IEEE P802.11
Wireless LANs

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| CC36-Resolution-for-CID-5154 |
| Date: 2022-02-03 |
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Abstract

This submission proposes CR for CIDs 5154.

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: adding modification based on offline discussions
* Rev 2: Align the doc with 802.11be D1.2 baseline,
Modifying the Enabled Link / Disabled Link definition due to John’s comment,
Adding Link disablement Parameters field in the EHT Operation element due to Vishnu’s comments,
Adding distinction between link disablement (between AP MLD and associated non-AP MLD) and BSS Link disablement (between AP MLD and all associated non-AP MLDs operating on that link) both in Description part and text part – due to Vishnu’s comments.
* Rev 3: Align the doc with 802.11be D1.3 and additional modifications based on further offline comments (Laurent, Abhi, Kaiying):
replacing “BSS Link disablement” with “Link unavailability” and moving all normative behavior texts to section 35.3.6.3.
Removing all changes from section 35.3.6.1 (TID-To-Link mapping)
Link unavailability parameters will be included in MLE (instead of EHT Operation)
Remove periodicity from Link Unavailability parameters
Update specific fields in RNR for critical update indication.
Updating the Discussion part accordingly
* Rev 4: Additional modifications based on offline comments:
Unavailable Link Indication subfield is included in the BSS Parameters field
The event of “Inclusion of the Link Unavailability Parameters subfield in the Basic Multi link element” is defined as critical update event.
Adding Individual TWT agreements suspension on unavailable links and resumption on (becoming) available links
* Rev 5: Additional updates following further offline comments:
Align the doc with 802.11be D1.31 and remove previous deleted sections

Update the size & description of Link Unavailability Duration subfield .

Add a note corresponding to Link Unavailability Count subfield for non-primary link of an AP affiliated with NSTR Mobile AP MLD

Remove the encoding of “unknown” value from the Link Unavailability Duration subfield (while the size of the subfield is increased to 3 octets and max value is 16383s)

Moving Unavailable Link Indication subfield to be included in the MLD Parameters field

Remove the classification of inclusion of the Link Unavailability Parameters subfield as a Critical Update (since it is added in Link Info for Beacon and Probe response frames).

Adding Link Unavailability Parameters subfield to both Common Info Part of MLE and Link Info Part of MLE in Beacon, Probe response, ML Probe response, Association Response and Reassociation Response frames for upcoming unavailability of a link.

Adding rule for minimal time of advanced notification of an unavailable link.

Adding rules for individual TWT agreements and TID-To-Link mapping corresponding to unavailable link

Adding notification of remaining unavailability duration (on other available links), so all associated non-AP MLDs will know when the link becomes available.

Adding a requirement for the AP affiliated with AP MLD and operating on a link that will become unavailable to exclude any associated the non-MLD non-AP STA (i.e. “legacy” non-AP STA)

- Rev 6: Additional updates following further offline comments (Shawn):

 Adding an exception to the rule of setting the Neighbor AP TBTT Offset subfield in reported AP (of the same AP MLD) to 255 in case the reported AP is operating on an unavailable link.

Adding rule to set the TBTT Offset subfield to 255 in case that the Unavailable Link Indication subfield corresponding to a reported AP is set to 1

Update the rules for reinitiating the frame exchange on a link that became available (after a period of unavailability)

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGbe Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGbe Editor: Editing instructions preceded by “TGbe Editor” are instructions to the TGbe editor to modify existing material in the TGbe draft. As a result of adopting the changes, the TGbe editor will execute the instructions rather than copy them to the TGbe Draft.***

| **CID** | **Commenter** | **Pg/Ln** | **Section** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- | --- |
| 5154 | George Cherian |  |  | The procedure, if an AP MLD chooses to disable a link (for any reason) is missing. Please specify. | As in comment | **Revised**Agree in principle with the comment. Following the discussion below, need to add a notification-based mechanism to allow the AP MLD to temporarily prohibit the frame exchange on one or more setup links (as the normative behavior defined for a disabled link).**TGbe Editor, please implement changes as shown in doc 11-21/1237r5 tagged as 5154.** |

## Discussion

According to 802.11be D1.1 section 35.3.6.1.1 the non-AP STA affiliated with a non-AP MLD can temporarily prohibit any frame exchange on the enabled link it is operating by a simple notification of entering into a Power Save mode.

The AP MLD also needs a similar notification-based mechanism (as clearly specified in CID5154) that will allow it to temporarily prohibit any frame exchange on one or more links it is operating with any of the non-AP STAs affiliated with associated non-AP MLDs that are operating on any of these links for any reason it has (one use case can be Reducing AP Power consumption, especially when the AP MLD handles multiple TX/RX chains on different bands. Another use case can be signaling the unavailability of nonprimary link of NSTR mobile AP).

This proposal covers the above issues (from the AP MLD perspective) and includes a mechanism to notify the unavailability of a link by the AP using Beacon and Probe Response frames.

It should be noted that unavailability of the link is a **different** operation than Deleting a link (which is discussed in the 11-21/534r7): When the link becomes unavailable by the AP MLD, all the non-AP MLDs operating on that link are kept associated with all the link parameters, so once the link becomes available the frame exchange can be immediately initiated on this link, where in case the link is deleted/removed all the related link parameters are erased and this link can’t be used anymore from this point onwards.

The proposed solution is based on the following guidelines:

* The link(s) can become available / unavailable in a resolution of TBTTs.
* Adding an indication in the RNR element (which includes the information corresponding to the link that becomes unavailable) – to avoid any Probe Request / Association Request frames transmission by non-AP MLDs on the unavailable link(s).
Please note that these RNRs are included in the Beacon / Probe response frames of the APs affiliated with the same AP MLD (as the affiliated AP operating on the link that becomes unavailable), as shown in the example illustrated in the following diagram:


In this example, AP MLD is associated with non-AP MLD1 and non-AP MLD2 and on each enabled link, it includes the RNR elements for the affiliated APs (of the same AP MLD). An indication of link unavailability of 5 GHz Link will be included in the RNR elements corresponding to AP2, which are included in the Beacon and Probe response frames transmitted on the 2.4GHz and 6GHz links. In this way, an unassociated non-AP MLD 3 will avoid initiating the transmission of any Probe Request / Authentication / Association Request frame during the period of the unavailability of Link 2.

* Adding an indication in the Multi link element – to announce that the current link becomes unavailable for the associated MLDs operating on the link to become unavailable. It is much needed if the associated non-AP MLD has only one enabled link with the AP MLD.
* The indication for the unavailable link should be included in the MLD parameters subfield of the RNR.

\*\*\*\* End of discussion part \*\*\*\*\*

*TGbe editor: Please note baseline is 11be D1.31 and REVme D0.1*

***TGbe editor: Please implement the changes showing in the highlighted blue and grey***

**9.4.2.170 Reduced Neighbor Report element**

**9.4.2.170.2 Neighbor AP Information field**

[CID 5154]

***TGbe editor: Update the following Figure 9-709b (MLD Parameters subfield format) as follows:***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B7 | B8 B11 | B12 B19 | B20 | B21 B23 |
|  | MLD ID | Link ID | BSS Parameters Change Count | Unavailable Link Indication | Reserved |
| Bits: | 8 | 4 | 8 | 1 | 3 |

**Figure 9-709b—MLD Parameters subfield format**

***TGbe editor: Add the following at the end of this subclause as follows:***

The Unavailable Link Indication subfield is set to 1 if the operating link of the AP described in this Neighbor AP Information field is not available, as defined in 35.3.6.3. Otherwise, it is set to 0.

**9.4.2.** **312 Multi-Link element**

**9.4.2.312.2 Basic Multi-Link element(#6700)**

**9.4.2.312.2.1 Common Info field of the Basic Multi-Link element(#7567)**

[CID 5154]

***TGbe editor: Update the following Figure 9-1002d (Presence Bitmap subfield of the Basic Multi-Link element format) as follows:***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 | B5 |  B6 B11 |
|  | Link ID Info Present | BSSParameters Change Count Present | Medium Synchronization Delay Information Present | EMLCapabilities Present | MLDCapabilities Present | Link Unavailability Parameters Present | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 1 | 1 | 6 |

**Figure 9-1002d—****Presence Bitmap subfield of the Basic Multi-Link element format**

***TGbe editor: Add the following at the end of this subclause as follows:***

The Link Unavailability Parameters Present subfield is set to 1 if the Link Unavailability Parameters subfield is present in the Common Info field. Otherwise, the Link Unavailability Parameters Present subfield is set to 0.

**9.4.2.312.2.2 Multi-Link Control field of the Basic Multi-Link element(#7567)**

[CID 5154]

***TGbe editor: Update the following Figure 9-1002h (Common Info field of the Basic Multi-Link element format) as follows:***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Common Info Length | MLD MACAddress | Link ID Info | BSSParameters Change Count | Medium Synchronization Delay Information | EMLCapabilities | MLDCapabilities | Link Unavailability Parameters |
| Octets: | 1 | 6 | 0 or 1 | 0 or 1 | 0 or 2 | 0 or 2 | 0 or 2 | 0 or 4 |

**Figure 9-1002e— Common Info field of the Basic Multi-Link element format**

***TGbe editor: Add the following at the end of this subclause as follows:***

The format of the Link Unavailability Parameters subfield is defined in figure 9-1002ha (Link Unavailability Parameters subfield format)

|  |  |  |
| --- | --- | --- |
|  | Link Unavailability Count | Link Unavailability Duration |
| Octets: | 1 | 3 |

**Figure 9-1002ha— Link Unavailability Parameters subfield format**

The subfields of the Link Unavailability Parameters are defined in Table 9-401ha (Subfields of Link Unavailability Parameters subfield).

**Table 9-401ha—** **Subfields of** **Link Unavailability Parameters subfield**

| **Subfield** | **Definition** | **Encoding** |
| --- | --- | --- |
|  Link Unavailability Count | This subfield indicates the number of TBTTs (in the range of [0,255]) after which the link becomes unavailableFor non-primary link of an AP affiliated with NSTR Mobile AP MLD – see NOTE1 below | A non-zero value indicates that the link becomes unavailable (as defined in 35.3.6.3) after an amount of TBTTs indicated by this value.The value 0 indicates that the link unavailability occurs at any time after the Beacon frame is transmitted or that the link, on which a reported AP is operating, is already unavailable |
| Link Unavailability Duration | When the Link Unavailability Count has a non-zero value, this subfield indicates the duration for which the link will be unavailable.When the Link Unavailability Count value is set to zero, this subfield indicates the remaining duration for which the link will unavailable. | The value is expressed in TUs |

NOTE1: In case the unavailable link is a non-primary link of an AP affiliated with NSTR Mobile AP MLD, the Link Unavailability Count subfield indicates the number of TBTTs corresponding to the primary link, after which the non-primary link (on which the reported AP is operating) will become unavailable

NOTE2: The Link Unavailability Parameters subfield included in the Common Info field applies to the reporting AP.

**9.4.2.312.2.3 Link Info field of the Basic Multi-Link element (#7567)**

[CID 5154]

***TGbe editor: Update the following Figure 9-1002k (STA control field format) as follows:***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B3 | B4 | B5 | B6 | B7 | B8 | B9 | B10 |  B11 B15 |
|  | Link ID | Complete Profile | MACAddress Present | Beacon Interval Present | DTIM Info Present | NSTRLink Pair Present | NSTRBitmap Size | Link Unavailability Parameters Present | Reserved |
| Bits: | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 5 |

**Figure 9-1002k— STA Control field format**

***TGbe editor: Add the following after the 11th paragraph of this subclause as follows:***

The Link Unavailability Parameters Present subfield is set to 1 if the Link Unavailability Parameters subfield is present in the STA Control field. Otherwise, the Link Unavailability Parameters Present subfield is set to 0.

***TGbe editor: Update the following Figure 9-1002l (STA Info field format) as follows:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | STA Info Length | STA MACAddress | Beacon Interval | DTIM Info | NSTRIndication Bitmap | Link Unavailability Parameters |
| Octets: | 1 | 0 or 6 | 0 or 2 | 0 or 2 | 0 or 1 or 2 | 0 or 3 |

**Figure 9-1002l— STA Info field format**

***TGbe editor: Add the following after the 18th paragraph of this subclause as follows:***

The format of the Link Unavailability Parameters subfield is defined in section 9.4.2.312.2.2, figure 9-1002ha (Link Unavailability Parameters subfield format) and applies to the reported AP.

[CID 5154]

## Discovery of an AP MLD

* + - 1. **AP behavior**

***TGbe editor: Please update the following 6th paragraph as follows:***

(#6970)The TBTT offset between two APs affiliated with the same AP MLD shall never be larger than 254 TUs. An AP affiliated with an AP MLD shall not set the Neighbor AP TBTT Offset subfield to 255 for an AP affiliated with the same AP MLD, except under the rules defined in [35.3.11 (Multi-link procedures for](#bookmark30) [channel switching, extended channel switching, and channel quieting(#4112)(#2324)(#2600))](#bookmark30) and except if the link on which the reported AP is operating is indicated as an unavailable link, as defined in 35.3.6.3 (AP Notification of Link Unavailability) .

***TGbe editor: Please add the following new subclause to section 35.3.6***

35.3.6.3 AP Notification of Link Unavailability

An AP MLD may turn any of its links into an unavailable link. When a link is notified as an unavailable link, it shall not be used for any frame exchange by any of its BSS members that are affiliated with MLD (i.e. AP MLD or non-AP MLD) as well as by an unassociated non-AP MLDs.

NOTE: Specifically, Class 1 frames including Beacon and Probe Response frames will not be transmitted on an unavailable link.

An AP MLD shall notify the unavailability state of a link, using the Unavailable Link Indication subfield in the MLD Parameters subfield of the Neighbor AP Information field in the Reduced Neighbor Report element included in the Beacon or Probe Response frames transmitted by any of the APs affiliated with the AP MLD.
This way, the reporting AP (which is affiliated with AP MLD and is operating on an available link), transmits Beacon and Probe Response frames that include a notification of the unavailability status of the links to which the reported APs affiliated with the same AP MLD pertain.

When the Unavailable Link Indication subfield is set to 1, the reported link (i.e. the link on which the reported AP is operating) is defined as an unavailable link. Otherwise, the reported link is defined as an available link.

NOTE: The Unavailable Link Indication is mainly used for unassociated non-AP MLD which utilizes the RNR for the Discovery of the AP MLD and each of its affiliated APs (as specified in 35.3.4), to avoid sending Probe Request / (Re)Association Request frames on an unavailable link.

If the Unavailable Link Indication subfield corresponding to a reported AP is set to 1, then the Neighbor AP TBTT Offset subfield included in the same TBTT Information field of the Reduced Neighbor Report element shall be set to 255.

An AP affiliated with an AP MLD shall notify an upcoming unavailability of the available link it is operating, using the Link Unavailability Parameters subfield in the Basic Multi-link element carried in the transmitted Beacon, Probe response, ML Probe response, Association Response and Reassociation Response frames. The notification shall be applied both in the Common Info field contained in the Multi-link element corresponding to the reporting AP and in the Link Info field contained in the Multi-link element corresponding to the reported AP.

NOTE: When the Link Unavailability Parameters subfield is included in the Common Info field of the Basic Multi-link element contained in the Nontranmsittted BSSID Profile subelement of the Multiple BSSID element carried in the transmitted Beacon and/or Probe response frames of an AP corresponding to the transmitted BSSID in the multiple BSSID set, it refers to the AP corresponding to the nontranmsittted BSSID (i.e. reported AP) operating on the link that will become unavailable.

An AP affiliated with an AP MLD that intends to turn its operating link into unavailable link shall start including the Link Unavailability Parameters subfield for a duration that is greater than or equal to the maximum value of the DTIM interval corresponding to each of the AP(s) affiliated with the same AP MLD unless the AP is required to turn its operating link into unavailable link within a short duration to meet regulatory rules.

NOTE 1 – Advertising the Link Unavailability Parameters subfield for a duration that includes the DTIM beacon on another link makes it possible for a non-AP MLD that is monitoring only the other link and is in doze state to wake-up only to receive the DTIM beacon on that link to get the notification (by receiving the Link Unavailability Parameters subfield in the per-STA profile, corresponding to the affected AP, of the Basic Multi-Link element).

NOTE2: The Link Unavailability Count value shall be applied in reference to the most recent TBTT value corresponding to the affected AP (i.e. operating on the link to become unavailable) and not to the reporting AP.

An AP affiliated with an AP MLD that intends to turn its operating link into unavailable link shall verify that it is not associated with any non-MLD non-AP STA on the link to become unavailable.

NOTE: For the non-MLD non-AP STA, the associated AP affiliated with an AP MLD, which is operating on the link to become unavailable, may disassociate them or use BTM in advance before the link actually becomes unavailable

When a link on which an AP affiliated with an AP MLD is operating becomes unavailable:

* All the existing individual TWT agreements between the AP MLD and any of the associated non-AP MLDs corresponding to the unavailable link shall be suspended
* The DL/UL TID-to-Link mapping of both AP MLD and all its associated non-AP MLD which utilize the unavailable link as an enabled link (i.e. at least one TID is mapped to this link) will be the default TID-to-Link mapping. Obviously, the unavailable link will not be used for any frame exchange for any of the TIDs.

An AP affiliated with an AP MLD shall notify the remaining unavailability duration of an unavailable link on which another AP affiliated with the same AP MLD is operating, using the Link Unavailability Parameters subfield in the Basic Multi-link element carried in the transmitted Beacon, Probe response, ML Probe response, Association Response and Reassociation Response frames. The notification shall be applied in the Link Info Part contained in the Multi-link element corresponding to the reported AP.

The non-AP STA affiliated with a non-AP MLD shall not delete the GTK/IGTK/BIGTK values when the AP affiliated with the associated AP MLD turns the link on which it is operating to an unavailable link.

NOTE: The non-AP MLD uses the GTK/IGTK/BIGTK for protected broadcast/groupcast management frames reception when the link becomes available.

When a link becomes available after a time period for which it was declared as an unavailable link, frame exchange operation on this link can be initiated by any member of the BSS that is affiliated with an MLD (i.e. AP MLD or non-AP MLD and is operating on this link) following CCA performance until a frame is detected by which it can set its NAV, or a period equal to NAVSyncDelay has transpired, whichever is earlier. The frame exchange is initiated using all the link parameters that were defined before the link has been defined as an unavailable link. (subject to power state (see 35.3.11) and enablement status (see 35.3.6.1) of the affiliated non-AP EHT STA). In addition, all the existing (suspended) individual TWT agreements between the AP MLD and any of the associated non-AP MLDs corresponding to the (becoming) available link shall be resumed.

An AP affiliated with an AP MLD shall notify the availability of another AP affiliated with the same AP MLD by setting the Unavailable Link Indication subfield to 0 of the TBTT Information field corresponding to the other AP in the Reduced Neighbor Report element carried in its Beacon and Probe Response frame when the duration indicated in the Unavailability Parameter subfield of the Basic Multi-Link element and has expired

The AP notification of Link Unavailability procedure described here applies only if at least one link of the AP MLD remains available while other links corresponding to other APs affiliated with the same AP MLD are unavailable. In case all the Links corresponding to APs affiliated with the same AP MLD are simultaneously unavailable, the AP MLD shall terminate the BSS of each of the affiliated AP (as detailed in 11.1.6 Terminating a BSS) and shall disassociate each of the associated non-AP MLDs

Straw Poll:

Do you support to incorporate the proposed draft text in this document 11-21/1237r5 to the next revision of TGbe Draft 1.31, for addressing the CID 5154?

Result: Yes/No/Abstain