IEEE P802.11
Wireless LANs

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| CC34 Comment Resolution for 35.3.10.4 Traffic Indication  |
| Date: 2021-4-23 |
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Abstract

This submission proposes comment resolutions for the following CIDs related to 35.3.10.4 Traffic Indication in CC34:

CID

1432

1697

2135

2136

2153

2302

2341

2342

3149

3256

3322

3387

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Updated based on comments from the MAC call on April 26 (in green); changed the AID Offset to indicate an 11 bit AID value; added a guidance for AID assignments for non-EHT STAs, non-AP MLDs (default mode), and non-AP MLDs (non-default mode); clarified the Per-link Traffic Bitmap definition for the case when it is used for link recommendation.
* Rev 2: Removed the first editor’s note in r1; made editorial changes based on inputs from Abhi and Arik.
* Rev 3: Updated based on Arik’s follow up comments (in cyan).
* Rev 4: Removed the guidance for AID assignments and the two paragraphs on TPC and Link Measurement Request frames based on discussion in the MAC ad-hoc meeting on May 6 and offline discussions.
* Rev 5: Updated based on Guogang and Ming’s comments in the MAC ad-hoc meeting on May 10 and offline discussions. (in yellow)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause Number** | **Page.****Line** | **Comment** | **Proposed Change** | **Resolution** |
| 1432 | Chien-Fang Hsu | 35.3.10.4 | 140.36 | Is the recommendation for a specific TID or for all traffic? | the indication should carry information of TID or all traffic between the non-AP MLD and AP MLD. In addition to the indication, a protocol is required to define how to respond the recommendation. | Revised.As shown in the following sentence, “An AP MLD may recommend a non-AP MLD to use one or more enabled links,” an AP MLD recommends one or more enabled links.TGbe editor to make the changes with the CID tag (#1432) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 1697 | GEORGE CHERIAN | 35.3.10.4 | 140.36 | "The format of the indication is TBD."Resolve the TBD. | As in the comment | Revised.The details of the link recommendation have been added.TGbe editor to make the changes with the CID tag (#1697) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2135 | Laurent Cariou | 35.3.10.4 | 0.00 | Define how the traffic indication is done, in addition to current TIM, when non-default TID-mapping is used | as in comment | Revised.A procedure for multi-link traffic indication has been added.TGbe editor to make the changes with the CID tag (#2135) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2136 | Laurent Cariou | 35.3.10.4 | 0.00 | Define how the recommandation is provided in a broadcast manner | as in comment | Revised.A procedure for link recommendation in a broadcast manner has been added.TGbe editor to make the changes with the CID tag (#2136) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2153 | Laurent Cariou | 35.3.10.4 | 0.00 | "The format of the indication is TBD." The link recommendation is an important tool that we agreed for dynamic load balancing. Dynamic load balancing will be done with non-AP MLDs operating with default mapping (TIDs mapped to all links, all links enabled) and these non-AP MLDs will wake up on the link that they want to use and keep the other STAs in doze as desribed in 35.3.6.2. The link recommendation is the tool that the AP can use to recommand to steer the non-AP MLD to the link that, from what it knows (which is a partial information yet important), would be better for its operation. We need to define such link recommendation in a broadcast way and unicast way. For unicast, this can be in A-ctrl field or any other signaling. For Broadcast, the simplest would be to have a linkID bitmap for each non-AP MLD that can be included in beacons. And we need to clearly state that when this information is received, it is a recommendation ("should" statement) to wake up on the recommended link. | as in comment | Revised.A procedure for link recommendation in a broadcast manner has been added.TGbe editor to make the changes with the CID tag (#2153) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2302 | Michael Montemurro | 35.3.10.4 | 140.32 | If affiliated STAs of an non-AP MLD signal power-save mode independently (see 35.3.10.1), how does the AP MLD know when to buffer traffic? Presumably the AP MLD would buffer traffic when all links were in doze state. | Add requirements to explain that an AP MLD buffers traffic when all links for a non-AP MLD are in dose state. Explain any requirements associated to active and doze states relating to MLO. Ensure that TIM signaling is consistent with this behavior. | Revised.A sentence has been added to describe when the TIM bit of a non-AP MLD is set to 1.TGbe editor to make the changes with the CID tag (#2302) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2341 | Minyoung Park | 35.3.10.4 | 140.32 | When an AP MLD and a non-AP MLD have negotiated a TID-link mapping (non-default mapping), the current TIM element is inadequate to indicate to the non-AP MLD which AP(s) has buffered data, because a TIM bit indicates buffered BU at the MLD level. The AP MLD needs to indicate which AP has buffered data when the TID-link mapping is used. | Define a new element called Multi-link Traffic element that includes a link bitmap per non-AP MLD that indicates link(s) that have buffered data. | Revised.A new element and related procedures have been defined.TGbe editor to make the changes with the CID tag (#2341) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 2342 | Minyoung Park | 35.3.10.4 | 140.37 | The detail of how an AP MLD recommends one or more enabled links to a non-AP MLD is missing. | Define a signaling that an AP MLD can recommend one or more enabled links to a non-AP MLD. One way is to use the A-Control field of a frame from the AP MLD to include the recommended links. | Revised.A procedure for link recommendation in a broadcast manner has been added.TGbe editor to make the changes with the CID tag (#2342) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 3149 | Yongho Kim | 35.3.10.4 | 140.38 | Once an AP recommends a STA to use enabled links, the STA shall be able to choose links to wake up. It is necessary to define the procedure for a STA to choose links to wake up and letting the AP know the chosen links. | As in the comment. | Revised.A procedure for link recommendation in a broadcast manner has been added.TGbe editor to make the changes with the CID tag (#3149) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 3256 | Yuchen Guo | 35.3.10.4 | 140.36 | What's the purpose of this recommendation? Suggest to add "to retrieve pending buffer" or similar words at the end of the first sentence. | as in comment | Revised.Added a clarification to the sentence.TGbe editor to make the changes with the CID tag (#3256) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 3322 | Yunbo Li | 35.3.10.4 | 140.36 | "An AP MLD may recommend a non-AP MLD to use one or more enabled links." The sentence is broken, to use one or more enabled links for what? | Complete the sentence. E.g. to use one or more enbable links to receive buffered traffic. | Revised.Added a clarification to the sentence.TGbe editor to make the changes with the CID tag (#3322) in doc.: IEEE 802.11-21/0612r5[https://mentor.ieee.org/802.11/dcn/21/11-21-0612-05-00be-cc34-cr-tim-indication.docx] |
| 3387 | Zhou Lan | 35.3.10.4 | 140.33 | Please clarify if the TIM element on different link need to be identical or not. | As stated in the comment | Revised.The following change has been made in 35.3.10.2 (Basic BSS operation) in 802.11be D0.4: “An AP MLD shall assign a single AID to a non-AP MLD during multi-link setup (see 35.3.10.4 (Traffic indication)) and the traffic indication for the non-AP MLD shall be consistent across the Beacon frames transmitted by the APs affiliated with the AP MLD, that are operating on the links that are part of the multi-link setup.”No changes need. |

**35.3.10.4 Traffic indication**

An AP MLD shall assign a single AID to a non-AP MLD upon successful multi-link setup. All the STAs of the non-AP MLD shall have the same AID as the one assigned to the non-AP MLD during multi-link setup.

An AP MLD shall indicate pending buffered traffic for non-AP MLDs using partial virtual bitmap of TIM element in a Beacon frame as described in 9.4.2.5 (TIM element).

**TGbe Editor to make the changes to the following paragraph:**

An AP MLD may recommend a non-AP MLD to use one or more enabled links to retrieve individually addressed buffered BU(s).(#3256, 3322) The AP’s indication may be carried in a broadcast or a unicast frame. (#1697, 2153)

**TGbe Editor to add the following paragraphs at the end of Subclause 35.3.10.4 (Traffic indication): (#2135)**

An AP MLD shall buffer a BU with a TID at the AP MLD if the TID is not mapped to any link on which the corresponding STA of a non-AP MLD is in active mode, and it shall set the bit in the partial virtual bitmap of the TIM element that corresponds to the AID of the non-AP MLD to 1.(#2302)

TPC Request and Link Measurement Request frames are Measurement MMPDUs.

An AP MLD buffers an MMPDU that is not a Measurement MMPDU and intended for receipt by a STA affiliated with a non-AP MLD in the AP MLD when all STAs affiliated with the non-AP MLD are in PS mode. In this case, the bit in the partial virtual bitmap of the TIM element that corresponds to the AID of the non-AP MLD shall be set to 1.(#2302)

An AP affiliated with an AP MLD shall include the Multi-Link Traffic element (see 9.4.2.295d Multi-Link Traffic element) in a Beacon frame it transmits if at least one of the associated non-AP MLD has successfully negotiated a TID-link mapping (see 35.3.6.1.3 Negotiation of TID-to-link mapping) with the AP MLD and the AP MLD has buffered BU(s) for the non-AP MLD. The Multi-link Traffic element includes Per-link Traffic Indication Bitmap subfield(s) that corresponds to the AID(s) of the non-AP MLD(s), starting from the bit number *k* of the traffic indication virtual bitmap, in the Per-link Traffic Indication Bitmap List field. The AID Offset subfield of the Multi-Link Traffic Control field of the Multi-Link Traffic element contains the value *k*. The order of the Per-link Traffic Indication Bitmap subfield(s) follows the order of the bits that are set to 1 in the Partial Virtual Bitmap subfield of the TIM element that corresponds to the AID(s) of the non-AP MLD(s). If a non-AP MLD has successfully negotiated a TID-link mapping with an AP MLD with a non-default mapping, the bit position *i* of the Per-link Traffic Indication Bitmap subfield that corresponds to the link with the Link ID equals to *i* on which a STA of 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. If a non-AP MLD is in the default mapping mode (see 35.3.6.1.2 Default mapping mode), the bit position *i* of the Per-link Traffic Indication Bitmap subfield that corresponds to the link with the Link ID equal to *i* on which a STA affiliated with the non-AP MLD is operating may be set to 1 to indicate to the non-AP MLD a ~~recommended~~ link on which buffered BU(s) should be retrieved. An example of the construction of the Multi-Link Traffic element is shown in Figure 35-xyz1 (Example of Multi-Link Traffic element construction). (#1432, 1697, 2136, 2153, 2341, 2342, 3149)

When a non-AP MLD that is in the default mapping mode (see 35.3.6.1.2 Default mapping mode) detects that the bit corresponding to its AID is 1 in the TIM, any STA affiliated with the non-AP MLD may issue a PS-Poll frame, or a U-APSD trigger frame if the STA is using U-APSD and all ACs are delivery-enabled, to retrieve buffered BU(s) in the AP MLD.

When a non-AP MLD that is in the default mapping mode (see 35.3.6.1.2 Default mapping mode) detects that the bit corresponding to its AID is 1 in the TIM and the Multi-link Traffic element is present in a Beacon frame, any STA affiliated with the non-AP MLD that operates on the link(s) indicated in the Multi-Link Traffic element should issue a PS-Poll frame, or a U-APSD trigger frame if the STA is using U-APSD and all ACs are delivery-enabled, to retrieve buffered BU(s) in the AP MLD.

When a non-AP MLD that has successfully negotiated TID-to-link mapping (see 35.3.6.1.3 Negotiation of TID-to-link mapping) detects that the bit corresponding to its AID is equal to 1 in the TIM and any bit of the Per-link Traffic Indication Bitmap subfield that corresponds to a link on which a STA affiliated with the non-AP MLD is operating is equal to 1 in the Multi-Link Traffic element, the STA affiliated with the non-AP MLD that operates on that link may issue a PS-Poll frame, or a U-APSD trigger frame if the STA is using U-APSD and all ACs are delivery-enabled, to retrieve buffered BU(s) from the AP MLD. ~~When a non-AP MLD detects that the bit corresponding to its AID is equal to 1 in the TIM and the Per-link Traffic Indication Bitmap subfield of the Multi-Link Traffic element is set to all 0s for that non-AP MLD, any STA affiliated with the non-AP MLD may issue a PS-Poll frame, or a U-APSD trigger frame if the STA is using U-APSD and all ACs are delivery-enabled, to retrieve buffered BU(s) from the AP MLD.~~ (#2341)

When an AP affiliated with an AP MLD receives a PS-Poll frame or a U-APSD trigger frame from a STA affiliated with an associated non-AP MLD that is in PS mode, it shall transmit buffered BU(s) to the STA, if one is available and not discarded for implementation dependent reasons, otherwise it may transmit a QoS Null frame.

If a buffered BU is an MMPDU that is intended for one STA affiliated with a non-AP MLD and that is not a Measurement MMPDU, and if it is transmitted on a link where another STA affiliated with the same non-AP MLD is operating on, following the procedure above, the frame shall carry information to determine the intended destination STA affiliated with the non-AP MLD.



**Figure 35-xyz1—Example of Multi-Link Traffic element construction**

**9.4.2.295d Multi-Link Traffic element (#2341)**

The Multi-Link Traffic element contains a list of per-link traffic indication bitmap(s) for non-AP MLD(s).

The Multi-Link Traffic element is defined in Figure 9-xyz1 (Multi-Link Traffic element format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Multi-Link Traffic Control | Per-link Traffic Indication List |
| Octets: | 1 | 1 | 1 | 2 | variable |

**Figure 9-xyz1—Multi-Link Traffic element format**

The Element ID, Length, and Element ID Extension fields are defined in 9.4.2.1 (General).

The Multi-Link Traffic Control is defined in Figure 9-xyz2 (Multi-Link Traffic Control field format)

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 B3 | B4 B14 | B15 |
|  | Bitmap Size | AID Offset | Reserved |
| Bits: | 4 | 11 | 1 |

**Figure 9-xyz2—Multi-Link Traffic Control field format**

The Bitmap Size subfield indicates the size of each Per-link Traffic Indication Bitmap subfield, in bits. The subfield is encoded to *m*, where (*m* + 1) is the size of the Per-link Traffic Indication Bitmap subfield. A value of 0 in the Bitmap Size subfield is reserved.

The AID Offset subfield indicates a bit numbered *k* of the traffic indication virtual bitmap.

The Per-link Traffic Indication List field is defined in Figure 9-xyz3 (Per-link Traffic Indication List field format). The Per-link Traffic Indication List field contains Per-link Traffic Indication Bitmap subfields that correspond to the AIDs of the non-AP MLDs starting from the bit numbered *k* of the traffic indication virtual bitmap. The Per-link Traffic Indication List field contains *l* Per-link Traffic Indication Bitmap subfields, where *l* is the number of the bits that correspond to the AIDs of the non-AP MLDs set to 1, counting from the bit numbered *k* of the traffic indication virtual bitmap, in the Partial Virtual Bitmap field of the TIM element that is included in a Beacon frame with the Multi-Link Traffic element.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | Per-link Traffic Indication Bitmap 1 | … | Per-link Traffic Indication Bitmap n | Padding |
| Bits: | m+1 |  | m+1 | variable (0-7) |

**Figure 9-xyz3—Per-link Traffic Indication List field format**

The Per-link Traffic Indication Bitmap subfield is defined in Figure 9-xyz4 (Per-link Traffic Indication Bitmap field format). Each Per-link Traffic Indication Bitmap subfield indicates per-link traffic indications for a non-AP MLD that has negotiated a TID-link mapping with an AP MLD or link recommendation for a non-AP MLD that is in the default mapping mode.

|  |  |
| --- | --- |
|  | B0 Bm |
|  | Per-link Traffic Indication Bitmap |
| Bits: | m+1 |

**Figure 9-xyz4—Per-link Traffic Indication Bitmap subfield format**

Each bit in the Per-link Traffic Indication Bitmap subfield corresponds to a link on which a STA affiliated with a non-AP MLD is operating, with the bit position *i* of the bitmap, B*i*, corresponding to a link with Link ID equal to *i*. When the Per-link Traffic Indication Bitmap subfield corresponds to a non-AP MLD that has successfully negotiated TID-to-link mapping, a value of 1 in the bit position *i* in the bitmap 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). When the Per-link Traffic Indication Bitmap subfield corresponds to a non-AP MLD that is in the default mapping mode, a value of 1 in the bit position *i* in the bitmap indicates that the link with the Link ID equal to *i* is recommended for retrieving buffered BU(s).

The Padding subfield contains 0–7 padding bits so that the length of the Per-link Traffic Indication List field is a multiple of 8 bits. The padding bits are set to 0.