IEEE P802.11
Wireless LANs

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| Comment Resolution on TWT |
| Date: July 10th, 2022 |
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 Abstract

This submission proposes resolutions for following 5 comments received for TGbe LB266:

* 5 CIDs: 13633, 11949, 13872, 11155, 13643, ~~11113, 11114, 11115~~, ~~13642~~

SP: Do you agree to the resolutions provided in doc 11-22/1051r1 for the following CIDs for inclusion in the latest 11be draft?

13633, 11949, 13872, 11155, 13643, ~~11113, 11114, 11115~~, ~~13642~~

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Updated based on further offline discussion.
* Rev 2: Minor—added the track change to some modified sentences
* Rev 3: Online changes for the resolution text for CIDs 11113, 11114, and 11115
* Rev 4: Added CIDs 11949, 13872, 11155

***TGbe editor: Please note Baseline is 11be D2.3***

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.

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| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 13633 | Rubayet Shafin | 510.51 | 11be includes multi-link operation. However, how restricted TWT will operate on multi-link devices (MLDs) is not clear. In general, mechanism for Broadcast TWT, which is a basis for restricted TTWT, for MLDs need to be defined. | Commenter will present a contribution on this. | **Rejected**The issue was discussed in the group; however, no consensus was reached.  |
| 11949 | Jarkko Kneckt | 509.39 | 802.11be should allow BC TWT flow setup to multiple links in the same way as individual TWT flows. | Please allow Link Id bitmap to BC TWT Setup signaling to be able to setup the BC TWT flow to multiple links. Please consider obtaining the timing information of the BC TWT flows from the TWT element included in the Beacon. | **Rejected**The issue was discussed in the group; however, no consensus was reached.  |
| 13872 | Ming Gan | 509.51 | The case broadcast TWT negotiation for MLD is missing, please specify it | please complete the missing case | **Rejected**The issue was discussed in the group; however, no consensus was reached.  |
| 11155 | Boon Loong Ng | 404.49 | The procedure for broadcast TWT (and restricted TWT) operation with MLDs is current missing in the spec. | Please provide a description of bTWT/rTWT operation with MLO. | **Rejected**The issue was discussed in the group; however, no consensus was reached.  |

**Discussion:**

Text related to broadcast TWT for multi-link operation is currently missing in the spec and needs to be added. In general, an AP affiliated with an AP MLD and an STA affiliated with a non-AP MLD should be able to negotiate a broadcast TWT schedule over one link between the AP MLD and the non-AP MLD on behalf of another link between the same AP MLD and the non-AP MLD. We need the necessary signalling to enable this for broadcast TWT (the procedure for individual TWT has been added in Draft 1.1). The following example can be helpful in illustrating this process and the outcome we strive to realize in this document:



Figure D-1: Example of Broadcast TWT schedule negotiation over a single link for schedule setup on a different link

In the example of Figure D-1, an AP MLD has three affiliated APs: AP 1 operates on 2.4 GHz band, AP 2 operates on 5 GHz band, and AP 3 operates on 6 GHz band. A non-AP MLD has three affiliated STAs: STA 1 operates on 2.4 GHz band, STA 2 operates on 5 GHz band, and STA 3 operates on 6 GHz band. Three links are set up and enabled between the AP MLD and the non-AP MLD: Link 1 between AP 1 and STA 1; Link 2 between AP 2 and STA 2; Link 3 between AP 3 and STA 3. Non-AP STA 1 affiliated with the non-AP MLD sends a broadcast TWT element to AP 1 affiliated with the AP MLD. The broadcast TWT element contains a Broadcast TWT Parameter Set field corresponding to a broadcast TWT schedule, Schedule A, and indicates a request to establish Schedule A over Link 3. Upon receiving the TWT element, AP 1 sends a TWT element to non-AP STA 1 and includes the Broadcast TWT Parameter Set field corresponding to Schedule A, and indicates the acceptance of the request made by the non-AP MLD. After the successful broadcast TWT negotiation over Link 1, Schedule A is established over Link 3.

**9. Frame formats**

**9.4.2.199 TWT element**

***TGbe editor: Please Change Figure 9-766 (Broadcast TWT Parameter Set field format) as follows:***

 

**Figure 9-766: Broadcast TWT Parameter Set field format (#13633)**

***TGbe editor: Please* change the paragraph (The Link ID Bitmap subfield indicates the links…) in Clause 9.4.2.199 as follows:**

The Link ID Bitmap subfield indicates the links to which an individual or broadcast TWT parameter set contained in the TWT element sent by a STA affiliated with an MLD applies. A value of 1 in bit position $i$ of the Link ID Bitmap subfield means that the link to which the TWT parameter set in the TWT element sent by a STA affiliated with an MLD applies. A value of 0 in bit position $i$ of the Link ID Bitmap subfield means that the link associated with the link ID $i $is not the link to which the TWT parameter set in the TWT element sent by a STA affiliated with an MLD applies (#13633).

**35.8 TWT operation**

***TGbe editor: Please insert the following subclause 35.8.3 (Broadcast TWT operation) under clause 35.8***

**35.8.3 Broadcast TWT operation (#13633)**

A TWT scheduling AP affiliated with an AP MLD and a TWT scheduled STA affiliated with a non-AP MLD, for negotiating membership of a broadcast TWT schedule, shall follow the rules defined in 26.8.3.1 (General), 26.8.3.2 (Rules for TWT scheduling AP), and 26.8.3.3 (Rules for TWT scheduled STA) with the following additional rules:

* The TWT scheduled STA affiliated with the non-AP MLD or the TWT scheduling AP affiliated with the AP MLD, while negotiating for a broadcast TWT schedule, may indicate the link between the AP MLD and the non-AP MLD for which the negotiation is being conducted. The TWT scheduled STA or the TWT scheduling AP transmitting the TWT element may make the link indication in the Link ID Bitmap subfield in the Broadcast TWT Parameter Set field corresponding to the broadcast TWT schedule.
	+ If a link is indicated in a Link ID Bitmap subfield in the Broadcast TWT Parameter Set field transmitted by a TWT scheduled STA affiliated with the non-AP MLD or a TWT scheduling AP affiliated with the AP MLD, the corresponding broadcast TWT schedule is negotiated on behalf of the STA affiliated with the same MLD and operating on the indicated link between the AP MLD and the non-AP MLD. The Target Wake Time field in the Broadcast TWT Parameter Set field shall be in reference to the TSF time of the link indicated in the Link ID Bitmap subfield in the Broadcast TWT Parameter Set field.
	+ A TWT scheduling AP affiliated with the AP MLD or a TWT scheduled STA affiliated with the non-AP MLD that receives a broadcast TWT parameter set containing a Link ID Bitmap subfield may indicate the link in the Link ID Bitmap subfield of the corresponding Broadcast TWT Parameter Set field in the TWT element in the response frame it transmits. The Link ID Bitmap subfield, if present in the Broadcast TWT Parameter Set field in the response frame, shall indicate the same link as that indicated in the corresponding Broadcast TWT Parameter Set field in the TWT element it received.
* If the Link ID Bitmap Present subfield in the Control field in a broadcast TWT element is set to 1, then all the Broadcast TWT Parameter Set fields included in the broadcast TWT element shall contain a Link ID Bitmap subfield; otherwise, none of the Broadcast TWT Parameter Set field included in the broadcast TWT element shall contain any Link ID Bitmap subfield.
	+ If a TWT scheduling AP affiliated with an AP MLD or a TWT scheduled STA affiliated with a non-AP MLD receives a broadcast TWT element that sets the Link ID Bitmap Present subfield to 0, it would indicate that all the broadcast TWT parameter set(s) included in the received broadcast TWT element apply to the link on which the broadcast TWT element is received.
* If a TWT scheduled STA affiliated with a non-AP MLD sends a TWT element to its associated AP affiliated with the AP MLD that includes a Link ID Bitmap subfield in a Broadcast TWT Parameter Set field, where the link indicated in the Link ID Bitmap subfield of the Broadcast TWT Parameter Set field indicates a different link than the link on which the TWT element is sent, then the TWT Setup Command subfield in the Request Type field of the Broadcast TWT Parameter Set field shall be set to 0 (Request TWT).
* The AP MLD or the non-AP MLD shall not transmit a TWT element over a link set up between them that includes a TWT parameter set field containing a Link ID Bitmap subfield with $k$-th bit in the bitmap set to 1 if the corresponding $k$-th link is disabled for the non-AP MLD through TID-to-Link mapping.

***TGbe editor: Please add the following subsection 35.9.6 (Restricted TWT with multi-link operation) under clause 35.9***

**35.9 Restricted TWT (R-TWT)**

**35.9.6 Restricted TWT with multi-link operation (#13633)**

An R-TWT scheduling AP or an R-TWT scheduled STA, in the context of multi-link operation, for negotiating membership of a restricted TWT schedule, shall follow the rules defined in 35.8.3 (Broadcast TWT operation) with additional rules described in this subclause.

For R-TWT operation between an AP MLD and a non-AP MLD, the AP MLD or the non-AP MLD shall not transmit a TWT element over any of the set up links between them that includes an R-TWT parameter set with the $k$-th bit in the Restricted TWT DL TID Bitmap subfield or Restricted TWT UL TID Bitmap subfield, if present, set to 1 if the TID $k$ for the respective direction is not mapped on the intended link for which the restricted TWT schedule is being negotiated. The AP MLD or the non-AP MLD shall not transmit a TWT element over any of the links between them that includes an R-TWT parameter set with the DL TID Bitmap Valid subfield or UL TID Bitmap Valid subfield, if present, to 0 if any of the TIDs is not mapped on the desired link for the respective direction (#13633).

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| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 11113 | Brian Hart | 512.18 | Unbalanced comma in "and, if there is not enough time then " | Try "and, if there is not enough time, then" | **Accepted.** |
| 11114 | Brian Hart | 512.19 | In math, "series" is the cumulative sum of a sequence of numbers; probably "sequence" is meant in " (without advancing to the next value in the series)" | Try " (without advancing to the next value in the sequence)" | **Accepted** |
| 11115 | Brian Hart | 512.19 | Since an MSDU or AMSDU has a single AC, likely "are" should be "is" | Try " The QSRC[AC] for the MSDU or A-MSDU is not affected." | **Accepted** |

***TGbe editor: Please* change the paragraph (A non-AP EHT STA with …) in Clause 35.9.4.1 as follows:**

A non-AP EHT STA with dot11RestrictedTWTOptionImplemented set to true as a TXOP holder shall ensure the TXOP ends before the start time of any r-TWT SPs advertised by the associated AP. Before starting transmission of any MPDU, a non-AP EHT STA with dot11RestrictedTWTOptionImplemented set to true that is not a TXOP responder and not a member of the upcoming restricted TWT service period shall check if there is enough time for the frame exchange to complete prior to the start of the restricted TWT service period and, if there is not enough time, (#11113) then the STA shall defer transmission by selecting a random backoff count using the present CW (without advancing to the next value in the sequence) (#11114). The QSRC[AC] for the MSDU or A-MSDU is not affected (#11115).

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| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| ~~13642~~  | ~~Rubayet Shafin~~ | ~~510.51~~  | ~~According to current specifications, for PPDU transmission on a link that forms an NSTR link pair with other STA(s) affiliated with the same non-AP MLD, the end time of the PPDUs transmitted on those links need to be aligned in order to prevent self-interference at the non-AP MLD side due to NSTR constraints. However, if a restricted TWT schedule is established on a link that is a part of an NSTR link pair and if PPDUs transmitted during restricted TWT service period (SP) need to be aligned, for example through adding extra padding, with PPDU transmitted on other links, then the traffic flow for the low-latency traffic during restricted TWT SP can get severely interrupted. This can disrupt the latency-sensitive applications at the client side.~~ | ~~Please provide text to handle the NSTR constraints as depicted in the comment when an rTWT schedule is established on a link of an NSTR link pair.~~  | **~~Revised.~~**~~Agree in principle. Necessary text for handling NSTR issue with r-TWT operation has been added.~~**~~TGbe editor, please make change as shown in this doc 11-22/1051r1 tagged by #13642.~~** |
| 13643 | Rubayet Shafin | 510.51 | For the scenario where a restricted TWT schedule, which is not a trigger-enabled TWT, is established on a link between an AP MLD and a non-AP MLD that forms NSTR link pair(s) between the same AP MLD and non-AP MLD, while UL PPDU is being transmitted during the restricted TWT SP on the that link, if DL PPDU is being transmitted on another link that forms the NSTR link pair with the first link, then the overlapped portions of UL PPDU and DL PPDU will suffer from interference due to NSTR constraints. This may affect the latency-sensitive traffic flow during restricted TWT SP. | Please provide text to handle the NSTR constraints as depicted in the comment when an rTWT schedule is established on a link of an NSTR link pair. | **Rejected**The issue was discussed in the group; however, no consensus was reached.  |

***TGbe editor: Please insert the following subclause 35.3.16.10 (Restricted TWT operation) under clause 35.3.16 (Multi-Link channel access)* (#13642, #13643)**

**35.3.16.10 Restricted TWT operation (#13642, #13643)**

When a non-trigger enabled R-TWT schedule is established on a link (the first link) between an AP MLD and a non-AP MLD that forms NSTR link pair(s) with another link (the second link) between the same AP MLD and the non-AP MLD, the AP affiliated with the AP-MLD and operating on the second link shall end transmission of any frames on the second link before the restricted TWT SP starts on the first link, and if the frame transmitted on the second link solicits an immediate response, then the AP affiliated with the AP MLD should end the transmission of the frame on the second link at least aSIFSTime duration before the r-TWT SP starts on the first link. (#13642)

When an R-TWT schedule is established on a link (the first link) between an AP MLD and a non-AP MLD that forms NSTR link pair with another link (the second link) between the same AP MLD and the non-AP MLD and the second link also has another r-TWT schedule established such that the R-TWT SP on the second link overlaps in time with the R-TWT SP on the first link and the R-TWT schedule on the second link has higher priority TIDs negotiated than that of the R-TWT schedule on the first link, then for handling NSTR interference, the R-TWT SP on the second link should be prioritized over the R-TWT SP on the first link such that any kind of adjustment in the PPDU transmission, either through padding the PPDU or through truncation of the TXOP, needs to be made at the PPDU transmission on the first link so that PPDU transmission on the second link remains uninterrupted. (#13643)