IEEE P802.11
Wireless LANs

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| MLD Load Balancing Using TID to Link Mapping  |
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Abstract

Proposed draft text for enhancements to TID mapping.

The submission proposes text changes to resolve CID 14055, 10488, 11106, 11108, 11763, and ~~12632~~ from LB266. All proposed changes are based on 802.11be Draft 2.1.

Please see discussion notes below for a review of introduced changes.

# Revision History

|  |  |  |
| --- | --- | --- |
| **Date** | **Revision** | **Changes** |
| 2022-09-06 | 0 | Initial draft |
| 2022-09-09 | 1 | AID list negotiation moved from Beacons to broadcast addressed frames. Added rule for TWT suspension after disablement. Two new CIDs, new authors, clarifications  |
| 2022-09-15 | 2 | New CIDs added. Revised author list. Adding that priority 1 should only be used when necessary. Groupcast negotiation simplified. Added broadcast TWT suspension rule to disabled links.  |
| 2022-10-09 | 3 | Removed group negotiation  |
| 2022-10-12 | 4 | minor |

# LB266 Comments and discussion [against Draft 2.0]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **P.L** | **Clause** | **Comment** | **Proposed Change** | **Proposed Resolution** |
| 14055 | 427.05 | 35.3.7.1 | There are situations in which performing load balancing between links by an AP becomes vital to the operation of an 802.11 network. The spec needs an enforceable and flexible mechanism to perform load balancing between links | Introduce a load balancing mechanism, preferably by extending TID to Link Mapping | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #14055. |
| 10488 | 427.07 | 35.3.7.1 | TID-to-link mapping as defined is useless for Enterprise. For 802.11be to support Enterprise use cases, it is required to have the following enhancements:- Introduce a priority level in TID-to-link mapping negotiations- Define "enhanced TID to link subset" mapping capability- Introduce a method for both non-AP STAs and APs to identify reasons for TID mapping changes- Add scalable TID-to-link mapping mechanisms (broadcast advertisement and group-negotiation) | as in comment | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #14055.Note: an “enhanced TID to link subset mapping” is defined in document 22/1510.  |
| 12632 | 430.25 | 35.3.7.1.5 | It is not clear why in case of disabled link for non-AP MLD, the individual TWT agreements are automatically deleted? This is opposed to REVme D1.0 section 26.8.4.2 which enables to suspend the individual TWT agreement under some circumstances. Please add the option to suspend the individual TWT agreement for a disabled link | Following the method used in REVme D1.0 section 26.8.4.2, if the non-AP STA affiliated with non-AP MLD,  need to add indication in the TWT Information frames that should indicate the suspension of TWT agreement during the disablement link periodThis indication is applicable for EHT non-AP STA affiliated with non-AP MLD. | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #12632. |
| 11106 | 429.15 | 35.3.7.1.3 | When a STA can just decline a neg for almost any reason, we know from experience that the neg will rarely succeed in the field, even if it helps the collective experience of all STAs in the area . | Given the AP is most responsible and most able to improve the collective experience of all STAs in an area, ensure the AP can enforce a T2LM neg. At the same time non-AP STAs (and APs) have constraints that need to be considered and addressed: they need to be able express their constraints and to propose alteratives, and for these constraints and alternative to be taken into account by the AP. Incorporate these considerations into the T2LM feature. | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #14055. |
| 11108 | 429.17 | 35.3.7.1.3 | PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED is a very opaque status code:. Preferred for what reason? Are the reasons different for different links? | Add richer and per-link status/reason codes. | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #14055. |
| 11763 | 267.49 | 9.6.35.3 | TID-to-link mapping is versatile tool which can be used in multiple use cases. The reason code for an MLD to reject a proposed mapping by its peer MLD should be descriptive enough in each of the myriad use cases that the peer MLD can understand why the mapping was rejected and can propose a better mapping. | Extend the status code field to more reason codes to address more use cases. | Resolution: Revised, please implement the changes as shown in document 22/1509r[motioned revision] marked #14055. |

**Discussion:**

This document addresses the problem of load balancing between different links of an AP MLD. To mitigate excess collisions in high scale environments with a large number of STAs contending, the AP must have a reliable mechanism to balance loads among its links.

This contribution introduces:

* A priority level to TID to link mapping request frames, using which an AP can indicate the urgency of the request.
* Specific reason codes for the request are also introduced for individual negotiation.
* A period of time allocated to allow for acceptance of the request or negotiation of an alternate mapping in case the proposed mapping is undesirable for the non-AP recipient of the request.

TGbe editor: Modify section 9.4.2.314 as shown below (#14055):

### **9.4.2.314 TID-To-Link Mapping element**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | TID-To-Link Mapping Control | Mapping Switch Time | Expected Duration |

 Octets: 1 1 1 1 or 2 0 or 2 0 or 3

|  |  |  |  |
| --- | --- | --- | --- |
| Link Mapping Of TID 0(Optional) | … | Link Mapping Of TID 7(Optional) | Link Reason Code List(Optional)) |

 Octets: 0 or 2 0 or 2 Variable

**Figure 9-1002am—TID-To-Link Mapping element format**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 | B3 | B4 | B5 | B6 B7 | B8 |  | B15 |
| Direction | Default Link Mapping | Mapping Switch Time Present | Expected Duration Present | Priority | Reserved | Link Mapping Presence Indicator (Optional)  |
| Bits: | 2 | 1 | 1 | 1 | 1 | 3 |  | 0 or 8 |  |

**Figure 9-1002an—TID-To-Link Mapping Control field format**

The Default Link Mapping subfield is set to 1 if the TID-To-Link Mapping element represents the default TID-to-link mapping. Otherwise, it is set to 0.

The Mapping Switch Time Present subfield is set to 1 if the Mapping Switch Time field is present and 0 otherwise.

The Expected Duration Present subfield is set to 1 if the Expected Duration field is present and 0 otherwise.

The Priority subfield indicates the priority level for the proposed Link Mapping and is interpreted according to Table 9-xx1 when the TID-To-Link Mapping element is carried in a frame other than the TID-To-Link Mapping Response frame, and according to Table 9-xx2 when the TID-To-Link Mapping element is carried in a TID-To-Link Mapping Response frame.

The Link Mapping Presence Indicator subfield indicates whether the Link Mapping Of TID n field is present

in the TID-To-Link Mapping element (i.e., it identifies the TID(s) for which the mapping is provided in the

element). A value of 1 in bit position n of the Link Mapping Presence Indicator subfield indicates that the

Link Mapping Of TID n field is present in the TID-To-Link Mapping element. Otherwise, the Link Mapping

Of TID n field is not present in the TID-To-Link Mapping element. When the Default Link Mapping subfield is set to 1, this subfield is not present.

The Mapping Switch Time field is present when the TID-To-Link Mapping element is transmitted by an AP affiliated with an AP MLD in a Beacon or Probe Response frame, and the indicated advertised TID-to-Link mapping is not yet established. The Mapping Switch Time field may be present when the TID-To-Link Mapping element is transmitted by an AP affiliated with an AP MLD in a TID-To-Link Mapping Request frame. Otherwise, the Mapping Switch Time field is not present. The absence of Mapping Switch Time field in the TID-To-Link Mapping element in a Beacon or Probe Response frame transmitted by an AP affiliated with an AP MLD indicates that the indicated TID-to-Link mapping is already established. The 2 octet Mapping Switch Time field has units of TUs and is set to the time at which the the new mapping is established using as a timebase the value of the TSF corresponding to the BSS identified by the BSSID of the frame containing the TID-To-Link Mapping element: i.e., bits 10 to 25 of the TSF or rem(floor(TSF / 1024), 65536)) of that time.

The Expected Duration field indicates the duration for which the proposed TID-to-link Mapping is expected to be effective in units of TUs when the Mapping Switch Time field is present, and the remaining duration for which the proposed TID-to-link Mapping is expected to be effective in units of TUs when the Mapping Switch Time field is not present. The Expected Duration field is present if the TID-To-Link Mapping element is carried in a Beacon or a Probe Response frame transmitted by an AP affiliated with an AP MLD, and is not present otherwise.

**Table 9-xx1 —Priority subfield carried in a frame other than the TID-To-Link Mapping Response frame**

|  |  |  |  |
| --- | --- | --- | --- |
|  **Priority Subfield** | **Carried in a Beacon or Probe Response Frame** | **Carried in a (Re)Association Response Frame** | **Carried in a (Re)Association Request or a TID-To-Link Mapping Request Frame**  |
| 0 | N/A | Prefer to change | Prefer to change |
| 1 | Mandatory | Mandatory (See Note 1) | Strongly prefer to change |
| Note 1— Priority 1 is used in (Re)Association Response frames only when the AP MLD is advertising a TID-to-link mapping scheme. See 35.3.7.1.8 Association Procedures for TID-to-link mapping for further details. |

**Table 9-xx2 —Priority subfield carried in a TID-To-Link Mapping Response frame**

|  |  |  |  |
| --- | --- | --- | --- |
| **Priority Subfield** | **Link Mapping Presence Indicator subfield** | **Status Code** | **Description** |
| 0 | All 0 | 133 (DENIED\_TID\_TO\_LINK\_MAPPING) | Prefer not to change |
| 1 | All 0 | 133 (DENIED\_TID\_TO\_LINK\_MAPPING) | Strongly prefer not to change |
| 0 | At least one 1 | 134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED) | This TID-To-Link Mapping element specifies a preferred TID-to-link mapping to be suggested.  |
| 1 | At least one 1 | 134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED) | This TID-To-Link Mapping element specifies a strongly preferred TID-to-link mapping to be suggested.  |

The Link Mapping Of TID n field (where n= 0, 1… 7 ) indicates the link(s) on which frames belonging to the TID n are allowed to be sent (i.e., carries a bitmap of the links to which the TID n is mapped to). A value of 1 in bit position i (where i = 0, 1…14 ) of the Link Mapping Of TID n field indicates that TID n is mapped to the link associated with the link ID i for the direction as specified in the Direc- tion subfield. A value of 0 in bit position i indicates that the TID n is not mapped to the link associated with the link ID i. When the Default Link Mapping subfield is set to 1, this field is not present.

The Link Reason Code List field indicates a Reason Code associated with a link in a TID-to-link mapping negotiation. This field is present in TID-To-Link Mappingelements transmitted by an AP affiliated with an AP MLD except when the TID-To-Link Mapping element is carried in a Beacon frame or when the AP MLD sets the Default Link Mapping subfield of the TID-To-Link Control field to 1. This field is present in all TID-To-Link Mapping elements with Priority subfield set to1 transmitted by a STA affiliated with a non-AP MLD, except when the non-AP MLD sets the Default Link Mapping subfield of the TID-To-Link Control field to 1. The Link Reason Code List field may be present when transmitted by a STA affiliated with a non-AP MLD with Priority subfield set to 0 or with the Default Link Mapping subfield set to 0. The Link Reason Code List field is not present when carried in a Beacon frame. The format of the Link Reason Code List field is defined in Figure 9-1002ab (Link Reason Code List field format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Link Reason Code Presence Indicator | Link 1 Reason Code  | Link 2 Reason Code  | … | Link m Reason Code  | Padding |
| Bits: | 16 | 4 | 4 |  | 4 | 0 or 4 |

**Figure 9-1002ab—** **Link Reason Code List field format**

The Link Reason Code Presence Indicator subfield indicates the links for which a Link Reason Code subfield is present. In bit position n of the Link Reason Code Presence Indicator subfield, a value of 1indicates that the Link Reason Code subfield is present for the link associated with the link ID n. Otherwise, the Link Reason Code subfield for the link associated with link ID n is not present.

Each Link x Reason Code subfield indicates the Reason Code for a link that has a corresponding bit set to 1 in the Link Reason Code Presence Indicator subfield, in increasing order of link ID.

Table 9-xx3 lists the Reason Codes transmitted by APs. Table 9-xx4 lists the Reason Codes transmitted by non-APs.

The Padding subfield contains either 0 or 4 bits so that the length of the Link Reason Code List field is a multiple of 8 bits. The padding bits, if present, are set to 0.

**Table 9-xx3 — Encoding of the Link x Reason Code field when transmitted by an AP**

|  |  |  |
| --- | --- | --- |
| Value  | Reason Code | Description  |
| 0 | OPERATIONS ADMIN\_MAINTENANCE | The TID-to-link mapping is requested due to operations, administration, and maintenance.  |
| 1 | REGULATORY RELATED  | The TID-to-link mapping is requested due to regulatory related measurements and restrictions.  |
| 2 | LOW RATE  | The recipient STA affiliated with a non-AP MLD has a poor transmission rate. The STA consumes too much medium time on the link. |
| 3 | QOS RELATED | The link is exclusively intended for traffic with QoS requirements.   |
| 4 | CHANNEL LOAD  | The BSS load is too high.  |
| 5 | COEXISTENCE, INTERNAL | Operation is impacted due to internal coexistence. |
| 6 | COEXISTENCE, EXTERNAL | Operation is impacted due to external coexistence. |
| 7 | R\_TWT ENABLED | R-TWT is enabled for this BSS |
| 8-14 | Reserved |  |
| 15 | OTHER\_REASON | An AP has another reason for the TID-to-link mapping.  |

**Table 9-xx4 — Encoding of the Link Reason Code field when transmitted by a non-AP**

|  |  |  |
| --- | --- | --- |
| Value  | Reason code | Description |
| 0 | POWER SAVING  | The STA intends to save power and disable the link.  |
| 1 | POOR RSSI | The STA has transmission range issues and cannot operate the link efficiently. |
| 2 | TRAFFIC THROUGHPUT | The STA prefers the link for higher throughput. |
| 3 | HIGH QOS REQUIREMENT | The STA prefers to have the link to ensure that the traffic QoS requirements are met. |
| 4 | R\_TWT | The STA prefers the link for r-TWT operation |
| 5 | PREFERRED LINK  | The STA prefers to receive DL frames and UL triggers frames primarily on this link. The non-AP STA anticipates being most often awake on this link. |
| 6 | COEXISTENCE, INTERNAL | The STA is experiencing an unacceptable level of interference on the link due to internal coexistence issues  |
| 7 | COEXISTENCE EXTERNAL | The STA is experiencing an unacceptable level of interference on the link due to external co-existence issues. |
| 8-15 | Reserved  |  |

9.6.35 Protected EHT Action frame details

TGbe editor: Modify section 9.6.35.2 as shown below (#14055):

### **9.6.35.2 TID-To-Link Mapping Request frame format**

**Table 9-623e—TID-To-Link Mapping Request frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | Dialog Token |
| 4 | TID-To-Link Mapping (see [9.4.2.314 (TID-To-Link Mapping](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark159) [element)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark159)) |

The Category field is defined in 9.4.1.11 (Action field).

The Protected EHT Action field is defined in 9.6.35.1 (Protected EHT Action field).

The Dialog Token field is set to a value chosen by the STA sending the TID-To-Link Mapping Request frame to identify the request/response transaction.

The TID-To-Link Mapping field contains one or two TID-To-Link Mapping elements as specified in

9.4.2.314 (TID-To-Link Mapping element). When it contains two TID-To-Link Mapping elements, the Direction subfield in one of the TID-To-Link Mapping elements is set to 0 and the Direction sub- field in the other of the TID-To-Link Mapping elements is set to 1.

TGbe editor: Modify section 9.6.35.3 as shown below (#14055):

### **9.6.35.3 TID-To-Link Mapping Response frame format**

The TID-To-Link Mapping Response frame is sent by a STA affiliated with an MLD in response to a TID-To- Link Mapping Request frame to accept or reject a proposed TID-to-link mapping, or sent by a STA affiliated with an MLD to suggest a preferred TID-to-link mapping. The Action field of the TID-To-Link Mapping Response frame contains the information shown in [Table 9-623f (TID-To-Link Mapping Response frame](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark194) [Action field format)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark194).

**Table 9-623f—TID-To-Link Mapping Response frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | Dialog Token |
| 4 | Status Code |
| 5 | TID-To-Link Mapping (see [9.4.2.314 (TID-To-Link Mapping](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark159) [element)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark159)) |

The Category field is defined in [9.4.1.11 (Action field)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark71).

The EHT Action field is defined in [9.6.34.1 (EHT Action field)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark186).

When the TID-To-Link Mapping Response frame is transmitted as a response to a TID-To-Link Mapping Request frame, the Dialog Token field is the value in the corresponding TID-To-Link Mapping Request frame. When the TID-To-Link Mapping Response frame is transmitted as an unsolicited response, then the Dialog token is set to 0.

The Status Code is defined in [9.4.1.9 (Status Code field)](file:///C%3A%5CUsers%5Cpmonajem%5CDocuments%5CDocs%5CIEEE%20802.11%5C11be%5CSource%5CTGbe_Cl_09.doc#bookmark69).

The TID-To-Link Mapping field contains zero, one, or two TID-To-Link Mapping elements as specified in

9.4.2.314 (TID-To-Link Mapping element) in order to suggest a preferred mappingcontains one or two TID-To-Link Mapping elements if the Status Code is set to 134 (PREFERRED\_TID\_TO\_LINK\_MAP- PING\_SUGGESTED). Otherwise, it does not contain a TID-To-Link Mapping element. When it contains two TID-To-Link Mapping elements, the Direction subfield in one of the TID-To-Link Mapping elements is set to 0 (Downlink) and the Direction subfield in the other of the TID-To-Link Mapping elements is set to 1 (Uplink).

### 35.3.7.1 TID-to-link mapping

TGbe editor: Modify section 35.3.7.1.1 as shown below (#12632):

### 35.3.7.1.1 General

The TID-to-link mapping mechanism allows an AP MLD and a non-AP MLD that performed or are performing multi-link setup to determine how UL and DL Qos traffic corresponding to TID values between 0 and 7 will be assigned to the setup links for the non-AP MLD.

An AP MLD may support TID to link mapping negotiation. A non-AP MLD that performs multi-link (re)setup on at least two links with an AP MLD that sets the TID-To-Link Mapping Negotiation Supported subfield of the MLD Capabilities field of the Basic Multi-Link element to a nonzero value shall support TID-to-link mapping negotiation with the TID-To-Link Mapping Negotiation Supported subfield of the MLD Capabilities field of the Basic Multi-Link element it transmits to at least 1. An MLD with dot11EHTBaseLineFeaturesImplementedOnly equal to true shall not set the TID-To-Link Mapping Negotiation Supported subfield of MLD Capabilities field of the Basic Multi-Link element to 3.By default, all TIDs shall be mapped to all setup links for both DL and UL (see 35.3.7.1.2 (Default mapping mode)). When a negotiated aTID-to-link mapping is in effect according to the procedures defined in 35.3.7.1.3 (Negotiation of TID-to-link mapping), 35.3.7.1.7 (Advertised TID-to-link mapping in Beacon and Probe Response frames), and 35.3.7.1.8 (Association Procedures for TID-to-link mapping) then a TID can be mapped to a link set, which is a subset of setup links, spanning from only one setup link to all the setup links.

A setup link is defined as enabled for a non-AP MLD if at least one TID is mapped to that link either in DL or in UL and is defined as disabled if no TIDs are mapped to that link both in DL and UL. At any point in time, a TID shall always be mapped to at least one setup link both in DL and UL, which means that a TID-to-link mapping change is only valid and successful if it will not result in having any TID for which the link set for DL or UL is made of zero setup links. By default, all setup links shall be enabled (see 35.3.7.1.2 (Default mapping mode)).

* If a link is enabled for a non-AP MLD, then:

may be used for individually addressed frame exchange, subject to the power state of the non-AP STA operating on that link and only MSDUs or A- MSDUs with TIDs mapped to that link may be transmitted on that link between the corresponding STA and AP of the non-AP MLD and AP MLD in the direction (DL/UL) corresponding to the TID-to-link mapping.

* MSDUs or AMSDUs as defined in 10.23.2 with TIDs mapped to that link may be transmitted on that link between the corresponding STA and AP affiliated with the non-AP MLD and AP MLD, respectively, in the direction (DL/UL) corresponding to the TID-to-link mapping.
* Individually addressed Management frames and Control frames may be sent on any enabled links between the corresponding STA affiliated with the non-AP MLD and AP affiliated with the associated AP MLD both in DL and UL.

If a link is disabled for a non-AP MLD, it shall not be used for individually addressed frame exchange between the corresponding STA affiliated with the non-AP MLD and AP affiliated with the associated AP MLD, including Management frames.

A STA affiliated with an MLD that operates on a disabled link shall suspend all wireless functionalities on that link until the link is enabled.

NOTE 1— Suspension of wireless functionalities refers to functionalities such as frame generation, schedules, scoreboard maintenances, etc., while still preserving previously negotiated parameters with the peer EHT STA(s).NOTE 2—Group addressed frames delivery procedure is defined in 35.3.15 (Multi-link group addressed frame delivery and reception).

When a link becomes disabled for a non-AP MLD, if the expected duration of the disablement is indicated in the Expected Duration field of the TID-To-Link mapping element that initiated the link disablement, and if the non-AP STA affiliated with the non-AP MLD corresponding to the disabled link has set the TWT Information Frame Disabled field to 0 in the TWT element sent during a TWT setup, then the non-AP STA shall consider all TWT Individual and Boradcast agreements suspended until the link is enabled. Otherwise, if the non-AP STA has not set the TWT Information Frame Disabled field to 0, or if the expected duration of the disablement is not specified, then all TWT Individual agreements and broadcast TWT memberships shall be considered terminated.

If a TID is mapped in UL to a set of enabled links for a non-AP MLD, then the non-AP MLD may use any link within this set of enabled links to transmit individually addressed MSDUs or A-MSDUs corresponding to that TID.

If a TID is mapped in DL to a set of enabled links for a non-AP MLD, then:

— The non-AP MLD may retrieve individually addressed buffered BUs buffered at the AP MLD that are MSDUs or A-MSDUs corresponding to that TID on any link within this set of enabled links.— The AP MLD may use any link within this set of enabled links to transmit individually addressed MSDUs or A-MSDUs corresponding to that TID, subject to the power state of the non-AP STA on each of these links.

NOTE 2—If the default mode is used, the non-AP MLD can retrieve BUs buffered by the AP MLD on any setup link but the AP MLD can recommend a link as defined in 35.3.12.4 (Traffic indication).

A non-AP MLD may retrieve buffered BUs that are MMPDUs buffered at the AP MLD on any enabled link. An AP MLD may use any enabled links to transmit individually addressed bufferable management frames that are not that are not a TPC Request frame or a Link Measurement Request frame, subject to the power state of the non-AP STA on each of the links.

If a STA affiliated with a non-AP MLD is in active mode on a link with a set of TIDs mapped for DL transmission, its associated AP affiliated with the AP MLD shall transmit to the STA:

— MSDUs/A-MSDUs corresponding to that set of negotiated TIDs for the non-AP MLD, and

— MMPDUs that are not a TPC Request frame or a Link Measurement Request frame for the non-AP

MLD or its affiliated STAs,

unless it is transmitted to another STA affiliated with the same non-AP MLD and in active mode.

NOTE 3—Operation with STAs affiliated with a non-AP MLD in power save mode are defined in 35.3.12.4 (Traffic indication).

### 35.3.7.1.2 Default mapping mode

Under this mode, all TIDs are mapped to all setup links for DL and UL, and all setup links are enabled. A non-AP MLD associated with an AP MLD shall operate under this mode if a TID-to-link mapping is not advertised by the AP MLD (see 35.3.7.1.7(Advertised TID-to-link mapping in Beacon and Probe Response frames)), and a TID-to-link mapping negotiation for a different mapping did not occur, was unsuccessful or was torn down.

### 35.3.7.1.3 Negotiation of TID-to-link mapping

TGbe editor: Modify section 35.3.7.1.3 as shown below (#14055):

An MLD that supports TID-to-link mapping

negotiation has dot11TIDtoLinkMappingActivated equal to true and shall set to a nonzero value the TID-tolink Mapping Negotiation Supported subfield in the MLD Capabilities and Operations field of the Basic

Multi-Link element that it transmits. An MLD that does not support TID-to-link mapping negotiation has

dot11TIDtoLinkMappingActivated equal to false and shall set the TID-to-link Mapping Negotiation

Supported subfield to 0. If the TID-to-link Mapping Negotiation Supported subfield value received from a

peer MLD is equal to 1, the MLD that initiates a TID-to-link mapping negotiation to the peer MLD shall

send only the TID-to-link Mapping element where all TIDs are mapped to the same link set. If the TID-tolink Mapping Negotiation Supported subfield value received from a peer MLD is equal to 3, the MLD that

initiates a TID-to-link mapping negotiation to the peer MLD shall send the TID-to-link Mapping element

where each TID is mapped to the same or different link set.

After the multi-link (re)setup is successful and 4-way handshake is complete (if RSNA is required), to negotiate a new TID-to-link mapping, an initiating non-AP MLD with dot11TIDtoLinkMappingActivated equal to true shall send an individually addressed TID-to-link Mapping Request frame to a responding MLD that has indicated support of TID-to-link mapping negotiation.

An AP MLD with dot11TIDtoLinkMappingActivated equal to true that initiates a TID-to-link mapping negotiation may perform one of the following:

- Send an individually addressed TID-to-link Mapping Request frame to a non-AP MLD

- Advertise a TID-to-link Mapping by including a TID-To-Link Mapping element in Beacon and Probe Response frames as defined in 35.3.7.1.7 (Advertised TID-to-link mapping in Beacon and Probe Response frames).

The AP MLD shall include a Reason Code for each link whose TID settings are requested to be changed in the TID-to-Link Mapping element of a TID-to-Link Mapping Request frame.

After receiving an individually addressed TID-to-link Mapping Request frame, the responding MLD shall

send an individually addressed TID-to-link Mapping Response frame to the initiating MLD according to the

following rules:

— If the responding MLD accepts the requested TID-to-link mapping in the TID-to-link Mapping

element, it shall set to 0 (SUCCESS) the Status

Code in the TID-to-link Mapping Response frame. The TID-to-link Mapping Response frame may include, in the TID-to-link Mapping element, link specific Reason Codes for all setup links to signal the responding MLD’s preferences to use the mapped links.

— Otherwise, the responding MLD shall indicate rejection of the proposed TID-to-link mapping by

setting to either 133 (DENIED\_TID\_TO\_LINK\_MAPPING) or

134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED) the Status Code in the TID-to-link

Mapping Response frame and including link specific Reason Codes in the TID-To-Link Mapping element when using either value. When the Status Code in the TID-to-link Mapping Response frame is

134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED), the responding MLD is

suggesting a preferred mapping as indicated in the TID-to-link Mapping element included in the

frame

An MLD may suggest a preferred TID-to-link mapping to a peer MLD by sending an unsolicited TID-tolink Mapping Response frame with the Dialog Token field set to 0 that includes the TID-to-link Mapping element and sets the Status Code to

134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED). An MLD shall not send an unsolicited

TID-to-link Mapping Response frame that includes the TID-to-link Mapping element and sets the Status

Code to either 0 (SUCCESS) or 133 (DENIED\_TID\_TO\_LINK\_MAPPING).

If indicated by a peer MLD, an MLD should take into account the preferred TID-to-link mapping when it initiates a new TID-to-link mapping. In addition, an AP MLD should take into account the traffic flow(s) affiliated with the non-AP MLD and the capabilities and constraints (if any) of the non-AP MLD.

NOTE 2—A non-AP MLD can indicate its constraints (such as single radio) during multi-link setup.

NOTE 3––A non-AP MLD can indicate its link preferences by using the link specific Reason Codes in the TID-To-Link Mapping element.

An MLD may set the Priority subfield of the TID-To-Link Control field in a TID-to-link Mapping element to 1 to indicate that the requested TID-to-link mapping is strongly preferred. An MLD should not set the Priority subfield to 1 in circumstances that do not necessitate indication of a strong preference. An MLD should not use NO REASON Reason Code in a TID-to-link mapping request with the Priority subfield set to 1.A non-AP MLD should accept a TID-to-link mapping initiated by its associated AP MLD with Priority subfield set to 1.

When two MLDs have negotiated a TID-to-link mapping, either MLD may teardown the negotiated TID-to- link mapping by sending an individually addressed TID-To-Link Mapping Teardown frame, except a non-AP MLD shall not tear down a negotiated TID-to-link mapping if the current TID-to-link mapping was established by an advertisement of TID-to-link mapping. Also, a non-AP MLD should not tear down a negotiated TID-to-link mapping if the current TID-to-link mapping was initiated by the AP MLD indicating a Priority subfield value of 1; instead, the non-AP MLD should initiate a new TID-to-link mapping negotiation.

After teardown, if a mapping scheme is advertised by the AP MLD as described in 35.3.7.1.7 (Advertised TID-to-link mapping in Beacon and Probe Response frames)), the MLDs shall operate in the established mode as described in 35.3.7.1.7 (Advertised TID-to-link mapping in Beacon and Probe Response frames), otherwise they shall operate in the default mapping mode (see 35.3.7.1.2 (Default mapping mode)).

If an MLD has successfully negotiated the TID-to-link mapping with a peer MLD, both the MLD and the peer MLD shall update uplink and/or downlink TID-to-link mapping information according to the negotiated TID-to-link mapping. In case a TID-to-link mapping of a specific TID is missing in the negotiation, the most recent TID-to-link mapping of this TID remains unchanged and valid. If an MLD has failed to negotiate the TID-to-link mapping with a peer MLD, the most recent TID-to-link mapping of all TID remains unchanged and valid.

NOTE4—If there is no successfully negotiated TID-to-link mapping for a TID then the TID is mapped to all setup links for DL and UL.

When an MLD has successfully negotiated with a peer MLD an uplink and/or downlink TID-to-link

mapping in which the bit position I of the Link Mapping Of TID n field in the TID-to-link Mapping element

in the (Re)Association Request frame, TID-To-Link Mapping Request frame, Beacon frame, or Probe Response frame is set to 0, the TID n shall not be mapped to the link associated with the link ID i in the uplink and/or downlink based on the Direction subfield in the TID-To-Link Mapping element.

When an MLD has successfully negotiated with a peer MLD an uplink and/or downlink TID-to-link mapping in which the bit position i of the Link Mapping Of TID n field in the TID-to-link Mapping element in the (Re)Association Request frame, TID-To-Link Mapping Request frame, Beacon frame, or Probe Response frame is set to 1, the TID n shall be mapped to the link associated with the link ID i in the uplink and/or downlink basd on the Direction subfield in the TID-To-Link Mapping element

An AP that transmits a TID-to-link mapping request may include the Mapping Switch Time field and set it to the time, in units of TUs, of a DTIM Beacon on one of the APs affiliated with the AP MLD. If the requested TID-to-link mapping negotiation is successful, the new TID-to-link mapping is effective immediately after the indicated mapping switch time.

The AP should allow enough time for the responding non-AP MLDs to repond to the request frame by setting the initial value of the Mapping Switch Time field to a sufficiently large value.

A non-AP MLD that receives from its associated AP MLD a TID-To-Link Mapping Request frame that includes a Mapping Switch Time field should send a TID-to-link Mapping Response frame before the indicated mapping switch time either with the status code SUCCESS or to request an alternate preferred mapping. The non-AP STA shall include a link specific Reason Code in the TID-to-link Mapping element of the TID-to-link Mapping Request frame to request alternate preferred mapping.

### 35.3.7.1.7 Advertised TID-to-link mapping in Beacon and Probe Response frames

tGbe editor: Modify section 35.3.7.1.7 as shown below (#14055):

An AP MLD may advertise a mandatory TID-to-link mapping by including a TID-To-Link Mapping element in the Beacon and Probe Response frames that the APs affiliated with the AP MLD transmit. In a TID-To-Link Mapping element used to advertise a TID-to-link mapping, the Priority subfield of the TID-To-Link Control field shall be set to 1.

An AP that advertises a TID-to-link mapping shall include the Mapping Switch Time field and set it to the time, in units of TUs, of a DTIM Beacon of one of the APs affiliated with the AP MLD. Beginning at the indicated time, the indicated TID-to-link mapping is established and the Mapping Switch Time field is no longer included. An AP MLD shall not advertise a TID-to-link mapping that does not map all TIDs to the same link set, both for DL and UL. The Direction field of an advertised TID-To-Link Mapping element shall be set to 2.

NOTE 1— An advertised TID-to-link mapping will include a mapping for all TIDs

NOTE 2— Since the Link IDs can be different for MLDs affiliated with each BSSID in a multiple BSSID set, inheritance will not apply to advertised TID-To-Link mapping for aPs that are part of a multiple BSSID set, and therefore the TID-To-Link Mapping element needs to be carried in each Nontransmitted BSSID Profile to which an advertised mapping applies.

An AP MLD shall include two TID-To-Link Mapping elements in the Beacon and Probe Response frames that the aPs affiliated with the AP MLD transmit, if there is already an established advertised TID-to-link mapping and a new non-default advertised TID-to-link mapping will replace it. In this case, the AP MLD shall not include the Mapping Switch Time field in the currently established advertised TID-To-Link Mapping element, and shall include the Mapping Switch Time field in the new TID-To-Link Mapping element, in order to indicate an advertised TID-to-link mapping that will be established in the future. The value of the Expected Duration field of the existing TID-To-Link Mapping element shall indicate a remaining duration that ends at the same time as indicated by the Mapping Switch Time field of the new TID-To-Link Mapping element.

NOTE 3— If the newly advertised TID-to-link mapping is the default mapping, the AP MLD sets the Expected Duration field of the currently advertised TID-to-link mapping to the remaining time until the default mapping is established as described in 9.4.2.314 (TID-To-Link Mapping element) and does not include the TID-To-Link Mapping element for the newly advertised TID-to-link mapping in the Beacon and Probe Response frames. After the establishment of the default mapping, no TID-To-Link Mapping elements are included in the Beacon or Probe Response frames transmitted by the aPs affiliated with the AP MLD.

All APs affiliated with an AP MLD that advertises a TID-to-link mapping shall include the same mapping in all Beacon and Probe Response frames from the time at which the TID-to-link mapping is first advertised until the time at which the TID-to-link mapping is no longer advertised, and shall include the Expected Duration field in all TID-to-link mapping elements in Beacons. From when a new TID-to-link mapping is advertised in a Beacon frame until the advertised TID-to-link mapping is established, the Mapping Switch Time field shall be included in the TID-To-Link Mapping element and set to the time, in units of tUs, at which the TID-to-link mapping will be established, then not included thereafter. The time indicated by the Mapping Switch Time field shall be the TBTT of the DTIM Beacon of one of the aPs affiliated with the AP MLD. The Mapping Switch Time field should initially be set to a sufficiently large value. After an advertised TID-to-link mapping is established, the duration indicated by Expected Duration field shall indicate the time when the advertised TID-to-link mapping is expected to end. During the advertisement of the TID-to-link mapping the time indicated may be updated to indicate an earlier time than initially indicated, but shall not be updated to indicate a later time than initially indicated. The duration indicated by Expected Duration field shall be exact when the duration is smaller than two DTIM periods of the AP transmitting the frame carrying the field.

At the time indicated by the Mapping Switch Time field of a TID-To-Link Mapping element in a Beacon or a Probe Response frame received by a STA affiliated with a non-AP MLD from an AP affiliated with its associated AP MLD, the non-AP MLD shall update its TID-to-link mapping according to the rules that establish a TID-to-link mapping in this subclause and with the consequences of the updated mapping defined in 35.3.7.1.1 (General).

The TID-to-link mapping that is established in a non-AP MLD beginning at the time indicated by the Mapping Switch Time field in a newly changed TID-To-Link Mapping element received by a non-AP MLD in a Beacon or a Probe Response frame from its associated AP MLD is derived as follows:

- The set of mapped links for each TID and direction for a non-AP MLD are the set of links that are included in the non-AP MLD multi-link setup with the associated AP MLD and have been mapped to that TID for that direction in the advertised TID-to-link mapping.

NOTE 4—An individually negotiated TID-to-link mapping whose negotiation was completed prior to the establishment of an advertised TID-to-link mapping is discarded at the time of the establishment of the advertised TID-to-link mapping.

NOTE 5—A non-AP MLD ignores links that are included in the link mappings of an advertised TID-to-link mapping that are not part of the non-AP MLD multi-link setup procedure. For example, if the AP MLD operates on links 1,2, and 3, and it advertises that link 3 is disabled and all TIDs are mapped to links 1 and 2, then for a non-AP MLD that is associated with the AP MLD using links 1 and 2 the default mapping will apply. In this case, for a non-AP MLD that is associated with the AP MLD using links 1 and 3, link 3 will be disabled.

NOTE 6—In absence of an advertised mapping by the AP a default TID-to-link mapping is assumed unless an individual TID-to-link mapping is successfully negotiated.

NOTE 7—No TID-To-Link Mapping Request nor TID-To-Link Mapping Response frames are transmitted by non-AP STAs affiliated with the associated non-AP MLDs in response to an advertised TID-to-link mapping.

A non-AP MLD that is associated with an AP MLD that advertises a TID-to-link mapping may initiate a negotiation for a TID-to-link mapping that is different from the TID-to-link mapping established from the advertisement as described in this section. Any MLD shall not initiate a negotiation for a TID-to-link mapping that maps a TID to a link if the requested TID is not already mapped to the link in the advertised TID-to-link mapping.

### 35.3.7.1.8 Association Procedures for TID-to-link mapping

TGbe editor: Modify section 35.3.7.1.8 as shown below (#14055):

During a multi-link (re)setup procedure, a non-AP MLD may initiate a TID-to-link mapping negotiation by including the TID-to-link Mapping element in the (Re)Association Request frame if an AP MLD has indicated a support of TID-to-link mapping negotiation.

After receiving the (Re)Association Request frame, the AP

MLD shall reply to the (Re)Association Request frame according to 11.3.5.3 (Authentication—destination

STA or MLD), 11.3.5.5 (Deauthentication—destination STA or MLD), and 35.3.5 (Multi-link (re)setup),

and perform the following TID-to-link mapping negotiation procedure:

— Where the AP MLD advertises a TID-To-Link Mapping that is already established according to 35.3.7.1.7(Advertised TID-to-link mapping in Beacon and Probe Response frames), if the non-AP MLD does not include at least one TID-to-link Mapping Request element or requests a mapping that maps TIDs to a link in a direction that is not enabled in the advertised mapping, the AP shall include in the (Re)Association Response frame a TID-To-Link Mapping element with the Mapping Switch Time Present subfield equal to 0, the Priority subfield set to 1, and indicating the TID-to-link mapping that is advertised in Beacons for each of the links accepted in the association procedure. After the transmission of the (Re)Association Response frame the TID-to-link mapping included in that frame is established and shall be used during the association unless and until a new TID to link mapping is advertised or negotiated.

— Otherwise, if the AP MLD does not accept an individually requested TID-to-link mapping in an Association Request frame, the AP MLD shall indicate rejection of the proposed TID-to-link mapping by including in the (Re)Association Response frame the TID-to-link Mapping element that suggests a preferred TID-to-link mapping, and the default TID-to-link mapping remains established until a new TID to link mapping is advertised or negotiated.

The AP MLD that rejects a (Re)Association Request may include a TID-to-link Mapping-related status code in the (Re)Association Response frame even if the non-AP MLD does not initiate a TID-to-link mapping negotiation. Status code 134 (PREFERRED\_TID\_TO\_LINK\_MAPPING\_SUGGESTED) may be used.

— Otherwise, the AP MLD can accept the requested TID-to-link mapping in the TID-to-link Mapping element in the received (Re)Association Request frame only if it accepts the multi-link (re)setup for all links on

which at least one TID is requested to be mapped. The AP MLD that accepts the requested TID-tolink mapping shall not include in the (Re)Association Response frame the TID-to-link Mapping element.

An AP MLD shall not set the Priority subfield of the TID-To-Link Mapping element to 1 when carried in a (Re) Association Response frame except as described in this subclause.

NOTE 1—Whether the multi-link (re)setup is successful or not is independent from whether the TID-to-link mapping negotiation that is done jointly with the multi-link setup is successful or not. A multi-link (re)setup can be successful even if the TID-to-link mapping negotiation is not successful.