IEEE P802.11
Wireless LANs

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| Proposed Draft Text for TWT for MLD |
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Abstract

This submission proposes draft text for TWT for MLD

Revisions:

* Rev 0: Initial version of the document.
* Rev 4: Some change according to the offline discussion with Abhi, Laurent, Young Hoon and so on, thanks
* Rev 5: Some change according to the offline discussion with Chunyu and Kumail,thanks

**The texts are based on the following motion**

Individual TWT agreement(s) could be set up on a setup link for more than one setup link.

[Motion 115, #SP60, [16] and [231]]

***Editing instructions formatted like this are intended to be copied into the TGbe Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGbe Editor: Editing instructions preceded by “TGbe Editor” are instructions to the TGbe editor to modify existing material in the TGbe draft. As a result of adopting the changes, the TGbe editor will execute the instructions rather than copy them to the TGbe Draft.***

***Discussion for the motion***

A TWT requesting STA affiliated with a TWT requesting MLD may negotiate individual TWT agreements with a TWT responding STA affiliated with a TWT responding MLD

* STA1 of STA MLD and AP1 of AP MLD operating on link 1 can exchange TWT setup frames (in a single negotiation) to negotiate
	+ A TWT agreement on link1 between STA1 and AP1

* + A TWT agreement on link2 between STA2 and AP2

* + 2 TWT agreements, one on link1 between STA1 and AP1, one on link1 between STA2 and AP2
		- These agreements can have same start time and end time, same parameters
		- These agreements can also have different ones as well (specifically ensure no overlap for instance)

***TGbe Editor: please insert Clause 35.5 as follows:***

35. Extremely High Throughput (EHT) MAC specification

35.5 TWT operation

35.5.1 Individual TWT agreements

A STA affliated with an MLD may negotiate individual TWT agreements with another STA affiliated with another MLD as defined in 10.47.1 (TWT overview) and 26.8.2 (Individual TWT agreements) except the following:

* The STA affiliated with the MLD may indicate the link(s) that are requested for TWT agreement setup in the TWT element of the management frame (such as TWT Setup frame) with a value of Request TWT, Suggest TWT or Demand TWT in the TWT Command field and with the TWT Request field equal to 1.
	+ If only one link is indicated, a TWT agreement is requested for the STA operating on that link.
	+ If multiple links are indicated, multiple TWT agreements are requested with the same TWT parameters; one for each of the STAs that are operating on the indicated links.
* The other STA affiliated with the other STA MLD may indicate the link(s) in the TWT element of the Management frame (such as TWT Setup frame) with a value of Accept TWT, Alternate TWT, Dictate TWT or Reject TWT in the TWT Command field and with the TWT Request field equal to 0 as a response. The link(s) in the TWT element sent by the other STA affiliated with other STA MLD, if it is not an unsolicited response, shall be the same as the link(s) in the TWT element received from the STA affiliated with the MLD.
* The Target Wake Time field of the TWT element shall be interpreted in reference to the TSF time of the link on which the frame carrying the TWT element is transmitted.

During the negotiation of TWT agreements, a TWT requesting STA affiliated with an MLD and a TWT responding STA affiliated with another MLD may indicate different link(s) in each TWT element if there are more than one TWT element in the Management frame.

An example of TWT agreements negotiation between two MLDs is shown in Figure 35-x-a (Example of TWT agreements negotiation).



Figure 35-x-a – Example of TWT agreements negotiation

In this example, 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. Non-AP STA 1 affiliated with the non-AP MLD sends a TWT element in a TWT setup frame to AP 1 affiliated with the AP MLD. The TWT element sent by non-AP STA 1 indicates the links of AP 1, AP 2, and AP 3 to request three links on which to setup TWT agreements (one link between AP 1 and non-AP STA 1, one link between AP 2 and non-AP STA 2, and one link between AP 3 and non-AP STA 3), and is with a value of Request TWT in the TWT Command field and with the TWT Request field equal to 1. Moreover, the TWT element indicates a Target Wake Time value of T1 and Nominal Minimum TWT Wake Duration of T. AP 1 affiliated with the AP MLD sends a TWT element in a TWT setup frame to non-AP STA 1 affiliated with the non-AP MLD and the TWT element sent by AP 1 indicates the links of AP 1, AP 2, and AP 3 with a value of Accept TWT in the TWT Command field and with the TWT Request field equal to 0. After successful TWT agrements setup on three links, three TWT SPs with the same TWT parameters exist on these three links (link 1 between AP 1 and non-AP STA 1, link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3). An example of how these TWT SPs on the three links occur in time is shown in Figure 35-x-b (Example of negotiated TWT SPs occurrence in time). The Target Wake Time of the TWT element and the TSF time of AP1 (TSF1) as reference are used to calculate the starting time of subsequent TWT SPs on the three links so that their start times are aligned and have the same duration.



Figure 35-x-b – Example of negotiated TWT SPs occurrence in time

In another instance, non-AP STA 1 affiliated with the non-AP MLD sends three TWT elements in a TWT setup frame to AP 1 affiliated with the AP MLD. These three TWT elements sent by non-AP STA 1 indicate the links of AP 1, AP 2, and AP 3 to request three links to be setup TWT agreements, respectively, have different parameters, such as target wake up time, and all are with a value of Request TWT in the TWT Command field and with the TWT Request field equal to 1. AP 1 affiliated with the AP MLD sends three TWT elements in a TWT setup frame to non-AP STA 1 affiliated with the non-AP MLD and these three TWT elements sent by AP 1 indicate the links of AP 1, AP 2, and AP 3 respectively; and they are all with a value of Accept TWT in the TWT Command field and with the TWT Request field equal to 0. After successful TWT agreements setup on the three links, three TWT SPs with different TWT parameters exist on these three links(link 1 between AP 1 and non-AP STA 1, link 2 between AP 2 and non-AP STA 2, and link 3 between AP 3 and non-AP STA 3).

Another example of TWT agreements negotiation between two MLDs is shown in Figure 35-y (Another Example of TWT agreements negotiation).



Figure 35-y – Another Example of TWT agreements negotiation

In this example, 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. Non-AP STA 1 affiliated with the non-AP MLD sends a TWT element in a TWT setup frame to AP 1 affiliated with the AP MLD. The TWT element sent by non-AP STA 1 indicates the link of AP 2 to request one link to be setup TWT agreement (one link between AP 2 and non-AP STA 2), and is with a value of Request TWT in the TWT Command field and with the TWT Request field equal to 1. AP 1 affiliated with the AP MLD sends a TWT element in a TWT setup frame to non-AP STA 1 affiliated with the non-AP MLD and the TWT element sent by AP 1 indicates the link of AP 2 with a value of Accept TWT in the TWT Command field and with the TWT Request field equal to 0. A successful TWT agrement is setup on one link (link 2 between AP 2 and non-AP STA 2). In another instance, the link 2 in this TWT negotiation can be replaced by link 1, then a successful TWT agrement is setup on link 1 (link 1 between AP 1 and non-AP STA 1).

***TGbe Editor: please modify Clause 9.4.2.199 of 802.11ax D8.0 as follows:***

* **TWT element**

***Replace Figure 9-686 (TWT element format) with the following:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | Element ID | Length | Control | TWT Parameter Information |
| Octets:  | 1 | 1 | 1 | variable |
| * **TWT element format**
 |

***Change Figure 9-687 (Control field format) as follows.***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2           B3 | B4 | B5 | B6 |  B7 |
|  | NDP Paging Indicator | Responder PM Mode | Negotiation Type | TWT Information Frame Disabled | Wake Duration Unit(#20352) | Link ID Bitmap Present | Reserved |
| Bits: | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
|  | * **Control field format**
 |

***Insert the following (including table) after the 5th paragraph (“The Responder PM Mode subfield...”):***

The Negotiation Type subfield indicates whether the information included in the TWT element is for the negotiation of parameters of broadcast or individual TWT(s) or a Wake TBTT interval. The MSB of the Negotiation Type subfield is the Broadcast field.

The TWT Information Frame Disabled subfield is set to 1 to indicate that the reception of TWT Information frames is disabled by the STA; otherwise, it is set to 0.

The Wake Duration Unit subfield indicates the unit of the Nominal Minimum TWT Wake Duration field. The Wake Duration Unit subfield is set to 0 if the unit is 256 us and is set to 1 if the unit is a TU. A non-HE STA sets the Wake Duration Unit subfield to 0.

The Link ID Bitmap field is present if the Link ID Bitmap Present field is equal to 1; otherwise, The Link ID Bitmap field is not present. (#20352)

If the Broadcast field of the Negotiation Type subfield is 1, then one or more broadcast TWT parameter sets are contained in the TWT element (see Figure 9-687b (Broadcast TWT Parameter Set field format)). If the Broadcast field of the Negotiation Type subfield is 0, then only one Individual TWT parameter set is contained in the TWT element (see Figure 9-687a (Individual TWT Parameter Set field format)). An S1G STA sets the Negotiation Type subfield to 0.

A TWT element that has the Broadcast field in the Control field set to 1 is referred to as broadcast TWT element.

The Negotiation Type subfield determines the interpretation of the Target Wake Time, TWT Wake Interval Mantissa and TWT Wake Interval Exponent subfields of the TWT element as defined in Table 9-296a (Interpretation of Negotiation Type subfield, Target Wake Time, TWT Wake Interval Mantissa and TWT Wake Interval Exponent fields).

|  |
| --- |
| * **Interpretation of Negotiation Type subfield, Target Wake Time, TWT Wake Interval Mantissa and TWT Wake Interval Exponent fields**
 |
| **Negotiation Type subfield** | **Target Wake Time field** | **TWT Wake Interval Mantissa and TWT Wake Interval Exponent fields** | **Description** |
| 0 | A future Individual TWT SP start time | Interval between individual TWT SPs | Individual TWT negotiation between TWT requesting STA and TWT responding STA or individual TWT announcement by TWT responder. See 10.48 (Target wake time (TWT)), and 26.8.2 (Individual TWT agreements).The TWT element contains one individual TWT parameter set. |
| 1 | Next Wake TBTT time | Interval between wake TBTTs | Wake TBTT and wake interval negotiation between TWT scheduled STA and TWT scheduling AP. See 26.8.6 (Negotiation of wake TBTT and wake interval).The TWT element contains one individual TWT parameter set. |
| 2 | A future Broadcast TWT SP start time | Interval between broadcast TWT SPs | Provide broadcast TWT schedules to TWT scheduled STAs by including the TWT element in broadcast Management frames sent by TWT scheduling AP. See 26.8.3.2 (Rules for TWT scheduling AP).The TWT element contains one or more broadcast TWT parameter sets. |
| 3 | A future Broadcast TWT SP start time | Interval between broadcast TWT SPs | Manage memberships in broadcast TWT schedules by including the TWT element in individually addressed Management frames sent by either a TWT scheduled STA or a TWT scheduling AP. See 26.8.3 (Broadcast TWT operation).The TWT element contains one or more broadcast TWT parameter sets. |

The TWT Parameter Information field contains a single Individual TWT Parameter Set field with format defined in Figure 9-687a (Individual TWT Parameter Set field format) if the Broadcast subfield in the Control field is 0 and contains one or more Broadcast TWT Parameter Set fields with format defined in Figure 9-687b (Broadcast TWT Parameter Set field format) if the Broadcast subfield of the Control field is 1. The number of Broadcast TWT Parameter Set fields present is determined by the values of the Last Broadcast Parameter Set subfields(#20112) of the Request Type fields.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  | Request Type | Target Wake Time | TWT Group Assignment | Nominal Minimum TWT Wake Duration | TWT Wake Interval Mantissa | TWT Channel | NDP Paging (optional) | Link ID Bitmap |
| Octets:  | 2 | 0 or 8 | 0, 3 or 9 | 1 | 2 | 1 | 0 or 4 | 0 or 2 |
| * **Individual TWT Parameter Set field format**
 |  |

***TGbe Editor:Insert the following paragraphs and figure after paragraph 21 (“The TWT Wake Interval Mantissa…”):***

Link ID Bitmap subfield indicates the links to which the TWT element negotiated by a STA is applied. A value of 1 in bit position *i* of the Link Bitmap subfield means that the link associated with the link ID *i* is the link to which the TWT element negotiated by a STA is applied. A value of 0 in bit position *i* of the Link Bitmap subfield means that the link associated with the link ID *i* is not the link to which the TWT element negotiated by a STA is applied.