deliver the received MSDU to an LLC layer in order. If a packet is not successfully received, another MSDU following the MSDU cannot be delivered to the LLC layer even if the another MSDU is successfully received.

[00150] For a TID, both a transmitter and a receiver may send a DELBA to delete a block session.

[00151] An existing frame structure of an ADDBA request/response is shown in FIG. 13. FIG. 13 shows a frame structure of an ADDBA request/response. For functions of fields in FIG. 13, refer to the existing protocol. A frame body of an ADDBA request frame includes the fields shown in Table 3. A frame body of an ADDBA response frame includes the fields shown in Table 4.

Table 3

Order	Information
1	Category (category)
2	Block ACK action (block acknowledgment action)
3	Dialog token (dialog token)
4	Block ACK parameter set (block acknowledgment parameter set)

Order	Information
5	Block ACK timeout value (block acknowledgment timeout value)
6	Block ACK starting sequence control (block acknowledgment starting sequence control)
7	ADDBA extension (optional) (add block acknowledgment extension) field

Table 4

Order	Information
1	Category
2	Block ACK action
3	Dialog token
4	Status code (status code)
5	Block ACK parameter set (block acknowledgment parameter set)
6	Block ACK timeout value (block acknowledgment timeout value)
7	ADDBA extension (optional) (add block acknowledgment extension) field

[00152] To implement roaming of a multi-link device, this application provides a solution in which roaming of the multi-link device is implemented by performing a context (context) transfer operation between different AP MLDs. The solution provided in this application is applicable to a deployment form II of a roaming AP MLD (that is, a non-collocated AP MLD) architecture. In other words, when the roaming AP MLD (that is, the non-collocated AP MLD) architecture is the deployment form II, roaming of the multi-link device can be implemented by using the solution in this application. A general procedure of the solution provided in this application is shown in FIG. 14. FIG. 14 is a flowchart of a multi-link device communication method according to an embodiment of this application. As shown in FIG. 14, a non-AP MLD sends a roaming request (Roaming Request) frame to trigger roaming from a current AP MLD (that is, an AP MLD currently associated with the non-AP MLD) to a target AP MLD. Optionally, the current AP MLD transfers a context to the target AP MLD. After the context is transferred, the current AP MLD or the target AP MLD returns a roaming response (Roaming Response) frame to the non-AP MLD. As shown in FIG. 14, the method includes the following steps.

[00153] 1401: The non-AP MLD generates a request frame.

[00154] The request frame is used to request to roam to the target AP MLD.

[00155] In a possible implementation, the request frame is used to trigger roaming from a first AP MLD to the target AP MLD. The request frame may be considered as a roaming request. In

other words, the request frame is used to trigger roaming of the non-AP MLD from the first AP MLD to the target AP MLD.

[00156] In a possible implementation, the request frame is used to trigger the first AP MLD to transfer a context to the target AP MLD, so that the non-AP MLD roams to the target AP MLD. The request frame may be considered as a roaming context transfer request. The context is used to configure an MLD upper MAC sublayer, for example, an MLD upper MAC sublayer of the target (target) AP MLD. The context may include one or more of the following information: a parameter of an MLD upper MAC sublayer needed for data sending and receiving, a PTK, or a PN. For example, the context may include at least one of a BA session-related parameter and a security-related parameter. The BA session-related parameter (also referred to as a BA session context) is a parameter of the MLD upper MAC sublayer needed for data sending and receiving, for example, an SN (sequence number). The security-related parameter (also referred to as a security context) includes, for example, one or more of a PTKSA and information related to encryption and decryption, and includes, for another example, a PN (packet number). In a possible implementation, the context further includes one or more pieces of link indication information, the link indication information indicates a first link, and the first link includes a link that the non-AP MLD requests the target AP MLD to establish. The context transfer step in this embodiment of the present invention is optional.

[00157] 1402: The non-AP MLD sends the request frame to the first AP MLD.

[00158] Correspondingly, the first AP MLD receives the request frame from the non-AP MLD. The first AP MLD is an AP MLD currently associated with the non-AP MLD. In other words, there is currently at least one link between the first AP MLD and the non-AP MLD. Alternatively, an association is established between the non-AP MLD and one or more links of the first AP MLD. The request frame may include first indication information, and the first indication information is used to determine the target AP MLD.

[00159] In a possible implementation, the first indication information indicates the target AP MLD. For example, the first indication information includes an MLD MAC address or an MLD ID of the target AP MLD (that is, an ID of the target AP MLD). The first indication information may further include other information uniquely identifying the target AP MLD. This is not limited herein.

[00160] In a possible implementation, the first indication information includes a wildcard (wildcard) MLD MAC address field or a wildcard BSSID. In this case, the non-AP MLD does not know a specific AP MLD to which the non-AP MLD roams. In other words, the first AP MLD determines the target AP MLD for roaming. For example, the wildcard MLD MAC address field includes a broadcast address or a wildcard BSSID. For example, the field is set to all 1s. The

broadcast address or the wildcard BSSID indicates that the non-AP MLD does not know a specific AP MLD to which the non-AP MLD roams. The broadcast address or the wildcard BSSID is not limited in embodiments of this application. For example, the wildcard BSSID is a special value specified in a protocol, for example, all 0s or all 1s. The value indicates that the first AP MLD determines a specific AP MLD to which the non-AP MLD roams, that is, the first AP MLD determines the target AP MLD to which the non-AP MLD roams. The special value is not limited in embodiments of this application.

[00161] In a possible implementation, the first indication information indicates an AP MLD set (including multiple AP MLDs), and the first indication information indicates that the first AP MLD determines to select an AP MLD from the AP MLD set as the target AP MLD to which the non-AP MLD roams. In other words, when the first indication information indicates an AP MLD set (including multiple AP MLDs), the first indication information implicitly indicates that the non-AP MLD does not know a specific AP MLD to which the non-AP MLD roams. In this case, the first AP MLD may determine a specific AP MLD for roaming in the AP MLD set. For example, the first indication information includes multiple AP MLDs, that is, an AP MLD set. For example, the first indication information includes an index, and the index is associated with an AP MLD set.

[00162] In a possible implementation, the request frame further includes one or more pieces of second indication information, each piece of second indication information indicates one first link, and the first link is a link that the non-AP MLD requests the target AP MLD to establish. For example, each piece of second indication information includes a link ID of one first link. The link that the non-AP MLD requests the target AP MLD to establish may include one or more first links, and different first links are associated with different stations. In other words, the request frame further includes second indication information, the second indication information indicates a first link, and the first link includes one or more links that the non-AP MLD requests the target AP MLD to establish. For example, the second indication information includes an identifier of the first link, that is, an identifier of the one or more links that the non-AP MLD requests the target AP MLD to establish. Optionally, the request frame further includes third indication information, and the third indication information indicates a primary link in the first links. In other words, the third indication information indicates a primary link in the one or more first links. For example, the request frame further includes a primary link indication field corresponding to each link in the first links, and the primary link indication field corresponding to each link indicates whether the link is a primary link. Optionally, the request frame further includes an information parameter used to establish the first link.

[00163] In a possible implementation, the request frame further includes fourth indication information, and the fourth indication information indicates a link status of the first link after the

non-AP MLD receives a response frame. Alternatively, the fourth indication information indicates a link status of the first link after context transfer between the first AP MLD and the target AP MLD is completed. Alternatively, the fourth indication information is used for a link status of the first link after the first AP MLD or the target AP MLD returns a response frame. For example, each link ID of the first link is followed by an enable/disable (enable/disable) state indication. The enable state indication following the link ID indicates that a link corresponding to the link ID is enabled after the non-AP MLD receives the response frame, or indicates that a link corresponding to the link ID is an enabled link after the non-AP MLD receives the response frame. Alternatively, the enable state indication following the link ID indicates that a link corresponding to the link ID is in an enabled state after the non-AP MLD receives the response frame. The disable state indication following the link ID indicates that a link corresponding to the link ID is disabled after the non-AP MLD receives the response frame, or indicates that a link corresponding to the link ID is a disabled link after the non-AP MLD receives the response frame. Alternatively, the disable state indication following the link ID indicates that a link corresponding to the link ID is in a disabled state after the non-AP MLD receives the response frame. Alternatively, a delete state indication following the link ID (for example, corresponding to a link between the first AP MLD and the non-AP MLD) indicates that a link corresponding to the link ID is deleted after the first AP MLD returns the response frame. For example, each link ID of the first link is followed by an awake/doze (awake/doze) state indication. The awake state indication following the link ID indicates that a link corresponding to the link ID is in an awake state after the non-AP MLD receives the response frame. The doze state indication following the link ID indicates that a link corresponding to the link ID is in a doze state after the non-AP MLD receives the response frame.

[00164] Optionally, the request frame further includes fourth indication information, and the fourth indication information indicates a link status of a second link after the first AP MLD returns the response frame. Alternatively, the fourth indication information indicates a link status of the second link after context transfer between the first AP MLD and the target AP MLD is completed. The second link includes the link between the first AP MLD and the non-AP MLD. For example, each link ID of the second link and/or each link ID of the first link are/is followed by an enable/disable (enable/disable) state indication. The enable state indication following the link ID indicates that a link corresponding to the link ID is enabled after the first AP MLD returns the response frame, or indicates that a link corresponding to the link ID is an enabled link after the first AP MLD returns the response frame. The disable state indication following the link ID indicates that a link corresponding to the link ID is disabled after the first AP MLD returns the response frame. Certainly, the fourth indication information may not indicate the link status of the second link after the first AP MLD returns the response frame, but the link status of the second

link is inferred based on the link status of the first link. For example, the first link is in a disabled state. In this case, the second link between a station of the non-AP MLD operating on the first link (for the target AP MLD) and an AP of the first AP MLD is in an enabled state. For another example, the first link is in an enabled state. In this case, the second link between a station of the non-AP MLD operating on the first link (for the target AP MLD) and an AP of the first AP MLD is in a disabled state, where enable/disable (enable/disable) in the link status may also be replaced with awake/doze (awake/doze).

[00165] When the request frame further includes the fourth indication information, the primary link in the first links may be indicated in the following manner: An ID of only one link in the links included in the first links is followed by an enable state indication, and the link is a primary link. When the request frame further includes the fourth indication information, the primary link in the first links may also be indicated in the following manner: IDs of multiple links in the links included in the first links are followed by an enable state indication, and the request frame further includes a primary link indication field corresponding to each enabled link in the first links, to indicate whether the enabled link is a primary link. In a possible implementation, the non-AP MLD requires that the primary link that the non-AP MLD requests the target AP MLD to establish needs to be accepted; otherwise, all links established by the target AP MLD are rejected. In this way, the target AP MLD does not establish a link that does not meet a requirement of the non-AP MLD. In this implementation, data transmission between the non-AP MLD and the current AP MLD and data transmission between the non-AP MLD and the target AP MLD can be facilitated by indicating at least one of the link status of the second link and the link status of the first link after the first AP MLD returns the response frame.

[00166] In a possible implementation, the request frame further includes timeout information, and the timeout information is used to determine a validity time for feeding back a response frame corresponding to the request frame. For example, the timeout information is used by the first AP MLD or the target AP MLD to determine the validity time for feeding back the response frame corresponding to the request frame. The timeout information may be a timeout time value. For example, the timeout information includes a time length (duration), and the timeout information indicates that the first AP MLD or the target AP MLD needs to feed back the response frame within the time length after receiving the request frame. Otherwise, the roaming request or the context transfer request is considered to fail. For example, the timeout information indicates an absolute time, and the first AP MLD or the target AP MLD needs to feed back the response frame before the time. If the response frame is not fed back before the time, it is considered that the roaming request or the context transfer request fails. In this implementation, the request frame further includes the timeout information, and the timeout information is used to determine the validity

time for feeding back the response frame corresponding to the request frame. This can avoid long-time waiting of the non-AP MLD, and avoid affecting roaming experience.

[00167] In a possible implementation, the request frame is a management frame, for example, a link reconfiguration request frame. In other words, a link reconfiguration request frame may be reused as the request frame. In a possible implementation, a new element is added to the link reconfiguration request (Link Reconfiguration Request) frame to carry one or more of the first indication information, the second indication information, the third indication information, the fourth indication information, or the timeout information. After receiving the link reconfiguration request frame, the first AP MLD further performs context transfer in addition to a link reconfiguration operation. In this implementation, an advantage of reusing the link reconfiguration request frame is that the first AP MLD can be triggered to perform context transfer when the link is established with the target AP MLD. This can reduce signaling overheads while reducing interaction for switching to the target AP MLD.

[00168] FIG. 15 shows an example of a frame structure of a request frame according to an embodiment of this application. As shown in FIG. 15, the request frame includes a category (Category) field, an MLD MAC address (Address), link information (Link Info) (optional), and a timeout time value (optional). The category field in this embodiment of this application may indicate a category of a frame/message, that is, used to distinguish between different categories of action frames (action frames). The category indicated by the category (Category) field in FIG. 15 corresponds to the request frame used to request to roam to the target AP MLD, for example, the request frame used to trigger context transfer. The MLD MAC address field indicates the MLD MAC address or the MLD ID of the target AP MLD. The MLD MAC address field is an example of the first indication information. Refer to FIG. 15. The link information field includes a second field, and optionally includes a first field. The first field indicates the link status of the second link after the first AP MLD returns the response frame. Refer to FIG. 15. The first field includes a link ID (Link ID) and a link status indication (for example, enable/disable (enable/disable)), where each link ID is an ID of a link in the second links, and x1 and y1 are integers greater than or equal to 0. If a link ID is associated with an enable state indication, a link corresponding to the link ID is not disabled after the first AP MLD returns the response frame. If a link ID is associated with a disable state indication, a link corresponding to the link ID is disabled after the first AP MLD returns the response frame. The second field indicates the first link, the link status of the first link after the first AP MLD returns the response frame, and the primary link in the first links. The second field may include a link ID (Link ID), a link status indication (for example, enable/disable (enable/disable)), and a primary link indication (optional). Refer to FIG. 15. The second field includes a link ID (Link ID), a link status indication, and a primary link indication. Each link ID

is an ID of a link in the first links, the primary link indication associated with each link ID indicates whether the link is a primary link, and x2 and y2 are integers greater than 0. For example, when a value of a primary link indication associated with a link ID is 1, a link corresponding to the link ID is a primary link. The second indication information includes each link ID in the second field, that is, the link ID of the first link. In other words, each link ID in the second field is an example of the second indication information. The third indication information includes the primary link indication associated with each link ID in the second field. In other words, the primary link indication associated with each link ID in the second field is an example of the third indication information. The fourth indication information includes a link status indication associated with each link ID in the second field, and optionally, further includes a link status indication associated with each link ID in the first field. In other words, at least one of the link status indication associated with each link ID in the first field and the link status indication associated with each link ID in the second field is an example of the fourth indication information. The timeout time value is the foregoing timeout information. The timeout time value indicates a time length or an absolute time.

[00169] FIG. 16 shows an example of a frame structure of another request frame according to an embodiment of this application. As shown in FIG. 16, the request frame includes a category (Category) field, a wildcard MLD MAC address/wildcard BSSID, link information (Link Info) (optional), and a timeout time value (optional). The wildcard MLD MAC address or the wildcard BSSID indicates that the non-AP MLD does not know a specific AP MLD to which the non-AP MLD roams. In other words, the wildcard MLD MAC address or the wildcard BSSID indicates any target AP MLD, or the first AP MLD determines the target AP MLD to which the context is transferred. For functions of other fields in FIG. 16, refer to the descriptions of the fields in FIG. 15.

[00170] 1403: The first AP MLD receives the request frame, and transfers the context to the target AP MLD.

[00171] The request frame is used to request to roam to the target AP MLD. The first indication information in the request frame is used to determine the target AP MLD.

[00172] In a possible implementation, the request frame is used to trigger the first AP MLD to transfer the context to the target AP MLD, and the first indication information indicates the target AP MLD. The first AP MLD may determine, based on the request frame, the target AP MLD to which the context is transferred, and transfer the context to the target AP MLD.

[00173] In a possible implementation, the request frame includes first indication information, the first indication information indicates an AP MLD set (including multiple AP MLDs), and the first indication information indicates that the first AP MLD determines to select an AP MLD from

the AP MLD set as the target AP MLD to which the context is transferred. The first AP MLD selects, based on the request frame, an AP MLD from the AP MLD set as the target AP MLD to which the context is transferred, and transfer the context to the target AP MLD. An implementation in which the first AP MLD selects, based on the request frame, an AP MLD from the AP MLD set as the target AP MLD to which the context is transferred is not limited. For example, the first AP MLD first estimates a distance between each AP MLD in the AP MLD set and the non-AP MLD; and then selects an AP MLD closest to the non-AP MLD in the AP MLD set as the target AP MLD to which the context is transferred. For example, the first AP MLD selects, in the AP MLD set, an AP MLD with highest signal strength between the AP MLD and the non-AP MLD as the target AP MLD to which the context is transferred. For example, the first AP MLD selects an AP MLD with lightest load in the AP MLD set as the target AP MLD to which the context is transferred.

[00174] In a possible implementation, the request frame includes first indication information, and the first indication information includes a wildcard MLD MAC address field or a wildcard BSSID, and indicates that there is no specified target AP MLD, or indicates that the first AP MLD determines the target AP MLD to which the context is transferred. The first AP MLD selects, based on the request frame, an AP MLD as the target AP MLD to which the context is transferred, and transfers the context to the target AP MLD. A manner in which the first AP MLD selects the target AP MLD to which the context is transferred is not limited. For example, the first AP MLD selects an AP MLD closest to the non-AP MLD from nearby AP MLDs as the target AP MLD to which the context is transferred. For example, the first AP MLD selects a closest AP MLD as the target AP MLD to which the context is transferred. For example, the first AP MLD selects an AP MLD with lightest load from nearby AP MLDs as the target AP MLD to which the context is transferred.

[00175] That the first AP MLD transfers the context to the target AP MLD may be: The first AP MLD transmits at least one of the BA session context and the security context to the target AP MLD. In a possible implementation, when the non-AP MLD roams from the current AP MLD to the target AP MLD, to avoid packet loss, the BA session context may be transferred from the current AP MLD to the target AP MLD. Transferring the context (including the BA session context) to the target AP MLD can avoid packet loss. Therefore, transmission of the non-AP MLD is not interrupted in a process in which the non-AP MLD roams to the target AP MLD, that is, a roaming mechanism supporting resumable packet transmission can be implemented. In a multi-link scenario, a block acknowledgment session needs to be established before multi-link aggregation transmission is used. The first AP MLD transmits the BA session context to the target AP MLD. In this way, the BA session establishment procedure does not need to be performed before multi-link aggregation transmission is used between the non-AP MLD and the target AP MLD, so that a delay in roaming of the non-AP MLD to the target AP MLD can be reduced. For example, for

downlink TID #n transmission, the first AP MLD may transfer a BA session context of a transmitter (that is, an AP MLD end) of a TID #n to the target AP MLD. The BA session context includes at least one of the following: an SN counter; WinStart_O and WinSize_O of a send buffer; a sending success or failure state and a quantity of retransmissions of each MSDU/MPDU in a sending window; whether an A-MSDU is enabled; whether a block acknowledgment policy is an immediate block acknowledgment or a delayed block acknowledgment; a timeout value of a block session; whether fragmentation is allowed; and whether an HE (High efficiency) fragmentation operation is supported. For another example, for uplink TID #n transmission, the first AP MLD may transfer a BA session context of a receiver (that is, an AP MLD end) of a TID #n to the target AP MLD. The BA session context includes at least one of the following: a scoreboard of a receiver; corresponding WinStart_R (window start location) and WinSize_R (window size), where the scoreboard is used to record specific MSDUs successfully received; WinStart_B (window start location) and WinSize_B (window size, where the window size is a buffer size) of a receive reordering buffer, where the receive reordering buffer is used to buffer a received MSDU, because a MAC layer needs to deliver the received MSDU to an LLC layer in order; and if a packet is not successfully received, another MSDU following the MSDU cannot be delivered to the LLC layer even if the another MSDU is successfully received; whether an A-MSDU is enabled; whether a block acknowledgment policy is an immediate block acknowledgment or a delayed block acknowledgment; a timeout value of a block session; whether fragmentation is allowed; and whether an HE fragmentation operation is supported. The security context may include one or more of the following: a PTK, a PN counter (Counter), or a replay counter (Replay Counter).

[00176] In a possible implementation, the target AP MLD configures, based on the context from the first AP MLD, for example, at least one of the BA session context and the security context, an MLD upper MAC sublayer used by the target AP MLD to perform data transmission with the non-AP MLD. A parameter of the configured MLD upper MAC sublayer may be the same as a parameter of an MLD upper MAC sublayer used by the first AP MLD to perform data transmission with the non-AP MLD. This implementation can achieve an effect equivalent to transferring the MLD upper MAC sublayer from the first AP MLD to the target AP MLD, thereby implementing roaming of the non-AP MLD.

[00177] In a possible implementation, the target AP MLD establishes one or more link associations with the non-AP MLD based on the context from the first AP MLD, for example, including at least one of the BA session context and the security context, and the second indication information, and performs transmission with the non-AP MLD by using multi-link aggregation transmission.

[00178] 1404: The first AP MLD or the target AP MLD sends the response frame to the non-

AP MLD.

[00179] Correspondingly, the non-AP MLD receives the response frame from the first AP MLD or the target AP MLD. In a possible implementation, after completing context transfer to the target AP MLD (that is, sending the context to the target AP MLD), the first AP MLD sends the response frame to the non-AP MLD. In a possible implementation, after receiving the context from the first AP MLD, the target AP MLD sends the response frame to the non-AP MLD. Two dashed-line boxes in FIG. 14 show two possible solutions of step 1404.

[00180] The response frame includes sixth indication information (optional) and fifth indication information. The sixth indication information indicates the target AP MLD. In a possible implementation, the first indication information in the request frame indicates the target AP MLD to the context is transferred, and the response frame may include the sixth indication information, or may not include the sixth indication information. In a possible implementation, the first indication information in the request frame indicates to roam from the first AP MLD to the target AP MLD, for example, indicates the first AP MLD to transfer the context to the target AP MLD. The response frame includes the sixth indication information and the fifth indication information. The fifth indication information indicates a status code (status code) and/or a critical update count value (critical update counter) corresponding to the first link. The status code indicates that a request for establishing the first link is rejected or accepted, and the critical update count value is a current quantity of updates of a BSS critical parameter of an AP on the first link. When the BSS critical parameter of the AP on the first link changes, the BSS critical parameter update count value is increased by 1 or another value. The receiver (a station in the non-AP MLD) maintains or retains the BSS critical parameter update count value (which may be briefly referred to as the critical update count value). When a BSS critical parameter update count value, broadcast by any AP in the MLD, of the AP on the first link is received next time, the BSS critical parameter update count value is compared with the BSS critical parameter update count value received or maintained last time. If the two values are the same, it indicates that the BSS critical parameter of the AP on the first link does not change. If the two values are not the same, the BSS critical parameter of the AP on the first link changes. For example, the fifth indication information further includes a link ID of each link in the first links, and a status code and a critical update count value (or a critical update counter) corresponding to each link. The status code corresponding to each link indicates that a request for establishing the link is rejected or accepted. The critical update count value corresponding to each link indicates whether a BSS critical parameter of an AP on the link is updated. The response frame carries a critical update count value of an added link, so that the non-AP MLD can learn, based on the critical update count value, whether a corresponding BSS critical parameter changes.

[00181] In a possible implementation, the non-AP MLD requires that a primary link requested (specified) by the non-AP MLD needs to be accepted; otherwise, all requested links (that is, links requested to be established by the target AP MLD) are rejected. For example, the protocol specifies that the primary link requested (specified) by the non-AP MLD needs to be accepted by the target AP MLD; otherwise, all requested links (that is, links requested to be established by the target AP MLD) are rejected by the target AP MLD. For example, the target AP MLD may perform one of the following three operations: accepting all the links that are requested (accept all the links that are requested), or accepting a subset of the links that are requested, where the subset of the links that are requested includes the primary link (accept a subset of the links that are requested, and the subset of the links includes the primary link that is requested in the Roaming Request frame), or rejecting all the links that are requested.

[00182] The critical update count value is a non-negative integer count value. When a BSS critical parameter (which may be named a critical BSS parameter) of an AP corresponding to a link ID is updated, a corresponding critical update count value is increased, for example, by 1. The BSS critical parameter may include one or more of the following: a channel switch announcement element (channel switch announcement element), an extended channel switch announcement element (extended channel switch announcement element), an enhanced distributed channel access (enhanced distributed channel access, EDCA) parameters element (parameters element), a quiet element (quiet element), a DSSS parameter set (DSSS parameter set), an HT operation element (HT operation element), a wide bandwidth channel switch element (wide bandwidth channel switch element), a channel switch wrapper element (channel switch wrapper element), an operating mode notification element (operating mode notification element), a quiet channel element (quiet channel element), a VHT (very high throughput) operation element (operation element), an HE (high efficiency) operation element (operation element), a broadcast TWT element (broadcast TWT element), a BSS color change announcement element (BSS color change announcement element), an MU EDCA parameter set element (MU EDCA parameter set element), a spatial reuse parameter set element (spatial reuse parameter set element), a UORA parameter set element (UORA Parameter Set element), an index adjustment factor field in a multiple BSSID configuration element (Index Adjustment Factor field in a Multiple BSSID Configuration element), an EHT (extremely high throughput) operation element (operation element), a transmit power envelope element (Transmit Power Envelope element, if the AP is an EHT AP), and a UHR (ultra high reliability) operation element (operation element). One or more BSS critical parameters may also be listed as link critical parameters. In addition, a BSS critical parameter update event includes one or more of the following: inclusion of channel switch announcement element (inclusion of channel switch announcement element), inclusion of extended channel switch announcement

element (inclusion of extended channel switch announcement element), modification of enhanced distributed channel access (Modification of enhanced distributed channel access, EDCA) parameters element (parameters element), inclusion of quiet element (inclusion of quiet element), modification of DSSS parameter set (Modification of DSSS parameter set), modification of hT operation element (Modification of HT operation element), inclusion of wide bandwidth channel switch element (inclusion of wide bandwidth channel switch element), inclusion of channel switch wrapper element (inclusion of channel switch wrapper element), inclusion of operating mode notification element (inclusion of operating mode notification element), inclusion of quiet channel element (inclusion of quiet channel element), modification of VHT (very high throughput) operation element (Modification of VHT operation element), modification of HE (high efficiency) operation element (Modification of HE operation element), inclusion of broadcast TWT element (inclusion of broadcast TWT element), insertion or removal of a broadcast TWT parameter set field in a broadcast TWT element (Insertion or removal of a Broadcast TWT Parameter Set field in a Broadcast TWT element), inclusion of BSS color change announcement element (inclusion of BSS color change announcement element), modification of MU EDCA parameter set element (Modification of MU EDCA parameter set element), modification of spatial reuse parameter set element (Modification of spatial reuse parameter set element), modification of the UORA parameter set element (Modification of the UORA Parameter Set element), insertion of an index adjustment factor field in a multiple BSSID configuration element (Insertion of an Index Adjustment Factor field in a Multiple BSSID Configuration element), modification of the EHT (extremely high throughput) operation element (Modification of the EHT operation element), inclusion, modification, or removal of transmit power envelope element (inclusion, modification or removal of Transmit Power Envelope element, if the AP is an EHT AP), and modification of the UHR (ultra high reliability) operation element (Modification of the UHR operation element).

[00183] In a possible implementation, the station (a station in the non-AP MLD) locally maintains, based on the link ID and the critical update count value in the response frame, the critical update count value corresponding to the link ID. For example, after subsequently receiving a management frame such as a beacon frame or a probe response frame to obtain a critical update count value corresponding to the link ID, the station compares a local critical update count value with the recently received critical update count value. If the two values are the same, it indicates that a critical parameter of a BSS to which an AP corresponding to the link ID belongs is not updated. If the two values are not the same, a critical parameter of a BSS to which an AP corresponding to the link ID belongs is updated. In this case, the non-AP MLD to which the station belongs may send, via any station, a probe request frame to an AP MLD to which the AP corresponding to the link ID belongs, to request the critical parameter of the BSS to which the AP

corresponding to the link ID belongs; and then receive a probe response frame to obtain a latest parameter, or receive a beacon frame sent by the AP corresponding to the link ID, to obtain a latest parameter.

[00184] In a possible implementation, the response frame further includes eighth indication information, and the eighth indication information indicates to perform roaming between different AP MLDs in a same roaming domain or a mobile domain, for example, including a context transfer operation, or perform roaming between different AP MLDs in different roaming domains or mobile domains, for example, including a context transfer operation. The eighth indication information includes one or more bits. For example, when a value of the eighth indication information is 1, the eighth indication information indicates to perform roaming between different AP MLDs in a same roaming domain or mobile domain. When a value of the eighth indication information is 0, the eighth indication information indicates to perform roaming between different AP MLDs in different roaming domains or mobile domains. The roaming domain or the mobility domain may also be expressed as a non-collocated AP MLD or a roaming (roaming) AP MLD, and the non-collocated AP MLD or the roaming (roaming) AP MLD includes multiple AP MLDs.

[00185] Step 1404 is optional. In a possible implementation, the first indication information in the request frame indicates the target AP MLD to which the context is transferred. If the first AP MLD or the target AP MLD rejects the request in the request frame or does not complete context transfer to the target AP MLD within a first duration after receiving the request frame, the first AP MLD or the target AP MLD sends, to the non-AP MLD, the response frame indicating that the request in the request frame is rejected.

[00186] In a possible implementation, the response frame is a link reconfiguration response frame. In other words, a link reconfiguration response frame may be reused as the response frame. In a possible implementation, a new element is added to the link reconfiguration response frame (Link Reconfiguration Response) to carry the sixth indication information and the fifth indication information. In this implementation, the link reconfiguration response frame is reused, so that signaling overheads can be reduced.

[00187] FIG. 17 shows an example of a frame structure of a response frame according to an embodiment of this application. As shown in FIG. 17, the response frame includes a category (Category) field, an MLD MAC address field (optional), link information (Link Info), and a scenario indication field (optional). The MLD MAC address field indicates the MLD MAC address or the MLD ID of the target AP MLD. The MLD MAC address field is an example of the sixth indication information. Refer to FIG. 17. The link information field includes a link ID of a link requested to be established (or added) in the request frame, and a status code (status code) and a critical update count value (critical update counter) corresponding to each link ID. The scenario

indication field, that is, the eighth indication information, indicates to perform a context transfer operation between different AP MLDs in a same roaming AP MLD or a context transfer operation in different roaming AP MLDs.

[00188] In embodiments of this application, the non-AP MLD sends the request frame to the first AP MLD, and the first AP MLD receives the request frame and transfers the context to the target AP MLD. The context associated with the non-AP MLD may be transferred to the target AP MLD, so that the target AP MLD subsequently establishes a link association with the non-AP MLD based on the context, that is, roaming of the non-AP MLD is implemented. Transferring the context to the target AP MLD may ensure that transmission of the non-AP MLD is not interrupted in the process in which the non-AP MLD roams to the target AP MLD, that is, roaming that supports resumable packet transmission is implemented, thereby reducing packet loss.

[00189] FIG. 18 is a flowchart of another multi-link device communication method according to an embodiment of this application. Based on the method procedure in FIG. 14, a transmission operation related to a non-AP MLD after a first AP MLD sends a response frame is added to the method procedure in FIG. 18. As shown in FIG. 18, the method includes the following steps.

[00190] 1801: The non-AP MLD generates a request frame.

[00191] 1802: The non-AP MLD sends the request frame to the first AP MLD.

[00192] 1803: The first AP MLD transfers a context to a target AP MLD based on the request frame.

[00193] 1804: The first AP MLD sends a response frame to the non-AP MLD.

[00194] For step 1801 to step 1804, refer to step 1401 to step 1404 in FIG. 14. Details are not described herein again.

[00195] 1805: Perform data transmission between the non-AP MLD and the target AP MLD.

[00196] In a possible implementation, after receiving the response frame, the non-AP MLD establishes a link and/or an association with the target AP MLD, and performs data transmission. The target AP MLD may establish the link and/or the association with the non-AP MLD based on the context from the first AP MLD, and implement data transmission with the non-AP MLD. For example, fifth indication information in the response frame indicates a status code and/or a critical update count value corresponding to a first link. The non-AP MLD may determine, based on the fifth indication information, a link that the target AP MLD accepts to establish, and further establish the link and/or the association with the target AP MLD.

[00197] 1806: The first AP MLD sends downlink data to the non-AP MLD.

[00198] In a possible implementation, fourth indication information in the request frame indicates that a link status of a second link is an enabled (enable) or awake state after the response frame is returned. In another possible implementation, fourth indication information in the request

frame indicates that a link status of the first link is a disabled or doze state after the response frame is returned. In this case, a station in the non-AP MLD operating on the first link may communicate with the first AP MLD. When the link status of the second link is enabled or awake, the first AP MLD sends a remaining data packet (that is, downlink data) in a transmission queue to the non-AP MLD, where the transmission queue includes a data packet to be sent to the non-AP MLD. In this embodiment of this application, after sending the response frame to the non-AP MLD, the first AP MLD may continue to send the downlink data to the non-AP MLD. A sequence of step 1806 and step 1805 is not limited. Step 1805 and step 1806 may be performed in parallel. Step 1806 is optional.

[00199] 1807: The first AP MLD sends link deletion information to the non-AP MLD.

[00200] Correspondingly, the non-AP MLD receives the link deletion information from the first AP MLD. The link deletion information indicates the non-AP MLD to delete (or disable) a link of the first AP MLD. In a possible implementation, when a last SN associated with the non-AP MLD on the first AP MLD is refreshed or times out, the link deletion information is sent to the non-AP MLD. In this way, the link can be released in time to fully utilize link resources.

[00201] 1808: The non-AP MLD deletes, based on the link deletion information, the link associated with the first AP MLD.

[00202] In a possible implementation, step 1807 and step 1808 are replaced with the following: When quality of a link between the non-AP MLD and the first AP MLD is lower than a threshold, the non-AP MLD deletes the link associated with the first AP MLD, and sends, to the first AP MLD, an indication indicating the first AP MLD to delete the link between the first AP MLD and the non-AP MLD. In this way, resource utilization can be improved. The threshold may be set based on an actual requirement.

[00203] In this embodiment of this application, after sending the response frame to the non-AP MLD, the first AP MLD continues to send the downlink data to the non-AP MLD until the last SN associated with the non-AP MLD on the first AP MLD is refreshed or times out. In this way, the first AP MLD may send the remaining data packet in the transmission queue to the non-AP MLD, so that the non-AP MLD receives complete downlink data from the first AP MLD. Roaming of the non-AP MLD is implemented by transferring the context to the target AP MLD, thereby reducing packet loss.

[00204] FIG. 19 is a flowchart of another multi-link device communication method according to an embodiment of this application. Optionally, the method is applicable to a single radio multi-link device (single radio MLD). Based on the method procedure in FIG. 14, a transmission operation related to a non-AP MLD after a first AP MLD sends a response frame is added to the method procedure in FIG. 19. The method procedure in FIG. 19 and the method procedure in FIG.

18 are two parallel method procedures. A difference between the method procedure in FIG. 19 and the method procedure in FIG. 18 lies in that in the method procedure in FIG. 19, after sending the response frame, the first AP MLD no longer sends downlink data to the non-AP MLD; and in the method procedure in FIG. 18, after sending the response frame, the first AP MLD may continue to send downlink data to the non-AP MLD. As shown in FIG. 19, the method includes the following steps.

[00205] 1901: The non-AP MLD generates a request frame.

[00206] 1902: The non-AP MLD sends the request frame to the first AP MLD.

[00207] 1903: The first AP MLD transfers a context to a target AP MLD based on the request frame.

[00208] For step 1901 to step 1903, refer to step 1401 to step 1403 in FIG. 14. Details are not described herein again.

[00209] 1904: The first AP MLD sends downlink data to the non-AP MLD.

[00210] In a possible implementation, fourth indication information in the request frame indicates that a link status of a second link is a disabled (disable) or doze state after the first AP MLD or the target AP MLD returns a response frame. In another possible implementation, fourth indication information in the request frame indicates that a link status of a first link is an enabled or awake state after a response frame is returned. In this case, a station in the non-AP MLD operating on the first link is in a disabled or doze state after the response frame is returned. When the link status of the second link is a disabled or doze state, before sending the response frame to the non-AP MLD, the first AP MLD sends a remaining data packet (that is, downlink data) in a transmission queue to the non-AP MLD, where the transmission queue includes a data packet to be sent to the non-AP MLD.

[00211] 1905: The first AP MLD sends the response frame to the non-AP MLD.

[00212] For step 1905, refer to step 1404 in FIG. 14. Details are not described herein again.

[00213] 1906: The non-AP MLD deletes a link of the first AP MLD.

[00214] In a possible implementation, the request frame further optionally includes the fourth indication information, the fourth indication information indicates the link status of the second link after the response frame is returned, the second link includes a link between the first AP MLD and the non-AP MLD, and the link status of the second link is a disabled or doze state; or the fourth indication information indicates the link status of the first link after the response frame is returned. The non-AP MLD learns of the link status of the second link between the first AP MLD and the non-AP MLD according to a corresponding rule. In a possible implementation, the response frame further includes seventh indication information, and the seventh indication information indicates the non-AP MLD to delete the link of the first AP MLD. The non-AP MLD deletes the link of the

first AP MLD based on the seventh indication information. In a possible implementation, the protocol specifies that after receiving the response frame, the non-AP MLD deletes the link established with the first AP MLD.

[00215] 1907: Perform data transmission between the non-AP MLD and the target AP MLD.

[00216] For step 1907, refer to step 1805 in FIG. 18. Details are not described herein again.

[00217] In this embodiment of this application, before sending the response frame to the non-AP MLD, the first AP MLD sends the remaining data packets in the transmission queue to the non-AP MLD. In this way, the first AP MLD may send the remaining data packets in the transmission queue to the non-AP MLD, so that the non-AP MLD receives complete downlink data from the first AP MLD.

[00218] It should be understood that sequence numbers of the foregoing processes do not mean execution sequences. The execution sequence of the processes should be determined based on functions and internal logic of the processes, and should not be construed as any limitation on the implementation processes in embodiments of this application.

[00219] It should be further understood that in embodiments of this application, unless otherwise stated or there is a logic conflict, terms and/or descriptions in different embodiments are consistent and may be mutually referenced, and technical features in different embodiments may be combined based on an internal logical relationship thereof, to form a new embodiment.

[00220] It should be further understood that, in some of the foregoing embodiments, a device in an existing network architecture is mainly used as an example for description. It should be understood that, a specific form of the device is not limited in embodiments of this application. For example, all devices that can implement a same function in the future are applicable to embodiments of this application.

[00221] It may be understood that in the foregoing method embodiments, methods and operations implemented by a device (for example, a non-AP MLD, a first AP MLD, or a target AP MLD) may alternatively be implemented by a component (for example, a chip or a circuit) that may be used in the device.

[00222] It may be further understood that some optional features in embodiments of this application may be independent of other features in some scenarios, or may be combined with other features in some scenarios. This is not limited.

[00223] A person skilled in the art should be aware that units and algorithm steps in the examples described with reference to embodiments disclosed in this specification can be implemented by hardware or a combination of hardware and computer software in this application. Whether a function is performed by hardware or hardware driven by computer software depends on particular applications and design constraints of the technical solutions. A person skilled in the

art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[00224] The following describes in detail communication apparatuses provided in embodiments of this application with reference to FIG. 20 to FIG. 22. It should be understood that descriptions of apparatus embodiments correspond to the descriptions of the method embodiments. Therefore, for content that is not described in detail, refer to the foregoing method embodiments. For brevity, some content is not described again.

[00225] In embodiments of this application, functional modules of a transmitter device or a receiver device may be obtained through division based on the foregoing method examples. For example, functional modules may be obtained through division based on corresponding functions, or two or more functions may be integrated into one processing module. The integrated module may be implemented in a form of hardware, or may be implemented in a form of a software functional module. It should be noted that in embodiments of this application, module division is an example, and is merely logical function division. Another division manner may be used during actual implementation. An example in which functional modules may be obtained through division based on corresponding functions is used below for description.

[00226] FIG. 20 is a block diagram of a communication apparatus 10 according to an embodiment of this application. The apparatus 10 includes a transceiver module 11 and a processing module 12. The transceiver module 11 may implement a corresponding communication function, and the processing module 12 is configured to perform data processing; or the transceiver module 11 is configured to perform receiving-related and sending-related operations, and the processing module 12 is configured to perform an operation other than receiving and sending. The transceiver module 11 may also be referred to as a communication interface or a communication unit.

[00227] Optionally, the apparatus 10 may further include a storage module 13. The storage module 13 may be configured to store instructions and/or data. The processing module 12 may read the instructions and/or the data in the storage module, to cause the apparatus to implement actions of a device in the foregoing method embodiments.

[00228] In a design, the apparatus 10 may correspond to the non-AP MLD in the foregoing method embodiments, or may be a component (for example, a chip) of the non-AP MLD.

[00229] The apparatus 10 may implement steps or procedures performed by the non-AP MLD in the foregoing method embodiments. The transceiver module 11 may be configured to perform receiving-related and sending-related operations of the non-AP MLD in the foregoing method embodiments. The processing module 12 may be configured to perform processing-related operations of the non-AP MLD in the foregoing method embodiments.

[00230] 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.

[00231] In another design, the apparatus 10 may correspond to the first AP MLD in the foregoing method embodiments, or may be a component (for example, a chip) of the first AP MLD.

[00232] The apparatus 10 may implement steps or procedures performed by the first AP MLD in the foregoing method embodiments. The transceiver module 11 may be configured to perform receiving-related and sending-related operations of the first AP MLD in the foregoing method embodiments. The processing module 12 may be configured to perform processing-related operations of the first AP MLD in the foregoing method embodiments.

[00233] 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.

[00234] It should be further understood that the apparatus 10 herein is embodied in a form of functional module. The term "module" herein may be an application-specific integrated circuit (application specific-integrated circuit, ASIC), an electronic circuit, a processor (for example, a shared processor, a dedicated processor, or a group processor) configured to execute one or more software or firmware programs, a memory, a combined logic circuit, and/or another appropriate component that supports the described function.

[00235] The apparatus 10 in the foregoing solutions has a function of implementing the corresponding step performed by the device (for example, the first AP MLD) in the foregoing methods. The function may be implemented by hardware, or may be implemented by hardware executing corresponding software. The hardware or the software includes one or more modules corresponding to the foregoing function. For example, the transceiver module may be replaced with a transceiver (for example, a sending unit in the transceiver module may be replaced with a transmitter, and a receiving unit in the transceiver module may be replaced with a receiver), and another unit such as the processing module may be replaced with a processor, to respectively perform receiving and sending operations and a related processing operation in the method embodiments.

[00236] In addition, the transceiver module 11 may be a transceiver circuit (for example, may include a receiver circuit and a transmitter circuit), and the processing module may be a processing circuit.

[00237] FIG. 21 is a diagram of another communication apparatus 20 according to an embodiment of this application. The apparatus 20 includes a processor 21. The processor 21 is configured to execute a computer program or instructions stored in a memory 22, or read

data/signaling stored in the memory 22, to perform the methods in the foregoing method embodiments. Optionally, there are one or more processors 21.

[00238] Optionally, as shown in FIG. 21, the apparatus 20 further includes the memory 22. The memory 22 is configured to store the computer program or the instructions and/or the data. The memory 22 and the processor 21 may be integrated together, or may be disposed separately. Optionally, there are one or more memories 22.

[00239] Optionally, as shown in FIG. 21, the apparatus 20 further includes a transceiver 23. The transceiver 23 is configured to receive and/or send a signal. For example, the processor 21 is configured to control the transceiver 23 to receive and/or send a signal.

[00240] In a solution, the apparatus 20 is configured to implement operations performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments.

[00241] It should be understood that, the processor mentioned in embodiments of this application may be a central processing unit (central processing unit, CPU), and may alternatively 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 discrete gate or a transistor logic device, a discrete hardware component, or the like. The general-purpose processor may be a microprocessor, or the processor may be any conventional processor or the like.

[00242] It should be further understood that the memory mentioned in embodiments of this application may be a volatile memory and/or a nonvolatile memory. The nonvolatile memory may be 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), or a flash memory. The volatile memory may be a random access memory (random access memory, RAM). For example, the RAM may be used as an external cache. By way of example, and not limitation, the RAM includes a plurality of forms: a static random access memory (static RAM, SRAM), a dynamic random access memory (dynamic RAM, DRAM), a synchronous dynamic random access memory (synchronous DRAM, SDRAM), a double data rate synchronous dynamic random access memory (double data rate SDRAM, DDR SDRAM), an enhanced synchronous dynamic random access memory (enhanced SDRAM, ESDRAM), a synchlink dynamic random access memory (synchlink DRAM, SLDRAM), and a direct rambus random access memory (direct rambus RAM, DR RAM).

[00243] It should be noted that when the processor is a general-purpose processor, a DSP, an ASIC, an FPGA or another programmable logic device, a discrete gate or a transistor logic device,

or a discrete hardware component, a memory (storage module) may be integrated into the processor.

[00244] It should further be noted that the memory described herein is intended to include, but is not limited to, these and any other appropriate type of memory.

[00245] FIG. 22 is a diagram of a system on chip 30 according to an embodiment of this application. The system on chip 30 (which may also be referred to as a processing system) includes a logic circuit 31 and an input/output interface (input/output interface) 32.

[00246] The logic circuit 31 may be a processing circuit in the system on chip 30. The logic circuit 31 may be coupled to a storage unit, and invoke instructions in the storage unit, so that the system on chip 30 can implement the methods and functions in embodiments of this application. The input/output interface 32 may be an input/output circuit in the system on chip 30, and outputs information processed by the system on chip 30, or inputs to-be-processed data or signaling information to the system on chip 30 for processing.

[00247] In a solution, the system on chip 30 is configured to implement operations performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments.

[00248] For example, the logic circuit 31 is configured to implement processing-related operations performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments; and the input/output interface 32 is configured to implement sending-related and/or receiving-related operations performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments.

[00249] An embodiment of this application further provides a computer-readable storage medium. The computer-readable storage medium stores computer instructions for implementing a method performed by a device in the foregoing method embodiments.

[00250] For example, when the computer program is executed by a computer, the computer may be caused to implement the method performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments.

[00251] An embodiment of this application further provides a computer program product, including instructions. When the instructions are executed by a computer, the method performed by the non-AP MLD or the first AP MLD in the foregoing method embodiments is implemented.

[00252] An embodiment of this application further provides a communication system, including a non-AP MLD, a first AP MLD, and a target AP MLD.

[00253] For explanations and beneficial effects of related content in any one of the apparatuses provided above, refer to the corresponding method embodiments provided above. Details are not described herein again.

[00254] In the several embodiments provided in this application, it should be understood that the disclosed apparatus and method may be implemented in other manners. For example, the

described apparatus embodiments are merely examples. For example, division into the units is merely logical function division, and another division manner may be used during actual implementation. For example, multiple units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections may be implemented through some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electrical, mechanical, or other forms.

[00255] All or some of the foregoing embodiments may be implemented by software, hardware, firmware, or any combination thereof. When software is used to implement embodiments, all or some of embodiments may be implemented in a form of a computer program product. The computer program product includes one or more computer instructions. When the computer program instructions are loaded and executed on a computer, the procedure or functions according to embodiments of this application are all or partially generated. The computer may be a general-purpose computer, a dedicated computer, a computer network, or another programmable apparatus. For example, the computer may be a personal computer, a server, a network device, or the like. The computer instructions may be stored in a computer-readable storage medium or may be transmitted from a computer-readable storage medium to another computer-readable storage medium. For example, the computer instructions may be transmitted from a website, computer, server, or data center to another website, computer, server, or data center in a wired (for example, a coaxial cable, an optical fiber, or a digital subscriber line (DSL)) or wireless (for example, infrared, radio, or microwave) manner. The computer-readable storage medium may be any usable medium accessible to the computer, or a data storage device, for example, a server or a data center, integrating one or more usable media. The usable medium may be a magnetic medium (for example, a floppy disk, a hard disk, or a magnetic tape), an optical medium (for example, a DVD), a semiconductor medium (for example, a solid state disk (solid state disk, SSD)), or the like. For example, the usable medium may include but is not limited to any medium that can store program code, for example, a USB flash drive, a removable hard disk drive, a read-only memory (read-only memory, ROM), a random access memory (random access memory, RAM), a magnetic disk, or an optical disc.

[00256] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

CLAIMS

1. A multi-link device communication method, wherein the method is applied to a non-access point multi-link device non-AP MLD, and the method comprises:

generating a request frame, wherein the request frame is used to request to roam to a target access point multi-link device AP MLD, the request frame comprises first indication information, and the first indication information is used to determine the target AP MLD; and

sending the request frame to a first AP MLD.

2. The method according to claim 1, wherein the first indication information indicates the target AP MLD, or the first indication information is a wildcard basic service set identifier BSSID.

3. The method according to claim 1 or 2, wherein the request frame further comprises one or more pieces of second indication information, each piece of second indication information indicates one first link, and the first link is a link that the non-AP MLD requests the target AP MLD to establish.

4. The method according to claim 3, wherein the request frame further comprises one or more of the following: third indication information or a parameter used to establish one or more first links, and the third indication information indicates a primary link in the one or more first links.

5. The method according to any one of claims 1 to 4, wherein the request frame further comprises fourth indication information, and the fourth indication information indicates a link status of the first link after a response frame is received.

6. The method according to claim 5, wherein the link status comprises enable and disable, or the link status comprises an awake state and a doze state.

7. The method according to any one of claims 1 to 6, wherein the request frame further comprises timeout information, and the timeout information is used to determine a validity time for feeding back a response frame corresponding to the request frame.

8. The method according to any one of claims 1 to 7, wherein the request frame is a link reconfiguration request frame.

9. The method according to any one of claims 1 to 8, wherein the method further comprises:

receiving a response frame from the first AP MLD, wherein the response frame comprises fifth indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to the first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a basic service set BSS critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

10. The method according to claim 9, wherein the response frame further comprises sixth indication information, and the sixth indication information indicates the target AP MLD.

11. The method according to claim 9 or 10, wherein the response frame is a link reconfiguration response frame.

12. A multi-link device communication method, wherein the method is applied to a first access point multi-link device AP MLD, and the method comprises:

receiving a request frame from a non-AP MLD, wherein the request frame is used to request to roam to a target AP MLD, the request frame comprises first indication information, and the first indication information is used to determine the target AP MLD; and

transferring a context to the target AP MLD.

13. The method according to claim 12, wherein the context comprises a block acknowledgment BA session-related parameter and/or a security-related parameter.

14. The method according to claim 12 or 13, wherein the first indication information indicates the target AP MLD, or the first indication information is a wildcard basic service set identifier BSSID.

15. The method according to any one of claims 12 to 14, wherein the request frame further comprises one or more pieces of second indication information, each piece of second indication information indicates one first link, and the first link is a link that the non-AP MLD requests the target AP MLD to establish.

16. The method according to claim 15, wherein the request frame further comprises at least one of third indication information and a parameter used to establish one or more first links, and the third indication information indicates a primary link in the one or more first links.

17. The method according to any one of claims 12 to 16, wherein the request frame further comprises fourth indication information, and the fourth indication information indicates a link status of the first link after a response frame is received.

18. The method according to claim 17, wherein the link status comprises enable and disable, or the link status comprises an awake state and a doze state.

19. The method according to any one of claims 12 to 18, wherein the request frame further comprises timeout information, and the timeout information is used to determine a validity time for feeding back a response frame corresponding to the request frame.

20. The method according to any one of claims 12 to 19, wherein the request frame is a link reconfiguration request frame.

21. The method according to any one of claims 12 to 20, wherein the method further comprises:

sending a response frame to the non-AP MLD, wherein the response frame comprises fifth

indication information, the fifth indication information indicates a status code and/or a critical update count value corresponding to the first link, the status code indicates that a request for establishing the first link is rejected or accepted, the critical update count value is a current quantity of updates of a basic service set BSS critical parameter of an AP on the first link, and when the BSS critical parameter of the AP on the first link changes, the critical update count value is increased by 1.

22. The method according to claim 21, wherein the response frame further comprises sixth indication information, and the sixth indication information indicates the target AP MLD.

23. The method according to claim 22, wherein the request frame further comprises the fourth indication information, the fourth indication information indicates the link status of the first link after the response frame is received, and the first link is a link that the non-AP MLD requests the target AP MLD to establish; and after the sending the response frame to the non-AP MLD, the method further comprises:

when the link status of the first link is a disabled state or a doze state, sending a remaining data packet in a transmission queue to the non-AP MLD, wherein the transmission queue comprises a data packet to be sent to the non-AP MLD; and when a last sequence number SN associated with the non-AP MLD on the first AP MLD is refreshed or times out, sending link deletion information to the non-AP MLD, wherein the link deletion information indicates the non-AP MLD to delete a link of the first AP MLD.

24. The method according to any one of claims 21 to 23, wherein the response frame is a link reconfiguration response frame.

25. A communication apparatus, comprising a processor, wherein the processor is coupled to a memory, the memory is configured to store a computer program or instructions, and the processor is configured to execute the computer program or the instructions in the memory, so that the communication apparatus performs the method according to any one of claims 1 to 11; or the communication apparatus performs the method according to any one of claims 12 to 24.

26. A communication system, wherein the communication system comprises a first communication apparatus and a second communication apparatus, the first communication apparatus is configured to perform the method according to any one of claims 1 to 11, and the second communication apparatus is configured to perform the method according to any one of claims 12 to 24.

27. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program or instructions, and when the computer program or the instructions are run on a computer, the computer is caused to perform the method according to any one of claims 1 to 24.

28. A chip, comprising a communication interface and a processor, wherein the communication interface is configured to receive and send a signal of the chip, and the processor is configured to execute a computer program or instructions, so that a communication apparatus comprising the chip performs the method according to any one of claims 1 to 24.

29. A computer program product, wherein when the computer program product runs on a computer, the computer is caused to perform the method according to any one of claims 1 to 24.