IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Comment resolution for ML Reconfiguration (light version)** | | | | |
| **Date: 2021-06-18** | | | | |
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Abstract

Proposed draft text for multi-link (ML) reconfiguration, broadly referring to a set of post-association procedures to make changes to links between APs and non-AP STAs affiliated with two MLDs, and without disassociation.

The submission proposes text changes based on 2 CIDs from Comment Collection (CC) 34: 1857, 2513. All proposed changes are based on Draft 1.0.

# Revision History

|  |  |  |
| --- | --- | --- |
| **Date** | **Revision** | **Changes** |
| 2021-04-16 | 0 | Initial draft |
| 2021-04-30 | 1 | Note about co-hosted BSSs and non-transmitted BSSIDs when adding APs |
| 2021-05-16 | 2 | Minor edits, terminology |
| 2021-05-29 | 3 | AP removal announcement through the Reconfiguration variant of ML element  ML Configuration Request/Response/Notify frames renamed to ML Reconfiguration |
| 2021-06-16 | 4 | Minor bug fixes, inheritance rules for complete profile |
| 2021-06-18 | 5 | Limiting to AP add/remove procedures, using the Reconfiguration variant of ML element. |

# Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Proposed Resolution** |
| 1857 | 125.59 | 35.3.1 | The AP MLD Multi Link Operation (MLO) should specify how AP MLD adds new affiliated AP(s) or removes affiliated AP(s). AP MLD may need to add or delete the affiliated AP in order to optimize network performance or to minimize its power consumption in order to be nature friendly. | Please describe how AP MLD may add new affiliated APs and/or remove affiliated APs. | Agree in principle with the comment.  Resolution: Revised, please implement the changes as shown in doc.:IEEE 802.11-21/0534r5 and identified with the CID 1857. |
| 2513 | 132.23 | 35.3.5.3 | There are cases when an AP of an AP MLD will need to shutdown. In such scenarios other links affiliated with the MLDs should not be affected. | Add a single link tear down procedure. | Agree in principle with the comment.  Resolution: Revised, please implement the changes as shown in doc.:IEEE 802.11-21/0534r5 and identified with the CID 2513. |

**Discussion on CIDs 1857 and 2513:**

The comments ask to clarify how AP MLD may add a new affiliated AP or delete an affiliated AP. Currently, 802.11be does not specify this operation, which may lead to interoperability issues in the 802.11be deployments.

An AP MLD may need to adjust the number of available affiliated APs based on traffic load, interference and the number of associated STAs. All devices should be environmentally friendly, so it is important to minimize and optimize AP MLD power consumption. Detailed description of the AP MLD configuration use cases is described in the submission 20/810r1.

802.11be should specify how an AP MLD adds a new affiliated AP. Similarly, 802.11be should specify how an associated non-AP MLDs sets up a link with a new affiliated AP in order to exchange data with the new affiliated AP, but this is left to future contributions.

The baseline 802.11 allows an AP to signal that it will terminate/stop operating by sending a BSS Transition Management Request frame with BSS Termination Included field set to 1 to all associated STAs. The current 802.11 description forces the AP to disassociate all STAs before the BSS is terminated.

The disassociation of the non-AP MLD terminates data transmission in all links of the non-AP MLD. This is not desired in ML setup, because non-AP MLD may have links with other affiliated APs and data transmission with these APs may continue without interrupts. 802.11be should clarify when the disassociation of the non-AP MLD is needed and how non-AP MLD operates if one of the APs to which it has a link is deleted.

CID 2513 requests to clarify signaling to delete a link. It is not clear whether the comment refers to a single “AP-side” link (what is identified by a Link ID), or to one of the links in an ML configurtaion between an AP MLD and a non-AP MLD (called client-side, for reference). We interpret the comment as as the AP-side link and propose a procedure. In our view client-side link deletion is also a useful mechanism, but this is left to future contributions.

### **9.4.2.295b Multi-Link element** [#1857], [#2513]

### 9.4.2.295b.1 General

TGbe editor: Add a new row to Table 9-322am (Type subfield encoding) in numerical order, and update the Reserved row:

Table 9-322am—Type subfield encoding

|  |  |
| --- | --- |
| **Type subfield value** | **Multi-Link element variant name** |
|  |
| 0 | Basic |  |
| 1 | Probe Request |  |
| 2 | Reconfiguration |  |
| 3-7 | Reserved |  |

TGbe editor: Modify the paragraph at P128L19 as follows:

The Presence Bitmap subfield is used to indicate the presence of various subfields in the Common Info field as described in 9.4.2.295b.2 (Basic variant Multi-Link element), 9.4.2.295b.3 (Probe Request variant Multi-Link element), and 9.4.2.295b.4 (Reconfiguration variant Multi-Link element)).

TGbe editor: Modify the paragraph at P128L24 as follows:

The Common Info field carries information that are common to all the links except for Link ID Info subfield and BSS Parameters Change Count subfield that are for the link on which Multi-Link element is sent and is optionally present based on the value of the Type subfield (see 9.4.2.295b.2 (Basic variant Multi-Link element), 9.4.2.295b.3 (Probe Request variant Multi-Link element), and 9.4.2.295b.4 (Reconfiguration variant Multi-Link element)).

TGbe editor: Modify the paragraph at P128L35 as follows:

The Link Info field carries information specific to the links and is optionally present based on the value of the Type subfield (see 9.4.2.295b.2 (Basic variant Multi-Link element), 9.4.2.295b.3 (Probe Request variant Multi-Link element) and 9.4.2.295b.4 (Reconfiguration variant Multi-Link element)).

TGbe editor: Add the following new sub-clause:

### 9.4.2.295b.4 Reconfiguration variant Multi-Link element [#1857], [#2513]

The Reconfiguration variant Multi-Link element is used to announce an ML reconfiguration operation (see 35.3.6 (Multi-link reconfiguration)).

The format of the Presence Bitmap subfield of the Reconfiguration variant Multi-Link element is defined in Figure 9-322n0 (Presence Bitmap subfield of the Reconfiguration variant Multi-Link element format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 | B1 | B2 B11 |
|  | EML  Capabilities  Present | MLD  Capabilities  Present | Reserved |
| Bits: | 1 | 1 | 10 |

Figure 9-322n0—Presence Bitmap subfield of the Reconfiguration variant Multi-Link element format

The EML Capabilities Present subfield is set to 1 if the EML Capabilities field is present in the Common Info field. Otherwise, the EML Capabilities Present subfield is set to 0.

The MLD Capabilities Present subfield is set to 1 if the MLD Capabilities subfield is present in the Common Info field. Otherwise, the MLD Capabilities Present subfield is set to 0.

The format of the Common Info subfield of the Reconfiguration variant Multi-Link element is defined in Figure 9-322n1 (Common Info field of the Reconfiguration variant Multi-Link element format).

|  |  |  |
| --- | --- | --- |
|  | EML  Capabilities | MLD  Capabilities |
| Octets: | 0 or 2 | 0 or 2 |

Figure 9-322n1—Common Info field of the Reconfiguration variant Multi-Link element format

The EML Capabilities subfield has the same definition as the EML Capabilities subfield of the Common Info field of the Basic variant Multi-Link element (see 9.4.2.295b.2 and Figure 9-788el—EML Capabilities subfield format).

The MLD Capabilities subfield has the same definition as the MLD Capabilities subfield of the Common Info field of the Basic variant Multi-Link element (see 9.4.2.295b.2 and Figure 9-788em—MLD Capabilities subfield format).

The Link Info field contains one 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 9-322an1 (Optional subelement IDs for the Reconfiguration variant Multi-Link element).

Table 9-322an1— Optional subelement IDs for the Reconfiguration variant Multi-Link element

|  |  |  |
| --- | --- | --- |
| **Subelement ID** | **Name** | **Extensible** |
| 0 | Per-STA Profile | Yes |
| 1-220 | Reserved |  |
| 221 | Vendor Specific | Vendor defined |
| 222-255 | Reserved |  |

One or more Per-STA Profile subelements are included in the list of subelements.

Each Per-STA Profile subelement starts with a STA Control field, followed by a variable number of fields and elements, as defined in 35.3.6 (Multi-link reconfiguration).

The format of a Per-STA Profile subelement is defined in Figure 9-788ez2 (Per-STA Profile subelement format for the Reconfiguration variant Multi-Link element).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Subelement  ID | Length | STA Control | STA Info | STA Profile |
| Octets: | 1 | 1 | 2 or 4 | variable | variable |

Figure 9-788ez2—Per-STA Profile subelement format for the Reconfiguration variant Multi-Link element

The format of the STA Control field is defined in Figure 9-788ek2 ([STA Control field format for the Reconfiguration variant Multi-Link element)](#bookmark46).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B3 | B4 | B5 | B6 | B7 | B8 | B9 B15 |  |
|  | Link ID | Complete  Profile | MAC Address Present | NSTR Link Pair Present | NSTR Bitmap Size | Delete  Imminent | Reserved | Delete Timer |
| Bits: | 4 | 1 | 1 | 1 | 1 | 1 | 7 | 0 or 16 |

Figure 9-788ek2—STA Control field format for the Reconfiguration variant Multi-Link element

The Link ID subfield specifies a value that uniquely identifies the link that the reported AP is operating on.

The Complete Profile subfield is set to 1 when the Per-STA Profile subelement of the Multi-Link element is complete as defined in 35.3.2.2 (Advertisement of complete or partial per-link information). Otherwise, the subfield is set to 0.

The MAC Address Present subfield indicates the presence of the STA MAC Address subfield in the STA Info field and is set to 1 if the STA MAC Address subfield is present in the STA Info field; otherwise set to 0. An STA sets this subfield to 1 when the element carries complete profile.

The Delete Imminent subfield is set to 1 to indicate that the AP corresponding to the Per-STA Profile subelement will be removed at the time indicated by the Delete Timer subfield, and set to 0 otherwise.

The Delete Timer subfield is present when the Delete Imminent subfield is nonzero, and indicates the number of target beacon transmission times (TBTTs) of the AP corresponding to the Per-STA Profile subelement until the AP is removed; it is not present when the Delete Imminent subfield is zero.

The NSTR Link Pair Present and NSTR Bitmap Size subfields have the same definition as similarly named subfields in the STA Control field of the Per-STA Profile subelement for the Basic Variant Multi-Link element.

If the NSTR Link Pair Present subfield is equal to 1 in the STA Control field, then the Per-STA Profile subelement contains an NSTR Indication Bitmap field whose size is indicated in the NSTR Bitmap Size subfield; otherwise, the NSTR Indication Bitmap field is not pres­ent. The NSTR Bitmap Size subfield in a STA Control field is set to 1 if the length of the corresponding NSTR Indication Bitmap subfield is 2 octets, and is set to 0 if the length of the corresponding NSTR Indica­tion Bitmap subfield is 1 octet. The NSTR Bitmap Size subfield in a STA Control field is reserved if the NSTR Link Pair Present subfield in that field is 0.

Each bit B*j* in the NSTR Indication Bitmap field included in the Per-STA Profile subelement with Link ID subfield equal to *i* (where 0 ≤ *i* ≤ 15) is set to 1 if the link pair corresponding to link IDs equal to I and *j* is NSTR and the Basic variant Multi-Link element contains a Per-STA Profile subelement with link ID *j*; otherwise, it is set to 0. Bit B*i* in the NSTR Indication Bitmap field included in the Per-STA Profile subele­ment with Link ID subfield equal to *i* is reserved.

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.

9.6.35 Protected EHT Action frame details

9.6.35.1 Protected EHT Action field [#1857], [#2513]

TGbe editor: Add the following rows to the end of Table 9-526p and change the reserved range:

|  |  |
| --- | --- |
| Table 9-526p—Protected EHT Action field values | |
| Value | Meaning |
| 6 | ML Reconfiguration Notify |
| 7–255 | Reserved |

TGbe editor: Add the following new subclause:

9.6.35.8 ML Reconfiguration Notify frame format [#1857], [#2513]

The ML Reconfiguration Notify frame is an Action frame of category Protected EHT. The Action field of an ML Reconfiguration Notify frame contains the information shown in Table 9-xxx2 (ML Reconfiguration Notify frame Action field format).

|  |  |
| --- | --- |
| Table 9-xxx2—ML Reconfiguration Notify frame Action field format | |
| Order | Information |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | Dialog Token |
| 4 | Multi-Link |

The Category field is defined in Table 9-51 (Category values).

The Protected EHT Action field is defined in 9.6.36.1 (General).

The Dialog Token field is a nonzero value chosen by the transmitting AP MLD to identify different transmissions of the frame.

The Multi-Link element is defined in 9.4.2.295b (Multi-Link element); the variant of the Multi-Link element used in the frame is the Reconfiguration variant (9.4.2.295b.4 (Reconfiguration variant Multi-Link element)).

TGbe editor: Add the following new clause and renumber other sections under 35.3 accordingly; the requested section number is the section immediately after Multi-link (re)setup (35.3.5 in 11be Draft 1.0), to maintain a logical flow.

35.3.6 Multi-link reconfiguration [#1857], [#2513]

35.3.6.1 General

*Multi-link reconfiguration* (ML reconfiguration, or reconfiguration for short) refers to a set of procedures through which an AP MLD can add APs to, or remove APs from its multi-link operation.

Reconfiguration procedures can use any link that has already been set up between the associated MLDs (i.e., through any affiliated AP that has an affiliated non-AP STA associated with it), as long as the link is enabled.

### 35.3.6.2 Adding or removing affiliated APs

### 35.3.6.2.1 Adding new affiliated APs

An AP MLD may add new affiliated APs anytime during its operation. New affiliated APs may be announced through Basic variant Multi-Link and Reduced Neighbor Report elements in Beacon and Probe Response frames.

NOTE—The MAC address of any new co-hosted AP is assumed to be within the address space defined by the value of the Max Co-Hosted BSSID Indicator field (see 9.4.2.249 (HE Operation element) and 26.17.7 (Co-hosted BSSID set)). Similarly, the MAC address of any new nontransmitted BSSID is assumed to be within the address space defined by the value of the MaxBSSID Indicator (see 9.4.2.45 (Multiple BSSID element) and 11.1.3.8 (Multiple BSSID procedure)).

### 35.3.6.2.1 Removing affiliated APs

An AP MLD may remove one or more of its affiliated APs anytime during its operation. Removal of APs shall be announced through an ML Reconfiguration element (see 9.4.2.295b.4 (Reconfiguration variant Multi-Link element)) in a Beacon frame or an ML Reconfiguration Notify frame (notify frame for short) with the RA field set to the broadcast address.

For each affiliated AP that is about to be removed, the AP MLD shall include a Per-STA Profile subelement with the subfields of the Per-STA Control field set as following: The Link ID subfield shall identify the AP, the Delete Imminent subfield shall be set to 1, and the Delete Timer subfield shall be set to the number of target beacon transmission times (TBTTs) of that AP before it is removed. The initial value of the Delete Timer subfield shall be longer than the MLD max idle period.

If the link corresponding to the removed AP has an NSTR relationship with one or more AP links that are not going to be removed, the AP MLD shall also include Per-STA Profile subelements for those APs to indicate an updated NSTR Bitmap (including possibly no NSTR Bitmap).

If an AP removal needs to be announced while other AP removals are in progress, the notify frame shall include updated values of the Delete Timer subfield for all APs that are about to be removed, and all Per-STA Profile subelements shall contain fields and elements that assume all APs in the notify frame have been removed.

An affiliated AP that is going to be removed shall also follow the procedure in 11.21.7 (BSS transition management for network load balancing) to notify STAs that are not affiliated with any MLD and are associated with that AP of the corresponding BSS termination.

Once an affiliated AP to which a non-AP MLD has a link is removed, from the non-AP MLD perspective the link to the removed AP has been deleted and the non-AP MLD shall not transmit any frames to that AP. The non-AP MLD will operate on the remaining links as specified in 36.3.6.3 (Changes to multi-link operation after reconfiguration).

35.3.6.3 Changes to multi-link operation after reconfiguration

There shall be no changes to the operation of links that are not added or deleted by reconfiguration, e.g., no changes to security keys, power management mode, power state, established TWTs, and the TIDs mapped to those links.

Once a link is deleted, the AP and non-AP STA terminating the link at the time of deletion shall no longer transmit frames to and receive frames from each other on that link, and all operation aspects such as power management mode and established TWTs shall no longer be valid.

A new link added through reconfiguration shall:

* Use the same PMK, PTK, and PN space as the existing links.
* Use a different GTK/IGTK/BIGTK and PN space. The GTK/IGTK/BIGTK of the new link is delivered to the non-AP MLD using the group key handshake defined in 12.7.7 (Group key handshake).

A TID with default mapping (i.e., not mapped to specific link(s)) can be transmitted over any new link that has been successfully added through reconfiguration. To maintain TID operation continuity under reconfiguration, the MLDs should steer TIDs away from affected links before they are deleted, using the TID-to-link mapping procedure defined in 35.3.6.1 (TID-to-link mapping).