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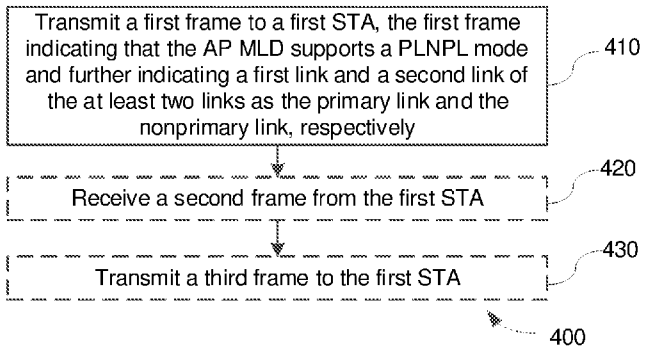

FIG. 4

(57) Abstract: The present disclosure provides a wireless communication method, applied in a first Access Point (AP) affiliated with an AP Multi-Link Device (MLD). The method includes: transmitting a first frame to a first STAtion (STA) affiliated with a non-AP MLD, the first frame indicating that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link, and the first frame further indicating a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

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WIRELESS COMMUNICATION METHODS AND APPARATUSES

TECHNICAL FIELD

The present disclosure relates to communication technology, and more particularly, to wireless communication methods and apparatuses.

BACKGROUND

According to the related art, a NonSimultaneous Transmit and Receive (NSTR) mobile Access Point (AP) Multi-Link Device (MLD) operation has been specified as follows.

1) An NSTR mobile AP MLD is an AP MLD which sets dot11SoftAPMLDImplemented to true and has one NSTR pair of links with the following restrictions:

- Each AP affiliated with a mobile AP MLD is not required to support all the Extremely High Throughput (EHT) AP mandatory features
    - •Support of Multi-User (MU) operation is optional for the APs affiliated with a mobile AP MLD
    - •Support of two or more spatial streams is optional for the APs affiliated with a mobile AP MLD
- Only one AP of the affiliated APs operating in an NSTR pair of links sends Beacon and Probe Response frames
- The mobile AP MLD is in a mobile device that is typically battery powered
- Each AP affiliated to a mobile AP MLD has different Medium Access Control (MAC) address

2) An NSTR mobile AP MLD shall designate one link of an NSTR link pair as the primary link to transmit Beacon and Probe Response frames. The other link of the NSTR link pair is the nonprimary link.

At least the following problems need to be addressed about multi-link setup and related operations for such AP MLD:

- Mechanism to discover the NSTR Mobile AP MLD;
- Mechanism of multi-link setup between an NSTR Mobile AP MLD and a non-AP MLD which intends to be associated with the AP MLD;
- How does the STAtion (STA) learn the full information of the other link (since no beacons are sent in the other link); and
- What about Traffic IDentifier (TID)-to-link mapping negotiation for the NSTR Mobile AP MLD for transmission, as the transmission on the nonprimary link is possible only when the transmission happened on the primary link.

SUMMARY

The present disclosure provides wireless communication methods and apparatuses, facilitating multi-link setup and operation for an Access Point (AP) Multi-Link Device (MLD) such as NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD.

According to a first aspect of the present disclosure, a wireless communication method is provided. The wireless communication method is applied in a first AP affiliated with an AP MLD, and includes: transmitting a first frame to a first STAtion (STA) affiliated with a non-AP MLD. The first frame indicates that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

According to a second aspect of the present disclosure, a wireless communication method is provided. The wireless communication method is applied in a first STAtion (STA) affiliated with a non-AP MLD, and includes: receiving a first frame from a first AP affiliated with an AP MLD.

The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

According to a third aspect of the present disclosure, a wireless communication apparatus is provided. The wireless communication apparatus is applied in a first AP affiliated with an AP MLD, and includes: a communication unit configured to transmit a first frame to a first STAtion (STA) affiliated with a non-AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

According to a fourth aspect of the present disclosure, a wireless communication apparatus is provided. The wireless communication apparatus is applied in a first STA affiliated with a non-AP MLD, and includes: a communication unit configured to receive a first frame from a first AP affiliated with an AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

According to a fifth aspect of the present disclosure, an AP device is provided. The AP device includes: a memory having a computer program stored thereon; and a processor configured to invoke and run the computer program whereby the AP device is operative to perform the method of the above first aspect.

According to a sixth aspect of the present disclosure, a STA device is provided. The STA device includes: a memory having a computer program stored thereon; and a processor configured to invoke and run the computer program whereby the STA device is operative to perform the method of the above second aspect.

According to a seventh aspect of the present disclosure, a chip is provided. The chip includes a processor configured to invoke and run a computer program from a memory whereby an apparatus provided with the chip is operative to perform the method of the above first aspect or the method of the above second aspect.

According to an eighth aspect of the present disclosure, a computer readable storage medium is provided. The computer readable storage medium has a computer program stored thereon, and the computer program, when executed by a computer, causes the computer to perform the method of the above first aspect or the method of the above second aspect.

According to a ninth aspect of the present disclosure, a computer program product is provided. The computer program product includes computer program instructions, and the computer program instructions, when executed by a computer, cause the computer to perform the method of the above first aspect or the method of the above second aspect.

According to a tenth aspect of the present disclosure, a computer program is provided. The computer program, when executed by a computer, causes the computer to perform the method of the above first aspect or the method of the above second aspect.

With the embodiments of the present disclosure, the multi-link setup and operation for the AP MLD in the PLNPL mode can be efficiently implemented.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages will be more apparent from the following description of embodiments with reference to the figures, in which:

FIG. 1 illustrates a communication system 100 that the present disclosure may be applied;

FIG. 2 illustrates a communication system 200 that the present disclosure may be applied;
FIG. 3 illustrates a format of Basic Multi-Link element according to embodiments of the present disclosure;
FIG. 4 is a flowchart illustrating a wireless communication method 400 according to embodiments of the present disclosure;
FIG. 5 illustrates addition of the PLNPL Capabilities subfield in the Common Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure;
FIG. 6 illustrates an exemplary format of the PLNPL Capabilities subfield according to an embodiment of the present disclosure;
FIG. 7 illustrates addition of the PLNPL Info Present subfield in the STA Control field in the Link Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure;
FIG. 8 illustrates addition of the PLNPL Info subfield in the STA Info field in the Link Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure;
FIG. 9 illustrates a first format of the PLNPL Info subfield (PLNPL Info subfield format-1) according to an embodiment of the present disclosure;
FIG. 10 illustrates a second format of the PLNPL Info subfield (PLNPL Info subfield format-2) according to an embodiment of the present disclosure;
FIG. 11 illustrates a third format of the PLNPL Info subfield (PLNPL Info subfield format-3) according to an embodiment of the present disclosure;
FIG. 12 illustrates addition of the NSTR Mobile AP MLD Operation Support subfield in the MLD Capabilities subfield in the Common Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure;
FIG. 13 illustrates a flowchart illustrating multi-link setup between an NSTR mobile AP MLD and a non-AP MLD according to an embodiment of the present disclosure;
FIG. 14 illustrates a TID-TO-Link mapping negotiation procedure of the wireless communication method 400 according to an embodiment of the present disclosure;
FIG. 15 illustrates another TID-TO-Link mapping negotiation procedure of the wireless communication method 400 according to an embodiment of the present disclosure;
FIG. 16 illustrates two exemplary TID-to-link mapping negotiation procedures for a NSTR Mobile AP MLD according to embodiments of the present disclosure;
FIG. 17 is a flowchart illustrating a wireless communication method 1700 according to embodiments of the present disclosure;
FIG. 18 illustrates a TID-TO-Link mapping negotiation procedure of the wireless communication method 400 according to an embodiment of the present disclosure;
FIG. 19 illustrates another TID-TO-Link mapping negotiation procedure of the wireless communication method 400 according to an embodiment of the present disclosure;
FIG. 20 is a block diagram of a wireless communication apparatus 2000 according to an embodiment of the present disclosure;
FIG. 21 is a block diagram of a wireless communication apparatus 2100 according to an embodiment of the present disclosure;
FIG. 22 is a block diagram of a communication device 2200 according to embodiments of the present disclosure; and
FIG. 23 is a block diagram of an apparatus 2300 according to embodiments of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, the present disclosure will be described with reference to embodiments shown in the attached drawings. However, it is to be understood that those descriptions are just provided for illustrative purpose, rather than limiting the present disclosure. Further, in the following, descriptions of known structures and techniques are omitted so as not to unnecessarily obscure the concept of the present disclosure.

Various embodiments of the present disclosure can be applied to wireless local area network (WLAN) standards, such as the IEEE 802.11 standards including the IEEE 802.11ax

specification and the IEEE 802.11be specification, and/or any other appropriate wireless communication standard, such as the Worldwide Interoperability for Microwave Access (WiMAX), Bluetooth, and/or ZigBee standards, and/or any other protocols either currently known or to be developed in the future. The WLAN may include a plurality of Basic Service Sets (BSS), and network nodes in a basic service set are STAtions (STAs). STAs may include Access Point STAs (AP STAs) and non-AP STAs, and each BSS may include one AP STA and a plurality of non-AP STAs associated with the AP. Another version is that STAs include a STA and a peer STA that is in peer to peer communication with the STA. In this case, the peer STA may be an AP STA or a non-AP STA.

The 802.11 communication system may perform communications between an AP STA and a non-AP STA, and may also perform communications between non-AP STAs.

The AP STA (also named as AP for the sake of simplification) is also known as a wireless access point, a hot spot, or the like. The AP is an access point for a mobile user to access a wired network, and is mainly deployed at home, or inside a building or a campus, with a coverage radius typically of tens to hundreds of meters. Certainly, the AP may alternatively be deployed outdoors. An AP is equivalent to a bridge that connects a wired network and a wireless network. A main function of the AP is to connect wireless network clients together and then connect the wireless network to Ethernet. An AP device may be a terminal device (e.g., a mobile phone) or a network device (e.g., a router) with a Wireless Fidelity (Wireless Fidelity, Wi-Fi) chip.

A non-AP STA (also named as STA for the sake of simplification) may be a mobile phone, a tablet computer (pad), a computer with a wireless transceiving function, a virtual reality (VR) device, an augmented reality (AR) device, a wireless device in industrial control, a Set Top Box (STB), a wireless device in self-driving, a vehicle-mounted communication device, a wireless device in remote medical, a wireless device in smart grid, a wireless device in transportation safety, a wireless device in smart city, a wireless device in smart home, and the like.

FIG. 1 illustrates a communication system 100 that the present disclosure may be applied. As illustrated, the communication system 100 includes one AP and two STAs accessing the network via the AP. It should be appreciated that the communication system 100 can include a plurality of APs and STAs of a different number.

It should be noted that a device having communication functions in a network/system according to embodiments of the present disclosure may also be referred to as a communication device. For example, the communication system 100 as illustrated in FIG. 1 may include an AP 110 and STAs 120 having communication functions, and the AP 110 and the STAs 120 can be specific devices as mentioned above. The communication device may further include other devices in the communication system 100, such as a network controller, a network gateway and the other network entities, and the present disclosure is not limited thereto.

It shall be noted that a role of a single one STA may not be absolute. For example, when a STA is a mobile phone connected to a router, it may serve as a non-AP STA. But, when the mobile phone provides a hot spot for other mobile phone(s), it actually serves as an AP.

AP and non-AP STA may be devices applied in Internet of Vehicles (IOV), Internet of Things (IoT) nodes, sensors and the like in IoT, smart cameras, smart remote control, smart water meters and electricity meters in smart home, or sensors in smart city, and the like.

Embodiments of the present disclosure may be applied in a wireless communication chip, an Application Specific Integrated Circuit (ASIC), System On Chip (SOC), and the like.

As used herein, a downlink transmission refers to a transmission from an AP device to a STA device, and an uplink transmission refers to a transmission in an opposite direction.

References in the specification to "one embodiment," "an embodiment," "an example

embodiment," and the like indicate that the embodiment described may include a particular feature, structure, or characteristic, but it is not necessary that every embodiment includes the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to affect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

It shall be understood that although the terms "first" and "second" etc. may be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another. For example, a first element could be termed a second element, and similarly, a second element could be termed a first element, without departing from the scope of example embodiments. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed terms.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be liming of example embodiments. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises", "comprising", "has", "having", "includes" and/or "including", when used herein, specify the presence of stated features, elements, and/or components etc., but do not preclude the presence or addition of one or more other features, elements, components and/ or combinations thereof.

In the following description and claims, unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skills in the art to which this disclosure belongs.

In order to increase network capacity while reducing network delay, Multi-Link Aggregation (MLA) technology is introduced. In a system supporting MLA, some services can be transmitted on at least two links. A device supporting MLA is a Multi-Link Device (MLD).

MLD devices may include an AP MLD and a non-AP MLD, which may also be referred to as a STA MLD.

In the embodiments of present disclosure, the AP MLD may include a plurality of APs (or multiple APs are affiliated with the AP MLD), the non-AP MLD may include a plurality of STAs (or multiple STAs are affiliated with the non-AP MLD), and multiple links may be formed between the APs in the AP MLD and the STAs in the non-AP MLD. Data communication may be achieved via a link between an AP in the AP MLD and a corresponding STA in the non-AP MLD.

FIG. 2 illustrates a communication system 200 that the present disclosure may be applied. As illustrated in FIG. 2, an AP MLD 210 may include AP1, AP2,…,APn, and a non-AP MLD 220 may include STA1, STA2,…, STAn, where n is an integer greater than 1. Link 1 is formed between AP1 and STA1, Link 2 is formed between AP2 and STA2, and so on. Data communication may be achieved between AP1 and STA1 via Link 1, between AP2 and STA2 via Link 2, and so on.

FIG. 3 illustrates a format of Basic Multi-Link element according to embodiments of the present disclosure. The Basic Multi-link element is used to carry information of an MLD and its affiliated STAs during multi-link discovery and multi-link setup.

Advertisement of multi-link information in Multi-Link element has been specified in IEEE P802.11be™/D1.2 as:

- An AP affiliated with an AP MLD shall follow the rules defined in 35.3.4.4 (Multi-Link element usage rules in the context of discovery) for including a Basic Multi-Link element in a Beacon frame that it transmits or in a Probe Response frame, which is not an ML probe response, that it transmits.

- An AP affiliated with an AP MLD shall follow the rules in 35.3.4.2 (Use of ML probe request and response) for including a Basic Multi-Link element in a Probe Response frame, which is an ML probe response, that it transmits.
- An AP affiliated with an AP MLD shall include, in a Beacon frame or a Probe Response frame, which is not an ML probe response, only the Common Info field of the Basic Multi-Link element as defined in 9.4.2.295b (Multi-Link element) unless conditions in 35.3.10 (Multi-link general procedures) are satisfied. The Common info field of the Basic Multi-Link element carried in the Beacon frame or Probe Response frame shall
  - include the MLD MAC address subfield for the AP MLD with which the AP is affiliated
  - include the Link ID Info subfield for the AP by settigng the Link ID Info Present subfield of the Multi-Link Control field of the Basic Multi-Link element to 1
  - include the BSS Parameters Change Count subfield for the AP by setting the BSS Parameters Change Count

Discovery of an AP MLD has been specified in IEEE P802.11be™/D1.2 as:

- An ML probe request is a Probe Request frame that is sent outside the context of active scanning that is used to discover an AP:
  - with the Address 1 field set to the broadcast address and the Address 3 field set to the BSSID of an AP, or with the Address 1 field set to the BSSID of an AP's BSS.
  - with the MLD ID subfield (if present) set to the MLD ID that identifies the targeted AP MLD with which the requested AP(s) are affiliated.
  - and that includes a Probe Request Multi-Link element defined in 9.4.2.295b.3 (Probe Request Multi-Link element).
- An ML probe response is a Probe Response frame:
  - that is transmitted in response to receiving an ML probe request
  - and that includes Basic Multi-Link element which can carry complete or partial per-STA profile(s), based on the soliciting request, for each of the requested AP(s) of the targeted AP MLD.

Multi-link (re)setup has been specified in IEEE P802.11be™/D1.2 as:

- For a non-AP MLD to perform multi-link (re)setup with an AP MLD, the non-AP MLD and the AP MLD shall exchange (Re)Association Request/Response frames and shall follow the MLD (re)association procedure as described in 11.3 (STA Authentication and association). A (Re)Association Request/Response frame exchange that results in a successful association is for a multi-link setup if both the frames carried Basic Multi-Link element. Otherwise the association is not for a multi-link setup.
- In the (Re)Association Request frame, the non-AP MLD indicates the links that are requested for (re)setup and the capabilities and operational parameters of the requested links as described in 35.3.5.4 (Usage and rules of Basic Multi-Link element in the context of multi-link (re)setup). The non-AP MLD may request to (re)setup links with a subset of APs affiliated with the AP MLD.
  NOTE—The links that are requested for resetup and the capability and operation parameters of each link that are requested for resetup are independent of the existing setup links with an associated AP MLD and the capability and operation parameters of each setup link with an associated AP MLD.
  In the (Re)Association Response frame, the AP MLD indicates the links that are accepted for (re)setup and the capabilities and operational parameters of the accepted links as described in 35.3.5.4 (Usage and rules of Basic Multi-Link element in the context of multi-link (re)setup). The AP MLD may not accept all the links that are requested for (re)setup. The (Re) Association Response frame shall be sent to the non-AP STA affiliated with the non-AP MLD that sent the (Re) Association Request frame.

In view of the above, the present disclosure specifies a Primary Link and Nonprimary Link (PLNPL) mode for solving the problems existing in the current multi-link setup and operation for an AP MLD such as a NSTR mobile AP MLD.

To be specific, taking the scenario as illustrated in FIG. 2 as an example for sake of explanation, when the non-AP MLD 220 is operating in the PLNPL mode with the AP MLD 210 supporting the PLNPL mode with which the non-AP MLD 220 is associated, any of following applies:

(1) For at least one link pair of the non-AP MLD 220, Link 1 and Link 2 belonging to the link pair, which can be, e.g., a Simultaneous Transmit and Receive (STR) or NSTR link pair, have been successfully set up between the non-AP MLD 220 and the AP MLD 210, and Link 1 is designated as a primary link and Link 2 is designated as a nonprimary link during multi-link setup.

(2) The setup of the link between STA2 affiliated with the non-AP MLD 220 and AP2 in the nonprimary link (e.g., Link 2) is performed by exchange of management frames between STA1 affiliated with the non-AP MLD 220 and AP1 affiliated with the AP MLD 210 in the primary link.

(3) STA2 in the nonprimary link acquires information of complete or partial profile of AP2 from specific management frames, which are transmitted by AP1 in the primary link. STA1 receives the specific management frames from AP1 and then provide them to STA2.

(4) STA1 and STA2 affiliated with the non-AP MLD 220 that is associated with the AP MLD 210 follows the procedure of start time sync Physical layer Protocol Data Units (PPDUs) medium access when intending to transmit in the nonprimary link with the following additional constraints.

—STA2 may initiate a PPDU transmission to AP2 in the nonprimary link only if STA1 in the primary link is also initiating the PPDU as a transmission opportunity (TXOP) holder with the same start time.

Similarly, taking the scenario as illustrated in FIG. 2 for sake of explanation, when the AP MLD 210 is operating in the PLNPL mode with the non-AP MLD 220 supporting the PLNPL mode, which is associated with the AP MLD 210, the following applies:

(1) For at least one link pair of the AP MLD 210, Link 1 and Link 2 belonging to the link pair have been successfully set up between the AP MLD 210 and the non-AP MLD 220, and Link 1 is designated as a primary link and Link 2 is designated as a nonprimary link during the multi-link setup.

(2) The setup of the link between STA2 and AP2 in the nonprimary link is performed by exchange of management frames between STA1 and AP1 in the primary link.

(3) Only AP1 sends Beacon and Probe Response frames, while AP2 doesn't send Beacon and Probe Response frames.

(4) The information of complete or partial profile of AP2 is carried by specific management frames, which are transmitted by AP1 in the primary link. STA1 receives the specific management frames from AP1 and then provide them to STA2.

(5) APs (AP1 and AP2) affiliated with the AP MLD 210 follow the procedure of start time sync PPDUs medium access when intending to transmit in the nonprimary link with the following additional constraints.

—AP2 initiates a PPDU transmission to STA2 in the nonprimary link only if AP1 is also initiating the PPDU as a TXOP holder with the same start time.

FIG. 4 is a flowchart illustrating a wireless communication method 400 according to embodiments of the present disclosure. The wireless communication method 400 can be performed at a first AP affiliated with an AP MLD supporting the PLNPL mode. For example, the wireless communication method 400 may be applied in the scenario as illustrated in FIG. 2. Then, the first AP may be AP1 and the AP MLD may be the AP MLD 210.

At block 410, the first AP transmits a first frame to a first STAtion (STA) affiliated with a non-AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link, and further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

In an embodiment, the first frame may be a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

In an embodiment, in the PLNPL mode, the first frame carries complete or partial profile of the second AP. For example, the complete or partial profile of the second STA may be carried in a Basic Multi-Link element carried in the first frame.

In an embodiment, in the PLNPL mode, a second AP affiliated with the AP MLD (e.g., AP2 as illustrated in FIG. 2) initiates a Physical layer Protocol Data Unit (PPDU) transmission to a second STA affiliated with the non-AP MLD (e.g., STA2 as illustrated in FIG. 2) in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a TXOP holder with the same start time.

In an embodiment, the first frame may include a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode (also referred to as a PLNPL operation). The first PLNPL Capabilities subfield contains several subfields that are used to advertise the capabilities for the PLNPL operation. For example, the first PLNPL Capabilities subfield may be contained in the Common Info field of the Basic Multi-Link element carried in the first frame, as shown in FIG. 5, which illustrates addition of the PLNPL Capabilities subfield in the Common Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure.

In an embodiment, the first PLNPL Capabilities subfield may include at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

FIG. 6 illustrates an exemplary format of the PLNPL Capabilities subfield according to an embodiment of the present disclosure. As shown, the PLNPL Capabilities subfield includes the PLNPL Support subfield, the TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield, the TXOP DURATION OFFSET subfield and the Power save Mode subfield.

The PLNPL Support subfield indicates support of the PLNPL operation for an MLD, i.e., an AP MLD or a non-AP MLD. The PLNPL Support subfield is set to 1 if the MLD supports the PLNPL operation. Otherwise, it is set to 0.

The exemplary encoding for the TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield is defined in Table 1(TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK).

Table 1: Encoding for TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield

Value of TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield	**Description**
0	—For non-AP MLD: For start time sync PPDUs medium access of STAs affiliated with a non-AP MLD that is associated with an AP MLD, the duration of the TXOP gained by a STA affiliated with the non-AP MLD in the nonprimary link is only allowed to be equal to or shorter than the duration of the TXOP gained a STA affiliated with the non-AP MLD in the primary link. —For AP MLD: For start time sync PPDUs medium access of APs affiliated with an AP MLD, the duration of the TXOP gained by an AP affiliated with the AP MLD in the nonprimary link is only allowed to be equal to or

	shorter than the duration of the TXOP gained an AP affiliated with the AP MLD in the primary link.
1	—For non-AP MLD: For start time sync PPDUs medium access of STAs affiliated with a non-AP MLD that is associated with an AP MLD, the duration of the TXOP gained by a STA affiliated with the non-AP MLD in the nonprimary link is only allowed to be equal to the duration of the TXOP gained a STA affiliated with the non-AP MLD in the primary link. —For AP MLD: For start time sync PPDUs medium access of APs affiliated with an AP MLD, the duration of the TXOP gained by an AP affiliated with the AP MLD in the nonprimary link is only allowed to be equal to the duration of the TXOP gained an AP affiliated with the AP MLD in the primary link.
2	—For non-AP MLD: For start time sync PPDUs medium access of STAs affiliated with a non-AP MLD that is associated with an AP MLD, the duration of the TXOP gained by a STA affiliated with the non-AP MLD in the nonprimary link is only allowed to be equal to or shorter than the duration of the TXOP gained a STA affiliated with the non-AP MLD in the primary link plus TXOP_DURATION_OFFSET. —For AP MLD: For start time sync PPDUs medium access of APs affiliated with an AP MLD, the duration of the TXOP gained by an AP affiliated with the AP MLD in the nonprimary link is only allowed to be equal to or shorter than the duration of the TXOP gained an AP affiliated with the AP MLD in the primary link plus TXOP_DURATION_OFFSET.
3	Reserved

The TXOP DURATION OFFSET subfield may indicate a maximum offset allowed between an end of a TXOP gained by the second AP in the nonprimary link and an end of a TXOP gained by the first AP in the primary link for start time sync PPDUs medium access of APs affiliated with the AP MLD, such as an NSTR mobile AP MLD.

The Power save Mode subfield indicates whether power save modes for the first AP and/or the second AP are supported in the PLNPL mode. Table 2 shows exemplary encoding for the Power save Mode subfield.

Table 2: Encoding for Power save Mode subfield

Value of Power save Mode subfield	**Description**
0	The power save modes for APs affiliated with the NSTR AP MLD in the primary link and nonprimary link are supported;
1	The power save mode for AP affiliated with the NSTR AP MLD in the primary link is supported; The power save mode for AP affiliated with the NSTR AP MLD in the nonprimary link is not supported
2	The power save modes for APs affiliated with the NSTR AP MLD in the primary link and nonprimary link are not supported;
3	Reserved

In an embodiment, the first frame may include link identifier information for the primary link and link identifier information for the nonprimary link.

For example, the first frame may include a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and a PLNPL Info Present subfield indicates the presence of the PLNPL Info subfield.

In an embodiment, the first frame may further indicate at least one of: support of an UpLink (UL) Multi-User (MU) operation for the first AP; and support of a DownLink (DL) MU operation for the first AP, e.g., by the PLNPL Info subfield.

The PLNPL Info Present subfield may be contained in the STA Control field in the Link Info field of the Basic Multi-Link element, as shown in FIG. 7, which illustrates addition of the PLNPL Info Present subfield in the STA Control field in the Link Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure.

The PLNPL Info subfield may be contained in the STA Info field in the Link Info field of the Basic Multi-Link element of FIG. 3, as shown in FIG. 8, which illustrates addition of the PLNPL Info subfield in the STA Info field in the Link Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure.

The PLNPL Info Present subfield indicates presence of the PLNPL Info subfield in the STA Info field and is set to 1 if the PLNPL Info subfield is present in the STA Info field; otherwise it is set to 0. If a link identified by the Link ID subfield of the STA Control field is neither a primary link nor a nonprimary link, the PLNPL Info Present subfield is set to 0.

The PLNPL Info subfield may indicate information for the nonprimary link(s) and/or primary link(s), and supported operations on the links in the PLNPL mode. For example, the PLNPL Info subfield may have three formats as shown in FIGS. 9-11, respectively.

FIG. 9 illustrates a first format of the PLNPL Info subfield (PLNPL Info subfield format-1) according to an embodiment of the present disclosure.

As shown in FIG. 9, the PLNPL Info subfield may include a Primary Link Indicator, a PrimaryLink Indication Bitmap, a NonPrimaryLink Indication Bitmap, a DL MU Operation Support subfield, a UL MU Operation Support subfield, an Rx NSS subfield, a Tx NSS subfield and a reserved subfield.

The Primary Link Indicator subfield indicates whether the link identified by the Link ID subfield of the STA Control field is the primary link or the nonprimary link of one or more link pair. The Primary Link Indicator subfield is set to 1 if the link identified by the Link ID subfield is the primary link of one or more link pair; otherwise it is set to 0 if the link identified by the Link ID subfield is the nonprimary link of one or more link pair.

If the Primary Link Indicator subfield is equal to 1, then the PLNPL Info subfield contains the NonPrimaryLink Indication Bitmap subfield and contains no PrimaryLink Indication Bitmap subfield. If the Primary Link Indicator subfield is equal to 0, then the PLNPL Info subfield contains the PrimaryLink Indication Bitmap subfield and contains no NonPrimaryLink Indication Bitmap subfield.

Each bit Bj ($j \neq i$) in the PrimaryLink Indication Bitmap subfield included in the Per-STA Profile sub-element with Link ID subfield being i (where $0 \leq i < 15$) is set to 1 if the link with Link ID value being j is the primary link of the link pair corresponding to Link IDs being <i, j>, of which the link with Link ID value being i is the nonprimary link, and the Basic Multi-Link element contains a Per-STA Profile sub-element with Link ID value being i; otherwise it is set to 0. Bit Bi in the PrimaryLink Indication Bitmap subfield included in the Per-STA Profile sub-element with Link ID subfield value being i is reserved.

Each bit Bj ($j \neq i$) in the NonPrimaryLink Indication Bitmap subfield included in the Per-STA Profile sub-element with Link ID subfield being i (where $0 \leq i < 15$) is set to 1 if the link with Link ID value being j is the nonprimary link of the link pair corresponding to Link IDs being <i, j>, of which the link with Link ID value being i is the primary link, and the Basic Multi-Link element contains a Per-STA Profile sub-element with Link ID value being i; otherwise it is set to 0. Bit

Bi in the NonPrimaryLink Indication Bitmap subfield included in the Per-STA Profile sub-element with Link ID subfield value being i is reserved.

FIG. 10 illustrates a second format of the PLNPL Info subfield (PLNPL Info subfield format-2) according to an embodiment of the present disclosure.

As shown in FIG. 10, the PLNPL Info subfield may include a Primary Link Indicator, a Peer Link ID, a DL MU Operation Support subfield, a UL MU Operation Support subfield, an Rx NSS subfield, a Tx NSS subfield and a reserved subfield.

The Primary Link Indicator subfield indicates whether the link identified by the Link ID subfield of the STA Control field is the primary link or the nonprimary link of one link pair. The Primary Link Indicator subfield is set to 1 if the link identified by the Link ID subfield of the STA Control field is the primary link of one link pair; otherwise it is set to 0 if the link identified by the Link ID subfield of the STA Control field is the nonprimary link of one link pair.

If the Primary Link Indicator subfield is equal to 1, then the PLNPL Info subfield contains the NonPrimary Link ID subfield and contains no Primary Link ID subfield. If the Primary Link Indicator subfield is equal to 0, then the PLNPL Info subfield contains the Primary Link ID subfield and contains no NonPrimary Link ID subfield.

The Peer Link ID subfield indicates the link identifier for the nonprimary link of the link pair which contains the link identified by the Link ID subfield of the STA Control field and the link identified by the Peer Link ID subfield if the Primary Link Indicator subfield indicates the link identified by the Link ID subfield of the STA Control field is the primary link.

The remaining subfields of PLNPL Info subfield format-2 are the same as those of PLNPL Info subfield format-1.

FIG. 11 illustrates a third format of the PLNPL Info subfield (PLNPL Info subfield format-3) according to an embodiment of the present disclosure.

As shown in FIG. 11, the PLNPL Info subfield may include a Primary Link Indicator, a Primary Link ID, a NonPrimary Link ID, a DL MU Operation Support subfield, a UL MU Operation Support subfield, an Rx NSS subfield, a Tx NSS subfield and a reserved subfield.

The PLNPL Info subfield format-3 differs from the PLNPL Info subfield format-2 only in the Primary Link ID and the NonPrimary Link ID, and explanations of the same subfields will be omitted.

The Primary Link ID subfield contains the link identifier for the primary link of the link pair which contains the link identified by the Link ID subfield of the STA Control field and the link identified by the Primary Link ID subfield.

The NonPrimary Link ID subfield contains the link identifier for the nonprimary link of the link pair which contains the link identified by the Link ID subfield of the STA Control field and the link identified by the NonPrimary Link ID subfield.

Referring back to FIG. 4, as another embodiment, the wireless communication method 400 may further include steps as illustrated by blocks 420 and 430. To be specific, the first AP receives a second frame from a first STA affiliated with a non-AP MLD at block 420, and transmits a third frame to the first STA at block 430. For example, the second frame may be an Association Request frame, and the third frame may be an Association Response frame.

As an example, the second frame indicates that the non-AP MLD supports the PLNPL mode and is used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link, and the third frame

indicates successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD. In this example, the second frame may carry complete or partial profile of the second STA.

In an embodiment, when the non-AP MLD supports the PLNPL mode, the second frame carries complete or partial profile of the second AP. For example, the complete or partial profile of the second STA may be carried in a Basic Multi-Link element carried in the second frame, e.g., as illustrated in FIG. 3.

In an embodiment, at least one of the second frame and the third frame may include link identifier information for the primary link and link identifier information for the nonprimary link. For example, the second frame and/or the third frame may include the PLNPL Info subfield illustrated in FIGS. 8-11 and the PLNPL Info Present subfield as illustrated in FIG. 7.

In an embodiment, the third frame carries complete profile of the first and second APs. For example, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame, e.g., as illustrated in FIG. 3.

As another example, the second frame indicates that the non-AP MLD supports the PLNPL mode and is used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link, and the third frame indicates successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

In an embodiment, the second frame further indicates at least one of: support of a UL MU operation for the first STA; and support of a DL MU operation for the first STA. For example, a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in second frame may also indicate such information.

In an embodiment, the third frame further indicates at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP. For example, a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in the third frame may also indicate such information.

In an embodiment, the second frame may include a PLNPL Capabilities subfield indicating capabilities for the PLNPL operation, which is contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 5.

In an embodiment, the PLNPL Capabilities subfield includes at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode, e.g., as illustrated in FIG. 6;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported, e.g., as defined in Table 2;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA, e.g., as defined in Table 1; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

In an embodiment, the third frame may include a PLNPL Capabilities subfield indicating capabilities for the PLNPL operation, which is contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 5.

In an embodiment, the PLNPL Capabilities subfield may include at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode, e.g., as illustrated in FIG. 6;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported, e.g., as defined in Table 2;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP, e.g., as defined in Table 1; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the AP MLD may be a NSTR mobile AP MLD, and the first frame may further indicate support for a NSTR Mobile AP MLD operation.

For example, the first frame may include a NSTR Mobile AP MLD Operation Support subfield for indicating support for the NSTR Mobile AP MLD operation. This subfield may be contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 12, which illustrates addition of the NSTR Mobile AP MLD Operation Support subfield in the MLD Capabilities subfield in the Common Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure. The NSTR Mobile AP MLD Operation Support subfield may be set to 1 to indicate that the AP MLD supports to behave as an NSTR Mobile AP MLD; otherwise it is set to 0.

In another embodiment, the AP MLD may be a NSTR mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

For example, the second frame may also include a NSTR Mobile AP MLD Operation Support subfield as illustrated in FIG. 12 for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD. The NSTR Mobile AP MLD Operation Support subfield may be set to 1 to indicate that the non-AP MLD is capable of operating with an NSTR Mobile AP MLD with which it is associated, and the operation includes exchanging frames with the NSTR Mobile AP MLD in the primary link and nonprimary link; otherwise it is set to 0.

FIG. 13 illustrates a flowchart illustrating multi-link setup between an NSTR mobile AP MLD and a non-AP MLD according to an embodiment of the present disclosure. In this embodiment, AP1 and AP2 are affiliated with the NSTR mobile AP MLD, and STA1 and STA2 are affiliated with the non-AP MLD. It should be appreciated that APs of a different number and STAs of a different number can be also applicable.

At S1310, AP1 advertises complete or partial per-link information of links belonging to the NSTR Mobile AP MLD by transmitting a Beacon frame carrying a Basic Multi-Link element with the NSTR Mobile AP MLD Operation Support subfield equal to 1 and the PLNPL Info subfield in the STA Info field for per-STA profile corresponding to each of the links. Optionally, AP1 may also transmit a probe response frame carrying the Basic Multi-Link element and the PLNPL Info subfield to STA1.

At S1320, the non-AP MLD initiates the multi-link setup procedure and STA1 transmits an Association Request frame to AP1. The Association Request frame includes complete profile of STA1 and STA2 to request two links to be setup (one link between AP1 and STA1 as a primary link, and the other link between AP2 and non-AP STA2 as a nonprimary link) and a Basic Multi-Link element that carries the NSTR Mobile AP MLD Operation Support subfield equal to 1 and/or the PLNPL Info subfield in the STA Info field for per-STA profile corresponding to each of the requested links.

At S1330, AP1 transmits an Association Response frame to STA1 to indicate successful multi-link setup. The Association Response frame includes complete profile of AP1, AP2, and a Basic Multi-Link element that indicates the MLD MAC address of the AP MLD. After successful multi-link setup between the non-AP MLD and AP MLD, two links are setup (Link 1 between AP1 and non-AP STA1 as a primary link, and Link 2 between AP 2 and non-AP STA 2 as a non-primary link).

In an embodiment, in the PLNPL mode, at least one of the second frame and the third frame further indicates that Traffic IDentifiers (TIDs) mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL.

For example, during the multi-link setup procedure, the Association Request frame transmitted by the first STA may carry a TID-To-Link Mapping element for indicating that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL. Similarly, the Association Response frame transmitted by the first AP may carry a TID-To-Link Mapping element for indicating that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL. This is TID-To-Link mapping negotiation during the multi-link setup procedure.

In an embodiment, after the multi-link setup is successful, the wireless communication method 400 may further include a TID-TO-Link mapping negotiation procedure, as illustrated in FIG. 14.

As shown in FIG. 14, the first AP transmits a fourth frame to the first STA at block 1410, and receives a fifth frame from the first STA at block 1420. For example, the fourth frame may be a TID-To-Link Mapping Request frame, and the fifth frame may be a TID-To-Link Mapping Response frame.

In an example, the fourth frame may include a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is accepted.

In another example, the fourth frame may include a request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is rejected

In an embodiment, after the multi-link setup is successful, the wireless communication method 400 may further include another TID-TO-Link mapping negotiation procedure, as illustrated in FIG. 15.

As shown in FIG. 15, the first AP receives a fourth frame from the first STA at block 1510, and transmits a fifth frame to the first STA at block 1520. For example, the fourth frame may be a TID-To-Link Mapping Request frame, and the fifth frame may be a TID-To-Link Mapping Response frame.

In an example, the fourth frame may include a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that request is accepted.

In another example, the fourth frame may include a request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is rejected.

According to the present disclosure, when operating in PLNPL mode, a non-AP MLD that is associated with an NSTR mobile AP MLD and the NSTR mobile AP MLD shall ensure that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL or in UL.

FIG. 16 illustrates two exemplary TID-to-link mapping negotiation procedures for a NSTR Mobile AP MLD according to embodiments of the present disclosure. In this embodiment, two links are setup between the NSTR Mobile AP MLD and a Non-AP MLD, Link 1 between AP1

and non-AP STA 1 is designated as a primary link and Link 2 between AP 2 and non-AP STA2 is designated as a nonprimary link. This procedure is the same as those illustrated in FIG. 13, and detailed description thereof will be omitted here.

As shown in FIG. 16, one of the two TID-to-link mapping negotiation procedures occurs during multi-link setup, and the other one occurs after the multi-link setup is successful. For sake of description, it is assumed that all TIDs are mapped to Link 1 and Link 2 in DL and UL after the multi-link setup.

In the multi-link (re)setup, AP1 in the primary link should indicate that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL in a TID-To-Link Mapping element carried by the Association Response frame.

Similarly, in the multi-link (re)setup, STA1 should indicate that the TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL in a TID-To-Link Mapping element carried by the Association Request frame.

In other words, the TID-to-link mapping negotiation procedure in the multi-link setup is performed by exchange of the Association request frame and the Association Response frame between the non-AP MLD and the NSTR Mobile AP MLD.

After the multi-link (re)setup is successful, in the TID-To-Link Mapping negotiation procedure, the requesting MLD, which is one of the non-AP MLD and the NSTR mobile AP MLD, may indicate that TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, are requested to be mapped to the nonprimary link in DL and/or in UL in the TID-To-Link Mapping element carried by a TID-To-Link Mapping Request frame. In other words, the requesting MLD transmits the TID-To-Link Mapping Request frame to the requested MLD to request one or more TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL. In this case, the requested MLD, which is the other one of the non-AP MLD and the NSTR mobile AP MLD, may transmit a TID-To-Link Mapping response frame to the requesting MLD to accept the request.

Similarly, after the multi-link (re)setup is successful, in the TID-To-Link Mapping negotiation procedure, the requesting MLD may transmit the TID-To-Link Mapping Request frame to the requested MLD to request one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL. In this case, the requested MLD may transmit the TID-To-Link Mapping response frame to the requesting MLD to reject the request.

For example, as shown in FIG. 16, the non-AP MLD indicates in the TID-To-Link Mapping element carried by the TID-To-Link Mapping Request frame that TIDs except TID 1 and TID 2 (e.g., any two TIDs, which have not been mapped to the primary link or are not requested to be mapped to the primary link) are requested to be mapped to Link 2 in DL and UL, and then the NSTR AP MLD transmits the TID-To-Link Mapping Response frame to accept the TID-To-Link Mapping Request.

FIG. 17 is a flowchart illustrating a wireless communication method 1700 according to embodiments of the present disclosure. The wireless communication method 1700 can be performed at a first STA affiliated with a non-AP MLD. For example, the wireless communication method 1700 may be applied in the scenario as illustrated in FIG. 2. Then, the first STA may be STA1 and the non-AP MLD may be the non-AP MLD 220.

At block 1710, the first STA receives a first frame from a first AP affiliated with an AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link, and further indicates a

first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

In an embodiment, the first frame may be a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

In an embodiment, in the PLNPL mode, the first frame carries complete or partial profile of the second AP. For example, the complete or partial profile of the second STA may be carried in a Basic Multi-Link element carried in the first frame.

In an embodiment, in the PLNPL mode, a second AP affiliated with the AP MLD (e.g., AP2 as illustrated in FIG. 2) initiates a PPDU transmission to a second STA affiliated with the non-AP MLD (e.g., STA2 as illustrated in FIG. 2) in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a TXOP holder with the same start time.

In an embodiment, the first frame may include the PLNPL Capabilities subfield indicating capabilities for the PLNPL operation, e.g., as illustrated in FIG. 5.

In an embodiment, the PLNPL Capabilities subfield may include at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode, e.g., as illustrated in FIG. 6;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported, e.g., as defined in Table 2;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP, e.g., as defined in Table 1; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the first frame may include link identifier information for the primary link and link identifier information for the nonprimary link. For example, the first frame may include the PLNPL Info subfield illustrated in FIGS. 8-11 and the PLNPL Info Present subfield as illustrated in FIG. 7.

In an embodiment, the first frame may further indicate at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP, e.g., by the PLNPL Info subfield.

In an embodiment, the AP MLD may be a NSTR mobile AP MLD, and the first frame may further indicate support for a NSTR Mobile AP MLD operation. For example, the first frame may include the NSTR Mobile AP MLD Operation Support subfield as shown in FIG. 12.

In another embodiment, the AP MLD may be a NSTR mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD. For example, the second frame may include the NSTR Mobile AP MLD Operation Support subfield as shown in FIG. 12.

Referring back to FIG. 17, as another embodiment, the wireless communication method 1700 may further include steps as illustrated by blocks 1720 and 1730. To be specific, the first STA transmits a second frame to the first AP at block 1720, and receives a third frame from the first STA at block 1730. For example, the second frame may be an Association Request frame, and the third frame may be an Association Response frame.

As an example, the second frame indicates that the non-AP MLD supports the PLNPL mode and is used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link, and the third frame

indicates successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD. In this example, the second frame may carry complete or partial profile of the second STA.

In an embodiment, when the non-AP MLD supports the PLNPL mode, the second frame carries complete or partial profile of the second AP. For example, the complete or partial profile of the second STA may be carried in a Basic Multi-Link element carried in the second frame, e.g., as illustrated in FIG. 3.

In an embodiment, at least one of the second frame and the third frame may include link identifier information for the primary link and link identifier information for the nonprimary link. For example, at least one of the second frame and the third frame may include the PLNPL Info subfield illustrated in FIGS. 8-11 and the PLNPL Info Present subfield as illustrated in FIG. 7.

In an embodiment, the third frame carries complete profile of the first and second APs. For example, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame, e.g., as illustrated in FIG. 3.

As another example, the second frame indicates that the non-AP MLD supports the PLNPL mode and is used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link, and the third frame indicates successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

In an embodiment, the second frame further indicates at least one of: support of a UL MU operation for the first STA; and support of a DL MU operation for the first STA. For example, a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in the second frame may also indicate such information.

In an embodiment, the third frame further indicates at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP. For example, a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in the third frame may also indicate such information.

In an embodiment, the second frame may include a PLNPL Capabilities subfield indicating capabilities for the PLNPL operation, which is contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 5.

In an embodiment, the PLNPL Capabilities subfield includes at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode, e.g., as illustrated in FIG. 6;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported, e.g., as defined in Table 2;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA, e.g., as defined in Table 1; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

In an embodiment, the third frame may include a PLNPL Capabilities subfield indicating capabilities for the PLNPL operation, which is contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 5.

In an embodiment, the PLNPL Capabilities subfield may include at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode, e.g., as illustrated in FIG. 6;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported, e.g., as defined in Table 2;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP, e.g., as defined in Table 1; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the AP MLD may be a NSTR mobile AP MLD, and the first frame may further indicate support for a NSTR Mobile AP MLD operation.

For example, the first frame may include a NSTR Mobile AP MLD Operation Support subfield for indicating support for the NSTR Mobile AP MLD operation. This subfield may be contained in the Common Info field of the Basic Multi-Link element, as shown in FIG. 12, which illustrates addition of the NSTR Mobile AP MLD Operation Support subfield in the MLD Capabilities subfield in the Common Info field of the Basic Multi-Link element of FIG. 3 according to an embodiment of the present disclosure. The NSTR Mobile AP MLD Operation Support subfield may be set to 1 to indicate that the AP MLD supports to behave as an NSTR Mobile AP MLD; otherwise it is set to 0.

In another embodiment, the AP MLD may be a NSTR mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

For example, the second frame may also include a NSTR Mobile AP MLD Operation Support subfield as illustrated in FIG. 12 for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD. The NSTR Mobile AP MLD Operation Support subfield may be set to 1 to indicate that the non-AP MLD is capable of operating with an NSTR Mobile AP MLD with which it is associated, and the operation includes exchanging frames with the NSTR Mobile AP MLD in the primary link and nonprimary link; otherwise it is set to 0.

In an embodiment, in the PLNPL mode, at least one of the second frame and the third frame further indicates that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL.

In an embodiment, after the multi-link setup is successful, the wireless communication method 1700 may further include a TID-TO-Link mapping negotiation procedure, as illustrated in FIG. 18.

As shown in FIG. 18, the first STA receives a fourth frame from the first AP at block 1810, and transmits a fifth frame to the first AP at block 1820. For example, the fourth frame may be a TID-To-Link Mapping Request frame, and the fifth frame may be a TID-To-Link Mapping Response frame.

In an example, the fourth frame may include a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is accepted.

In another example, the fourth frame may include a request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is rejected

In an embodiment, after the multi-link setup is successful, the wireless communication method 1700 may further include another TID-TO-Link mapping negotiation procedure, as illustrated in FIG. 19.

As shown in FIG. 19, the first STA transmits a fourth frame to the first AP at block 1910, and receives a fifth frame from the first AP at block 1920. For example, the fourth frame may be a TID-To-Link Mapping Request frame, and the fifth frame may be a TID-To-Link Mapping Response frame.

In an example, the fourth frame may include a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the request is accepted.

In another example, the fourth frame may include a fourth request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, and the fifth frame indicates that the fourth request is rejected.

Correspondingly to the wireless communication method 400 as described above, a wireless communication T is provided. FIG. 20 is a block diagram of a wireless communication apparatus 2000 according to an embodiment of the present disclosure. The wireless communication apparatus 2000 can be e.g., an AP affiliated with an AP MLD such as a NSTR Mobile AP MLD as specified in IEEE P802.11be™/D1.2. Taking the scenario as shown in FIG. 2 as an example, the AP may be AP1, and the AP MLD further includes AP2.

As shown in FIG. 20, the wireless communication apparatus 2000 includes: a communication unit 2010 configured to transmit a first frame to a first STAtion (STA) affiliated with a non-AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

In an embodiment, the AP MLD is a NSTR mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

In an embodiment, the first frame includes a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the first frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the communication unit 2010 is further configured to: receive a second frame from the first STA, the second frame indicating that the non-AP MLD supports the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and

transmit a third frame to the first STA, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

In an embodiment, the second frame carries complete or partial profile of the second STA.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

In an embodiment, the third frame carries complete profile of the first and second APs.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame.

In an embodiment, at least one of the second frame and the third frame includes link identifier information for the primary link and link identifier information for the nonprimary link.

In an embodiment, the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

In an embodiment, the communication unit 2010 is further configured to: receive a second frame from the first STA, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and transmit a third frame to the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

In an embodiment, the AP MLD is a NSTR mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

In an embodiment, the second frame includes a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

In an embodiment, the second frame further indicates at least one of: support of a UL MU operation for the first STA; and support of a DL MU operation for the first STA.

In an embodiment, the second frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

In an embodiment, the third frame further indicates at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP.

In an embodiment, the third frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

In an embodiment, in the PLNPL mode, at least one of the second frame and the third frame further indicates that TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL.

In an embodiment, the second frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of: a PLNPL Support subfield indicating support of the PLNPL mode; a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported; a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

In an embodiment, the third frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

In an embodiment, the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

In an embodiment, in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

In an embodiment, in the PLNPL mode, a second AP affiliated with the AP MLD initiates a PPDU transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a TXOP holder with the same start time.

In an embodiment, the first frame includes link identifier information for the primary link and link identifier information for the nonprimary link.

In an embodiment, the first frame includes a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the first frame further indicates at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP.

In an embodiment, the first frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first

AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the communication unit 2010 is further configured to: transmit a fourth frame to the first STA, the fourth frame including a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and receive a fifth frame from the first STA, the fifth frame indicating that the request is accepted.

In an embodiment, the communication unit 2010 is further configured to: transmit a fourth frame to the first STA, the fourth frame including a request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and receive a fifth frame from the first STA, the fifth frame indicating that the request is rejected.

In an embodiment, the communication unit 2010 is further configured to: receive a fourth frame from the first STA, the fourth frame including a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and transmit a fifth frame to the first STA, the fifth frame indicating that the request is accepted.

In an embodiment, the communication unit 2010 is further configured to: receive a fourth frame from the first STA, the fourth frame including a fourth request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and transmit a fifth frame to the first STA, the fifth frame indicating that the fourth request is rejected.

In an embodiment, the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

Correspondingly to the wireless communication method 1700 as described above, a wireless communication apparatus is provided. FIG. 21 is a block diagram of a wireless communication apparatus 2100 according to an embodiment of the present disclosure. The wireless communication apparatus 2100 can be e.g., a STA affiliated with a non-AP MLD. Taking the scenario as shown in FIG. 2 as an example, the STA may be STA1, and the non-AP MLD further includes STA2.

As shown in FIG. 21, the wireless communication apparatus 2100 includes: a communication unit 2110 configured to receive a first frame from a first AP affiliated with an AP MLD. The first frame indicates that the AP MLD supports a PLNPL mode, in which at least two links belonging to the AP MLD includes a primary link and a nonprimary link. The first frame further indicates a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

In an embodiment, the AP MLD is a NSTR mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

In an embodiment, the first frame includes a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the first frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of: a PLNPL Support subfield indicating support of the PLNPL mode; a Power Save Mode subfield indicating whether

power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported; a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the communication unit 2110 is further configured to: transmit a second frame to the first AP, the second frame indicating that the non-AP MLD is operating in the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and receive a third frame from the first AP, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

In an embodiment, the second frame carries complete or partial profile of the second STA.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

In an embodiment, the third frame carries complete profile of the first and second APs.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame.

In an embodiment, at least one of the second frame and the third frame includes link identifier information for the primary link and link identifier information for the nonprimary link.

In an embodiment, the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

In an embodiment, the communication unit 2110 is further configured to: transmitting a second frame to the first AP, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and receiving a third frame from the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

In an embodiment, the AP MLD is a NSTR mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

In an embodiment, the second frame includes a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

In an embodiment, the second frame further indicates at least one of: support of a UL MU operation for the first STA; and support of a DL MU operation for the first STA.

In an embodiment, the second frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

In an embodiment, the third frame further indicates at least one of:
support of a UL MU operation for the first AP; and
support of a DL MU operation for the first AP.

In an embodiment, the third frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

In an embodiment, in the PLNPL mode, at least one of the second frame and the third frame further indicates that all TIDs mapped to the nonprimary link in DL and/or in UL are also mapped to the primary link in DL and/or in UL.

In an embodiment, the second frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of: a PLNPL Support subfield indicating support of the PLNPL mode; a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported; a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

In an embodiment, the third frame includes a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

In an embodiment, the PLNPL Capabilities subfield includes at least one of: a PLNPL Support subfield indicating support of the PLNPL mode; a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported; a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a TXOP gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

In an embodiment, the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

In an embodiment, the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

In an embodiment, in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

In an embodiment, the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

In an embodiment, in the PLNPL mode, a second AP affiliated with the AP MLD initiates a PPDU transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only

if the first AP in the primary link is also initiating the PPDU transmission as a TXOP holder with the same start time.

In an embodiment, the first frame includes link identifier information for the primary link and link identifier information for the nonprimary link.

In an embodiment, the first frame includes a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the first frame further indicates at least one of: support of a UL MU operation for the first AP; and support of a DL MU operation for the first AP.

In an embodiment, the first frame includes a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

In an embodiment, the communication unit 2110 is further configured to: receive a fourth frame from the first AP, the fourth frame including a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and transmit a fifth frame to the first AP, the fifth frame indicating that the request is accepted.

In an embodiment, the communication unit 2110 is further configured to: receive a fourth frame from the first AP, the fourth frame including a request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and transmit a fifth frame to the first AP, the fifth frame indicating that the request is rejected.

In an embodiment, the communication unit 2110 is further configured to: transmit a fourth frame to the first AP, the fourth frame including a request for requesting one or more TIDs, which have been mapped to the primary link in DL and/or in UL or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and receive a fifth frame from the first AP, the fifth frame indicating that the request is accepted.

In an embodiment, the communication unit 2110 is further configured to: transmit a fourth frame to the first AP, the fourth frame including a fourth request for requesting one or more TIDs, which have not been mapped to the primary link in DL and/or in UL or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and receive a fifth frame from the first AP, the fifth frame indicating that the fourth request is rejected.

In an embodiment, the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

FIG. 22 is a block diagram of a communication device 2200 according to embodiments of the present disclosure. The communication device 2200 shown in FIG. 22 includes a processor 2210, and the processor 2210 can invoke and run a computer program from a memory to implement the wireless communication method 400 or 1700 according to the embodiments of the present disclosure.

In an embodiment, as shown in FIG. 22, the communication device 2200 may further include a memory 2220. The processor 2210 may invoke and run a computer program from the memory 2220 to implement the wireless communication method 400 or 1700 according to the embodiments of the present disclosure.

The memory 2220 may be a separate device independent of the processor 2210, or may be integrated in the processor 2210.

In an embodiment, as shown in FIG. 22, the communication device 2200 may further include a transceiver 2230, and the processor 2210 may control the transceiver 2230 to communicate with other devices, e.g., transmitting information or data to other devices, or receiving information or data from other devices.

The transceiver 2230 may include a transmitter and a receiver. The transceiver 2230 may further include one or more antennas.

In an embodiment, the communication device 2200 may be an AP affiliated with an AP MLD or a STA affiliated with a non-AP MLD, and the communication device 2200 may implement the corresponding process implemented at the AP or the STA in the method according to the embodiments of the present disclosure.

FIG. 23 is a block diagram of an apparatus 2300 according to embodiments of the present disclosure. The apparatus 2300 includes a processor 2310, which is configured to invoke and run a computer program from the memory to implement the wireless communication method 400 or 1700 according to the embodiments of the present disclosure.

In an embodiment, as shown in FIG. 23, the apparatus 2300 may further include a memory 2320. The processor 2310 may invoke and run a computer program from the memory 2320 to implement the wireless communication method 400 or 1700 according to the embodiments of the present disclosure.

The memory 2320 may be a separate device independent of the processor 2310, or may be integrated in the processor 2310.

In an embodiment, the apparatus 2300 may further include an input interface 2330. The processor 2310 may control the input interface 2330 to communicate with other devices or chips, e.g., obtaining information or data sent by other devices or chips.

In an embodiment, the apparatus 2300 may further include an output interface 2340. The processor 2310 can control the output interface 2340 to communicate with other devices or chips, e.g., outputting information or data to other devices or chips.

In an embodiment, the apparatus 2300 can be applied to an AP affiliate with an AP MLD or a STA affiliate with a non-AP MLD according to the embodiments of the present disclosure, and the apparatus can implement the corresponding process implemented at the AP or the STA in the method according to the embodiments of the present disclosure.

In an embodiment, the apparatus can also be a chip. For example, the apparatus can be a system-level chip or a system-on-chip.

It should be understood that the processor according to the embodiments of the present disclosure may be a single CPU (Central Processing Unit), but could also include two or more processing units. For example, the processor may include general purpose microprocessors; instruction set processors and/or related chips sets and/or special purpose microprocessors such as Application Specific Integrated Circuits (ASICs). The processor may also include board memory for caching purposes. The computer program may be carried by a computer program product connected to the processor. The computer program product may include a non-transitory computer readable storage medium on which the computer program is stored. For example, the computer program product may be a flash memory, a Random-Access Memory (RAM), a Read-Only Memory (ROM), or an EEPROM, and the computer program modules described above could in alternative embodiments be distributed on different computer program products in the form of memories.

The embodiments of the present disclosure also provide a computer readable storage medium having a computer program stored thereon.

In an embodiment, the computer readable storage medium can be applied to the first/ second AP according to the embodiments of the present disclosure, and the computer program causes a computer to execute the corresponding process implemented by the first/ second AP in each method according to the embodiments of the present disclosure.

The embodiments of the present disclosure also provide a computer program product including computer program instructions.

In an embodiment, the computer program product can be applied to the first AP/ STA according to the embodiments of the present disclosure, and the computer program instructions cause the computer to perform the corresponding process implemented by the first/ second AP in each method according to the embodiments of the present disclosure.

The embodiment of the present disclosure also provides a computer program.

In an embodiment, the computer program can be applied to the first AP/ STA according to the embodiments of the present disclosure. When executed by the computer, the computer program causes the computer to perform the corresponding process implemented by the first/ second AP in each method according to the embodiments of the present disclosure.

The disclosure has been described above with reference to embodiments thereof. It should be understood that various modifications, alternations and additions can be made by one skilled in the art without departing from the spirits and scope of the disclosure. Therefore, the scope of the disclosure is not limited to the above particular embodiments but only defined by the claims as attached.

CLAIMS

1. A wireless communication method, applied in a first Access Point (AP) affiliated with an AP Multi-Link Device (MLD), the wireless communication method comprising:

transmitting a first frame to a first STAtion (STA) affiliated with a non-AP MLD, the first frame indicating that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD comprises a primary link and a nonprimary link, and the first frame further indicating a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

2. The wireless communication method according to claim 1, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

3. The wireless communication method according to claim 2, wherein the first frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

4. The wireless communication method according to any of claims 1 to 3, wherein the first frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

5. The wireless communication method according to claim 4, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

6. The wireless communication method according to claim 4 or 5, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

7. The wireless communication method according to any of claims 1 to 6, further comprising:

receiving a second frame from the first STA, the second frame indicating that the non-AP MLD supports the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and

transmitting a third frame to the first STA, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

8. The wireless communication method according to claim 7, wherein the second frame carries complete or partial profile of the second STA.

9. The wireless communication method according to claim 8, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

10. The wireless communication method according to any of claims 7 to 9, wherein the third frame carries complete profile of the first and second APs.

11. The wireless communication method according to claim 10, wherein the complete or partial profile of the second STA is contained in a Basic Multi-Link element carried in the third frame.

12. The wireless communication method according to any of claims 7 to 11, wherein at least one of the second frame and the third frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

13. The wireless communication method according to claim 12, wherein the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

14. The wireless communication method according to any of claims 1 to 6, further comprising:

receiving a second frame from the first STA, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and

transmitting a third frame to the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

15. The wireless communication method according to any of claims 7 to 14, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

16. The wireless communication method according to claim 15, wherein the second frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

17. The wireless communication method according to any of claims 7 to 16, wherein the second frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first STA; and

support of a DownLink (DL) MU operation for the first STA.

18. The wireless communication method according to claim 17, wherein the second frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

19. The wireless communication method according to any of claims 7 to 18, wherein the third frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

20. The wireless communication method according to claim 19, wherein the third frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

21. The wireless communication method according to any of claims 7 to 20, wherein in the PLNPL mode, at least one of the second frame and the third frame further indicates that Traffic IDentifiers (TIDs) mapped to the nonprimary link in DownLink (DL) and/or in UpLink (UL) are also mapped to the primary link in DL and/or in UL.

22. The wireless communication method according to any of claims 7 to 21, wherein the second frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

23. The wireless communication method according to claim 22, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

24. The wireless communication method according to claim 22 or 23, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

25. The wireless communication method according to claim 7 to 24, wherein the third frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

26. The wireless communication method according to claim 25, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

27. The wireless communication method according to claim 25 or 26, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

28. The wireless communication method according to any of claims 1 to 27, wherein the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

29. The wireless communication method according to any of claims 1 to 28, wherein in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

30. The wireless communication method according to claim 29, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

31. The wireless communication method according to any of claims 1 to 30, wherein in the PLNPL mode, a second AP affiliated with the AP MLD initiates a Physical layer Protocol Data Unit (PPDU) transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a transmission opportunity (TXOP) holder with the same start time.

32. The wireless communication method according to any of claims 1 to 31, wherein the first frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

33. The wireless communication method according to claim 32, wherein the first frame comprises a PLNPL Info subfield for indicating the link identifier information for the primary link

and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

34. The wireless communication method according to any of claims 1 to 33, wherein the first frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

35. The wireless communication method according to claim 34, wherein the first frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

36. The wireless communication method according to any of claims 1 to 35, further comprising:

transmitting a fourth frame to the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receiving a fifth frame from the first STA, the fifth frame indicating that the request is accepted.

37. The wireless communication method according to any of claims 1 to 35, further comprising:

transmitting a fourth frame to the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receiving a fifth frame from the first STA, the fifth frame indicating that the request is rejected.

38. The wireless communication method according to any of claims 1 to 35, further comprising:

receiving a fourth frame from the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmitting a fifth frame to the first STA, the fifth frame indicating that the request is accepted.

39. The wireless communication method according to any of claims 1 to 35, further comprising:

receiving a fourth frame from the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmitting a fifth frame to the first STA, the fifth frame indicating that the request is rejected.

40. The wireless communication method according to any of claims 36 to 39, wherein the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

41. A wireless communication method, applied in a first STAtion (STA) affiliated with a non-AP Multi-Link Device (MLD), the wireless communication method comprising:

receiving a first frame from a first Access Point (AP) affiliated with an AP Multi-Link Device (MLD), the first frame indicating that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD comprises a primary link and a nonprimary link, and the first frame further indicating a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

42. The wireless communication method according to claim 41, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

43. The wireless communication method according to claim 42, wherein the first frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

44. The wireless communication method according to any of claims 41 to 43, wherein the first frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

45. The wireless communication method according to claim 44, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

46. The wireless communication method according to claim 44 or 45, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

47. The wireless communication method according to any of claims 41 to 46, further comprising:

transmitting a second frame to the first AP, the second frame indicating that the non-AP MLD is operating in the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and

receiving a third frame from the first AP, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

48. The wireless communication method according to claim 47, wherein the second frame carries complete or partial profile of the second STA.

49. The wireless communication method according to claim 48, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

50. The wireless communication method according to any of claims 47 to 49, wherein the third frame carries complete profile of the first and second APs.

51. The wireless communication method according to claim 50, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame.

52. The wireless communication method according to any of claims 47 to 51, wherein at least one of the second frame and the third frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

53. The wireless communication method according to claim 52, wherein the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

54. The wireless communication method according to any of claims 41 to 46, further comprising:

transmitting a second frame to the first AP, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and

receiving a third frame from the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

55. The wireless communication method according to any of claims 47 to 54, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

56. The wireless communication method according to claim 55, wherein the second frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

57. The wireless communication method according to any of claims 47 to 56, wherein the second frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first STA; and

support of a DownLink (DL) MU operation for the first STA.

58. The wireless communication method according to claim 57, wherein the second frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

59. The wireless communication method according to any of claims 47 to 58, wherein the third frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

60. The wireless communication method according to claim 59, wherein the third frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

61. The wireless communication method according to any of claims 47 to 60, wherein in the PLNPL mode, at least one of the second frame and the third frame further indicates that all Traffic IDentifiers (TIDs) mapped to the nonprimary link in DownLink (DL) and/or in UpLink (UL) are also mapped to the primary link in DL and/or in UL.

62. The wireless communication method according to any of claims 47 to 61, wherein the second frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

63. The wireless communication method according to claim 62, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

64. The wireless communication method according to claim 62 or 63, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

65. The wireless communication method according to claim 47 to 64, wherein the third frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

66. The wireless communication method according to claim 65, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

67. The wireless communication method according to claim 65 or 66, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

68. The wireless communication method according to any of claims 41 to 67, wherein the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

69. The wireless communication method according to any of claims 41 to 68, wherein in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

70. The wireless communication method according to claim 69, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

71. The wireless communication method according to any of claims 41 to 70, wherein in the PLNPL mode, a second AP affiliated with the AP MLD initiates a Physical layer Protocol Data Unit (PPDU) transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a transmission opportunity (TXOP) holder with the same start time.

72. The wireless communication method according to any of claims 41 to 71, wherein the first frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

73. The wireless communication method according to claim 72, wherein the first frame comprises a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

74. The wireless communication method according to any of claims 41 to 73, wherein the first frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

75. The wireless communication method according to claim 74, wherein the first frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

76. The wireless communication method according to any of claims 41 to 75, further comprising:

receiving a fourth frame from the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmitting a fifth frame to the first AP, the fifth frame indicating that the request is accepted.

77. The wireless communication method according to any of claims 41 to 75, further comprising:

receiving a fourth frame from the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmitting a fifth frame to the first AP, the fifth frame indicating that the request is rejected.

78. The wireless communication method according to any of claims 41 to 75, further comprising:

transmitting a fourth frame to the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receiving a fifth frame from the first AP, the fifth frame indicating that the request is accepted.

79. The wireless communication method according to any of claims 41 to 75, further comprising:

transmitting a fourth frame to the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receiving a fifth frame from the first AP, the fifth frame indicating that the request is rejected.

80. The wireless communication method according to any of claims 76 to 79, wherein the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

81. A wireless communication apparatus, applied in a first Access Point (AP) affiliated with an AP Multi-Link Device (MLD), the wireless communication apparatus comprising:

a communication unit configured to transmit a first frame to a first STAtion (STA) affiliated with a non-AP MLD, the first frame indicating that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD comprises a primary link and a nonprimary link, and the first frame further indicating a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

82. The wireless communication apparatus according to claim 81, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

83. The wireless communication apparatus according to claim 82, wherein the first frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

84. The wireless communication apparatus according to any of claims 81 to 83, wherein the first frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

85. The wireless communication apparatus according to claim 84, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

86. The wireless communication apparatus according to claim 84 or 85, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

87. The wireless communication apparatus according to any of claims 81 to 86, wherein the communication unit is further configured to:

receive a second frame from the first STA, the second frame indicating that the non-AP MLD supports the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and

transmit a third frame to the first STA, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

88. The wireless communication apparatus according to claim 87, wherein the second frame carries complete or partial profile of the second STA.

89. The wireless communication apparatus according to claim 88, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

90. The wireless communication apparatus according to any of claims 87 to 89, wherein the third frame carries complete profile of the first and second APs.

91. The wireless communication apparatus according to claim 90, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame.

92. The wireless communication apparatus according to any of claims 87 to 91, wherein at least one of the second frame and the third frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

93. The wireless communication apparatus according to claim 92, wherein the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

94. The wireless communication apparatus according to any of claims 81 to 86, wherein the communication unit is further configured to:

receive a second frame from the first STA, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and

transmit a third frame to the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

95. The wireless communication apparatus according to any of claims 87 to 94, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

96. The wireless communication apparatus according to claim 95, wherein the second frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

97. The wireless communication apparatus according to any of claims 87 to 96, wherein the second frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first STA; and

support of a DownLink (DL) MU operation for the first STA.

98. The wireless communication apparatus according to claim 97, wherein the second frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

99. The wireless communication apparatus according to any of claims 87 to 98, wherein the third frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

100. The wireless communication apparatus according to claim 99, wherein the third frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

101. The wireless communication apparatus according to any of claims 87 to 100, wherein in the PLNPL mode, at least one of the second frame and the third frame further indicates that Traffic IDentifiers (TIDs) mapped to the nonprimary link in DownLink (DL) and/or in UpLink (UL) are also mapped to the primary link in DL and/or in UL.

102. The wireless communication apparatus according to any of claims 87 to 101, wherein the second frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

103. The wireless communication apparatus according to claim 102, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

104. The wireless communication apparatus according to claim 102 or 103, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

105. The wireless communication apparatus according to claim 87 to 104, wherein the third frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

106. The wireless communication apparatus according to claim 105, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

107. The wireless communication apparatus according to claim 105 or 106, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

108. The wireless communication apparatus according to any of claims 81 to 107, wherein the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

109. The wireless communication apparatus according to any of claims 81 to 108, wherein in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

110. The wireless communication apparatus according to claim 109, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

111. The wireless communication apparatus according to any of claims 81 to 110, wherein in the PLNPL mode, a second AP affiliated with the AP MLD initiates a Physical layer Protocol Data Unit (PPDU) transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a transmission opportunity (TXOP) holder with the same start time.

112. The wireless communication apparatus according to any of claims 81 to 111, wherein the first frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

113. The wireless communication apparatus according to claim 112, wherein the first frame comprises a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

114. The wireless communication apparatus according to any of claims 81 to 113, wherein the first frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

115. The wireless communication apparatus according to claim 114, wherein the first frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

116. The wireless communication apparatus according to any of claims 81 to 115, wherein the communication unit is further configured to:

transmit a fourth frame to the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receive a fifth frame from the first STA, the fifth frame indicating that the request is accepted.

117. The wireless communication apparatus according to any of claims 81 to 115, wherein the communication unit is further configured to:

transmit a fourth frame to the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receive a fifth frame from the first STA, the fifth frame indicating that the request is rejected.

118. The wireless communication apparatus according to any of claims 81 to 115, wherein the communication unit is further configured to:

receive a fourth frame from the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmit a fifth frame to the first STA, the fifth frame indicating that the request is accepted.

119. The wireless communication apparatus according to any of claims 81 to 115, wherein the communication unit is further configured to:

receive a fourth frame from the first STA, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmit a fifth frame to the first STA, the fifth frame indicating that the request is rejected.

120. The wireless communication apparatus according to any of claims 116 to 119, wherein the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

121. A wireless communication apparatus, applied in a first STAtion (STA) affiliated with a non-AP Multi-Link Device (MLD), the wireless communication apparatus comprising:

a communication unit configured to receive a first frame from a first Access Point (AP) affiliated with an AP Multi-Link Device (MLD), the first frame indicating that the AP MLD supports a Primary Link and NonPrimary Link (PLNPL) mode, in which at least two links belonging to the AP MLD comprises a primary link and a nonprimary link, and the first frame further indicating a first link and a second link of the at least two links as the primary link and the nonprimary link, respectively.

122. The wireless communication apparatus according to claim 121, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the first frame further indicates support for a NSTR Mobile AP MLD operation.

123. The wireless communication apparatus according to claim 122, wherein the first frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating the support for the NSTR Mobile AP MLD operation, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

124. The wireless communication apparatus according to any of claims 121 to 123, wherein the first frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

125. The wireless communication apparatus according to claim 124, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

126. The wireless communication apparatus according to claim 124 or 125, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the first frame.

127. The wireless communication apparatus according to any of claims 121 to 126, wherein the communication unit is further configured to:

transmit a second frame to the first AP, the second frame indicating that the non-AP MLD is operating in the PLNPL mode and being used for requesting the first link to be setup between the first AP and the first STA as the primary link and the second link to be setup between a second AP affiliated with the AP MLD and a second STA affiliated with the non-AP MLD as the nonprimary link; and

receive a third frame from the first AP, the third frame indicating successful setup of the first link and/ or the second link between the non-AP MLD and the AP MLD.

128. The wireless communication apparatus according to claim 127, wherein the second frame carries complete or partial profile of the second STA.

129. The wireless communication apparatus according to claim 128, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the second frame.

130. The wireless communication apparatus according to any of claims 127 to 129, wherein the third frame carries complete profile of the first and second APs.

131. The wireless communication apparatus according to claim 130, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the third frame.

132. The wireless communication apparatus according to any of claims 127 to 131, wherein at least one of the second frame and the third frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

133. The wireless communication apparatus according to claim 132, wherein the link identifier information for the primary link and the link identifier information for the nonprimary link are indicated by a PLNPL Info subfield contained in a Link Info field of a Basic Multi-Link element carried in at least one of the second frame and the third frame.

134. The wireless communication apparatus according to any of claims 121 to 126, wherein the communication unit is further configured to:

transmitting a second frame to the first AP, the second frame indicating that the non-AP MLD does not support the PLNPL mode and being used for initiating a multi-link setup between the non-AP MLD and the AP MLD; and

receiving a third frame from the first STA, the third frame indicating successful setup of only the first link between the non-AP MLD and the AP MLD or failure of the multi-link setup.

135. The wireless communication apparatus according to any of claims 127 to 134, wherein the AP MLD is a NonSimultaneous Transmit and Receive (NSTR) mobile AP MLD, and the second frame further indicates that the non-AP MLD is capable of operating with the NSTR mobile AP MLD.

136. The wireless communication apparatus according to claim 135, wherein the second frame comprises a NSTR Mobile AP MLD Operation Support subfield for indicating that the non-AP MLD is capable of operating with the NSTR mobile AP MLD, and the NSTR Mobile AP MLD Operation Support subfield is contained in a Common Info field of a Basic Multi-Link element carried in the second frame.

137. The wireless communication apparatus according to any of claims 127 to 136, wherein the second frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first STA; and

support of a DownLink (DL) MU operation for the first STA.

138. The wireless communication apparatus according to claim 137, wherein the second frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first STA; and support of the DL MU operation for the first STA, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the second frame.

139. The wireless communication apparatus according to any of claims 127 to 138, wherein the third frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

140. The wireless communication apparatus according to claim 59, wherein the third frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the third frame.

141. The wireless communication apparatus according to any of claims 127 to 140, wherein in the PLNPL mode, at least one of the second frame and the third frame further indicates that all Traffic IDentifiers (TIDs) mapped to the nonprimary link in DownLink (DL) and/or in UpLink (UL) are also mapped to the primary link in DL and/or in UL.

142. The wireless communication apparatus according to any of claims 127 to 141, wherein the second frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

143. The wireless communication apparatus according to claim 142, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and/or the second AP are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second STA is only allowed to be equal to or shorter than a duration of a TXOP gained by the first STA; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second STA and an end of the TXOP gained by the first STA.

144. The wireless communication apparatus according to claim 142 or 143, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element.

145. The wireless communication apparatus according to claim 127 to 144, wherein the third frame comprises a PLNPL Capabilities subfield indicating capabilities for an operation of the PLNPL mode.

146. The wireless communication apparatus according to claim 145, wherein the PLNPL Capabilities subfield comprises at least one of:

a PLNPL Support subfield indicating support of the PLNPL mode;

a Power Save Mode subfield indicating whether power save modes for the first AP and / or a second AP affiliated with the AP MLD are supported;

a TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK subfield indicating whether a duration of a transmission opportunity (TXOP) gained by the second AP is only allowed to be equal to or shorter than a duration of a TXOP gained by the first AP; and

a TXOP duration offset subfield indicating a maximum offset allowed between an end of the TXOP gained by the second AP and an end of the TXOP gained by the first AP.

147. The wireless communication apparatus according to claim 145 or 146, wherein the PLNPL Capabilities subfield is contained in a Common Info field of a Basic Multi-Link element carried in the third frame.

148. The wireless communication apparatus according to any of claims 121 to 147, wherein the first frame is a beacon frame or a probe response frame, and in the PLNPL mode, only the first AP transmits the beacon frame or the probe response frame, while a second AP affiliated with the AP MLD does not send any beacon frame or probe response frame.

149. The wireless communication apparatus according to any of claims 121 to 148, wherein in the PLNPL mode, the first frame carries complete or partial profile of a second AP affiliated with the AP MLD.

150. The wireless communication apparatus according to claim 149, wherein the complete or partial profile of the second STA is carried in a Basic Multi-Link element carried in the first frame.

151. The wireless communication apparatus according to any of claims 121 to 150, wherein in the PLNPL mode, a second AP affiliated with the AP MLD initiates a Physical layer Protocol Data Unit (PPDU) transmission to a second STA affiliated with the non-AP MLD in the nonprimary link only if the first AP in the primary link is also initiating the PPDU transmission as a transmission opportunity (TXOP) holder with the same start time.

152. The wireless communication apparatus according to any of claims 121 to 151, wherein the first frame comprises link identifier information for the primary link and link identifier information for the nonprimary link.

153. The wireless communication apparatus according to claim 152, wherein the first frame comprises a PLNPL Info subfield for indicating the link identifier information for the primary link and the link identifier information for the nonprimary link, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

154. The wireless communication apparatus according to any of claims 121 to 153, wherein the first frame further indicates at least one of:

support of a UpLink (UL) Multi-User (MU) operation for the first AP; and

support of a DownLink (DL) MU operation for the first AP.

155. The wireless communication apparatus according to claim 154, wherein the first frame comprises a PLNPL Info subfield for indicating at least one of: support of the UL MU operation for the first AP; and support of the DL MU operation for the first AP, and the PLNPL Info subfield is contained in a STA Info field in a Link Info field of a Basic Multi-Link element carried in the first frame.

156. The wireless communication apparatus according to any of claims 121 to 155, wherein the communication unit is further configured to:

receive a fourth frame from the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmit a fifth frame to the first AP, the fifth frame indicating that the request is accepted.

157. The wireless communication apparatus according to any of claims 121 to 155, wherein the communication unit is further configured to:

receive a fourth frame from the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

transmit a fifth frame to the first AP, the fifth frame indicating that the request is rejected.

158. The wireless communication apparatus according to any of claims 121 to 155, wherein the communication unit is further configured to:

transmit a fourth frame to the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are also requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receive a fifth frame from the first AP, the fifth frame indicating that the request is accepted.

159. The wireless communication apparatus according to any of claims 121 to 155, wherein the communication unit is further configured to:

transmit a fourth frame to the first AP, the fourth frame comprising a request for requesting one or more Traffic IDentifiers (TIDs), which have not been mapped to the primary link in DownLink (DL) and/or in UpLink (UL) or are not requested to be mapped to the primary link in DL and/or in UL, to be mapped to the nonprimary link in DL and/or in UL; and

receive a fifth frame from the first AP, the fifth frame indicating that the request is rejected.

160. The wireless communication apparatus according to any of claims 156 to 159, wherein the fourth frame is a TID-TO-Link Mapping Request frame, and the fifth frame is a TID-TO-Link Mapping Response frame.

161. An Access Point (AP) device, comprising:

a memory having a computer program stored thereon; and

a processor configured to invoke and run the computer program whereby the AP device is operative to perform the method of any of claims 1-40.

162. A STation (STA) device, comprising:

a memory having a computer program stored thereon; and

a processor configured to invoke and run the computer program whereby the STA device is operative to perform the method of any of claims 41-80.

163. A chip, comprising a processor configured to invoke and run a computer program from a memory whereby an apparatus provided with the chip is operative to perform the method of any of claims 1-40 or the method of any of claims 41-80.

164.A computer readable storage medium having a computer program stored thereon, the computer program, when executed by a computer, causing the computer to perform the method of any of claims 1-40 or the method of any of claims 41-80.

165.A computer program product, comprising computer program instructions, the computer program instructions, when executed by a computer, causing the computer to perform the method of any of claims 1-40 or the method of any of claims 41-80.

166.A computer program, the computer program, when executed by a computer, causing the computer to perform the method of any of claims 1-40 or the method of any of claims 41-80.

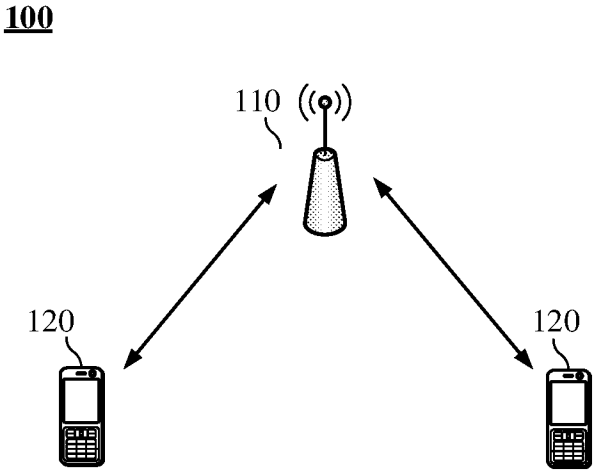

100
110
120
120

FIG. 1

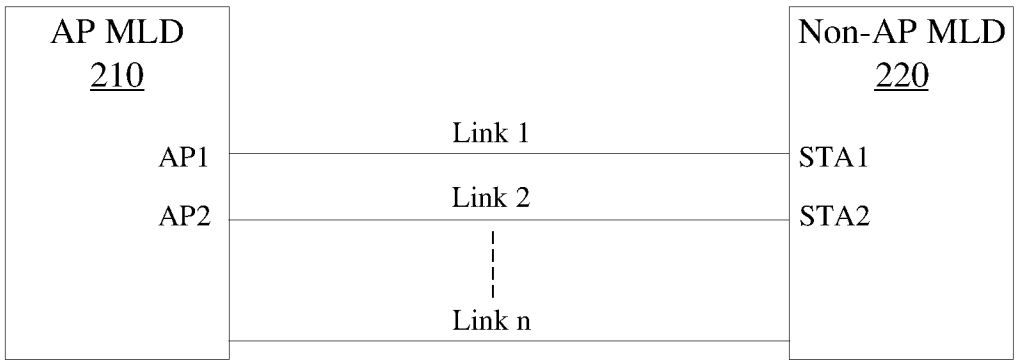

AP MLD
210
AP1
AP2
Link 1
Link 2
Link n
Non-AP MLD
220
STA1
STA2

FIG. 2

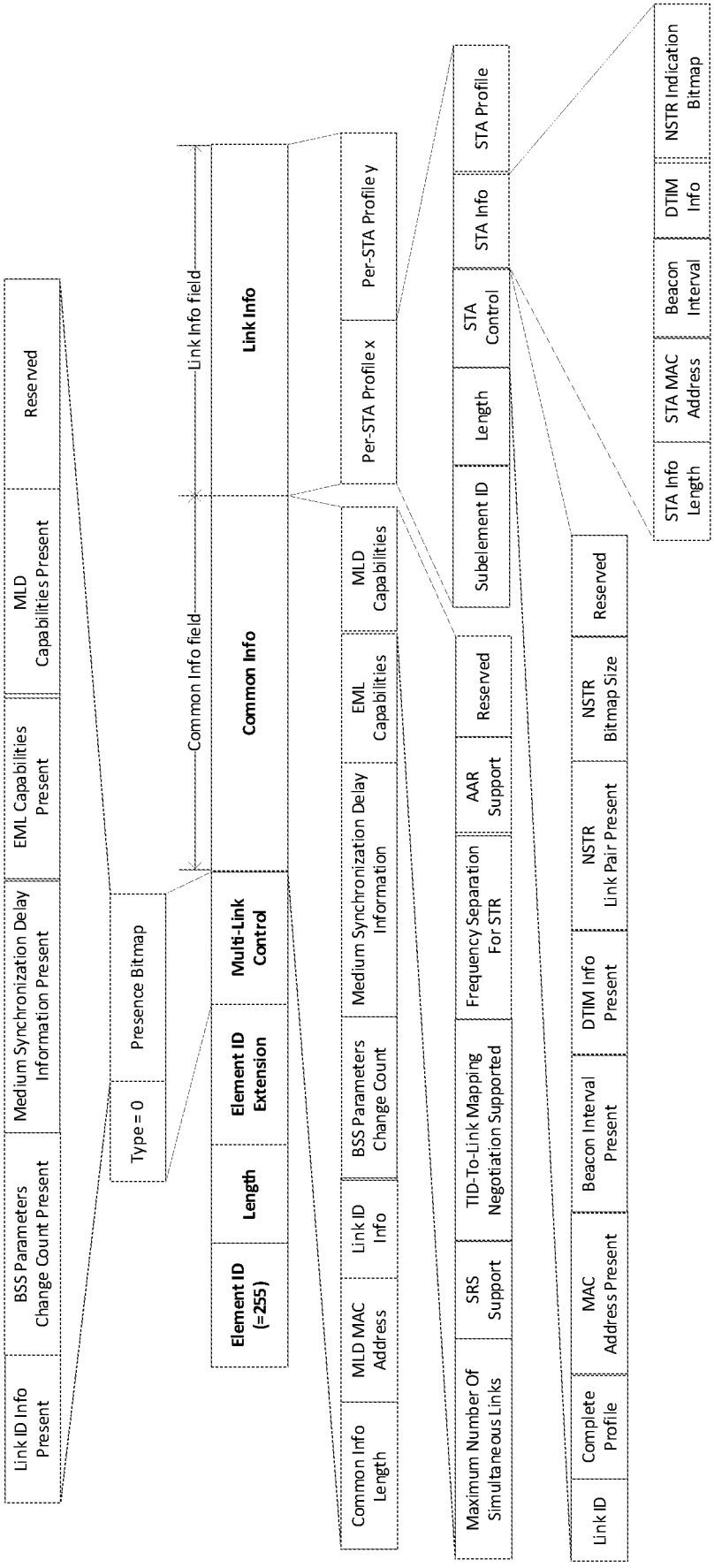

Link ID Info Present
BSS Parameters Change Count Present
Medium Synchronization Delay Information Present
EML Capabilities Present
MLD Capabilities Present
Reserved
Type = 0
Presence Bitmap
Common Info field
Link Info field
Element ID (=255)
Length
Element ID Extension
Multi-Link Control
Common Info
Link Info
Common Info Length
MLD MAC Address
Link ID Info
BSS Parameters Change Count
Medium Synchronization Delay Information
EML Capabilities
MLD Capabilities
Per-STA Profile x
Per-STA Profile y
Maximum Number Of Simultaneous Links
SRS Support
TID-To-Link Mapping Negotiation Supported
Frequency Separation For STR
AAR Support
Reserved
Subelement ID
Length
STA Control
STA Info
STA Profile
Link ID
Complete Profile
MAC Address Present
Beacon Interval Present
DTIM Info Present
NSTR Link Pair Present
NSTR Bitmap Size
Reserved
STA Info Length
STA MAC Address
Beacon Interval
DTIM Info
NSTR Indication Bitmap

FIG. 3

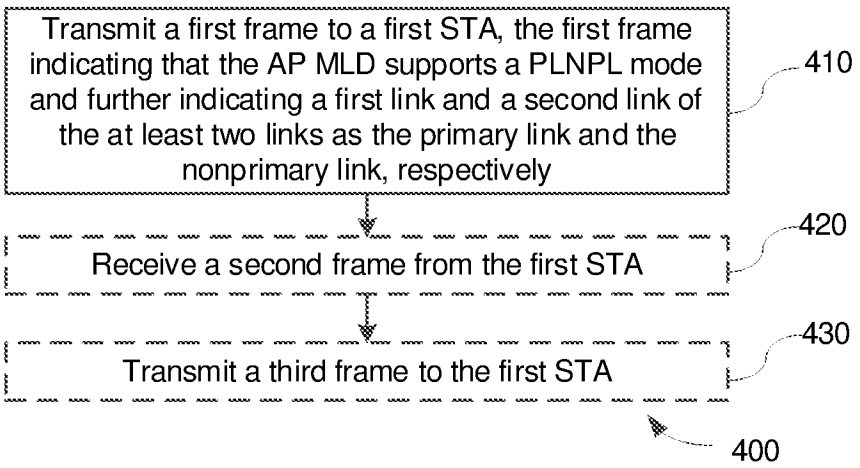


FIG. 4

Common Info Length	MLD MAC Address	Link ID Info	BSS Parameters Change Count	Medium Synchronization Delay Information	EML Capabilities	MLD Capabilities	**PLNPL Capabilities**
Octets: 1	6	0 or 1	0 or 1	0 or 2	0 or 2	0 or 2	0 or 1

FIG. 5

B0	B1 B2	B3 B6	B7 B8	B9 B15
PLNPL Support	**TXOP_DURATION_LIMITATION_FOR_NONPRIMARY_LINK**	**TXOP_DURATION OFFSET**	**Power save Mode**	**Reserved**
Bits: 1	2	4	2	7

FIG. 6

B0 B3	B4	B5	B6	B7	B8	B9
Link ID	Complete Profile	MAC Address Present	Beacon Interval Present	DTIM Info Present	NSTR Link PairPresent	NSTR BitmapSize
Bits: 4	1	1	1	1	1	1

B10	B11 B15
PLNPL Info Present	Reserved
Bits: 1	5

FIG. 7

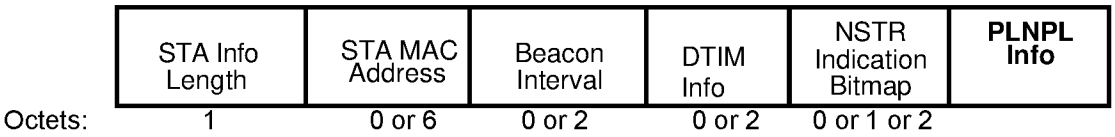


FIG. 8

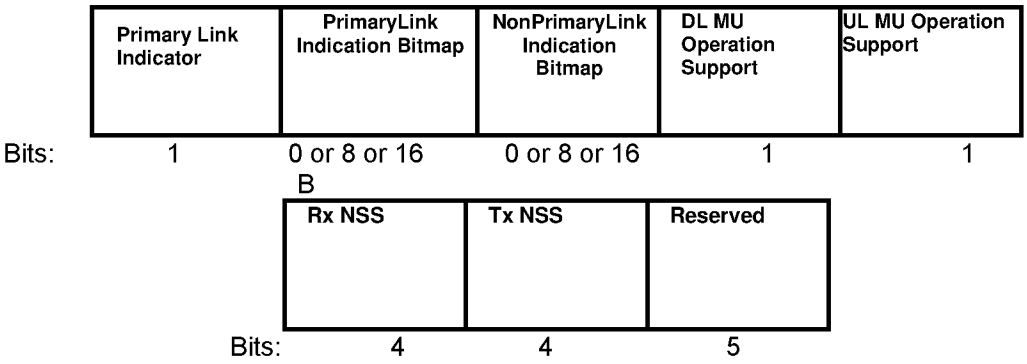


FIG. 9

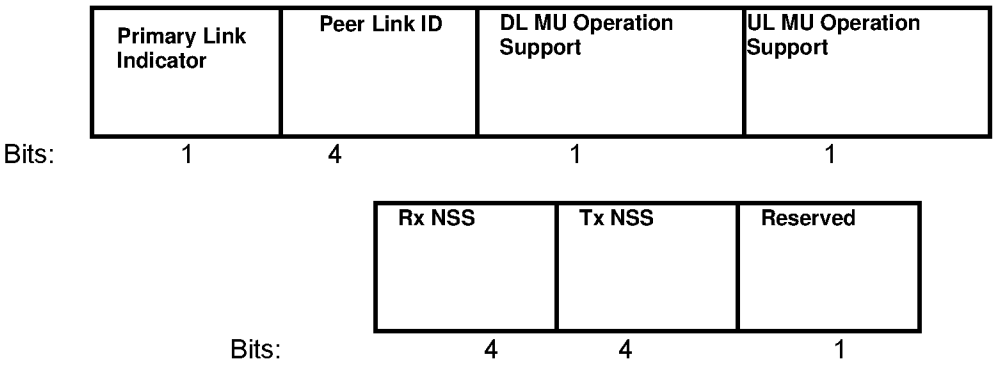


FIG. 10

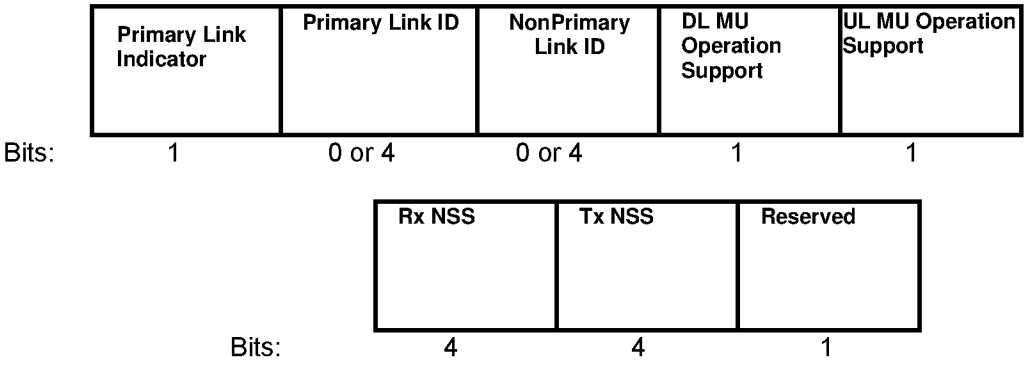


FIG. 11

Maximum Number Of Simultaneous Links	SRS Support	TID-To-Link Mapping Negotiation Supported	Frequency Separation For STR	AAR Support	**NSTR Mobile AP MLD Operation Support**	Reserved
Bits: 4	1	2	5	1	1	2

FIG. 12

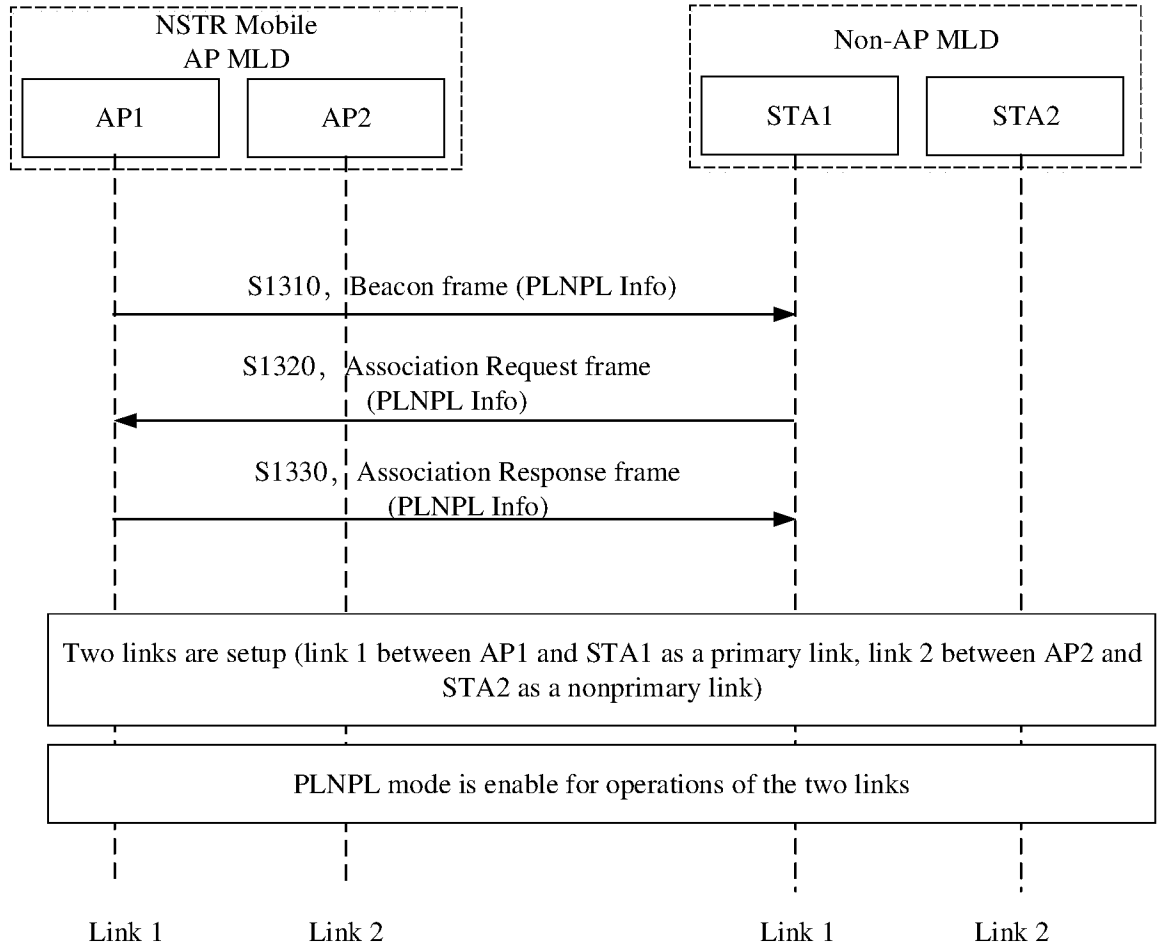


FIG. 13

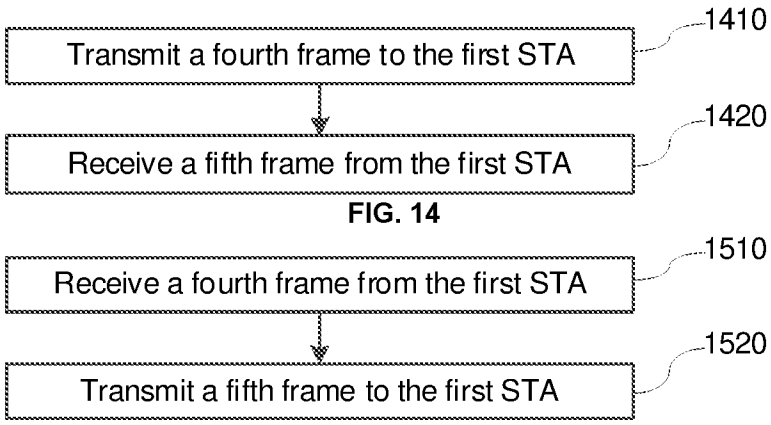


FIG. 14

FIG. 15

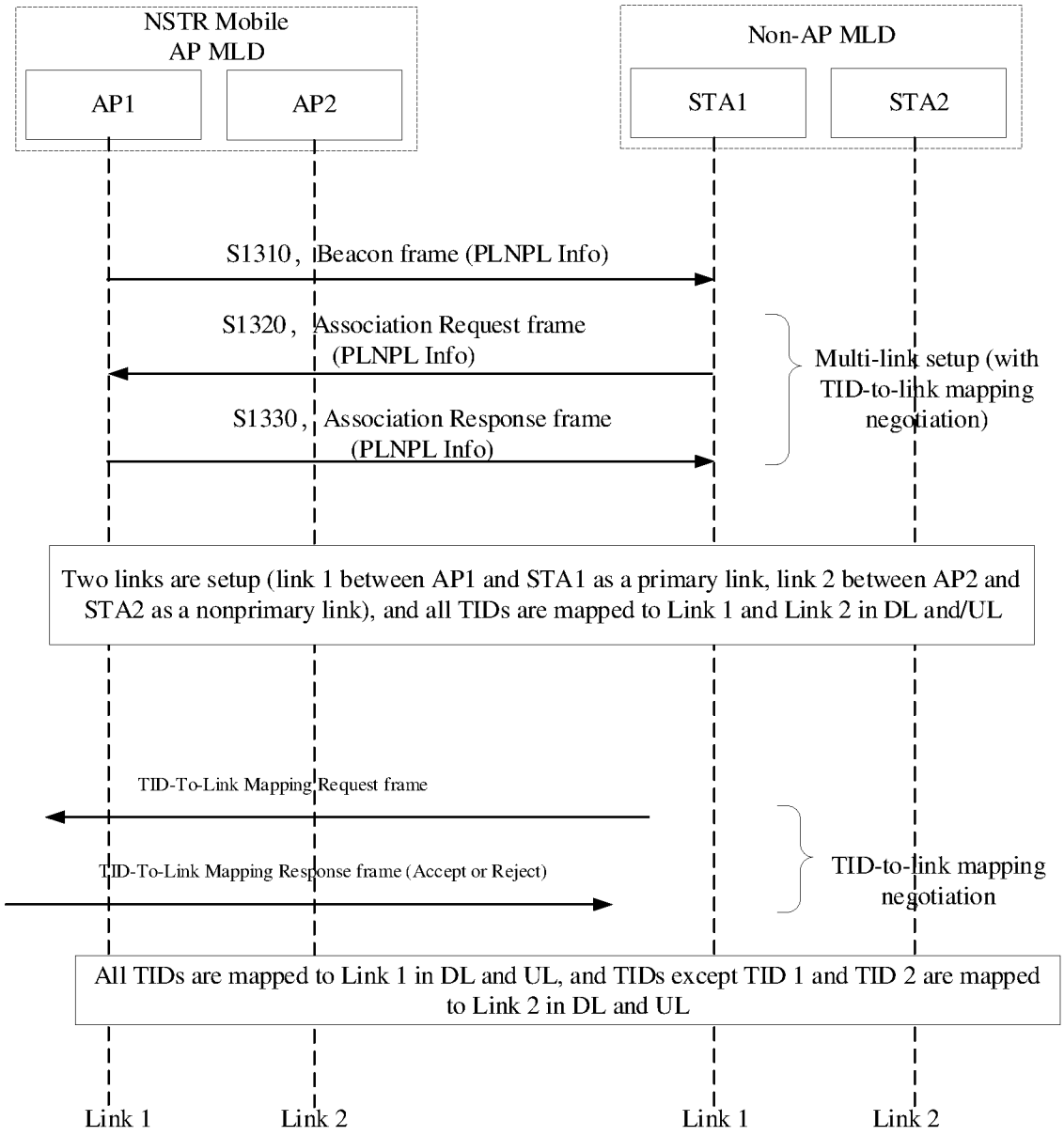


FIG. 16

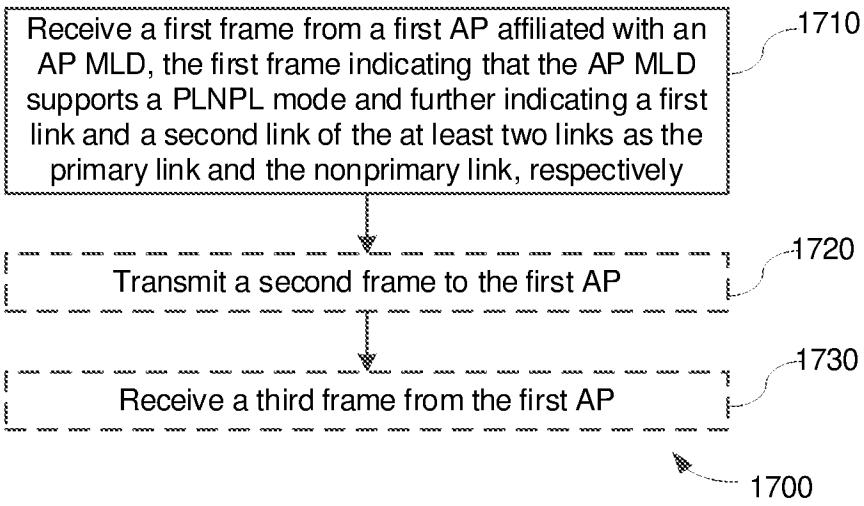


FIG. 17

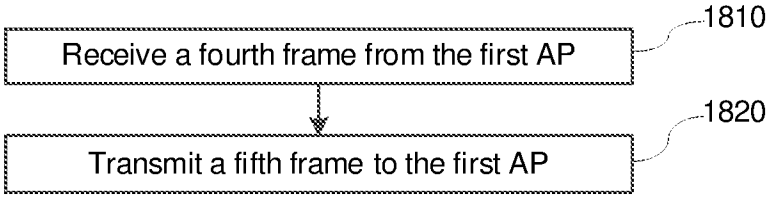


FIG. 18

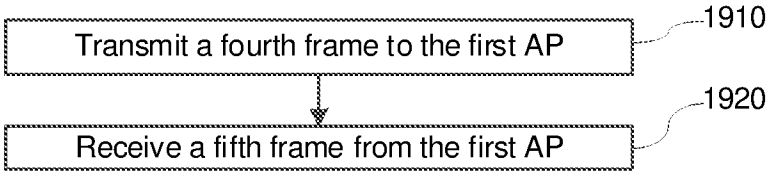


FIG. 19

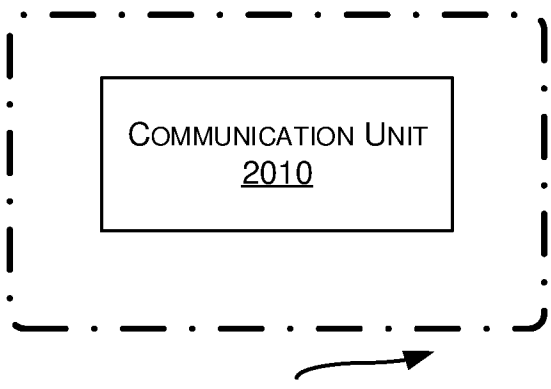
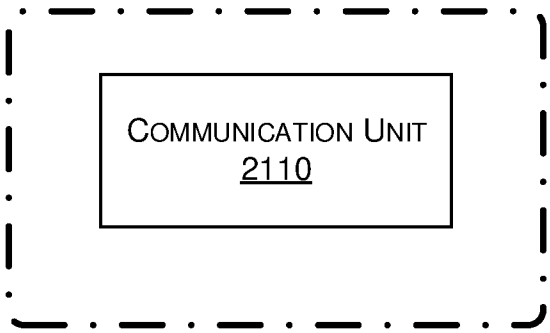
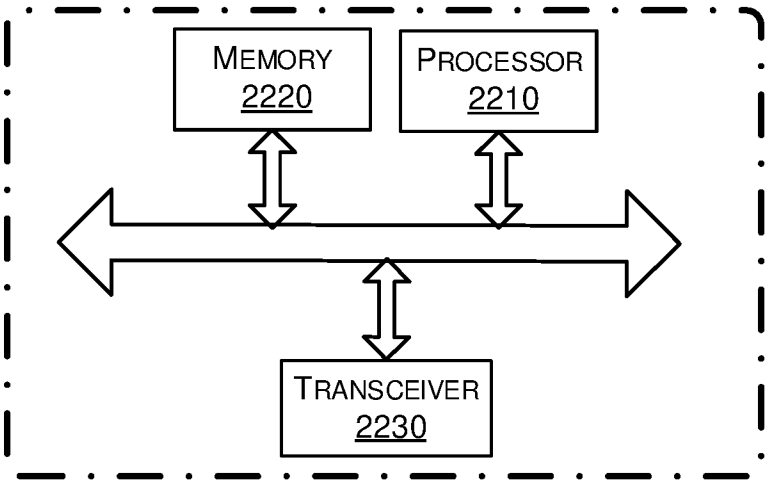


FIG. 20



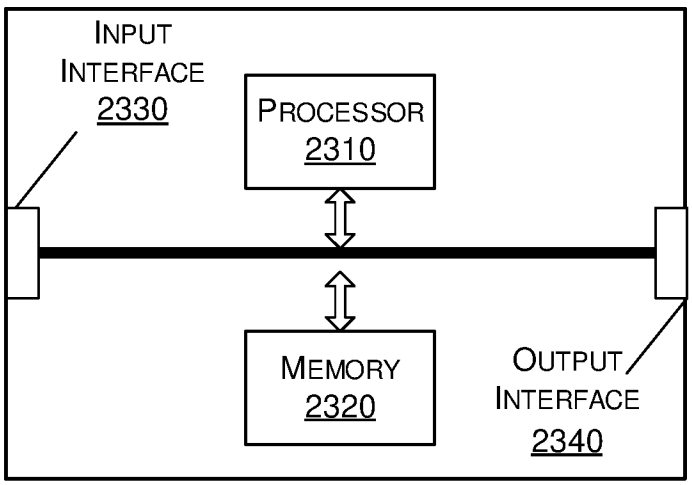
WIRELESS COMMUNICATION APPARATUS
2100

FIG. 21



COMMUNICATION DEVICE
2200

FIG. 22



APPARATUS
2300

FIG. 23

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/133262

A. CLASSIFICATION OF SUBJECT MATTER

H04W 76/15(2018.01)i; H04W 72/02(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04W; H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT;WPABS;ENTXT;DWPI;CJFD;VCN;3GPP;IEEE: AP, access point, MLD, multi-link device, STA, non-AP MLD, support, PLNPL, mode, primary, non-primary, link, STR, NSTR, non-STR, Simultaneous Transmit and Receive, TXOP, transmission opportunity, TID, traffic identifier, uplink, UL, downlink, DL, multi-User, MU, info field, subfield

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 112714472 A (ZTE CORP) 27 April 2021 (2021-04-27) see the whole document	1-166
A	WO 2021210869 A1 (ELECTRONICS & TELECOMMUNICATIONS RES INST et al.) 21 October 2021 (2021-10-21) see the whole document	1-166
A	WO 2021183045 A1 (PANASONIC IP CORP AMERICA) 16 September 2021 (2021-09-16) see the whole document	1-166
A	WO 2021109485 A1 (ZTE CORP) 10 June 2021 (2021-06-10) see the whole document	1-166
A	CN 109587052 A (SPREADTRUM COMMUNICATIONS SHANGHAI INC.) 05 April 2019 (2019-04-05) see the whole document	1-166
A	WO 2021172919 A1 (WILUS INST STANDARDS & TECH INC) 02 September 2021 (2021-09-02) see the whole document	1-166

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
24 June 2022	**30 June 2022**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing** **100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **WU,Xu** Telephone No. **86-010-62089859**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/133262

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	112714472	A	27 April 2021	None			
WO	2021210869	A1	21 October 2021	KR	20210127103	A	21 October 2021
WO	2021183045	A1	16 September 2021	SG	10202002245Y	A	28 October 2021
WO	2021109485	A1	10 June 2021	None			
CN	109587052	A	05 April 2019	EP	3920477	A1	08 December 2021
				WO	2020156591	A1	06 August 2020
				US	2022104071	A1	31 March 2022
WO	2021172919	A1	02 September 2021	KR	20220045104	A	12 April 2022