IEEE P802.11  
Wireless LANs

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| LB266 CR for TWT operation | | | | |
| Date: 2022-10-25 | | | | |
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Abstract

This submission proposes resolutions of comments received from TGbe comment collection LB266 based on TGbe D2.2.

14088 13835 10719 10769 13869 13597 10665 11876 12351 13320 12688 13836 (12 CIDs)

11950 13660 13658 13657 13659 14089 (6 CIDs)

Revisions:

* Rev 0: Initial version of the document.

1. **Introduction**

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. The introduction and the explanation of the proposed changes are 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 802.11be 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** | **Clause** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 14088 | 35.8 | 509.39 | A non-AP MLD that has multiple TWT agreements established across multple links should be able to tear down one or more agreements/schedule on a link while sending the TWT Teardown frame (or its equivalent) on a different link for efficient MLO and TWT operation. However, such mechanism is currently missing in 11be. | Please provide necessary mechanism to enhance the operation of TWT Teardown frame to make it more suitable for MLDs. | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #14088 in this document. |
| 13835 | 35.8.2 | 509.48 | A STA of an MLD can negotiate a TWT agreement on behalf of the other STA of the same MLD. Therefore, for functional balance, it is recommended to provide a procedure a STA affiliated with an MLD tear down the TWT agreements on behalf of the other STA of the same MLD. | Please define TWT teardown procedure for the MLD. | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #13835 in this document. |
| 10719 | 35.8.2 | 509.49 | do we need to define the TWT tear down between an AP MLD and non-AP MLD, please clarify. | as in the comment | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #10719 in this document. |
| 10769 | 35.8.2 | 509.49 | The iTWT procedure allows multiple TWT setup on different links. The tear-down procedure should have similar procedures by adding the link bitmap. | Complete the multi-link iTWT teardown procedures so that multiple iTWT teardown on different links can be done by similar procedures as the setup | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #10769 in this document. |
| 13869 | 35.8.2 | 509.51 | The TWT tear down operation for MLD is missing, please update the the text | please update the text | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #13869 in this document. |
| 13597 | 35.8.2 | 509.51 | The TWT Teardown frame can be sent by other STA. But, since the Link ID Bitmap is not present in the TWT Teardown frame, it is assumed that the Multi-Link Link Information element indicates the intended STA. For consistency, instead of the Multi-Link Link Information element, the Link ID Bitmap is preferred. Because the the Multi-Link Link Information element can't tear down the TWTs associated with multiple STAs. Please clarify the multi-link TWT teardown procedure. | As in the comment. | Revised-  Agree with the comment. The opeation of TWT teardown is added. Apply the the changes marked as #13597 in this document. |
| 10665 | 35.8.1 | 509.41 | Behavior related to TWT STA is already covered in baseline spec. Therefore, the 1st sentence is not adding any value. The two sentences in this paragraph can be consolidated as one. "An EHT TWT STA shall follow the rules in 26.8 with the following exception blah blah blah ..." | As in comment | Revised-  Agree with the comment. Apply the the changes marked as #10665 in this document. |
| 11876 | 35.8.1 | 509.44 | First sentence states the obvious and the second sentence is what is useful. Suggest amending this paragraph as follows: "An EHT TWT STA shall follow the rules as described in 26.8 (TWT operation), except that within trigger-enabled SPs, the triggering frame may be an MU RTS TXS Trigger frame with response rules defined in 35.2.1.2 (Triggered TXOP sharing procedure)." | As in comment. | Accepted- |
| 12351 | 35.8 | 509.55 | TWT is on link level. Do we need link-level setups for QoS characteristics? The charectaristics are on the MLD level. | TWT setup is per-link but the QoS characteristics are defined at MLD level, provide a procedure to perform link level QoS characteristics identification. | Rejected-  The traffic info carried in QoS characteristics element is at MLD level. It will contradict with QoS characteristics element to define link level QoS characteristics |
| 13320 | ï»¿35.8.2 | 510.06 | Just because a STA affiliated with an MLD sends a TWT element should not make that STA a TWT requesting/responding STA. The baseline definitions should be discussed in this subclause and clarified that TWT requesting/responding STA status depends on membership in the agreement and not just sending the TWT element | as in comment | Rejected-  The definitions of TWT requesting STA and TWT responding STA are originated from the baseline. The suggested change is out of the scope of TGbe. Encourage the commenter to submit the comment to REVme if there is technical issue. |
| 12688 | 35.8 | 509.38 | The entire section deals with Individual TWT agreement setup between MLDs. Why this section is not located under 35.3 Multi link operation? Also, the subclause should be designated as "ML setup of Individual TWT agreement" since it is mainly focused on the setup of multiple individual agreements corresponding to various links operating under the same MLD... | Please move the section under section 35.3 Multi link operation. In addition, change the subclause name as proposed in comment. | Revised-  Agree with the comment. The suggested change was done partially by the resolution of CID 11877 in 22/1526r1. Apply the the changes marked as #12688 in this document. |
| 13836 | 35.8.2 | 509.48 | There is a case that a non-AP STA and an AP operate on link1, and they have already negotiated TWT agreements. If a newly negotiated TWT agreement through link2 indicates already used TWT Flow ID of link1, previously negotiated TWT agreement of link1 that is use the same TWT Flow ID is deleted(changed).  Therefore, if a non-AP STA and an AP have no intend to delete already negotiated TWT agreement of other link, the non-AP STA and the AP should avoid to use a TWT Flow ID that is already in use on the other link. | Please provide guidance to select a TWT Flow ID. (e.g. shall not indicate a value in used ~ unless~) | Revised-  Agree with the comment. The TWT Flow Identifier between two STAs shall be unique. Apply the changes marked as #13836 in this document. |
| 11950 | 35.8.1 | 509.44 | 802.11be should allow TWT Information frame to control available links of the MLTWT flows. For instance, a STA that has TWT flow operating in links 1 and 2 should be able to temporarily suspend TWT Flow on link2. | Please add rules for TWT Information frame use when a STA has TWT Flow operating on multiple links. Please allow STA to suspend or resume a set of links/ all links by using TWT Information frame. | Revised-  Agree with the comment in principle. Use of TWT Information frames in multi-link operation is added. Apply the changes marked as #11950 in this document. |
| 13660 | 35.8 | 509.39 | Currently, TWT Information frame cannot operate on an MLD level. A multi-link device (MLD) may want to suspend TWT schedules on multiple links to save power. Same argument for schedule resumption. There should be a way to indicate for which link(s) among the multiple links between the AP MLD and the non-AP MLD the TWT Information frame is intended. | Please provide text to enhance functionality of TWT Information frame to indicate multiple intended links. | Revised-  Agree with the comment in principle. Use of TWT Information frames in multi-link operation is added. Apply the changes marked as #13660 in this document. |
| 13658 | 35.8 | 509.39 | Currently, when All TWT subfield in the TWT Information frame is set to 1 in the TWT Information field in a TWT Information frame, all individual TWT agreements or broadcast TWT schedules are intended by the TWT Information field of the TWT Information frame. All individual TWT agreements or broadcast TWT schedules are meant to be suspended or resumed by the TWT Information frame. There is no way to exclude any particular TWT agreements or schedules from the group of schedules or agreements that are being suspended or resumed. This is not very conducive for restricted TWT operation, e.g., an r-TWT scheduled STA can have multiple broadcast/individual TWT schedules/agreements and restricted TWT schedules. For some purpose (e.g. power saving), the scheduled STA may want to suspend the broadcast TWT schedules while still maintain the r-TWT schedules for low latency purposes. | Please provide mechanism and framework for selective schedule exclusion from All TWT suspension/resumption procedure. | Revised-  Agree with the comment in principle. Use of TWT Information frames in multi-link operation is added. Apply the changes marked as #13658 in this document. |
| 13657 | 35.8 | 509.39 | According to current 802.11 specification, while the TWT Information frame can be used for suspending and resuming all the broadcast TWT schedules followed by a broadcast TWT scheduled STA, the TWT Information frame cannot be used for suspending or resuming broadcast TWT SPs on a per-schedule basis. In 802.11be, with the inclusion of restricted TWT schedule, which is a variant of broadcast TWT schedule, it would be important to better manage the broadcast TWT schedules/restricted TWT schedules and hence, a mechanism is needed to suspend and resume particular broadcast/restricted TWT schedules while maintaining the others. | Please add procedures and mechanisms to enable suspension/resumption of TWT schedules on a per-schedule basis. | Revised-  Agree with the comment in principle. Use of TWT Information frames for R-TWT is added. Apply the changes marked as #13657 in this document. |
| 13659 | 35.8 | 509.39 | For r-TWT operation, the r-TWT scheduled STA should have the flexibility to set the Next TWT value in the TWT Information frame as needed. It may be any positive value; not necessarily from the available set of TWT values. This would help any change in the traffic pattern without negotiating a new r-TWT schedule with the r-TWT scheduling AP. | Please provide text to enable Flexible r-TWT as illustrated in the comment. | Revised-  Agree with the comment in principle. Use of TWT Information frames for R-TWT is added. Apply the changes marked as #13659 in this document. |
| 14089 | 35.8 | 509.39 | A non-AP MLD that has multiple TWT agreements established across multple links should be able to update the TWT parameters corresponding to one or more agreements/schedule on a link while sending the TWT Constraints Parameters element (or its equivalent) on a different link for efficient MLO and TWT operation. However, such mechanism is currently missing in 11be and needs to be provided. | As in comment | Rejected-  TWT Constraints Parameters element isn't used to update TWT parameters. It provides TWT constraint parameters that can be used during the establishment of individual TWT agreements and/or broadcast TWT schedules. However, TWT Info frame can provide a flexible TWT, updating TWT parameters. |

**Discussion:** None.

***TGbe editor: Please modify the subclause 9.6.24.9 (TWT Teardown frame format) as follows***  *(#14088, 13835, 10719, 10769, 13869, 13597)*

**9.6.24.9 TWT Teardown frame format**

The TWT Teardown frame is sent by a STA to request the teardown of a TWT agreement and is transmitted by either STA of an existing TWT agreement. The Action field of the TWT Teardown frame contains the information shown in Table 9-590 (TWT Teardown frame Action field format).

**Table 9-590—TWT Teardown frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | Unprotected S1G Action |
| 3 | TWT Flow |
| 4 | MLO Link Information element (optional) |

When present in a TWT Teardown frame, the MLO Link Information element is defined in 9.4.2.317 (MLO Link Information element).

***TGbe editor: Please modify the subclause 35.3.24.1 (General) as follows*** (#10665, 11876)

**35.3.24.1 General**

An EHT TWT STA shall follow the rules as described in 26.8 (TWT operation), except that within trigger-enabled SPs, the triggering frame may be an MU RTS TXS Trigger frame with response rules defined in 35.2.1.2 (Triggered TXOP sharing procedure.

**35.3.24.2 Individual TWT agreements**

*Please insert the following paragraphs at the end of this subclause (#14088, 13835, 10719, 10769, 13869, 13597)*

The TWT Flow Identifier field of the TWT element of the frame that successfully concluded the setup of the TWT agreement for two STAs operating on the same link shall be unique. (#13836)

A non-AP STA affiliated with a non-AP MLD may tear down an individual TWT agreement by sending a TWT Teardown frame with the Negotiation Type subfield set to 0 and one bit in the Link ID Bitmap subfield of the MLO Link Information element set to 1.

A non-AP STA affiliated with a non-AP MLD may tear down all individual TWT agreements setup on the link(s) indicated by the Link ID Bitmap subfield of the MLO Link Information element by sending a TWT Teardown frame with the Teardown All TWT field set to 1 if the the MLO Link Information element is present in the TWT Teardown frame. A non-AP STA affiliated with a non-AP MLD may tear down all individual TWT agreements setup on all setup links by sending a TWT Teardown frame with the Teardown All TWT field set to 1 if the MLO Link Information element is not present in the TWT Teardown frame.

When a TWT Teardown frame with the MLO Link Information element is successfully transmitted or received, the TWT agreement corresponding to the TWT Flow Identifier field, the MLD MAC address of the MLD with which TWT requesting STA is affiliated, the MLD MAC address of the MLD with which TWT responding STA is affiliated and the Link ID associated with the link indicated by the Link ID Bitmap subfield of the TWT Teardown frame shall be deleted. (#14088, 13835, 10719, 10769, 13869, 13597)

**9.6.24.12 TWT Information frame format**

The TWT Information frame is sent by a STA to request or deliver information about a TWT(11ax) and is transmitted by either STA of an existing TWT agreement (11ax)or is transmitted by a STA to a peer STA that has indicated support of its reception. The Action field of the TWT Information frame contains the information shown in Table 9-593 (TWT Information frame Action field format).

**Table 9-593—TWT Information frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | Unprotected S1G Action |
| 3 | TWT Information (9.4.1.60 (TWT Information field)) |
| 4 | MLO Link Information element (optional) |

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

The Unprotected S1G Action field is defined in 9.6.24.1 (Unprotected S1G Action field).

When present in a TWT Information frame, the MLO Link Information element is defined in 9.4.2.317 (MLO Link Information element).

***TGbe editor: please modify the following subclause 9.4.1.60 (TWT Information field) : (#13657, 13659)***

**9.4.1.60 TWT Information field**

The TWT Information field is present in the TWT Information frame (see 9.6.24.12 (TWT Information frame format)). The TWT Information field format is shown in Figure 9-189 (TWT Information field format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B0 B2 B3 B4 B5 B6 B7 B8 Bn | | | | | | |
|  | TWT Flow  Identifier/TWT Type | Response  Requested | Next TWT  Request | Next TWT  Subfield Size | All TWT | Next TWT |
| Bits: 3 1 1 2 1 0,32,48, or 64 | | | | | | |
| Figure 9-189—TWT Information field format | | | | | | |

The TWT Flow Identifier subfield is present when the All TWT subfield is set to 0 and contains the TWT flow identifier for which TWT information is requested or being provided.

The TWT Type subfield is present when the All TWT subfield is set to 1 and is encoded as defined in Table 9-xxx (TWT type subfield encoding)

Table 9-xxx TWT type subfield encoding

|  |  |
| --- | --- |
| Values | Descriptions |
| 0 | The TWT Information frame reschedules all TWTs as defined in 26.8.4 (Use of TWT Information frames) |
| 1 | The TWT Information frame reschedules all TWTs except R-TWTs as defined in 26.8.4 (Use of TWT Information frames) |
| 2 | The TWT Information frame reschedules all R-TWTs as defined in 26.8.4 (Use of TWT Information frames) |
| 3-7 | Reserved |

The Response Requested subfield indicates whether the transmitter of the frame containing the TWT Information field is requesting a TWT Information frame to be transmitted in response to this frame. The Response Requested subfield is set to 0 to request the recipient to not transmit a TWT Information frame in response to the frame. The Response Requested subfield is set to 1 to request the recipient to transmit a TWT Information frame in response to the frame.

The Next TWT Request subfield is set to 1 to indicate that the TWT Information frame is a request for the delivery of a TWT Information frame containing a nonzero length Next TWT field. Otherwise, it is set to 0.

The Next TWT Subfield Size subfield describes the size of the Next TWT subfield according to Table 9-112

(Next TWT Subfield Size subfield encoding).

The All TWT subfield is set to 1 by an HE STA to indicate that the TWT Information frame reschedules all TWTsas defined in 26.8.4 (Use of TWT Information frames). Otherwise, it is set to 0.

The All TWT subfield is set to 1 by an EHT STA to indicate that the TWT Information frame reschedules all TWTs, all TWTs except R-TWTs or all R-TWTs as defined in 26.8.4 (Use of TWT Information frames) and 35.8.6. (TWT Information frame exchange for R-TWT). Otherwise, it is set to 0.

**35.3.24 TWT in multi-link operation (#12688)**

***TGbe editor: please add the following new subclause 35.3.24.3 (Use of TWT Information frames in multi-link operation) : (#11950, 13660, 13658)***

**35.3.24.3 Use of TWT Information frames in multi-link operation**

A STA affiliated with an MLD may transmit a TWT Information frame with MLO Link Information element to its peer STA affiliated with another MLD to suspend and/or resume existing individual TWT agreements as described in 26.8.4.2 (TWT Information frame exchange for individual TWT) except that existing individual TWT agreements are setup for the link indicated by the Link ID Bitmap subfield of MLO Link Information element and the Next TWT subfield (if present) is in reference to the TSF of the link indicated by the Link ID Bitmap subfield.

A STA affiliated with an MLD may transmit a TWT Information frame with MLO Link Information element to its peer STA affiliated with another MLD to suspend and/or resume existing broadcast TWT schedules as described in 26.8.4.3 (TWT Information frame exchange for broadcast TWT) except that existing broadcast TWT schedules are setup for the link indicated by the Link ID Bitmap subfield of MLO Link Information element and the Next TWT subfield (if present) is in reference to the TSF of the link indicated by the Link ID Bitmap subfield.

A STA affiliated with an MLD may transmit a TWT Information frame with MLO Link Information element to its peer STA affiliated with another MLD to provide a flexible TWT that is independent of any existing TWT agreements or TWT schedules as described in 26.8.4.4 (TWT Information frame exchange for flexible wake time) except that the flexible TWT are setup for the link indicated by the Link ID Bitmap subfield of MLO Link Information element and the Next TWT subfield (if present) is in reference to the TSF of the link indicated by the Link ID Bitmap subfield.

A STA affiliated with an MLD may transmit a TWT Information frame with MLO Link Information element to its peer STA affiliated with another MLD to suspend and/or resume existing R-TWT schedules as described in 35.8.6 (TWT Information frame exchange for R-TWT) except that existing R-TWT schedules are setup for the link indicated by the Link ID Bitmap subfield of MLO Link Information element and the Next TWT subfield (if present) is in reference to the TSF of the link indicated by the Link ID Bitmap subfield.

***TGbe editor: please add the following new subclause 35.8.6（R-TWT schedule suspension and resumption）: (#13657, 13659)***

**35.8.6. TWT Information frame exchange for R-TWT**

An R-TWT scheduling AP may transmit a TWT Information frame to an R-TWT scheduled STA to suspend and/or resume existing R-TWT schedules.

An R-TWT sheducled STA that receives a TWT Information frame that contains an All TWT subfield equal to 1 and a TWT Type subfield equal to 0 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT).

An R-TWT sheducled STA that receives a TWT Information frame that contains an All TWT subfield equal to 1 and a TWT Type subfield equal to 1 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT), except that the broadcast TWT schedules does not include the R-TWT schedules.

An R-TWT sheducled STA that receives a TWT Information frame that contains an All TWT subfield equal to 1 and a TWT Type subfield equal to 2 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT), except that the broadcast TWT schedules only include the R-TWT schedules.

An R-TWT scheduled STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA that contains an All TWT subfield equal to 1, a TWT Type subfield equal to 0 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT).

An R-TWT scheduled STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA that contains an All TWT subfield equal to 1, a TWT Type subfield equal to 1 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT), except that the broadcast TWT schedules does not include the R-TWT schedules.

A R-TWT scheduled STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA that contains an All TWT subfield equal to 1, a TWT Type subfield equal to 2 shall follow the rules defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT), except that the broadcast TWT schedules only include the R-TWT schedules.