IEEE P802.11
Wireless LANs

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| Comment Resolution on TWT |
| Date: Oct 10th, 2022 |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Rubayet Shafin | Samsung Research America | 6625 Excellence Way., Plano, TX, 75023 |  | r.shafin@samsung.com |
| Boon Loong Ng |  |  |
| Peshal Nayak |  |  |
| Vishnu Ratnam |  |  |
| Yue Qi |  |  |
| Elliot Jen |  |  |

 Abstract

This submission proposes resolutions for following 6 comments received for TGbe LB266:

* 3 CIDs: 12445, 13638, 13661

SP: Do you agree to the resolutions provided in doc 11-22/1427r2 for the following CIDs for inclusion in the latest 11be draft?

12445, 13638, 13661

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Minor editorial.
* Rev 2: Based on offline feedback, included an acknowledgement procedure for the R-TWT members.

***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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 12445 | Ryuichi Hirata | 511.09 | Current r-TWT agreement setup is per-link basis. To ensure delivery of latency sensitive traffic within specified time, medium access protection and resource reservation should be used on multiple links. | Define r-TWT agreement setup in multi-link operation such as setup procedure of r-TWT agreements for other links in one link. | **Rejected**The issue was discussed in the group (see [11-22/1051](https://mentor.ieee.org/802.11/dcn/22/11-22-1051-04-00be-lb266-cr-for-twt.docx)); however, no consensus was reached. |
| 13638 | Rubayet Shafin | 426.04 | 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. Note that renegotiating another schedule for the second link might not be a seamless process. | The spec needs to provide some mechanisms to handle the case where an rTWT schedule is established on a link and the link is becoming unavailable. | **Revised.**Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled is added.**TGbe editor, please make change as shown in this doc 11-22/1427r2 tagged by #13638.** |
| 13661 | Rubayet Shafin | 426.01 | If a link of an AP MLD is about to be deleted or unavailable, the AP MLD may need to suspend all the existing TWT schedules on that link. Currently there is not an efficient way for the AP MLD to notify the scheduled STAs about this TWT suspension on that link | Please provide a mechanism to notify the STAs that are member of bTWT/rTWT schedules about impending suspension of the schedule. This can be equivalent to extension of the use of TWT Information frame. | **Revised.**Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled is added.**TGbe editor, please make change as shown in this doc 11-22/1427r2 tagged by #13638.** |

**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 (#13638):***

**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 (#13638)**

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 (#13638)**

Broadcast TWT ID subfield in the Link Replacement Information field indicates the broadcast TWT ID corresponding to the R-TWT schedule that is moved from one link between an AP MLD and a non-AP MLD onto another link 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) (#13638)***

**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) (#13638)***

**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) (#13638)***

**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) (#13638)***

**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 | Link Replacement Acknowledgement | No |
| 9–255 | Reserved |  |

***TGbe editor: Please insert the following table (Table 9-623yyy--Protected EHT Action field values) under clause 9 (#13638)***

**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)) (#13638)***

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

**35.8.zzz R-TWT link replacement in multi-link operation (#13638)**

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 suspended 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 first R-TWT schedule on the first link is specified by the Broadcast TWT ID subfield of the R-TWT Link Replacement element. 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. 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.

If the first R-TWT schedule became unavailable due to the unavailability of the first link through advertised TID-to-Link Mapping, then, upon re-enablement of the link, the first schedule is re-established on the first link and the second schedule is deleted on the second link starting from the first R-TWT SP that comes after the re-enablement time of the first link.