[0006] There is thus a need for communication apparatuses and methods that can solve the above mentioned issue. Furthermore, other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

SUMMARY

[0007] A non-limiting example facilitates providing communication apparatuses and communication methods for EHT virtualization for MLD devices.

[0007a] According to an aspect of the present disclosure, there is provided an Access Point (AP) included in a plurality of APs affiliated with an AP Multi-link Device (MLD), wherein each of the plurality of APs advertises a Basic Service Set Identifier (BSSID) and provides a link identified by a Link Identifier (ID), the AP comprising: circuitry, which in operation, generates a frame carrying a multi-link element containing information about the AP MLD and the plurality of APs; and a transmitter, which in operation, transmits the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted, wherein the AP MLD bridges wireless frames between the plurality of APs and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.

[0007b] According to another aspect of the present disclosure, there is provided a non-AP Station (STA) included in a plurality of non-AP STAs affiliated with a non-AP MLD, the non-AP STA comprising: circuitry, which in operation, generates a Probe Request frame carrying a Multi-link element containing a MLD MAC Address of an AP MLD and one or more Link IDs of links affiliated with the AP MLD; and a transmitter, which in operation, transmits the Probe Request frame to request information about the AP MLD and the one or more links of the AP MLD, wherein the AP MLD bridges wireless frames between a plurality of APs affiliated with the AP MLD and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.

[0007c] According to another aspect of the present disclosure, there is provided a communication method comprising: generating a frame at an AP included in a plurality of APs affiliated with an AP MLD, wherein each of the plurality of APs advertises a BSSID and provides a link identified by a Link ID, the frame carrying a multi-link element containing information about the AP MLD and the plurality of APs; and transmitting the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted, wherein the AP MLD bridges wireless frames between the plurality of APs and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.

[0008] According to an example of the present disclosure, there is provided an Access Point (AP) included in a plurality of APs affiliated with an AP Multi-link Device (MLD), wherein each of the plurality of APs advertises a Basic Service Set Identifier (BSSID) and provides a link identified by a Link Identifier (ID), the AP comprising: circuitry, which in operation, generates a frame carrying a multi-link

element containing information about the AP MLD and the plurality of APs; and a transmitter, which in operation, transmits the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted.

[0009] According to another example of the present disclosure, there is provided a non-AP Station (STA) included in a plurality of non-AP STAs affiliated with a non-AP MLD, the non-AP STA comprising: circuitry, which in operation, generates a Probe Request frame carrying a Multi-link element containing a MLD MAC Address of an AP MLD and one or more Link IDs of links affiliated with the AP MLD; and a transmitter, which in operation, transmits the Probe Request frame to request information about the AP MLD and the one or more links of the AP MLD.

[0010] According to another example of the present disclosure, there is provided a communication method comprising: generating a frame at an AP included in a plurality of APs affiliated with an AP MLD, wherein each of the plurality of APs advertises a BSSID and provides a link identified by a Link ID, the frame carrying a multi-link element containing information about the AP MLD and the plurality of APs; and transmitting the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted.

[0011] It should be noted that general or specific examples may be implemented as a system, a method, an integrated circuit, a computer program, a storage medium, or any selective combination thereof. Additional benefits and advantages of the examples in the disclosure will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various examples and features of the specification and drawings, which need not all be provided in order to obtain one or more of such benefits and/or advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying figures where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various embodiments and to explain various principles and advantages in accordance with present embodiments.

[0013] FIG. 1 illustrates an implementation of VLANs according to an example.

[0014] FIG. 2 illustrates an implementation of a network according to an example.

[0015] FIG. 3 depicts an illustration of an AP MLD having a Tier 1 virtualization in accordance with various embodiments.

CLAIMS

1. An Access Point (AP) included in a plurality of APs affiliated with an AP Multi-link Device (MLD), wherein each of the plurality of APs advertises a Basic Service Set Identifier (BSSID), and provides a link identified by a Link Identifier (ID), the AP comprising:

circuitry, which in operation, generates a frame carrying a multi-link element containing information about the AP MLD and the plurality of APs; and

a transmitter, which in operation, transmits the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted, wherein the AP MLD bridges wireless frames between the plurality of APs and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.

2. The AP according to claim 1, wherein the AP is a member of a multiple BSSID set or a member of a co-hosted BSSID set, or not a member of either a multiple BSSID set or a co-hosted BSSID set, and wherein the frame is one of a Beacon frame, a Probe Response frame, a FILS Discovery frame or an Association Response frame.

3. The AP according to claim 1, wherein the AP is a member of a multiple BSSID set and the circuitry is further configured to:

include in the frame a Multiple BSSID element, the Multiple BSSID element comprising a nontransmitted BSSID profile that carries another Multi-link element, the another Multi-link element containing information about another AP MLD with which another AP corresponding to the nontransmitted BSSID profile is affiliated with and a plurality of links affiliated with the another AP MLD, the another Multi-link element further indicating a Link ID of a link on which the another AP operates.

4. The AP according to claim 1, wherein each BSSID is included in a plurality of BSSIDs that is affiliated with the AP MLD, wherein the plurality of BSSIDs is mapped to two or more Service Set Identifiers (SSIDs), and wherein the Multi-link element further indicates the SSID corresponding to each AP.

5. The AP according to claim 4, wherein a SSID or one or more BSSIDs mapped to the SSID is indicated in a MAC data service primitive MA-UNITDATA.request, and wherein the transmitter is further configured to transmit a data frame corresponding to the MAC data service primitive MA-UNITDATA.request if the AP corresponds to the one or more BSSIDs mapped to the SSID.

6. The AP according to claim 1, wherein each BSSID is included in a plurality of BSSIDs that is affiliated with the AP MLD, wherein the plurality of BSSIDs is mapped to a single SSID, and wherein the Multi-link element further indicates the SSID.

7. The AP according to claim 1, wherein the Multi-link element further comprises:

a Type field;

a Common Information field carrying the Link ID of the link on which the Multi-link element is transmitted; and

one or more Per-link Information fields, each Per-link Information field representing a link of the plurality of APs excluding the link on which the Multi-link element is transmitted, each Per-link Information field carrying a Link ID and link specific information of the represented link, the link specific information indicating a BSSID and an operating channel associated with the represented link.

8. The AP according to claim 3, wherein the another Multi-link element further comprises:

a Type field;

a Common Information field carrying the Link ID of the link on which the another AP operates; and

one or more Per-link Information fields, each Per-link Information field representing a link of the plurality of links affiliated with the another AP MLD excluding the link on which on which the another AP operates, each Per-link Information field carrying a Link ID and link specific information of the represented link, the link specific information indicating a BSSID and an operating channel associated with the represented link.

9. The AP according to claim 7 and 8, wherein the link specific information further indicates an SSID corresponding to the BSSID of the represented link if the SSID is different from that of the link carried in the Common Information field.

10. The AP according to claim 7 and 8, wherein if the represented link corresponds to a nontransmitted BSSID, the link specific information further indicates a Transmitted BSSID, a MaxBSSID Indicator and a BSSID Index corresponding to the nontransmitted BSSID.

11. The AP according to claim 1, wherein the circuitry is further configured to provide information of one or more other APs by including one or more Neighbor Report elements or Reduced Neighbor Report (RNR) elements in the frame.

12. The AP according to claim 11, wherein the Multi-link element further indicates a BSSID and an operating channel associated with each link of the plurality of APs that do not correspond to any of the APs included in the Neighbor Report elements or RNR elements.

13. The AP according to claim 11, wherein the Neighbor Report or RNR elements further indicates a MLD MAC address of an AP MLD if a reported AP is affiliated with the AP MLD.

14. The AP according to claim 11, wherein if an AP indicated in the RNR element corresponds to a nontransmitted BSSID, the RNR element further indicates a Transmitted BSSID, a MaxBSSID Indicator and a BSSID Index corresponding to the nontransmitted BSSID.

15. The AP according to claim 1, wherein the circuitry is further configured to provide information of other one or more AP MLDs different than the AP MLD with which the AP is affiliated, by including in the frame a Neighbor MLD Report element carrying information of the other one or more AP MLDs.

16. The AP according to claim 1, wherein the Multi-link element further comprises:

a Type field;

a Common Information field; and

one or more Per-STA Information fields, each Per-STA Information field representing an AP of the plurality of APs, each Per-STA Information field carrying a Link ID and link specific information of the represented AP; each Per-STA Information field further carrying a Transmitting STA field that indicates whether the represented AP associated

with the Per-STA Information field is the AP that transmits the frame carrying the Multi-link element.

17. A non-AP Station (STA) included in a plurality of non-AP STAs affiliated with a non-AP MLD, the non-AP STA comprising:

circuitry, which in operation, generates a Probe Request frame carrying a Multi-link element containing a MLD MAC Address of an AP MLD and one or more Link IDs of links affiliated with the AP MLD; and

a transmitter, which in operation, transmits the Probe Request frame to request information about the AP MLD and the one or more links of the AP MLD, wherein the AP MLD bridges wireless frames between a plurality of APs affiliated with the AP MLD and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.

18. The non-AP STA according to claim 17, wherein the circuitry is further configured to:

generate a frame carrying another Multi-link element with a Type field set to a value indicating Update MAC Address, the another Multi-link element carrying the MLD MAC Address of the non-AP MLD and MAC Addresses of one or more links of the non-AP MLD; and

wherein the transmitter is further configured to transmit the frame to request the AP MLD to update its record of the non-AP MLD with the MAC Addresses of the one or more links.

19. A communication method comprising:

generating a frame at an AP included in a plurality of APs affiliated with an AP MLD, wherein each of the plurality of APs advertises a BSSID and provides a link identified by a Link ID, the frame carrying a multi-link element containing information about the AP MLD and the plurality of APs; and

transmitting the frame on a link, the Multi-link element indicating a Link ID of the link on which the frame is transmitted, wherein the AP MLD bridges wireless frames between the plurality of APs and a network implementing a plurality of virtual networks (VLANs) such that each SSID of a plurality of SSDs is mapped to a corresponding VLAN.