IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Comment resolution for ML Reconfiguration (light version)** | | | | |
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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 to resolve CIDs 4569, 6587, 6641 and 6728 from CC36 (and older CIDs 1857 and 2513 from CC34). All proposed changes are based on 802.11be Draft 1.2.

# 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 |
| 2021-06-22 | 6 | Removing NSTR Bitmap, focus on STR APs |
| 2021-06-23 | 7 | Add MLD MAC Address, bring back the Common Info field |
| 2021-10-29 | 8 | Rebased to Draft 1.1, added CIDs 4569, 6587, 6641, 6728; Reconfiguration variant inheritance clarifications, BTM Request and Disassociation usage and clarifications |
| 2021-11-01 | 9 | Reconfiguration Multi-Link element updates; rebased to Draft 1.2 |
| 2021-11-05 | 10 | Clarifications around BTM Request fields and AP removal with/without BSS termination |

# CC34 Comments and discussion [against Draft 0.4, included for history]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **P.L** | **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 Document IEEE 802.11-21/0534r8 and identified with [#1857]. |
| 2513 | 132.23 | 35.3.5.3 | There are cases when an AP of an AP MLD will need to shut down. 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 Document IEEE 802.11-21/0534r8 and identified with [#2513]. |

**Discussion on CIDs 1857 and 2513:**

The comments ask to clarify how AP MLD may add a new affiliated AP or remove an affiliated AP. As of Draft 1.0, these operations are not specified, which may lead to interoperability issues for 802.11be deployments.

An AP MLD may need to adjust the number of available affiliated APs based on traffic load, interference, number of associated STAs, maintenance and other factors. All devices should be environmentally friendly, so it is important to minimize and optimize the 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.

As for an affiliated AP removal, the baseline allows an AP to signal that it will terminate/stop operating by sending a BSS Transition Management (BTM) 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 non-AP MLD disassociation terminates data transmission over all links of the non-AP MLD. A disassociation of the non-AP MLD is not desired when one of the affiliated APs is terminated, because the 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 the non-AP MLD operates if associated AP MLD terminates an affiliated AP.

# CC36 Comments and discussion [against Draft 1.0]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **P.L** | **Clause** | **Comment** | **Proposed Change** | **Proposed Resolution** |
| 4659 | 246.15 | 35.3 | MLO as currently defined has a rather narrow/naive conception of how modern APs behave. To achieve widespread adoption, MLO needs to support and not degrade existing AP functionality. Practically this means supporting seamless link add/delete/change functionality. | Add mandatory and seamless link add/delete/change functionality within MLO. | Agree in principle with the comment. To make progress in the group AP side link add/remove has been implemented. Client side link add/remove is left to future.  Resolution: Revised, please implement the changes as shown in Document IEEE 802.11-21/0534r8 and identified with [#4659]. |
| 6587 | 254.50 | 35.3.5 | AP MLDs should be able to add/remove affiliated APs. | Define procedures to add/remove affiliated APs. | Agree in principle with the comment.  Resolution: Revised, please implement the changes as shown in Document IEEE 802.11-21/0534r8 and identified with [#6587]. |
| 6641 | 256.18 | 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 Document IEEE 802.11-21/0534r8 and identified with [#6641]. |
| 6728 | 256.18 | 35.3.5.3 | There could be instances where either a non-AP MLD or an AP MLD may need to remove (unassociated) one or more setup links without having to perform a multi-link tear down. 11be should allow such link removals. | Provide means for a non-AP MLD or an AP MLD to remove (unassociated) one or more setup links without having to perform a multi-link tear down. | Agree in principle with the comment.  Resolution: Revised, please implement the changes as shown in Document IEEE 802.11-21/0534r8 and identified with [#6728]. |

**Discussion:**

Refer to discussions on CIDs 1857 and 2513 in previous page for the need to indicate adding APs to and removing APs from AP MLDs.

There is also a need to clarify the scope of two management frames – Disassociation, and BSS Transition Management Request – transmitted in the context of terminating the BSS of the to-be-removed affiliated AP, as receiving non-AP MLDs can also interpret them as MLD-level. A Disassociation frame meant to terminate a single BSS should not be interpreted as an MLD-level disassociation operation.

It is proposed to include a Multi-Link element in the MLD-level Disassociation frames. Also, a new bit is proposed to be included in the BSS Transition Management Request frames to clarify the BSS termination scope (link-level or MLD-level).

### 9.3.3.4 Disassociation frame format

TGbe editor: Add a new row to Table 9-33 (Disassociation frame body):

**Table 9-33—Disassociation frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | |
| 1 | Reason code | |
| 2 | Reconfiguration Multi-Link element is optionally present |
| Last-1 | One or more Vendor Specific elements are optionally present. | |
| Last | The MME is present when management frame protection is enabled at the AP and the frame is a group addressed frame. | |
| NOTE—The MME appears after all the fields that it protects. Therefore, it appears last in the frame body to protect the frames as specified in 12.5.4. | | |

### 9.6.13.9 BSS Transition Management Request frame format

TGbe editor: Modify Figure 9-996 as follows:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 | B5 | B6 B7 |
|  | Preferred Candidate List Included | Abridged | Disassociation Imminent | BSS Termination Included | ESS Disassociation Imminent | BSS  Termination  Scope | Reserved |
| Bits**:** | 1 | 1 | 1 | 1 | 1 | 1 | 2 |

Figure 9-996—Request Mode field format

TGbe editor: Add this new bullet paragraph after the bullet paragraph starting with “The ESS Disassociation Imminent (bit 4) field indicates …” :

* The BSS Termination Scope (bit 5) field is reserved when the transmitting AP is not affiliated with an AP MLD or when the BSS Termination Included field is zero, and is ignored by a receiving STA that is not affiliated with a non-AP MLD or when the BSS Termination Included field is zero. The field is set to 1 to limit the scope of the BSS termination to the link on which the request is being transmitted, and is set to 0 otherwise.

### **9.4.2.295b Multi-Link element**

### 9.4.2.295b.1 General [#4659][#6587][#6641][#6728]

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 (see 9.4.2.295b.2 (Basic Multi-Link element)) |
| 1 | Probe Request (see 9.4.2.295b.3 (Probe Request Multi-Link element)) |
| 2 | Reconfiguration (see 9.4.2.295b.4 (Reconfiguration Multi-Link element)) |
| 3-7 | Reserved |

TGbe editor: Add the following new sub-clause:

### 9.4.2.295b.4 Reconfiguration Multi-Link element [#4659][#6587][#6641][#6728]

The Reconfiguration 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 Multi-Link element is defined in Figure 9-788eh0 (Presence Bitmap subfield of the Reconfiguration Multi-Link element format).

|  |  |  |
| --- | --- | --- |
|  | B0 | B1 B11 |
|  | MLD MAC Address Present | Reserved |
| Bits: | 1 | 11 |

Figure 9-788eh0—Presence Bitmap subfield of the Reconfiguration Multi-Link element format

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

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

|  |  |
| --- | --- |
|  | MLD MAC  Address |
| Octets: | 0 or 6 |

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

The MLD MAC Address subfield specifies the MAC Address of the MLD with which the STA transmitting the Reconfiguration Multi-Link element is affiliated.

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 Multi-Link element).

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

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

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

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B3 | B4 | B5 | B6 | B7 B15 |
|  | Link ID | Complete  Profile | MAC Address Present | Delete  Timer Present | Reserved |
| Bits: | 4 | 1 | 1 | 1 | 9 |

Figure 9-788ek2—STA Control field format for the Reconfiguration 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 Timer Present subfield is set to 1 to indicate the presence of the Delete Timer subfield in the STA Info field, and that the AP corresponding to the Per-STA Profile subelement will be removed at the time indicated by the Delete Timer subfield; it is set to 0 otherwise.

The STA Info field consists of zero or more fields whose presence is indicated by the subfields of the STA Control field. The subfields in the STA Info field appear in the same order as their corresponding presence subfield in the STA Control field.

The STA MAC Address subfield of the STA Info field carries the MAC address of the AP that can operate on the link identified by the Link ID subfield and is affiliated with the same MLD as the STA that transmitted the Reconfiguration Multi-Link element. The STA MAC Address subfield has the same format as the STA MAC Address subfield for the Basic Multi-Link element, shown in Figure 9-788ep (STA MAC Address subfield format).

The Delete Timer subfield of the STA Info field indicates the number of target beacon transmission times (TBTTs) of the AP corresponding to the Per-STA Profile subelement until the AP is removed. The format of the Delete Timer subfield is defined in Figure 9-788ek3 (Delete Timer subfield format).

|  |  |
| --- | --- |
|  | Delete Timer |
| Octets: | 2 |

Figure 9-788ek3—Delete Timer subfield

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

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 [#4659][#6587][#6641][#6728]

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 Multi-Link element)).

11.3.6.8 AP, AP MLD, or PCP disassociation initiation procedure

TGbe editor: Modify the indicated paragraph as follows:

1. If the state for the STA or the non-AP MLD is State 3 or State 4, the AP or PCP (with respect to the STA) or AP MLD (with respect to the non-AP MLD) shall generate a Disassociation frame to be transmitted to the indicated STA, or to a non-AP STA affiliated with the non-AP MLD. When removing an AP that is affiliated with an AP MLD (see 35.3.6.2.2 (Removing affiliated APs)), the Disassociation frame shall include a Reconfiguration Multi-Link element. The Reconfiguration Multi-Link element 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 transmitting AP, the Complete Profile subfield shall be set to 0, and the Delete Timer Present subfield shall be set to 0. The Per-STA Profile subelement shall not include a STA Profile field.

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 1.2), to maintain a logical flow.

35.3.6 Multi-link reconfiguration [#4659][#6587][#6641][#6728]

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 one or more affiliated APs to the AP MLD, or remove one or more affiliated APs from the AP MLD.

### 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. New affiliated APs shall be announced through the Basic Multi-Link and Reduced Neighbor Report elements in the 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)).

### 35.3.6.2.2 Removing affiliated APs

An AP MLD may remove one or more of its affiliated APs. An affiliated AP can be removed from an AP MLD either by terminating its BSS or through a reconfiguration operation that does not terminate its BSS.

NOTE—An affiliated AP that is removed from an AP MLD without terminating its BSS can still communicate with associated STAs that are not affiliated with any MLD.

When removing an affiliated AP by terminating the BSS the affiliated AP belongs to (see 6.3.12 (Stop)), the SME of the affiliated AP shall follow the procedure in 11.21.7.3 (BSS transition management request) to notify all associated STAs (affiliated with an MLD or otherwise) that support BTM of the BSS termination, with the BSS Transition Management Request frame fields set as follows:

* The Disassociation Imminent, BSS Termination Included, and BSS Termination Scope subfields of the Request Mode field are set to 1; other subfields of the Request Mode field are reserved.
* The Disassociation Timer field is set to the number of target beacon transmission times (TBTTs) of the affiliated AP before it transmits a Disassociation frame to the STA(s) receiving the BSS Transition Management Request frame.
* The BSS Termination Duration field shall be present and contain a BSS Termination Duration subelement (see 9.4.2.36 (Neighbor Report element)), with the BSS Termination TSF field of the subelement set to the value of the TSF timer when the BSS the affiliated AP belongs to will be terminated.

When removing an affiliated AP without terminating the BSS the affiliated AP belongs to, the AP MLD shall announce removal of the affiliated AP through a Reconfiguration Multi-Link element (see 9.4.2.295b.4 (Reconfiguration Multi-Link element)) transmitted in (i) all Beacon frames of all its affiliated APs, as well as all Probe Response frames it transmits, until all affiliated APs marked for removal have been removed, or (ii) at least one ML Reconfiguration Notify frame to each associated non-AP MLD such that for any affiliated AP that is to be removed, every associated non-AP MLD is notified of the affiliated AP removal before the affiliated AP is removed. For each affiliated AP that the AP MLD intends to remove, the Reconfiguration Multi-Link element 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 Complete Profile subfield shall be set to 0, the Delete Timer Present 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 affiliated AP before it is removed. The initial value of the Delete Timer subfield shall be longer than the MLD max idle period. The Per-STA Profile subelement shall not include a STA Profile field.

Before removal from an AP MLD, an affiliated AP shall follow the procedure in 11.3.5.8 (AP, AP MLD, or PCP disassociation initiation procedure) to transmit one or more Disassociation frames to all STAs associated with the affiliated AP, if the BSS the AP belongs to is also being terminated, or to all STAs associated with the affiliated AP that are also affiliated with a non-AP MLD, if the BSS the AP belongs to is not being terminated.

Upon receipt of a Disassociation frame, an associated non-AP MLD shall consider the link corresponding to the removed AP nonexistent, and the affiliated STA associated with the removed affiliated AP shall follow the procedure in 11.3.6.9 (AP, AP MLD, or PCP disassociation receipt procedure) to delete any information maintained for that link.