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 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 shall define mechanism(s) for an AP of an AP MLD to advertise complete or partial information of other links:

* Partial information to prevent frame bloating.
* For example, frames exchanged during ML setup are expected to carry complete information while Beacon frame is expected to carry partial information.
* The exact set of elements/fields that constitute partial information is TBD.

[Motion 115, #SP93, [14] and [115]]

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 4.0.

* Beacon frame format

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|  |  |
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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. Otherwise it is not present. |

* 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. Otherwise it is not present. |

* 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. Otherwise it is not present. |

* Reassociation Request frame format

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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. Otherwise it is not present. |

* 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. Otherwise it is not present. |

* Probe Request frame format

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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. Otherwise it is not present. |

* Probe Response frame format

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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. Otherwise it is not present. |

* 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 | TBD | Optional Subelements |
| Octets: | 1 | 1 | 1 | 2 | 0 or 6 | 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 | TBD |
|  | Number of Supported links | MLD MAC Address Present | TBD |
| Bits: | 3 | 1 | 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 present in the element. Otherwise the subfield is set to 0. The condition when MLD MAC Address is carried in this element are defined in clause 33.a.b.c (Usage and Rules of Multi-Link element in the context of multi-link setup).

Other subfields are TBD

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

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 | Yes |
| 2–220 | Reserved |  |
| 221 | Vendor Specific | Vendor defined |
| 222–255 | Reserved |  |

Each Per-STA Profile subelement carries a set of elements for a reported STA. The Link Identifier element is the first element in a Per-STA Profile subelement followed by variable number of elements as defined in 33.x.y.z (Container for Multi-Link Information).

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 and information of other STA of its affiliated MLD by including a Multi-Link element in certain Management frames that it transmits.

The AP of an AP MLD may include a 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, the MLD MAC address shall be carried in the Multi-Link element. 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).

The AP of an AP MLD shall include a Multi-Link element in the ML Probe Response frame and (Re-)Association Response frame that it transmits and the element shall contain the Per-STA Profile subelement(s) to provide capabilities and operational parameters of the other AP(s) affiliated with that AP MLD.

Whether a STA of a non-AP MLD includes Multi-Link element in a non-ML Probe Request frame is TBD.

A STA of a non-AP MLD shall include a Multi-Link element in the ML Probe Request frames that it transmits to provide MLD-level multi-link information. It is TBD whether an ML Probe Request frame includes Per-STA Profile subelements in the Multi-Link element.

The STA of a non-AP MLD shall include a Multi-Link element in the (Re-)Association Request frame that it transmits and the element shall contain the Per-STA Profile subelement(s) to provide capability information of the other STA(s) affiliated with that non-AP MLD.

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

**33.x.y.z.2 Complete or partial per-STA profile**

A Per-STA Profile when carried in the Multi-Link element may provide complete or partial information of the reported STA. The Link Identifier element shall be the first element carried in each Per-STA Profile subelement. The Complete Profile subfield of the Link Information field of the Link Identifier element shall be set to 1 when the STA profile is complete. Otherwise it shall be set to 0

An AP of an AP MLD may include complete or partial profile of another AP of its MLD in its ML Probe Response frame based on the soliciting ML Probe Request frame. When the soliciting ML Probe Request frame has not requested information of a specific AP of the AP MLD, the responding AP shall include information of all the other APs of the AP MLD. When the soliciting ML Probe Request frame has not requested specific information of a particular AP of the AP MLD, the responding AP shall provide complete information (i.e., complete profile of that AP).

An AP of an AP MLD shall include complete profile of another AP of its MLD in its (Re-)Association Response frame.

A STA of a non-AP MLD shall include complete profile of another STA of its MLD in its (Re-)Association Request frame.

It is TBD whether the Per-STA Profile subelement is carried in Beacon, (non-ML or ML) Probe Request frame and TBD whether the profile (when present) is complete or partial.

**33.x.y.z.3 Inheritance in a per-STA profile**

STAs of an MLD are expected to have similar capabilities and operational parameters on different links. Therefore, some of the elements that could be carried in the per-STA profile for a reported STA would have the same value as the reporting STA. In order to reduce frame bloating, when a per-STA profile carries complete information for a reported STA, it would inherit the elements from the reporting 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 9-34 (Beacon frame body) if the reporting STA is an AP or Table 9-36 (Association Request frame body) if the reporting STA is a non-AP for that element to be present while the reporting STA does not satisfy the corresponding condition. If any of the elements carried in the 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.

When carried in a ML Probe Response frame or (Re-)Association Response frame, each Per-STA Profile subelement in a Multi-Link element that is a complete profile shall contain a list of elements 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 that provide the capabilities and operation parameters of the reported AP, in the order defined in Table 9-34 (Beacon frame body)
* TBD elements in fixed order
* Any element specific to the reported AP or with content that is not inherited 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.

When carried in a (Re-)Association Request frame, each Per-STA Profile subelement in a Multi-Link element shall contains a list of elements 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 reported STA in the order defined in Table 9-36 (Association Request frame body).
* TBD elements in fixed order
* Any element specific to the reported non-AP STA or with content that is not inherited 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.

An example of a Multi-Link element containing a complete per-STA profile is shown in Figure 33-xxx



Figure 33-xxx – Illustration of Multi-Link element carrying a complete per-STA profile

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

An AP corresponding to the transmitted BSSID may include Multi-Link element in the Nontransmitted BSSID Profile subelement of a Multiple BSSID element when the corresponding nontransmitted BSSID that is affiliated with an AP MLD. See 33.3.14 (Multi-BSSID) for inheritance rules when the Multi-Link element is carried in a Multiple BSSID element.

**33.3.14 Multi-BSSID**

***TGbe editor: Please add the following paragraph to this subclause as shown***

When Multi-Link element is carried in a Nontransmitted BSSID Profile subelement in a Multiple BSSID element, the value of an element, that is not present in the Per-STA Profile subelement of the Multi-Link element for a reported AP, shall be the same as the corresponding element value as that of the nontransmitted BSSID profile that carried the Multi-Link element or as the element of the transmitted BSSID, present elsewhere in the frame, which is inherited by the nontransmitted BSSID. The hierarchy of inheritance is from transmitted BSSID to the nontransmitted BSSID that carried the Multi-Link element and from the nontransmitted BSSID to the AP reported in the per-STA profile.

* Link Identifier element

***TGbe editor: Please make modification to this subclause as shown***

The Link Identifier element identifies a link.

The Link Identifier 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. The format of the Link Information field is defined in Figure 9-388a (Link Information field format when carried in a TDLS setup frame) when included 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 included 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 the Link Identifier element is included in the Per-STA Profile subelement of Multi-Link element, it identifies a link. The format of the Link Information field is defined in Figure 9-388b (Link Information field format when carried in a Multi-Link element) when carried in a Multi-Link element.

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 – B3 | B4 | B5-B7 |
|  | Link ID | Complete Profile | Reserved |
| Bits: | 4 | 1 | 3 |
| Figure 9-388b – Link Information field format when included in a Multi-Link element |

The Link ID subfield specifies a value that uniquely identifies the link of the transmitting STA’s MLD where the reported STA is operating on.

The Complete Profile subfield is set to 1 when the Per-STA Profile subelement of the Multi-Link element carried all elements that would be provided if the reported STA were to transmit the frame that carried the Multi-link element. Otherwise the subfield is set to 0. Also see 33.x.y.z (Container for Multi-Link Information).

* **Non-Inheritance element**

***TGbe editor: Please add new paragraphs before and after 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.