IEEE P802.11
Wireless LANs

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| 11be Spec text for ML Element |
| Date: 2020-08-20 |
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Abstract

We propose the draft specification skeleton for MLD to help the creation of TGbe draft D0.1.

Revisions:

* Rev 0: Initial version of the document.

The texts is prepared for the following motions.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MAC | MLO-Discovery: ML element structure/general | Abhishek Patil | Laurent Cariou, Ming Gan, Liwen Chu, Jarkko Kneckt, Namyeong Kim, Cheng Chen, Rojan Chitrakar, Xiaofei Wang, James Yee, Yonggang Fang, Liuming Lu, Payam Torab | R1 | Motion 115, #SP98Motion 115, #SP99Motion 115, #SP91Motion 115, #SP92Motion 115, #SP93 (pending for reconfirmation with Laurent)Motion 119, #SP124 |

802.11be agrees to include a Control field in Multi-Link element to indicate the presence of certain fields.

[Motion 119, #SP124, [3] and [98]]

802.11be defines mechanism(s) to include MLO information that a STA of an MLD provides in its mgmt. frames, during discovery and ML setup, as described below:

* MLD (common) Information
	+ Information common to all the STAs of the MLD.
* Per-link information
	+ Capabilities and Operational parameter of other STAs of the MLD other than the advertising STA.

[Motion 115, #SP91, [10] and [93]]

802.11be supports that the MLO framework should follow an inheritance model when advertising complete information of other link(s):

* Note: inheritance mechanism is similar to that defined in 802.11ax for multiple BSSID feature.

[Motion 115, #SP92, [10] and [93]]

802.11be agrees to define a new Multi-Link element (MLE) to report/describe multiple STAs of an MLD with at least the following characteristics:

* MLD-level information may be included
* A STA profile subelement is included for each reported STA (if any) and is made of a variable number of elements describing this STA

Note: a control field for the element is not considered as MLD-level information.

Note: Name can be changed.

[Motion 115, #SP98, [10] and [97]]

802.11be supports that, for the ML element, an inheritance model is defined to prevent frame bloating when advertising complete information of other links.

* Define the inheritance mechanism, similar to 802.11ax, so that the value of an element of a reported STA that is not present in a STA profile of a ML element in a frame sent by a reporting STA is the same as the element of the reporting STA, present elsewhere in the frame.
* Define the inheritance mechanism, similar to 802.11ax, so that the value of an element of a reported STA that is not present in a STA profile of a ML element, if any, included in a non-transmitted BSSID profile of a non-transmitted BSSID in a multiple BSSID element in a frame sent by a reporting STA is the same as the element of the non-transmitted BSSID, present elsewhere in the frame or as the element of the reporting STA, present elsewhere in the frame.
* Note: an “element of a STA” refers in the text above to the instance of the element describing the capabilities/operation/functionalities of that STA, in a frame where multiple instances of the element can be found for other STAs.
* Note: some elements may not be inherited, signaling TBD.

[Motion 115, #SP99, [10] and [97]]

**Proposed spec text:**

The baseline for this text is 802.11 REVmd draft 3.4.

* Beacon frame format

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|  |  |
| --- | --- |
|

|  |
| --- |
| * Table 9-34 – Beacon frame body
 |

 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is optionally present if the reporting AP is affiliated with an AP MLD and dot11MultiLinkActivated is true. |

* Association Request frame format

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| * Table – 9-36 – Association Request frame body
 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is present if the reporting STA is affiliated with a non-AP MLD and dot11MultiLinkActivated is true. |

* Association Response frame format

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| * Table 9-37— Association Response frame body
 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is present if the reporting AP is affiliated with an AP MLD and dot11MultiLinkActivated is true. |

* Reassociation Request frame format

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|  |
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| * Table 9-38 – Reassociation Request frame body
 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is present if the reporting STA is affiliated with a non-AP MLD and dot11MultiLinkActivated is true. |

* Reassociation Response frame format

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|  |
| --- |
| * Reassociation Response frame body
 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is present if the reporting AP is affiliated with an AP MLD and dot11MultiLinkActivated is true. |

* Probe Request frame format

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|  |
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| * Table 9-40 – Probe Request frame body
 |
| Order | Information | Notes |
| <ANA> | Multi-Link | The Multi-Link element is optionally present if the reporting STA is affiliated with a non-AP MLD and dot11MultiLinkActivated is true. |

* Probe Response frame format

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|  |
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| * Table 9-41 – Probe Response frame body
 |
| Order | **Information** | **Notes** |
| <ANA> | Multi-Link | The Multi-Link element is optionally present if the reporting AP is affiliated with an AP MLD and dot11MultiLinkActivated is true. |

* Elements
* General

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|  |
| --- |
| * Element IDs
 |
| Element | Element ID | Element ID Extension | Extensible | Fragmentable |
| Multi-Link (see 9.4.2.x (Multi-Link element)) | <ANA> | <ANA> | Yes | Yes |

***TGbe editor: Please add a subclause in 9.4.2 as follows***

9.4.2.x Multi-Link element

The format of the Multi-Link element is defined in Figure 9-xxx1 (Multi-Link element format). The frames carrying this element and usage of this element is described in 33.x.y.z (Container for Multi-Link Information).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Multi-Link Control | MLD MAC Address | STR Capability  | Reporting AP Link ID | TBD | TBD | Optional Subelements |
| Octets: | 1 | 1 | 1 | 2 | 0 or 6 | 0 or TBD | 0 or 1 | TBD | TBD | variable |
|  | Figure 9-xxx1 – Multi-Link element format |

The Element ID, Length and Element ID Extension fields are defined in 9.4.2.1 (General).

The format of the Multi-Link Control field is defined in Figure 9-xxx2 (Multi-Link Control field format).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 – B2 | B3 | B4 | B5 | TBD | TBD | TBD |
|  | Number Of Link Supported | MLD MAC Address Present | STR Capability Present  | Reporting AP Link ID Present | TBD | TBD | TBD |
| Bits: | 3 | 1 | 1 | 1 | TBD | TBD | TBD |
|  | Figure 9-xxx2 – Multi-Link Control field format |

The Number Of Link Supported subfield carries the number of links supported by the MLD whose STA transmitted the frame carrying the element.

The MLD MAC Address Present subfield is set to 1 if the MLD MAC Address field is carried in the element. Otherwise the subfield is set to 0.

The STR Capability Present subfield is set to 1 if the STR Capability field is carried in the element. Otherwise the subfield is set to 0.

The Reporting AP Link ID Present subfield is set to 1 if the Tx Link ID Present field is carried in the element. Otherwise the subfield is set to 0. A STA of a non-AP MLD sets the subfield to 0. AP of AP MLD sets the subfield to 1 when the element is carried in ML Probe Response frame or (Re-)Association Response frame.

Other subfields are TBD

The MLD MAC Address field carries the MAC Address of the MLD.

The STR Capabilty field carries the STR capabilities of the MLD whose STA transmitted the frame carrying the element. The STR capability is with respect to a pair of links supported by the MLD. The format and size of the STR Capability field is TBD.

The Reporting AP Link ID field has the same format as Link Information field as defined in Figure 9-388b (Link Information field format when carried in Multi-Link element transmitted by an AP of an AP MLD) and carries the Link ID value for the reporting AP’s link.

Other fields are TBD

The Optional Subelements field contains zero or more subelements. The subelement format and ordering of subelements are defined in 9.4.3 (Subelements).

The Subelement ID field values for the defined subelements are shown in Table 9-xxx (Optional subelement IDs for Multi-Link).

|  |
| --- |
| Table 9-xxx – Optional subelement IDs for Multi-Link |
| Subelement ID | Name | Extensible |
| 0 | Per-STA Profile | No |
| 1–255 | Reserved |  |
| 221 | Vendor Specific | Vendor defined |
| 222–255 | Reserved |  |

When carried in a ML Probe Response frame or (Re-)Association Response frame, the Per-STA Profile subelement contains a list of elements for one or more reported APs of the AP MLD and is defined as follows:

* For each reported AP of the AP MLD, the Link Identifier element is the first element included, followed by a variable number of elements, in the order defined in Table 9-34 (Beacon frame body)
* Any element specific to the reported AP or with content that is different from the reporting AP.
* When included in the Per-STA Profile subelement for the reported AP, the Non-Inheritance element appears as the last element in the profile and carries a list of elements that are not inherited by the reported AP from the reporting AP.

NOTE – When the Multi-Link element is carried in the Nontransmitted BSSID Profile subelement in a Multiple BSSID element, the reporting AP is the AP corresponding to that nontransmitted BSSID.

When carried in a (Re-)Association Request frame, the Per-STA Profile subelement contains a list of elements for one or more STAs of the non-AP MLD and is defined as follows:

* For each reported STA of the non-AP MLD, the Link Identifier element is the first element included, followed by a variable number of elements that provide capability information of the STA in the order defined in Table 9-36 (Association Request frame body).
* Any capability element specific to the reported non-AP STA or with content that is different from the reporting non-AP STA.
* When included in the Per-STA Profile subelement for the reported non-AP STA, the Non-Inheritance element appears as the last element in the profile and carries a list of elements that are not inherited by the reported non-AP STA from the reporting non-AP STA.

The Vendor Specific subelements have the same format as their corresponding elements (see 9.4.2.25 (Vendor Specific element)). Zero or more Vendor Specific subelements are included in the list of optional subelements.

33. Extreme High Throughput (EHT) MAC specification

**33.x Multi-link operation**

**33.x.y Multi-Link Discovery and ML Setup Procedure**

***TGbe editor: Add new a subclause 33.x.y.z (Container for Multi-Link Information ) under clause 33 as follows:***

**33.x.y.z** **Container for Multi-Link Information**

**33.x.y.z.1 General**

A STA of an MLD advertises multi-link capabilities by including Multi-Link element in certain Management frames that it transmits. The element provides capabilities of the transmitting STA’s MLD and may provide information of other link that it operates on or is capable of operating on.

AP of an AP MLD may include Multi-Link element in the Beacon frames and non-ML Probe Response frames that it transmits to provide MLD-level multi-link information. For example when the AP supports SAE authentication (see 33.x.p.q (Multi-Link Authentication)). In order to prevent frame bloating, the Multi-Link element if carried in the Beacon frame or non-ML Probe Response frame should not contain Per-STA Profile subelement(s).

AP of an AP MLD shall include Multi-Link element in the ML Probe Response frame and (Re-)Association Response frame that it transmits. The AP shall carry the Per-STA Profile subelement(s) in Multi-Link element carried in these frames to provide information of other AP(s) affiliated with the MLD.

A non-AP STA of a non-AP MLD may include Multi-Link element in the non-ML Probe Request frames that it transmits to provide MLD-level multi-link information. In order to prevent frame bloating, the Multi-Link element if carried in the non-ML Probe Request frame should not contain Per-STA Profile subelement(s).

An example of Multi-Link element containing one or more Per-STA Profile subelements is shown in Figure 33-xxx



Figure 33-xxx – Illustration of Multi-Link element carrying Per-STA Profile subelements

***TGbe editor: doc 11-20/1288 provide the Visio files for the above Figure 33-xxx***

In order to prevent duplication of information, an AP of an AP MLD shall not include Reduced Neighbor Report element or Multiple BSSID element or another Multi-Link element in Per-STA Profile subelement for a reported AP.

The Multi-Link element may be fragmented and the content may be carried across one or more Fragment element (see 9.4.2.188 (Fragment element) if the reporting AP or non-AP STA is unable to fit the contents in a single element. Also see 10.28.11 (Element fragmentation).

**33.x.y.z.2 Inheritance**

When a per-STA profile is present in a Multi-Link element carried in a Probe Response frame or a Beacon frame or an (Re-)Association Response frame, the reporting AP shall include all elements that are specific to the reported AP. An element is considered to be specific to a reported AP if its value is different from the corresponding element advertised by the reporting AP or if the reported AP satisfies the condition as specified in the Table 9-34 (Beacon frame body) for that element to be present while the reporting AP does not satisfy the corresponding condition. If any of the elements carried in the Probe Response frame, Beacon frame or (Re-)Association Response frame of the reporting AP are not present in a per-STA profile, the values to use for the reported AP are the values of the corresponding element of the reporting AP unless the element is listed in the Non-Inheritance element (if included) in the per-STA profile for that AP.

When Multi-Link element is carried in the Nontransmitted BSSID Profile subelement in a Multiple BSSID element, the reporting AP is the AP corresponding to that nontransmitting BSSID and the elements inheritance (or not inherited) are with respect to the AP corresponding to nontransmitting BSSID. The Reporting AP Link ID field carries the Link ID for the AP corresponding to the nontransmitted BSSID.

When a per-STA profile is present in a Multi-Link element carried in a (Re-)Association Request frame, the reporting non-AP STA shall include all elements that are specific to the reported STA. An element is considered to be specific to a reported STA if its value is different from the corresponding element advertised by the reporting STA or if the reported STA satisfies the condition as specified in the Table 9-36 (Assocation Request frame body) for that element to be present while the reporting STA does not satisfy the corresponding condition. If any of the elements carried in the (Re-)Association Request frame of the reporting STA are not present in a per-STA profile, the values to use for the reported STA are the values of the corresponding element of the reporting STA unless the element is listed in the Non-Inheritance element (if included) in the per-STA profile for that STA.

* Link Identifier element

***TGbe editor: Please make changes to the first paragraph in this subclause as follows***

The Link Identifier element identifies a link.

The element format is defined in Figure 9-388 (Link Identifier element format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | Element ID | Length | Link Information |
| Octets: | 1 | 1 | variable |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| * Link Identifier element format
 |

The Element ID and Length fields are defined in 9.4.2.1 (General).

When included in a TDLS Payload (see 11.21.2 and 9.6.12) or TDLS Discovery Response frame (9.6.7.16), the Link Identifier element contains information that identifies a TDLS direct link and the format of the Link Information field is defined in Figure 9-388a (Link Information field format when carried in a TDLS setup frame)

|  |  |  |  |
| --- | --- | --- | --- |
|  | BSSID | TDLS Initiator STA Address | TDLS responder STA Address |
| Octets: | 6 | 6 | 6 |
| Figure 9-388a – Link Information field format when carried in a TDLS setup frame |

The BSSID subfield is set to the BSSID of the BSS to which the TDLS initiator STA is associated.

The TDLS initiator STA Address subfield is set to the TDLS initiator STA’s MAC address.

The TDLS responder STA Address subfield is set to the TDLS responder STA’s MAC address.

When carried as the first element in the Per-STA Profile subelement of Multi-Link element transmitted by an AP of an AP MLD, it identifies a link (i.e., another AP) of the AP MLD and the format of the Link Information field is defined in Figure 9-388b (Link Information field format when carried in a Multi-Link element transmitted by an AP of an AP MLD).

|  |  |  |
| --- | --- | --- |
|  | B0 – B3 | B4 – B7 |
|  | Link ID | Reserved |
| Bits: | 4 | 4 |
| Figure 9-388b – Link Information field format when carried in Multi-Link element transmitted by an AP of an AP MLD |

The Link ID subfield carries a value that uniquely identifies an AP of an AP MLD.

When carried as the first element in the Per-STA Profile subelement of Multi-Link element in an (Re-)Association Request frame, it identifies another STA of the non-AP MLD and the format of the Link Information field is defined in Figure 9-388c (Link Information field format when carried in a Multi-Link element transmitted by a STA of a non-AP MLD).

|  |  |
| --- | --- |
|  | MAC Address |
| Octets: | 6 |
| Figure 9-388c – Link Information field format when carried in Multi-Link element transmitted by a STA of a non-AP MLD |

The MAC Address subfield carries the MAC Address that uniquely identifies a STA of a non-AP MLD.

* **Non-Inheritance element**

***TGbe editor: Please make changes to the first paragraph in this subclause as follows***

The Non-Inheritance element can be present as the last element in the Nontransmitted BSSID Profile subelement of a Multiple BSSID element or as the last element in the Per-STA Profile subelement of a Multi-Link element.

The Non-Inheritance element when present in the Nontransmitted BSSID Profile subelement of a Multiple BSSID element identifies one or more elements that are not inherited by the BSS corresponding to the nontransmitted BSSID profile that carried it. The identified elements are present in the Management frame of the transmitted BSSID that carried the Multiple BSSID element.

The Non-Inheritance element when present in the Per-STA Profile subelement of a Multi-link element identifies one or more elements that are not inherited by the AP reported in the per-STA profile that carried it. The identified elements are present in the Management frame of the reporting AP that carried the Multi-Link element.