IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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](mailto: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:

* 6 CIDs: 13662, 11111, ~~11112~~, 11116, 11117, 12286, 12461.

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

13662, 11111, ~~11112~~, 11116, 11117, 12286, 12461.

Revisions:

* Rev 0: Initial version of the document.
* Rev 1:
  + Minor--revised the resolution for CID 11117. Thanks to Kumail.
  + Added CID 13662.
  + Removed CID 11112 and deferred to Abdel.
* Rev 2: Editorial.

***TGbe editor: Please note Baseline is 11be D2.2***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 13662 | Rubayet Shafin | 509.39 | For broadcast TWT operation with MLDs, there needs to be a mechanism to establish aligned broadcast TWT SPs across multiple links between the AP MLD and the non-AP MLD. Such aligned schedule would significantly improve the channel access opportunity for the non-AP MLD, and hence, would be crucial for the non-AP MLD's latency sensitive applications. However, currently, procedure to advertise and establish aligned schedule is missing in the spec. | Please provide framework and mechanism to enable advertisement and establishment of aligned broadcast TWT schedules across multiple links between the AP MLD and the non-AP MLD. | **Revised.**  Agree in principle. Necessary text to enable aligned TWT schedule has been added.  **TGbe editor, please make change as shown in this doc 11-22/xxxxr0 tagged by #13662.** |

**Discussion:**

Latency-sensitive traffic can be bursty and periodic. If there is a latency-sensitive TID, the non-AP MLD may want to map the TID to more than one (or all) setup links. For the latency-sensitive TID, STAs affiliated with the non-AP MLD may want to wake up at the same time so that the traffic corresponding to the latency-sensitive TID can flow over all the enabled links. This will increase the channel access opportunity for latency-sensitive flow. In such scenario, the non-AP MLD shall be benefitted if it becomes a member of a TWT schedule which can be aligned across multiple (or all) enabled links. All the broadcast TWT schedules may not possibly be aligned across multiple links by the TWT scheduling APs affiliated with an AP MLD. The AP MLD may align a selected set of schedules across multiple links and should indicate, during the broadcast TWT announcement phase, which schedules are aligned across multiple links.

**Aligned Schedule:** An aligned schedule is a TWT schedule offered by APs affiliated with an AP MLD across multiple links where the target wake time (TWT) of the schedule across the multiple links are aligned. This is illustrated in Figure D1, where TWT schedule A is an aligned schedule.



Figure D1: Illustration of aligned TWT schedule.

**Q:** Isn’t the realization of aligned schedule already possible through AP’s implementation?

**A:** Yes, an AP MLD can establish a TWT schedule across multiple links. However, since TWT scheduled STAs affiliated with the non-AP MLD operate independently on each link, the TWT scheduled STAs operating on a given link don’t know which schedules advertised on the link are aligned schedule. If a schedule, during the advertisement phase, is marked as “aligned” schedule, then it may be of interest for the TWT scheduled STAs affiliated with a non-AP MLD to become member of that schedule across multiple links to improve its latency-sensitive applications.

**Q:** What is the behavior changes for the STAs affiliated with the non-AP MLD?

**A:** In terms of operational procedures, there is no change to the non-AP STA-side behavior.

**9. Frame formats**

**9.4.2.199 TWT element**

***TGbe editor: Please Change Figure 9-768 (Request Type field in Broadcast TWT Parameter Set field format) as follows (#13662):***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 B3 | B4 | B5 | B6 | B7 B9 | B10 B14 | B15 |
|  | TWT  Request | TWT Setup  Command | Trigger | Last Broadcast Parameter Set | Flow  Type | Broadcast TWT Recommendation | TWT Wake  Interval Exponent | ~~Reserved~~  Aligned |
| Bits: | 1 | 3 | 1 | 1 | 1 | 3 | 5 | 1 |

**Figure 9-766: Request Type field format in Broadcast TWT Parameter Set field (#13662)**

***TGbe editor: Please* add the following paragraph after the paragraph (In a TWT element transmitted by a TWT requesting or TWT scheduled STA….) in Clause 9.4.2.199:**

The Aligned subfield indicates if the corresponding schedule is available on more than one links of the AP MLD. If the subfield is set to 1, it indicates that the schedule is available on multiple links and the target wake time of the schedules on the multiple links are aligned; otherwise, the schedule is not available on more than one links. The subfield is reserved if the Negotiation Type subfield of the Control field of the broadcast TWT element is set to 3. (#13662).

***TGbe editor: Please insert the following new row to Table 9-128 (Element IDs) (#13662)***

**Table 9-128—Element IDs**

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

***TGbe editor: Please insert the following new row to Table 9-60 (Beacon frame body) (#13662)***

**Table 9-60—Beacon frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned  + 1> | Aligned TWT Information | The Aligned TWT Information element is present if dot11MultiLinkActivated is true and the TWT scheduling AP has included a TWT element that contains at least one Broadcast TWT Parameter Set field with the Aligned subfield set to 1; otherwise it is not present. |

***TGbe editor: Please insert the following new row to Table 9-63 (Association Response frame body) (#13662)***

**Table 9-63—Association Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last  assigned + 1> | Aligned TWT Information | The Aligned TWT Information element is present if dot11MultiLinkActivated is true and the TWT scheduling AP has included a TWT element that contains at least one Broadcast TWT Parameter Set field with the Aligned subfield set to 1; otherwise it is not present. |

***TGbe editor: Please insert the following new row to Table 9-65 (Reassociation Response frame body) (#13662)***

**Table 9-65—Reassociation Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last  assigned + 1> | Aligned TWT Information | The Aligned TWT Information element is present if dot11MultiLinkActivated is true and the TWT scheduling AP has included a TWT element that contains at least one Broadcast TWT Parameter Set field with the Aligned subfield set to 1; otherwise it is not present. |

***TGbe editor: Please insert the following new row to Table 9-67 (Probe Response frame body) (#13662)***

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

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last  assigned + 1> | Aligned TWT Information | The Aligned TWT Information element is present if dot11MultiLinkActivated is true and the TWT scheduling AP has included a TWT element that contains at least one Broadcast TWT Parameter Set field with the Aligned subfield set to 1; otherwise it is not present. |

***TGbe editor: Please* add the following subclause under Clause 9.4.2 (Elements) *(#13662)*:**

**9.4.2.xxx Aligned TWT Information element (#13662)**

The Aligned TWT Information element format is shown in Figure 9-xx1 (Aligned TWT Information element format)

  
**Figure 9-xx1: Aligned TWT Information element format (#13662)**

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

The format of the Control field is shown in Figure 9-xx2 (Control field format in Aligned TWT Information element)



**Figure 9-xx2: Control field format in Aligned TWT Information element (#13662)**

The Aligned Schedule Link Bitmap Present subfield indicates whether or not the Aligned Schedule Link Bitmap subfield is present in an Aligned TWT Parameter Set field in the Aligned TWT Information element. If the Aligned Schedule Link Bitmap Present subfield is set to 1, it indicates that all the Aligned TWT Parameter Set fields contained in the Aligned TWT Information element contains the Aligned Schedule Link Bitmap; otherwise, none of the Aligned TWT Parameter Set field contains the Aligned Schedule Link Bitmap subfield.

The Aligned Schedule Information field contains one or more Aligned TWT Parameter Set fields. The Aligned TWT Parameter Set field format is shown in Figure 9-xx3 (Aligned TWT Parameter Set field format)



**Figure 9-xx3: Aligned TWT Parameter Set field format (#13662)**

The Broadcast TWT ID subfield in the Aligned TWT Parameter Set field indicates the broadcast TWT ID of the aligned schedule corresponding to the Aligned TWT Parameter Set field.

The Aligned Schedule Link Bitmap subfield, if present, indicates the link identifiers corresponding to the links on which the aligned schedule applies.

**35.8 TWT operation**

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

* + 1. **Broadcast TWT operation (#13662)**
* The TWT scheduling AP affiliated with an AP MLD, while announcing a broadcast TWT schedule in its BSS, can indicate whether the schedule is an aligned schedule. An aligned schedule is a broadcast TWT schedule that is available across multiple links such that the target wake times of the schedule on the multiple links are aligned; other TWT parameters of the schedule on those multiple links remain same.
* The TWT scheduling AP affiliated with the AP MLD, during the broadcast TWT announcement, may optionally indicate on which links the aligned schedule is available by specifying the links in the Aligned Schedule Link Bitmap subfield of the Aligned TWT Information element. If a Broadcast TWT Parameter Set field corresponding to an aligned schedule is included in a TWT element by an AP affiliated with an AP MLD during the broadcast TWT announcement phase, the AP shall include an Aligned TWT Information element in the same management frame containing the TWT element. If an aligned schedule is advertised on multiple links, the Broadcast TWT ID corresponding to the schedule on those links shall be the same.
* TWT scheduled STAs affiliated with a non-AP MLD that are interested in joining an existing aligned schedule on multiple links can send request to join the schedule on those links separately.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 11111 | Brian Hart | 512.03 | "otherwise, it is available for new membership" may be too optimistic since 100 STAs could request membership at the same time | Soften this. And probably invert the sentence for simplicity, so try "If the Restricted TWT Schedule Full subfield in the Broadcast TWT Info subfield in a Restricted TWT Parameter Set field is set to 0, it indicates that, at the transmission time, the corresponding r-TWT schedule is available for accommodating new membership ; otherwise, it is not available for new membership." | **Rejected.**  Based on the context from the previous sentences, the indicated sentence clearly articulates the intention. The suggested text would unnecessarily complicate the statement. |
| ~~11112~~ | ~~Brian Hart~~ | ~~512.14~~ | ~~Since the PHY really doesn't support stopping partway through an AMPDU, "MPDU" is probably wrong in "Before starting transmission of any MPDU, "~~ | ~~Try "Before starting transmission of any PPDU or determining the Duration field in any MDPU therein,"~~ | **~~Accepted~~** |
| 11116 | Brian Hart | 512.42 | "Non-AP EHT STAs may behave as if overlapping quiet intervals do not exist." is too loose, since Quiet elements also have a DFS purpose. Also "may" is wrong for clients that are expected to use that r-TWT SP. | Try "Non-AP EHT STAs that are members of an upcoming restricted TWT service period shall behave as if the quiet interval that overlaps the restricted TWT service period does not exist." | **Accepted** |
| 11117 | Brian Hart | 512.48 | Odd English "shall ensure QoS Data frames of r-TWT TID(s) to be first delivered during the r-TWT SPs". | Try "shall ensure that QoS Data frames of the r-TWT TID(s) are delivered first during each r-TWT SP" | **Revised.**  Accepted actually. Replaced “r-TWT” with “R-TWT” to align with the recent changes in the spec text.  **TGbe editor, please make the changes tagged by CID #11117 in 11-22/1774r1.** |
| 12286 | KENGO NAGATA | 511.56 | As described in this clause, a r-TWT scheduling AP can indicate whether or not the schedule is available for accommodating any new membership and can notify other STAs. However, in the case of multiple r-TWT scheduling APs schedule r-TWT SP respectively, multiple r-TWT SP might be overlapped and should be avoided. TGbe should define mechanisms to prevent this issue. | As in the comment. | **Rejected.**  Although agree with the commenter about the raised issue, this change would be more appropriate for multiple AP coordination topic, and we can revisit this in the next generation standards development phase. |
| 12461 | Daniel Verenzuela | 512.04 | All EHT STAs that support r-TWT should be allowed to use this feature with some level of fairness. The current recommendation "A STA should not request to establish membership in an r-TWT schedule advertised by the r-TWT scheduling AP with Restricted TWT Schedule Full subfield set to 1." can lead to EHT STAs not being able to participate in r-TWT SPs for long periods of time leading to unfairness in the use of this feature. | Define mechanism for EHT STAs that support r-TWT to be able to obtain membership of an r-TWT in a fairly even when r-TWT SPs are full. | **Rejected**  If the AP cannot accommodate any new membership in the schedule, it needs to declare upfront that the schedule is currently unavailable. The “Full Schedule” signaling is serving that purpose. It is not related to fairness. In fact, with this signaling, the AP is suggesting the STA to not waste effort in seeking membership in such schedule and rather try a different schedule that may satisfy the STA’s traffic requirements. This, in essence, is saving TWT negotiation time for the STA, which would be quite important if the STA has latency-sensitive traffic. |

***TGbe editor: Please modify the first paragraph in clause 35.8.5 (Traffic delivery) as follows:***

An R-TWT scheduling AP or a member R-TWT scheduled STA that has initiated or participated in a frame exchange during an R-TWT SP shall ensure that QoS Data frames of the R-TWT TID(s) are delivered first during the R-TWT SP. (#11117) In a trigger-enabled R-TWT SP, when scheduling the transmission of Trigger frames, the R-TWT scheduling AP shall first trigger member R-TWT scheduled STAs to facilitate them to first deliver their QoS Data frames of R-TWT UL TID(s), if any.