IEEE P802.11
Wireless LANs

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| LB275 Comment Resolution – Multi-Link Traffic Indication (MLTI) Part 2 |
| Date: 2023-10-12 |
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Abstract

This submission proposes comment resolution(s) for the following 12 CID(s) received in LB275 on TGbe D4.0 related to the Multi-link Traffic Indication in subclause 9.3.3.2, 9.4.2.315, 35.3.12.4:

CIDs:

19737 19754 19852 19785 19755 19786 19787 19788 20122 19206

19212 19721

Revisions:

* Rev 0: Initial version of the document. ( 2 new CIDs and 10 deferred CIDs from doc 11-23/1660r1)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause Number** | **Page.****Line** | **Comment** | **Proposed Change** | **Resolution** |
| 19737 | Abhishek Patil | 9.3.3.2 | 184.41 | In deployments, it has been observed that client devices from various vendors are unable to process Beacon frame beyond a certain value. As a result, they loose association (and start misbehaving). TGbe needs to make every effort to keep the beacon size under control. The Multi-Link Traffic element will cause beacon bloat which would further cause inter-op issues between an AP affiliated with an AP MLD and non-EHT clients associated with it. The size of the Multi-Link Traffic Indication element is governed by the number of link bitmaps being signaled (including the ones for legacy and default mapping) in the element. The size of each link bitmap is the same and determined by the maximum bitmap to be signaled for any client. In addition, the number of bits in the link bitmap are based on the 'spread' of the Link ID value assigned to each link on which the AP MLD operates on and current there aren't any rules requiring continuous link IDs. | Move the Multi-Link Traffic Indication element out of the Beacon frame into a separate (follow-up) frame. Beacon frame could provide (a single bit) an indication of AP's intention - i.e., whether conditions are satisfied that require transmission a follow-up frame so that relevant non-AP MLDs know whether to monitor for it. Such a framework can be extended to carry other elements defined by new amendments. Thus offloading the Beacon frame. Please see 11-23/1381r5 - let's work together as a group to enhance this proposal and address the beacon bloating issue. | Revised.Added an option to include the MLTI element in a separate action frame that follows a beacon frame.TGbe editor to make the changes with the CID tag (#19737) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19754 | Abhishek Patil | 9.4.2.315 | 290.24 | The value of N can be quiet large in a crowded and busy enterprise deployment (such as an airport, train station or a stadium). As an example, if an AP MLD wants to signal link bitmap for 50 devices, then the element would carry 50 link bitmaps. The standard does not provide any guidance on reducing the size of the link bitmap (in fact it allows an AP MLD to arbitrarily assign link ID values to its affiliated APs). Due to this, the size each link bitmap and as a result the size of the overall element can be very large. This will result in bloating of the Beacon frame causing issues such large management frame overhead in an enterprise scenario, inter-op issues with legacy etc. | TGbe spec much define ways to reduce Beacon frame bloating (for example provides rules to reduce the size of each link id bitmap and moving the element to a different (follow-up) frame. | Revised.Added an option to include the MLTI element in a separate action frame that follows a beacon frame.TGbe editor to make the changes with the CID tag (#19737) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19852 | Vishnu Ratnam | 35.3.12.4 | 541.53 | The size of the multi-link traffic indication element can be unnecessarily too large, since the AP may not have a specific link recommendation for many AIDs. A mechanism to reduce size of the MLTI element is needed. | Introduce an AID bitmap element as an optional subfield of the MLTI element that indicates the AIDs for which traffic is pending and the AP MLD has a link recommendation. The per link traffic indication list only inludes indication for the AIDs indicated in this AID bitmap. | Revised.Added an option to include the MLTI element in a separate action frame that follows a beacon frame. The AID element is included together with the MLTI element in the action frame.TGbe editor to make the changes with the CID tag (#19737) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19785 | Abhishek Patil | 35.3.12.4 | 542.47 | Nondefault mapping includes the case when all TIDs are mapped to a subset of link. However, this paragraph would not apply when all TIDs are mapped to a subset of links. Therefore, "nondefault mapping" is not accurate. Please update the sentence to accurately reflect this. | As in comment | Revised.Agree in principle.TGbe editor to make the changes with the CID tag (#19785) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19755 | Abhishek Patil | 9.4.2.315 | 291.23 | A non-AP MLD can retrieve DL BUs for any TID if all the TIDs are mapped to at least one link. Therefore, the AP MLD does not need to include Multi-Link Traffic Indication element in a Beacon frame of its affiliated APs. | Replace "all the enabled links" with "at least one enabled link". Same change on line 29. | Rejected.The suggested change assumes that a non-AP MLD always first uses a link on which all TIDs are mapped to retrieve buffered data without knowing whether it can use other enabled links on which not all TIDs are mapped. This could limit the performance of the non-AP MLD.  |
| 19786 | Abhishek Patil | 35.3.12.4 | 542.50 | Needs to be set to 1 only when there isn't at least one link where all TIDs are mapped to and the non-AP STA(s) operating on the link(s) where the TID is mapped to are in power-save mode. | Please update the sentence to clarify this. | Rejected.The suggested change assumes that a non-AP MLD always first uses a link on which all TIDs are mapped to retrieve buffered data without knowing whether it can use other enabled links on which not all TIDs are mapped. This could limit the performance of the non-AP MLD.  |
| 19787 | Abhishek Patil | 35.3.12.4 | 543.02 | When a non-AP MLD has all TIDs mapped to at least one enabled link, then it can receive DL BU(s) for any TID on that link. Based on the TID(s) of the retrieved BU(s), the non-AP MLD can then decide to wake-up on additional link(s). | Replace the 'all enabled links' with 'at least one link' | Rejected.The method described in the comment forces a non-AP MLD to first retrieve data on a link on which all TIDs are mapped and then use other enabled link, which could limit the performance of the non-AP MLD. |
| 19788 | Abhishek Patil | 35.3.12.4 | 544.25 | When a non-AP MLD has all TIDs mapped to at least one enabled link, then it can receive DL BU(s) for any TID on that link. Based on the TID(s) of the retrieved BU(s), the non-AP MLD can then decide to wake-up on additional link(s). Replace the 'all enabled links' condition with 'at least one link' | Replace the 'all enabled links' with 'at least one link' - 2 instances in this bullet. | Rejected.The method described in the comment forces a non-AP MLD to first retrieve data on a link on which all TIDs are mapped and then use other enabled link, which could limit the performance of the non-AP MLD. |
| 20122 | Gaurang Naik | 25 | 544.35 | If all TIDs are mapped to one link, non-AP MLDs can receive Beacons on that link. This condition does not seem correct.  | Change "mapped to all the enabled links" to "mapped to at least one enabled link" on L25 and change "that are not mapped to all enabled links" to "that are not mapped to at least one enabled link" on L26.  | Rejected.The method described in the comment forces a non-AP MLD to first retrieve data on a link on which all TIDs are mapped and then use other enabled link, which could limit the performance of the non-AP MLD. |

**TGbe Editor to insert the following Subclause 9.6.35.9a (Multi-Link Traffic Indication frame format) after Subclause 9.6.35.9 (Link Recommendation frame format) in TGbe D4.0****(#CID** 19737**)**

**9.6.35.9a Multi-Link Traffic Indication frame format**

The Multi-Link Traffic Indication frame is an Action No Ack frame of category Protected EHT. The Action field of a Multi-Link Traffic Indication frame contains the information shown in Table 9-628k1 (Multi-Link Traffic Indication frame Action field format).

**Table 9-628k1—Multi-Link Traffic Indication frame Action field format**

|  |  |
| --- | --- |
| **Order**  | **Meaning** |
| 1  | Category |
| 2  | Protected EHT Action |
| 3  | AID Bitmap element |
| 4  | Multi-Link Traffic Indication element |

The Category field is defined in Table 9-79 (Category values). The Protected EHT Action field is defined in Table 9-628c (Protected EHT Action field values).

The AID Bitmap element is described in 9.4.2.318 (AID Bitmap element) and is used to identify the non-AP MLDs for which a traffic indication is provided.

The Multi-Link Traffic Indication element is described in 9.4.2.315 (Multi-Link Traffic Indication element) and is used to describe the traffic indication for all the non-AP MLDs that are identified in the AID Bitmap element.

**TGbe Editor to make the following changes in Table 9-628c (Protected EHT Action field values) in TGbe D4.0:** **(#CID 19737)**

**9.6.35 Protected EHT Action frame details**

**9.6.35.1 Protected EHT Action field**

A Protected EHT Action field, in the octet immediately after the Category field, differentiates the Protected EHT Action frame formats. The Protected EHT Action field values associated with each frame format within the EHT category are defined in Table 9-628c (Protected EHT Action field values).

**Table 9-628c—Protected EHT Action field values**

|  |  |  |
| --- | --- | --- |
| **Value**  | **Meaning**  | **Time priority** |
| 0  | TID-To-Link Mapping Request  | No |
| 1  | TID-To-Link Mapping Response  | No |
| 2  | TID-To-Link Mapping Teardown  | No |
| 3  | EPCS Priority Access Enable Request  | No |
| 4  | EPCS Priority Access Enable Response  | No |
| 5  | EPCS Priority Access Teardown  | No |
| 6  | EML Operating Mode Notification  | No |
| 7  | Link Recommendation  | No |
| 8  | Multi-Link Operation Update Request  | No |
| 9  | Multi-Link Operation Update Response  | No |
| 10  | Link Reconfiguration Notify  | No |
| 11  | Link Reconfiguration Request  | No |
| 12  | Link Reconfiguration Response  | No |
| 13 | Multi-Link Traffic Indication | No |
| 14–255 |  |  |

**TGbe Editor to make the following changes in Subclause 35.3.12.4 (Traffic Indication) in TGbe D4.0:** **(#CID 19737)**

**35.3.12.4 Traffic indication**

**…**

**(Paragraph P542L25 – changes on top of resolutions in doc 11-23/1660r1 CID#19784, 19719)**

An AP MLD shall include the Multi-Link Traffic Indication element (see 9.4.2.315 (Multi-Link Traffic Indication element)) either in a Beacon frame it transmits and set dot11MultiLinkTrafficIndiationInBeaconActivated to true or in a Multi-Link Traffic Indication frame transmitted SIFS after a Beacon frame and set dot11MultiLinkTrafficIndicationInBeaconActivated to false, if the following condition is met:

— At least one associated non-AP MLD does not have all TIDs mapped to all the enabled links and the

AP MLD has buffered BU(s) with TID(s) that are not mapped to all enabled links for that non-AP MLD.

An AP MLD shall include the Multi-Link Traffic Indication element in a Beacon frame it transmits and set dot11MultiLinkTrafficIndicationInBeaconActivated to true, if the following condition is met:

— The AP MLD intends to provide link recommendations in a Beacon frame to retrieve individually

addressed buffered BUs to at least one associated non-AP MLD that has all TIDs mapped to all the enabled links and the AP MLD has buffered BU(s) for that non-AP MLD.

If an AP MLD does not include the Multi-Link Traffic Indication element in a Beacon frame, it shall set dot11MultiLinkTrafficIndicationInBeaconActivated to false.

The Multi-Link Traffic Indication element includes Per-Link Traffic Indication Bitmap *n* subfield(s) in the Per-Link Traffic Indication List field. The Per-Link Traffic Indication Bitmap *n* subfield(s) corresponds to the AID(s) of the non-AP MLD(s) or non-MLD non-AP STA(s), and the first Per-Link Traffic Indication Bitmap *n* subfield corresponds to (#19718)the non-AP MLD whose AID value is contained in the AID Offset subfield of the Multi-Link Traffic Indication Control field of the Multi-Link Traffic Indication element. When the Multi-Link Traffic Indication element is in a Beacon frame, the order of the Per-Link Traffic Indication Bitmap *n* subfields follows the order of the bits that are set to 1 in the Partial Virtual Bitmap subfield of the TIM element and corresponds to the AIDs of the non-AP MLDs or non-MLD non-AP STAs.(#19719) When the Multi-Link Traffic Indication element is in a Multi-Link Traffic Indication frame, the order of the Per-Link Traffic Indication Bitmap *n* subfields follow the order of the bits that are set to 1 in the Partial AID Bitmap subfield of the AID element carried in the Multi-Link Traffic Indication frame that correspond to the AIDs of the non-AP MLDs.

If a non-AP MLD has successfully negotiated a TTLM with an AP MLD (#19785)and not all TIDs are mapped to all enabled links, the bit position *i* of the Per-Link Traffic Indication Bitmap *n* subfield that corresponds to the link with the link ID that is equal to *i* on which a non-AP STA affiliated with the non-AP MLD is operating shall be set to 1 if the AP MLD has buffered BU(s) with TID(s) that are mapped to that link or MMPDU(s) for that non-AP MLD, otherwise, the bit shall be set to 0.

…

**(Paragraph P543L6)**

An example of the construction of the Multi-Link Traffic Indication element in a Beacon frame is shown in Figure 35-9 (Example of Multi-Link Traffic Indication element construction in a Beacon frame).

**TGbe Editor to change the caption of Figure 35-9 in TGbe D4.0 as follows:** **(#CID 19737)**

**Figure 35-9—Example of Multi-Link Traffic Indication element construction in a Beacon frame**

**TGbe Editor to make the following changes in Subclause 9.4.2.315 (Multi-Link Traffic Indication element) in TGbe D4.0:** **(#CID 19737)**

**9.4.2.315 Multi-Link Traffic Indication element**

The Per-Link Traffic Indication List field is defined in Figure 9-1001as (Per-Link Traffic Indication List field format). The Per-Link Traffic Indication List field contains *N* Per-Link Traffic Indication Bitmap *n* subfield(s) followed by the Padding subfield, where . The *N* Per-Link Traffic Indication Bitmap *n* subfield(s) correspond to the AID(s) of the non-AP MLD(s) or a non-MLD non-AP STA(s) that are identified by the corresponding bit(s) that are equal to 1, where *N* is the number of bit(s) that are equal to 1, in either

— the Partial Virtual Bitmap subfield of the TIM element in a Beacon frame with the Multi-Link Traffic Indication element counting from the bit position that corresponds to the AID value in the AID Offset subfield of the Multi-Link Traffic Indication element, or

— the Partial AID Bitmap subfield of the AID Bitmap element in a Link Recommendation frame with

the Multi-Link Traffic Indication element or in a Multi-Link Traffic Indication frame with the Multi-Link Traffic Indication element.

The Per-Link Traffic Indication Bitmap *n* subfield is defined in Figure 9-1001at (Per-Link Traffic Indication Bitmap n subfield format). When a Multi-Link Traffic Indication element is in a Beacon frame, each PerLink Traffic Indication Bitmap *n* subfield indicates either:

— per-link traffic indication for a non-AP MLD that does not have all TIDs mapped to all the enabled

links or

— link recommendation for a non-AP MLD that has all TIDs mapped to all the enabled links.

When a Multi-Link Traffic Indication element is in a Link Recommendation frame, each Per-Link Traffic Indication Bitmap *n* subfield indicates link recommendation for a non-AP MLD.

When a Multi-Link Traffic Indication element is in a Multi-Link Traffic Indication frame, each Per-Link Traffic Indication Bitmap *n* subfield indicates traffic indication for a non-AP MLD.

…

(Paragraph P291L20)

In a Beacon frame or in a Multi-Link Traffic Indication frame when the Per-Link Traffic Indication Bitmap *n* subfield corresponds to a non-AP MLD that has successfully negotiated a TTLM or is in the advertised TTLM wherein not all TIDs are mapped to all the enabled links, a value of 1 in the bit position *i* in the bitmap that corresponds to a link on which a non-AP STA affiliated with a non-AP MLD is operating indicates that there is buffered BU(s) with TID(s) mapped to the link with the link ID equal to *i* or MMPDU(s); a value of 0 in a bit position in the bitmap indicates that there is no buffered BU(s) with TID(s) mapped to the corresponding link nor MMPDU(s). …

**TGbe editor to replace dot11MultiLinkTrafficIndicationActivated with dot11MultiLinkTrafficIndicationInBeaconActivated in Table 9-60 (Beacon frame body)** (#CID 19737)

**9.3.3 (PV0) Management frames**

**9.3.3.2 Beacon frame format**

**…**

**Table 9-60—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| **Order**  | **Information**  | **Notes** |
| … |  |  |
| <Last assigned + 4> | Multi-Link Traffic Indication | The Multi-Link Traffic Indication element is present if dot11MultiLinkTrafficIndicationInBeaconActivated is true; otherwise, it is not present. |
| <Last assigned + 5> | TID-To-Link Mapping | One or two TID-To-Link Mapping elements are optionally present if dot11MultiLinkActivated and dot11TIDtoLinkMappingActivated are true; otherwise, none are present. |

**TGbe editor to replace dot11MultiLinkTrafficIndicationActivated with dot11MultiLinkTrafficIndicationInBeaconActivated in Annex C (two occurrences: P944L23 and P947L37 in TGbe D4.0)** **(#CID 19737)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 19206 | Minyoung Park | 35.3.12.4 | 542.63 | It is not clear how the Bitmap Size subfield is set since the paragraph is using "should" and lack of information about the "smallest link ID value". | Change "should" to "shall" and delete "minus the smallest link ID value" from the paragraph. | Revised.Agree with the comment. Also added a rule to assign link IDs for APs affiliated with an AP MLD.TGbe editor to make the changes with the CID tag (#19206) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19212 | Sanghyun Kim | 35.3.12.4 | 542.62 | Because the Bitmap Size subfield can be set to the difference between the largest and smallest link ID value amongst the bits that are set to 1 in the Per-Link Traffic Indication Bitmap subfield(s), interpretation of the Per-Link Traffic Indication Bitmap subfield needs to be corrected. For example, if the Bitmap size subfield is determined to be 3-1 = 2 (the largest link ID set to 1 is 3, and the smallest is 1), then B0 in the Per-Link Traffic Indication Bitmap subfield should correspond to Link ID 1, and B2 should correspond to Link ID 3. | Link ID offset information should be provided along with the Bitmap size subfield, and the link ID corresponding to B0 in the Per-Link Traffic Indication Bitmap subfield should be determined based on the information. | Revised.TGbe editor to make the changes with the CID tag (#19206) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |
| 19721 | Arik Klein | 35.3.12.4 | 542.62 | The difference between the largest link ID value and the smallest link ID value is measured among the Per-Link Traffic Indication Bitmap n subfields, not among the bits. Please rephrase the sentence as suggested. | The sentence should be revised as follows: "... where m is equal to the largest link ID value minus the smallest link ID value amongst the Per-Link Traffic Indication Bitmap n subfield(s) whose bits that are set to 1"Per-Link Traffic Indication Bitmap n subfield(s)." | Revised.TGbe editor to make the changes with the CID tag (#19206) in doc.: IEEE 802.11-23/1753r0[https://mentor.ieee.org/802.11/dcn/23/11-23-1753-00-00be-lb275-cr-mlti-part2.docx] |

**TGbe Editor to make the following changes in Subclause 35.3.12.4 (Traffic Indication) in TGbe D4.0:**

**35.3.12.4 Traffic indication**

…

**(Paragraph P542L62)**

The Bitmap Size subfield of the Multi-Link Traffic Indication Control field shall be set to *m*, where *m* is equal to the largest link ID value amongst the bits that are set to 1 in the Per-Link Traffic Indication Bitmap *n* subfield(s).(#19206)

**TGbe Editor to make the following changes in Subclause 35.3.3.2 (Link ID) in TGbe D4.0:**

**35.3.3.2 Link ID**

A link ID is an integer value between 0 and 14 that identifies an AP affiliated with the AP MLD based on that AP’s BSSID. (#19206)The link IDs that identify APs affiliated with an AP MLD shall starts from 0 and increase sequentially. Since the BSSID of each affiliated AP is different (see 35.3.2 (Multi-link device addressing)), an AP affiliated with an AP MLD shall not have the same link ID as another AP affiliated with the same AP MLD. The link ID associated with a specific BSSID shall not change for the lifetime of the BSS that is set up on the link associated with the link ID nor for the lifetime of any BSS of the other AP(s) affiliated with the same AP MLD.

NOTE - It is possible to have a gap in link ID sequence as a consequence of an affiliated AP being removed (by following the procedures in 35.3.6). When an AP MLD adds an affiliated AP (by following the procedures in 35.3.6), it assigns the lowest available link ID value. (#19206)