IEEE P802.11
Wireless LANs

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| Comment Resolution on TWT |
| Date: March 7th, 2023 |
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 Abstract

This submission proposes resolutions for following 1 comment received for TGbe LB271:

* 1 CID: 18205

SP: Do you agree to the resolutions provided in doc 11-22/357r0 for the following CIDs for inclusion in the latest 11be draft?

18205

Revisions:

* Rev 0: Initial version.

***TGbe editor: Please note Baseline is 11be D3.0***

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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 18205 | Rubayet Shafin | 617.44 | 11be includes multi-link operation and restricted TWT 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. | Please provide text for R-TWT/B-TWT negotiation for MLD. | **Revised.**Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled for an MLD is added.**TGbe editor, please make change as shown in this doc 11-22/357r0 tagged by #18205.** |

**Discussion:**

Due to power saving purpose or regulatory reasons, a link between an AP MLD and a non-AP MLD can be muted or become unavailable. If the non-AP MLD had an R-TWT schedule set up on that link for its latency-sensitive traffic, there needs to be a method to seamlessly retrieve or transmit latency-sensitive BUs on another link before the first link becomes unavailable. Currently, such a mechanism is missing in the R-TWT operation. Note that renegotiating another schedule for the second link might not be a seamless process. The issue is illustrated in Figure D-1.



Figure D-1: Illustration of the issue of Link disablement or deletion while there is still an R-TWT Schedule established on that link.

In Figure D-1, an R-TWT schedule is established on Link 1. The first R-TWT SP starts at time t1 and ends at time t2. The second R-TWT SP is scheduled to start at time t4 and scheduled to end at time t5. However, the link is scheduled to be deleted or disabled at time t3. Hence, the second R-TWT SP would not be available for the non-AP MLD, and hence, the latency-sensitive traffic for the non-AP MLD would be affected. Similar situation can also happen to other non-AP MLDs associated with the AP MLD and that have R-TWT schedules set up on Link 1. Hence the AP MLD needs a mechanism to establish a replacement R-TWT schedule on a different link before the restricted TWT on Link 1 becomes unavailable due to link deletion.

There can be many R-TWT scheduled non-AP MLDs in the BSS. If the AP MLD needs to perform 1-to-1 negotiation with all those non-AP MLD for establishing a replacement R-TWT schedule on a different link, then it can take quite a long time. Accordingly, a non-AP MLD that has latency-sensitive traffic may be affected due to excessive time taken for successful negotiation. To avoid this, the AP MLD should have the option to establish another R-TWT schedule on a second link on which the AP MLD is operating (if the AP MLD deems that it is possible for the second link to have an R-TWT schedule with the SP patterns matching that of the schedule on the soon-to-be-unavailable link). This process can be referred to as R-TWT Link Replacement and is depicted in Figure D-2.



Figure D-2: Illustration of R-TWT Link Replacement.

In Figure D-2, a non-AP MLD is associated with an AP MLD and is operating on three links—Link 1 between AP1 and STA1, Link 2 between AP2 and STA2, and Link 3 between AP3 and STA3. Two R-TWT schedules are established on Link 1—Schedule-A and Schedule-B. STA1 affiliated with the non-AP MLD is a member of both R-TWT schedules. Link 1 is scheduled to be unavailable starting from time t1. Before Link 1 becomes unavailable, AP MLD announces in its BSS that Schedule-A on Link 1 is replaced by another R-TWT schedule on Link 3, and Schedule-B on Link 2 is replaced by another R-TWT schedule on Link 2. Accordingly, STA3 becomes a member of the new R-TWT schedule on Link 3, and STA2 becomes a member of the new R-TWT schedule on Link 2.

**9. Frame formats**

***TGbe editor: Please add the following subclause 9.4.2.xxx (R-TWT Link Replacement element) including the figure under the subclause 9.4.2 (Elements) as follows (#18205):***

**9.4.2.xxx R-TWT Link Replacement element**

The format of the R-TWT Link Replacement element is shown in Figure 9-yy1.

***TGbe editor: Please add Figure 9-yy1 (R-TWT Link Replacement element format) as follows:***



**Figure 9-yy1: R-TWT Link Replacement element format (#18205)**

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

The format of the Link Replacement Information field is shown in Figure 9-yy2.



**Figure 9-yy2: Link Replacement Information field format (#18205)**

From Broadcast TWT ID subfield in the Link Replacement Information field indicates the broadcast TWT ID corresponding to the R-TWT schedule on the link, indicated by the From Link ID subfield, from which the R-TWT schedule is moved to a different link using the R-TWT Link Replacement element.

To Broadcast TWT ID subfield indicates the broadcast TWT ID corresponding to the R-TWT schedule on the link, indicated by the To Link ID subfield, to which the R-TWT schedule is moved using the R-TWT Link Replacement element.

The Link Replacement Time subfield value contains a positive unsigned integer corresponding to a TSF time at which the R-TWT schedule identified by the Broadcast TWT ID subfield of the Link Replacement Information field is moved from one link between the AP MLD and the non-AP MLD onto another link. The TSF time indicated in the Link Replacement Time subfield is with respect to the TSF of the link from which the R-TWT schedule is moved.

The Minimum TWT Wake Duration subfield indicates the minimum amount of time the R-TWT scheduled STA is expected to be awake for the period of TWT wake interval corresponding to the replacement R-TWT schedule on the link onto which the R-TWT schedule is moved. The unit of Minimum TWT Wake Duration subfield value of the R-TWT Link Replacement element is the same as that of the Nominal Minimum TWT Wake Duration subfield of the original R-TWT schedule on the link indicated in the From Link ID subfield of the Link Replacement Information field.

From Link ID subfield indicates the link of an AP MLD from which the R-TWT schedule is moved to another link.

To Link ID subfield indicates the link of an AP MLD where the R-TWT schedule is moved to.

***TGbe editor: Please insert the following new row to Table 9-128 (Element IDs) (#18205)***

**Table 9-128—Element IDs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| R-TWT Link Replacement (see 9.4.2.xxx R-TWT Link Replacement element) | 255 | <ANA> | Yes | Yes |

***TGbe editor: Please insert the following new row to Table 9-60 (Beacon frame body) (#18205)***

**Table 9-60—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned+ 1> | R-TWT Link Replacement | One or more R-TWT Link Replacement elements are optionally present if dot11MultiLinkActivated and the dot11RestrictedTWTOptionImplemented are true; otherwise, none are present. |

***TGbe editor: Please insert the following new row to Table 9-67 (Probe Response frame body) (#18205)***

**Table 9-67—Probe Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned + 1> | R-TWT Link Replacement | One or more R-TWT Link Replacement elements are optionally present if dot11MultiLinkActivated and the dot11RestrictedTWTOptionImplemented are true; otherwise, none are present. |

***TGbe editor: Please insert the following new row to Table 9-623c (Protected EHT Action field values) (#18205)***

**Table 9-623c—Protected EHT Action field values**

|  |  |  |
| --- | --- | --- |
| **Value** | **Meaning** | **Time priority** |
| 0 | TID-To-Link Mapping Request | No |
| 1 | TID-To-Link Mapping Response | No |
| 2 | TID-To-Link Mapping Teardown | No |
| 3 | EPCS Priority Access Enable Request | No |
| 4 | EPCS Priority Access Enable Response | No |
| 5 | EPCS Priority Access Teardown | No |
| 6 | EML Operating Mode Notification | No |
| 7 | Link Recommendation | No |
| 8 | Multi-Link Operation Update Request | No |
| 9 | Multi-Link Operation Update Response | No |
| 10 | Link Replacement Acknowledgement | No |
| 11–255 | Reserved |  |

***TGbe editor: Please insert the following table (Table 9-623yyy--Protected EHT Action field values) under clause 9 (#18205)***

**Table 9-623yyy—Protected Link Replacement Acknowledgement frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | Protected EHT Action |
| 3 | Dialog Token |
| 4 | R-TWT Link Replacement (9.4.2.xxx R-TWT Link Replacement element) |

***TGbe editor: Please add the following subsection 35.8.zzz (R-TWT link replacement in multi-link operation) under clause 35.8 (Restricted TWT (R-TWT)) (#18205)***

**35.8 Restricted TWT (R-TWT)**

**35.8.zzz R-TWT link replacement in multi-link operation (#18205)**

When a first R-TWT schedule is established on a first link between an AP MLD and one or more non-AP MLDs, and if the link is impending to be unavailable, then the AP MLD can announce, by including an R-TWT Link Replacement element in the Beacon and Probe Response frames it transmits, that the first R-TWT schedule on the first link becomes unavailable and, as a replacement, a second R-TWT schedule is established on a second link on which the AP MLD is operating starting from the time indicated in the Link Replacement Time subfield of the R-TWT Link Replacement element.

When a first STA affiliated with a non-AP MLD associated with an AP MLD has obtained a membership of a first R-TWT schedule on a first link between the AP MLD and the non-AP MLD, if the non-AP MLD receives an R-TWT Link Replacement element included in the Beacon or Probe Response frame it receives indicating that the first R-TWT schedule on the first link is scheduled to be unavailable and, as a replacement, a second R-TWT schedule is established on a second link on which the AP MLD is operating, then the non-AP MLD over any enabled link between the AP MLD and the non-AP MLD shall transmit a Link Replacement Acknowledgement frame to the AP MLD if the non-AP MLD is also operating on the second link. The Link Replacement Acknowledgement frame shall contain an R-TWT Link Replacement element with the same parameters as the R-TWT Link Replacement element received from the AP MLD. Upon successfully transmitting the Link Replacement Acknowledgement frame by the non-AP MLD, the first R-TWT schedule on the first link is deleted for the first STA affiliated with the non-AP MLD at the time indicated in the Link Replacement Time subfield of the R-TWT Link Replacement element and the second STA affiliated with the non-AP MLD and operating on the second link becomes member of the second R-TWT schedule on the second link starting from the time indicated in the Link Replacement Time subfield of the R-TWT Link Replacement element. The first link and the second link are identified by the From Link ID subfield and the To Link ID subfield of the R-TWT Link Replacement element, respectively. The Broadcast TWT ID subfields corresponding to the R-TWT schedule on the first link and the second link are identified by the From Broadcast TWT ID subfield and the To Broadcast TWT ID subfield of the R-TWT Link Replacement element, respectively. Minimum wake duration of the second R-TWT schedule on the second link is indicated by the Minimum TWT Wake Duration subfield of the R-TWT Link Replacement element. The R-TWT TID(s) for uplink and downlink corresponding to the second R-TWT schedule on the second link are derived by taking intersection of two sets, set-1 and set-2, where set-1 denotes the R-TWT TID(s) corresponding to the first R-TWT schedule on the first link and set-2 denotes the TID(s) that are mapped on the second link using TID-to-Link mapping for uplink and downlink, respectively. Other TWT parameters of the second R-TWT schedule on the second link remain the same as the TWT parameters of the first R-TWT schedule on the first link.