IEEE P802.11
Wireless LANs

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| LB275 CR for TID-To-Link Mapping Mode 2  |
| Date: August 21, 2023 |
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 Abstract

This submission proposes resolutions for following CIDs received for TGbe LB275:

19369, 20038, 19597, 19598, 20009

**Revisions:**

* Rev 0: Initial version of the document.
* Rev 1: Changes based on offline feedback.
* Rev 2: Added more discussion text and summarized answers to members questions in the discussion section. Added CID 20009.
* Rev 3: Editorial fixes and revision to discussion.
* Rev 4: Fixed CID tags to avoid any confusion.

***TGbe editor: The baseline for this document is 11be D4.0.***

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 | Clause | Page | Comment | Proposed Change | Resolution |
| 19369 | Brian Hart | 9.4.2.312.2.3 | 252.29 | While TTLM mode 3 remains important for some use cases, "TTLM mode 2" seems to be even more important. | Add TTLM mode 2 - i.e., M links with all TIDs mapped, N links with some TIDs mapped | RevisedAgree with the commenter. Added text to support TTLM mode 2.TGbe editor, please make the changes tagged by CID #19369 in 11-23/1468r4. |
| 20038 | Binita Gupta | 35.3.7.2.1 | 520.19 | TTLM Mode 2 is important for prioritizing QoS traffic by enabling mapping of a subset of TIDs carrying QoS traffic with high performance requirements to a link set. | Add procedures related to TTLM Mode 2 here and in other TTLM clauses. Commenter will bring a contribution. | RevisedAgree with the commenter. Added text to support TTLM mode 2.TGbe editor, please make the changes tagged by CID #19369 in 11-23/1468r4. |
| 19597 | Hanqing Lou | 9.4.2.312.2.3 | 252.29 | what is the difference between TTLM Negotiation Support field set to 0 and 1? An MLD mandatorily supports link management procedure with default TTLM. Value 0 here is no use | Change value 0 to reserved. | RevisedThe value 0 for TTLM Negotiation Support field indicates that the MLD does not support TTLM negotiation as defined in clause 35.3.7.2 (TTLM). Yes, the MLD supports default TTLM always, but that does not imply that it supports or does not support TTLM negotiation. Value 0 explicitly indicates not support TTLM negotiation. The text is revised to add ‘negotiation’ to clarify.TGbe editor, please make the changes tagged by CID #19597 in 11-23/1468r4. |
| 19598 | Hanqing Lou | 9.4.2.312.2.3 | 253.32 | When TTLM Negotiation Support is set to 2 it means reserved. This sentence implies the reserved value has some special meaning. For example, following this rule, if TTLM Negotiation Support is set to 2 it means it support TTLM default mapping? Then why should the STA set the value to 2 instead of 1? | Rewrite the Note and make it reasonable. | RevisedThe definition for value 2 has been added, and the defined TTLM negotiation functionality for value 2 is in addition to what is supported by value 1. This is what is explained in the NOTE. TGbe editor, please make the changes tagged by CID #19598 in 11-23/1468r4. |
| 20009 | Binita Gupta | 9.4.2.312.2.3 | 252.29 | TID-To-Link Mapping Mode 2 (value 2) has been discussed before in the group, where all TIDs map to m links and some TIDs map to n links (or 1 link). Such a mode is important for prioritizing specific TIDs for QoS differentiation. | Add TID-To-Link Mapping Mode 2. Commenter will bring a contribution. | RevisedAgree with the commenter. Added text to support TTLM mode 2.TGbe editor, please make the changes tagged by CID #19369 in 11-23/1468r4. |

Discussion:

TTLM mode 2, where a subset of TIDs (at the AC level granularity) are mapped to one link and all TIDs are mapped to remaining setup links for DL and UL, is important to enable mapping high QoS TIDs to one link to prioritize and reduce congestion for high QoS/low latency traffic flows. This CR doc provides a proposal for enabling individual negotiation for TTLM mode 2. The mode 2 mapping may be accepted based on non-AP MLD setting up an SCS stream for high QoS traffic flow for one of those TIDs mapped to the mode 2 link. A Status Code is added for the AP MLD to indicate this specific condition. Further, to minimize Beacon bloating, the rules for inclusion of Multi-Link Traffic Indication element are revised so that this element is not included in the Beacon when AP MLD uses TTLM mode 2 negotiation for one or more non-AP MLDs.

Note that the TTLM mode 3 is defined in the current draft spec, but it is more complex to implement for following reasons.

* Mode 3 requires supporting mapping of any TID to any link, at the TID level (not at the AC level), which is more complex to implement on the STA and the AP since TIDs of an AC may be split across links. Mode 2 maps all the TIDs of an AC to the same link and only allows mapping subset of TIDs to one of the links, providing a simpler solution.
* With mode 3, the STA needs to implement more complex logic of waking up on specific links to retrieve buffered BUs for specific TIDs based on negotiated mode 3 TTLM vs in mode 2 STA can have a simpler logic of waking up on one of the links which maps all TIDs.
* With mode 3, when TIDs get mapped to a subset of links, the AP MLD needs to include the Multi-Link Traffic Indication element in the Beacon, which could lead to Beacon bloating. With mode 2, since all TIDs are mapped to at least one link, the non-AP MLD can wake up on that link to retrieve BUs and the AP MLD does not need to include MLTI element in the Beacon frame, avoiding Beacon bloating concern. Note: there is a proposal made to separate MLTI element into a separate MLTI frame to address Beacon bloating issue from MLTI. However, in the absence of that this concern remains.

Hence, it is more complex to implement TTLM mode 3. TTLM mode 2 proposed here provides a simpler solution to enable prioritization for high QoS/low latency traffic flows on one of the links.

Also, summarizing below answers to member comments/questions on this TTLM mode 2 proposal:

**Question1:** TTLM mode 2 is harder to implement for single-radio devices, since these devices will mostly wake up on one of the links which map all TIDs, and hence may not use the link which maps a subset of TIDs that much.

**Answer1:** Single-radio devices can support implementation specific logic to determine when to switch to the link where a subset of TIDs is mapped in TTLM mode 2 to take advantage of the less congested link. Also, if theses devices do not intend to support mode 2, they can just declare support for mode 1 and AP MLD will not negotiate mode 2 mapping with these devices. Support for mode 2 is optional. The AP MLD can use TTLM to move devices which do not support mode 2 (and only support mode 1) in and out of the high-QoS link as needed.

**Question2:** AP can use bad EDCA/MU-EDCA parameter values on the specific high-QoS link for low TIDs (which are not high-QoS TIDs), to deprioritize traffic for those TIDs, instead of using TTLM mode 2.

**Answer2:** The AP MLD will support association for all types of devices over its links, including the high-QoS link. It is not desirable to fail client association for high-QoS link. As needed, AP can move clients to other links/bands using BTM steering. Using bad EDCA/MU-EDCA parameters for low TIDs on the specific link would also affect legacy devices (pre-11be devices) behavior, and it is preferred to not impact legacy devices as Wi-Fi 7 is being deployed. The AP would explicitly determine to move legacy devices to other links if needed. Hence using bad EDCA/MU EDCA parameters for low TIDs is not a preferred way in enterprise deployments.

**Question3:** How does the STA determine to wake up on the high-QoS link, without MLTI indicating which link the traffic should be retrieved from for high-QoS TIDs, since these TIDs are also mapped to other links?

**Answer3**: For low-latency traffic delivered over high-QoS TIDs, a STA would have SCS session setup or an R-TWT schedule setup with the AP, and based on either of those the STA can determine to wake up on the link which has high QoS TIDs mapped. For best effort traffic the STA can determine to wake up on one of the links which maps all TIDs.

**Question4:** Mapping only a subset of TIDs to a link could lead to lower utilization of that link capacity.

**Answer4:** The AP MLD can renegotiate TTLM mode 2 to map more TIDs to a link if it sees that the link is underutilized. The AP MLD can also allow devices supporting mode 1 on the high-QoS link if the link is underutilized.

**9.4.1.9 Status Code field**

***TGbe editor: Please add new status codes in the Table as shown below (#19369).***

**Table 9-78—Status codes**

|  |  |  |
| --- | --- | --- |
| **Status code** | **Name** | **Meaning** |
| … | … | … |
| <Next available> | DENIED\_TID\_TO\_LINK\_MAPPING\_SCS\_SETUP\_REQUIRED  | Requested TTLM is denied by the AP because to map a strict subset of TIDs to one of the links the initiating MLD needs to have an SCS stream setup for one of those TIDs. |

**﻿9.4.2.312.2.3 Common Info field of the Basic Multi-Link element**

***TGbe editor: Please update following Table as shown below (#19369).***

**Table 9-404j—Subfields of the MLD Capabilities And Operations subfield**

|  |  |  |
| --- | --- | --- |
| **Subfield** | **Definition** | **Encoding** |
| … | … | … |
| TID-To-Link Map- ping Negotiation Sup- port | Indicates support for TTLM negotia- tion. | Set to 0 if dot11TIDtoLinkMappingActivated is false and TTLM (#19597)negotiation is not supported by the MLD.Set to 1 if dot11TIDtoLinkMappingActivated is true and the MLD only supports the map- ping of all TIDs to the same link set, both for DL and UL.(#19369)(#19369)(#19598)Set to 2 if dot11TIDtoLinkMappingActivated is true and the MLD supports the mapping of a non-empty strict subset of TIDs to one of the links and the mapping of all TIDs to the remaining enabled links, both for DL and UL. TIDs of the same AC are mapped to the same link set.Set to 3 if dot11TIDtoLinkMappingActivated is true and the MLD supports the mapping of each TID to the same or different link set.See NOTE.(See 35.3.7.2.3 (Negotiation of TTLM)) |

**35.3.7.2.3 Negotiation of TTLM**

***TGbe editor: Please add following paragraph after 2nd paragraph in this subclause (#19369).***

If the TID-To-Link Mapping Negotiation Support subfield value received from a peer MLD is equal to 2, the MLD that initiates a TTLM negotiation with the peer MLD shall send only the TID-To-Link Mapping element where a non-empty strict subset of TIDs is mapped to one of the setup links and all TIDs are mapped to the remaining setup links which are enabled, both for DL and UL, or where all TIDs are mapped to the same link set, both for DL and UL.

***TGbe editor: Please modify 5th paragraph in this subclause and add NOTE as shown below(#19369).***

Upon receiving the individually addressed TID-To-Link Mapping Request frame, the responding MLD shall send an individually addressed TID-To-Link Mapping Response frame through an affiliated STA, on any enabled link, to the initiating MLD according to the following rules:

* If the responding MLD accepts the requested TTLM in the TID-To-Link Mapping element in the received TID-To-Link Mapping Request frame, it shall set to 0 (SUCCESS) the Status Code field in the TID-To-Link Mapping Response frame and not include the TID-To-Link Mapping element in the frame.
* Otherwise, the responding MLD shall indicate rejection of the proposed TTLM by either:
	+ Setting to 133 (DENIED\_TID\_TO\_LINK\_MAPPING) the Status Code in the TID-To-Link Mapping Response frame. The responding MLD shall not include the TID-To-Link Mapping element in the frame.
	+ Setting to 134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED) the Status Code field in the TID-To-Link Mapping Response frame. The responding MLD shall include a preferred mapping in the TID-To-Link Mapping element in the frame.
	+ Setting to xx (DENIED\_TID\_TO\_LINK\_MAPPING\_SCS\_SETUP\_REQUIRED) the Status Code field in the TID-To-Link Mapping Response frame if the TID-To-Link Mapping Request frame included mapping a strict subset of TIDs to one of the links. The responding MLD shall not include the TID-To-Link Mapping element in the response frame.

NOTE: An initiating MLD upon receiving a TID-To-Link Mapping Response frame with the Status Code field set to DENIED\_TID\_TO\_LINK\_MAPPING\_SCS\_SETUP\_REQUIRED, can send the same TID-To-Link Mapping Request frame after it has established an SCS stream, for one of the TIDs mapped on the link which has a subset of TIDs mapped in the requested TTLM.

﻿**35.3.7.2.4 Advertised TTLM in Beacon and Probe Response frames**

***TGbe editor: Please modify 16th paragraph in this subclause as shown below (#19369).***

﻿A non-AP MLD shall not transmit a response frame to acknowledge the reception of an advertised TTLM. However, a non-AP MLD may initiate a negotiation of a TTLM that maps TIDs to a subset of the enabled links of the advertised TTLM by transmitting a TID-To-Link Mapping Request frame as per the procedure described in 35.3.7.2.3 (Negotiation of TTLM).

**35.3.12.4 Traffic indication**

 ***Tgbe editor: Please modify 6th paragraph in this subclause as shown below (#19369).***

An AP affiliated with an AP MLD shall include the Multi-Link Traffic Indication element (see 9.4.2.315 (Multi-Link Traffic Indication element)) in a Beacon frame it transmits if all the following conditions are met:

* At least one of the associated non-AP MLDs has successfully negotiated a TTLM (see [35.3.7.2.3](#bookmark39) [(Negotiation of TTLM)](#bookmark39)) with the AP MLD for DL or bidirectional traffic and all TIDs are not mapped to at least one enabled link
* The AP MLD has buffered BU(s) with TID(s) that are not mapped to the enabled link(s) where all the TIDs are mapped for the non-AP MLD(s).

***TGbe editor: Please modify 19th paragraph in this subclause as shown below (#19369).***

An AP MLD shall set dot11MultiLinkTrafficIndicationActivated to true if any of the following conditions is met:

* There is at least one associated non-AP MLD that does not have all TIDs mapped to at least one enabled link, and the AP MLD has buffered BU(s) with TID(s) that are not mapped to the enabled link(s) where all the TIDs are mapped for that non-AP MLD.
* 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.

Otherwise, the AP MLD shall set dot11MultiLinkTrafficIndicationActivated to false.

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