IEEE P802.11
Wireless LANs

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| LB275 CR on R-TWT Replacement Link |
| Date: Oct 25th, 2023 |
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 Abstract

This submission proposes resolutions for the following 5 comments received for TGbe LB275:

* 7 CIDs: 19998, 20099, 20100, 20101, 20102, 20103, 20104

SP: Do you agree to the resolutions provided in doc 11-23/1783r1 for the following CIDs for inclusion in the latest 11be draft?

19998, 20099, 20100, 20101, 20102, 20103, 20104

Revisions:

* Rev 0:
	+ Initial version.
	+ Updates on revision column

***TGbe editor: Please note Baseline is 11be D4.1***

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** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 19998 | 580.22 | 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-sensitve 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/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20099 | 580.22 | Before a link is deleted or removed, if there was one or more R-TWT schedule on that link, then, in order to ensure smooth operation of the latency-sensitive applications, the AP MLD should provide an alternative link for the non-AP MLD for that R-TWT as a replacement. | A mechanism is needed to seamless transition of the R-TWT schedule from the soon-to-be-deleted link to the new link before the link is removed. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20100 | 580.22 | Before a link is disabled by the AP MLD, if there was one or more R-TWT schedule on that link, then, in order to ensure smooth operation of the latency-sensitive applications, the AP MLD should provide an alternative link for the non-AP MLD for that R-TWT as a replacement. | A mechanism is needed to seamless transition of the R-TWT schedule from the soon-to-be-deleted link to the new link before the link is disabled. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20101 | 580.22 | When an AP MLD initiate an advertised TTLM to disable a link, if there was one or more R-TWT schedule on that link, the AP MLD must take precautionary measures to ensure that the non-AP STAs operating on that link and are members of the R-TWT schedules are not affected. Spec should provide a mechanism to ensure that the latency-applications corresponding to those R-TWT schedules are not affected. | as in comment. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20102 | 611.35 | Before an AP is removed using ML reconfiguration, AP MLD should check if there is any R-TWT schedules on that link, and if there is any, then the AP MLD should move the schedule to a different link. A mechanism to allow such procedures need to be added in the spec. | as in comment. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20103 | 611.35 | An AP MLD before disabling a link (for example, using advertised TTLM) should always ensure that any R-TW schedule on that link is moved to a replacement link and the corresponding non-AP MLDs are notified about the new replacement link for the R-TWT. Such a mechanism needs to be provided in the spec. | as in comment. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |
| 20104 | 611.35 | An R-TWT link replacement procedure is currently missing in the spec and needs to be included to ensure smooth operation of the latency-sensitive applications of the non-AP MLD. | as in comment. | Agree in principle. Necessary text on mechanism to handle the issue with R-TWT link being disabled/deleted for an MLD is added.**TGbe editor, please make change as shown in this doc 11-23/1783r1 tagged by #19998.** |

**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 (Broadcast TWT Link Replacement element) including the figure under the subclause 9.4.2 (Elements) as follows (#19998):***

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

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

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



**Figure 9-yy1: Broadcast TWT Link Replacement element format (#19998)**

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 (#19998)**

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

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

The Link Replacement Time subfield value contains a positive unsigned integer corresponding to a TSF time at which the Broadcast 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 Broadcast TWT schedule is moved.

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

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

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

***TGbe editor: Please insert the following new row to Table 9-128 (Element IDs) (#19998)***

**Table 9-128—Element IDs**

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

***TGbe editor: Please insert the following new row to Table 9-60 (Beacon frame body) (#19998)***

**Table 9-60—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned+ 1> | Broadcast TWT Link Replacement | One or more Broadcast TWT Link Replacement elements are optionally present if dot11MultiLinkActivated and dot11TWTOptionActivated are true; otherwise, none are present. |

***TGbe editor: Please insert the following new row to Table 9-67 (Probe Response frame body) (#19998)***

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

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned + 1> | Broadcast TWT Link Replacement | One or more Broadcast TWT Link Replacement elements are optionally present if dot11MultiLinkActivated and dot11TWTOptionActivated are true; otherwise, none are present. |

***TGbe editor: Please insert the following new row to Table 9-628c (Protected EHT Action field values) (#19998)***

**Table 9-628c—Protected EHT Action field values(#19998)**

|  |  |  |
| --- | --- | --- |
| **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 Reconfiguration Notify | No |
| 11 | Link Reconfiguration Request | No |
| 12 | Link Reconfiguration Response | No |
| 13 | Link Replacement Acknowledgement | No |
| 14–255 | Reserved |  |

***TGbe editor: Please insert the following table (Table 9-623yyy--Protected EHT Action field values) under clause 9 (#19998)***

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

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

***TGbe editor: Please add the following subsection 35.3.24.3.zzz (Broadcast TWT link replacement) under clause 35.3.24.3 (Broadcast TWT Operation (#19998)***

**35.3.24.3 Broadcast TWT operation**

**35.3.24.3.zzz Broadcast TWT link replacement (#19998)**

When a first broadcast 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 a Broadcast TWT Link Replacement element in the Beacon and Probe Response frames it transmits on any of the links, that the first broadcast TWT schedule on the first link becomes unavailable and, as a replacement, a second broadcast TWT schedule is available for membership on a second link on which the AP MLD is operating starting from the time indicated in the Link Replacement Time subfield of the Broadcast TWT Link Replacement element. The second broadcast TWT schedule can either be an existing schedule on the second link or a schedule newly created by the AP on the second link.

When a first STA affiliated with a non-AP MLD associated with an AP MLD has obtained membership of a first broadcast TWT schedule on a first link between the AP MLD and the non-AP MLD, if the non-AP MLD receives a Broadcast TWT Link Replacement element included in the Beacon or Probe Response frame it receives indicating that the first broadcast TWT schedule on the first link is scheduled to be unavailable and, as a replacement, a second broadcast TWT schedule is available 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 a Broadcast TWT Link Replacement element with the same parameters as the Broadcast TWT Link Replacement element received from the AP MLD. Upon successfully transmitting the Link Replacement Acknowledgement frame by the non-AP MLD, the first broadcast 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 Broadcast TWT Link Replacement element and the second STA affiliated with the non-AP MLD and operating on the second link becomes a member of the second broadcast TWT schedule on the second link starting from the time indicated in the Link Replacement Time subfield of the Broadcast 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 Broadcast TWT Link Replacement element, respectively. The Broadcast TWT ID subfields corresponding to the broadcast 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 Broadcast TWT Link Replacement element, respectively. The minimum wake duration of the second broadcast TWT schedule on the second link is indicated by the Minimum TWT Wake Duration subfield of the Broadcast TWT Link Replacement element.

If a first R-TWT schedule established on a first link between an AP MLD and a non-AP MLD is replaced by a second R-TWT schedule available on a second link between the same AP MLD and the non-AP MLD using the Broadcast TWT Link Replacement element, then the R-TWT TID(s) for uplink and downlink corresponding to the second R-TWT schedule on the second link are derived by taking the 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 (see 35.3.7.1.7 (Advertised TID-to-link mapping in Beacon and Probe Response frames), 35.3.7.4 (Affiliated AP link disablement and enablement)). 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.