[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] Non-limiting and exemplary embodiments facilitate providing communication apparatuses and communication methods for EHT virtualization for MLD devices.

[0007A] In a first aspect, the present disclosure provides a non Access Point Multi-Link Device (non-AP MLD) to which multiple Access Points (APs) belong, the AP MLD comprising: a receiver, which, in operation, receives a frame that includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD, from the AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD, and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and a controller, which, in operation, determines whether to associate the non-AP MLD with the AP MLD based on the Multi-Link element included in the frame, when the controller determines that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.

[0007B] In a second aspect, the present disclosure provides a communication method for a non Access Point Multi-Link Device (non-AP MLD) to which multiple Access Points (APs) belong, the communication method comprising: receiving a frame that includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD, from an AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD, and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and determining whether or not to associate the non-AP MLD with the AP MLD based on the Multi-Link element included in the frame, when determining that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.

[0007C] In a third aspect, the present disclosure provides an integrated circuit for a non Access Point Multi-Link Device (non-AP MLD) to which multiple access points (APs) belong, the integrated circuit controls: receiving a frame which includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD from the AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD, and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and determining whether to associate the non-AP MLD with the AP MLD based on the Multi-Link element

included in the frame, when determining that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.

[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 embodiments 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 disclosed embodiments will become apparent from the specification and drawings. The benefits and/or advantages may be individually obtained by the various embodiments 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. A non Access Point Multi-Link Device (non-AP MLD) to which multiple Access Points (APs) belong, the AP MLD comprising:

a receiver, which, in operation, receives a frame that includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD, from the AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD, and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and

a controller, which, in operation, determines whether to associate the non-AP MLD with the AP MLD based on the Multi-Link element included in the frame, when the controller determines that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.

2. The non-AP MLD according to claim 1, wherein the Multi-Link element includes a common information field that carries MAC address of the AP MLD and a per-link information field that carries link information of the second virtual AP.

3. The non-AP MLD according to claim 1, wherein the frame is one of a Beacon frame and a Probe Response frame

the first virtual AP that corresponds to a first Basic Service Set Identifier (BSSID) that is a first transmitted BSSID belonging to a first multiple BSSID set for a first channel;

the second virtual AP that corresponds to a second BSSID being either one of a second transmitted BSSID or a second non-transmitted BSSID belonging to a second multiple BSSID set for a second channel, and

the first common SSID is an SSID common to the first BSSID and the second BSSID, and is advertised on the first channel by the first virtual AP.

4. The non-AP MLD according to claim 3, wherein the another AP MLD comprises:

a third virtual AP that corresponds to the first non-transmitted BSSID belonging to the first multiple BSSID set for the first channel; and

a fourth virtual AP that corresponds to another BSSID being either one of the second transmitted BSSID and the second non-transmitted BSSID belonging to the second multiple BSSID set for the second channel,

wherein when the another BSSID is the second transmitted BSSID, the fourth virtual AP advertises a second common SSID for the first non-transmitted BSSID and the second transmitted BSSID over the second channel.

5. The non-AP MLD according to claim 4, wherein the non-transmitted BSSID profile includes another Multi-Link element for the another AP MLD, which is different from the Multi-Link element for the AP MLD.

6. The non-AP MLD according to claim 5, wherein the another Multi-Link element included in the non-transmitted BSSID profile carries information of the third virtual AP and the fourth virtual AP.

7. The non-AP MLD according to claim 3, wherein a plurality of virtual APs corresponding to the first multiple BSSID set operate on the first channel and form a first virtual AP set, and a plurality of virtual APs corresponding to the second multiple BSSID set operate on the second channel and form a second virtual AP set.

8. The non-AP MLD according to claim 2, wherein the per-link information field includes a Link ID subfield and a non-transmitted BSSID information field.

9. A communication method for a non Access Point Multi-Link Device (non-AP MLD) to which multiple Access Points (APs) belong, the communication method comprising:

receiving a frame that includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD, from an AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD, and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and

determining whether or not to associate the non-AP MLD with the AP MLD based on the Multi-Link element included in the frame, when determining that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.

10. The communication method according to claim 9, wherein the Multi-Link element includes a common information field that carries MAC address of the AP

MLD and a per-link information field that carries link information of the second virtual AP.

11. The communication method according to claim 9, wherein the frame is one of a Beacon frame and a Probe Response frame

the first virtual AP that corresponds to a first Basic Service Set Identifier (BSSID) that is a first transmitted BSSID belonging to a first multiple BSSID set for a first channel;

the second virtual AP that corresponds to a second BSSID being either one of a second transmitted BSSID or a second non-transmitted BSSID belonging to a second multiple BSSID set for a second channel, and

the first common SSID is an SSID common to the first BSSID and the second BSSID, and is advertised on the first channel by the first virtual AP.

12. The communication method according to claim 11, wherein the another AP MLD comprises:

a third virtual AP that corresponds to the first non-transmitted BSSID belonging to the first multiple BSSID set for the first channel; and

a fourth virtual AP that corresponds to another BSSID being either one of the second transmitted BSSID and the second non-transmitted BSSID belonging to the second multiple BSSID set for the second channel,

wherein when the another BSSID is the second transmitted BSSID, the fourth virtual AP advertises a second common SSID for the first non-transmitted BSSID and the second transmitted BSSID over the second channel.

13. The communication method according to claim 12, wherein the non-transmitted BSSID profile includes another Multi-Link element for the another AP MLD, which is different from the Multi-Link element for the AP MLD.

14. The communication method according to claim 13, wherein the another Multi-Link element included in the non-transmitted BSSID profile carries information of the third virtual AP and the fourth virtual AP.

15. The communication method according to claim 11, wherein a plurality of virtual APs corresponding to the first multiple BSSID set operate on the first channel and form a first virtual AP set, and a plurality of virtual APs corresponding to the second multiple BSSID set operate on the second channel and form a second virtual AP set.

16. The communication method according to claim 10, wherein the per-link information field includes a Link ID subfield and a non-transmitted BSSID information field.

17. An integrated circuit for a non Access Point Multi-Link Device (non-AP MLD) to which multiple access points (APs) belong, the integrated circuit controls:

receiving a frame which includes a Service Set Identifier (SSID) field indicating a first common SSID, a Multi-Link element for an Access Point Multi-Link Device (AP MLD), and a Multiple Basic Service Set Identifier (BSSID) element for another AP MLD from the AP MLD which includes a first virtual AP and a second virtual AP, wherein the Multi-Link element includes a MAC address of the AP MLD,

and the Multiple BSSID element includes a non-transmitting BSSID profile of a first non-transmitting BSSID belonging to a first multiple BSSID set for a first channel; and

determining whether to associate the non-AP MLD with the AP MLD based on the Multi-Link element included in the frame, when determining that the non-AP MLD is participating in the first common SSID indicated by the SSID field included in the received frame.