IEEE P802.11
Wireless LANs

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| Comment resolutions for broadcast TWT |
| Date: 2019-05-01 |
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Abstract

This submission proposes resolutions for multiple comments related to TGax D4.0 with the following CIDs (14 CIDs):

* 20121, 20125, 20381, 20400, 20401, 20843, 21077, 21078, 21079, 21081,
* 21083, 21084, 21085, 21086

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Incorporates editorial suggestion received from Matt. Changes in green.
* Rev 2: Incoporates suggestions received during the ad-hoc presentation. This revision also addresses two of the CIDs that were deferred during the presentation at the ad-hoc meeting. Namely CID 20401 has the same resolution as earlier (confirmed with member that the resolution is fine), and CID 20843 resolved by adding a similar reference for the individual TWT. CID 20400 is still deferred. The changes are highlighted in this color.

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 TGax Draft. This introduction is not part of the adopted material.

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

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

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| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 20121 | Alfred Asterjadhi | 374.58 | Maybe good to specify that the same broadcast TWT ID subfield can appear up to two times if the TWT Command is Alternate TWT and multiple times if the Broadcast TWT ID field is zero. | As in comment. | Revised –Agree in principle with the comment. The normative behavior described in this subclause and in other subclasues is clear in stating that there can be more than one Broadcast TWT Parameter Set fields in these two cases. The proposed resolution is to simply add a note that indicates the possibility of these two conditions.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 20121. |
| 20125 | Alfred Asterjadhi | 373.61 | Please make this note consistent with the note located in the individual TWT subclause. Essentially add at the end of the note: "and is recommended to allocate enough resources in subsequent Trigger frames sent during the TWT SP so that the STA can send as much as possible of the data reported in the BSR". | As in comment. | Revised –Agree with the comment. Proposed resolution accounts for the suggested changes.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 20125. |
| 20381 | Laurent Cariou | 374.29 | AP isn't able to always predict if the current TF transmission is the last TF in the Broadcast TWT SP because the medium might be shared with other BSSs which will prevent additional transmissions | Replace the original sentence with the following 2 sentences: The TWT scheduling AP may set the More TF subfield to 0 when the Trigger frame is the last Trigger frame of the TWT SP. The TWT scheduling AP shall set the More TF subfield to 0 when the Trigger frame is sent outside of a trigger-enabled TWT SP | Revised –Agree in principle with the comment. Proposed resolution is to specify that the Trigger frame is the last scheduled Trigger frame rather than the last transmitted Trigger frame. Also added in the note that the AP can cancel the transmission of a scheduled Trigger frame if the AP gains access to the wireless medium outside of the TWT SP.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 20381. |
|  |  |  |  |  |  |
| 20401 | Liwen Chu | 374.43 | This may create mismatch of TWT start time between AP and STA. | Fix the issue | Rejected –The next TWT is obtained as the future value of the TWT field of the Broadcast TWT Parameter Set field which contains the bits 10:25 of the TSF timer at that TWT time and with bits 0 to 9 assumed to be 0. Since the requirement is unambiguous to both sides both AP and STA will have a clear indication as to which is the TWT for the particular broadcast TWT schedule. The mismatch may occur only because of clock drifting between the AP and the STA. With a +-100ppm requirement clock accuracy requirement there may be a drifting if the STA stays in doze state for significant amounts of time, however this is not the case because the STA generally wakes to read the Beacon to determine if the TIM bit for its AID is set to 1, in which case the STA also synchronizes its own internal clock to the value of the Timestamp field of the Beacon that is sent by the AP. In addition, to overcome this drifting the STA may decide to wake a little bit earlier than the estimated TWT start time. |
| 20843 | Mark RISON | 380.01 | "A TWT scheduling AP sets the bit in the TIM element of the Beacon frame that corresponds to the AID of theTWT scheduled STA to 1 to indicate that it expects the TWT scheduled STA to solicit available buffered BUs (see11.2.2.8 (Receive operation for STAs in PS mode during the CP))." -- this is in 26.8.3 so suggests it only applies to broadcast TWT, not individual TWT | Clarify applicability to individual TWT | Revised –Proposed resolution adds a similar sentence, as a note, for the individual TWT counterpart since this is baseline behavior.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 20843. |
| 21077 | Matthew Fischer | 371.21 | This sentence makes it sound like OPS is required for a TWT scheduled STA, but it is optional. | add text to the sentence to clarify that the OPS portion only applies to a STA that supports OPS | Revised –Agree in principle with the comment. Proposed resolution modifies the sentence to clarify that the optionality applies to both OPS and OFDMA-RA.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21077. |
| 21078 | Matthew Fischer | 371.54 | There is a relative time reference here, but no absolute time reference. | Add language to clarify what "at or after" is at or after. I think, just change "broadcast TWT" to "broadcast TWT SP" | Revised –Agree in principle with the comment. Proposed resolution accounts for the suggested change, accountind for some editorial modifications for clarity.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21078. |
| 21079 | Matthew Fischer | 372.08 | I think that join or leave has no clear definition, use the terms from 26.8.3.3 | Replace "join or leave" with "become a member or terminate membership" | Revised –Agree in principle with the comment. Proposed resolution accounts for the suggested change, accountind for some editorial modifications for clarity.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21079. |
| 21081 | Matthew Fischer | 375.37 | Broadcast announcement use is not described. | Add the sentence: "A TWT scheduling STA may transmit a broadcast TWT announcement at any time." | Revised –Agree in principle with the comment. Proposed resolution accounts for the suggested change with a minor editorial change of specifying a TWT scheduling AP.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21081. |
| 21083 | Matthew Fischer | 372.48 | Should define what a broadcast TWT announcement is - we have a table showing them and a statement that indicates that some are valid and implying that some are not. | Include the following sentence: "A TWT element transmitted within an MPDU that has a broadcast RA and a value of 1 in the Broadcast subfield of the TWT element is a broadcast TWT announcement." | Revised –Agree in principle with the comment. Proposed resoliution accounts for the suggested change, considering that there can be more than one such announcement in the TWT element and that the use of term broadcast Management frame is simpler.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21083. |
| 21084 | Matthew Fischer | 372.53 | persistence shall be a nonzero value, but not many lines later, the value of 0 is allowed | Remove the requirement to be a non-zero value. | Revised –Agree in principle with the comment. Proposed resolution accounts for the suggested change.TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21084. |
| 21085 | Matthew Fischer | 374.51 | wrong article | Change "the" twice to "a", just like in the previous paragraph! | Accepted |
| 21086 | Matthew Fischer | 374.20 | The language is probably not correct. A trigger frame is addressed to the RA. I think that the sentence is trying to state which STAs are identified in user info fields, which is not being address to, but being something else. Back in UL MU, it is the user info field that is said to be addressed to a STA. | Change "The Trigger frame shall be addressed to TWT scheduled STAs whose TIM bit" to "The User Info fields of the Trigger frame shall be addressed to TWT scheduled STAs whose TIM bit" | Revised –Agree in principle with the comment. Proposed resolution accounts for the suggested change, however, specifying that the Trigger frame shall contain User info fields addressed to the TWT scheduled STA, not precluding the fact that the Trigger might contain User Info fields addressed to other STAs as well. TGax editor to make the changes shown in 11-19/0724r2 under all headings that include CID 21086. |

**Discussion: *None.***

**TGax Editor: *Replace “TWT Command” with “TWT Setup Command” throughout the draft (#CID ED).***

* Broadcast TWT operation
* General

A TWT scheduling AP is an HE AP with dot11TWTOptionActivated equal to true that sets the Broadcast TWT Support field of the HE Capabilities element it transmits to 1 and that follows the rules in 26.8.3.2 (Rules for TWT scheduling AP), 26.14.2 (Power save with UORA and TWT), and those for scheduled OPS defined in 26.14.3 (Opportunistic power save).

A TWT scheduling AP includes a broadcast TWT element in the Beacon frame as described in 26.8.3.2 (Rules for TWT scheduling AP).

A TWT scheduling AP may include a TWT element with the Negotiation Type subfield equal to 3 in an (Re)Association Response frame or in a TWT setup frame to assign the recipient STA to a broadcast TWT schedule without having received a request from the STA to become a member of the broadcast TWT schedule if that STA has set the Broadcast TWT Support field of HE Capabilities element it transmits to 1.

The TWT scheduling AP may include a broadcast TWT element in FILS Discovery frames and in broadcast Probe Response frames to indicate the TWT SPs during which the AP intends to schedule for transmission Trigger frames with at least one RU with the AID12 subfield set to 2045. The broadcast TWT element shall carry only a broadcast TWT parameter set with the Broadcast TWT Recommendation subfield set to 2, the Trigger subfield set to 1 and the Broadcast TWT ID subfield set to 0. The AP transmits broadcast Probe Response frames if it has dot11FILSOmitReplicateProbeResponses equal to true.

An HE BSS belonging to a Multiple BSSID set (see 11.11.14 (Multiple BSSID set)) may advertise TWT element carried in the Management frames transmitted by the transmitted BSSID. An HE AP may include the TWT element in a nontransmitted BSSID profile carried in the Multiple BSSID element (see 9.4.2.46 (Multiple BSSID element)) to provide different TWT parameter values for STAs associated with that nontransmitted BSSID.

A non-AP HE STA shall obtain TWT parameter values from the most recently received TWT element carried in a Beacon, Probe Response, or (Re)Association Response frame from its associated AP unless the non-AP HE STA is associated with a nontransmitted BSSID of a multiple BSSID set, in which case it shall follow the rules in 11.1.3.8 (Multiple BSSID procedure) to determine the TWT parameter values.

A TWT scheduled STA is an non-AP HE STA that sets the Broadcast TWT Support field of the HE Capabilities element it transmits to 1 and receives a broadcast TWT element transmitted by an HE AP that is a TWT scheduling AP.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21077):***

A TWT scheduled STA follows the schedule provided by the TWT scheduling AP as described in 26.8.3.3 (Rules for TWT scheduled STA), with the addition of the rules described in 26.14.2 (Power save with UORA and TWT) if the STA supports UORA and the rules described in 26.14.3 (Opportunistic power save) if the STA supports OPS*(#21077)*. A TWT scheduled STA can negotiate the wake TBTT and wake interval for Beacon frames it intends to receive as described in 26.8.6 (Negotiation of wake TBTT and wake interval) or can join a particular broadcast TWT as described below.

An example of broadcast TWT operation is shown in Figure 26-8 (Example of broadcast TWT operation with optional TBTT negotiation(#21456)), where the AP is the TWT scheduling AP and STA 1 and STA 2 are the TWT scheduled STAs.

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|  |
| * Example of broadcast TWT operation with optional TBTT negotiation(#21456)
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**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21078):***

The TWT scheduling AP includes a broadcast TWT element in the Beacon frame that indicates a broadcast TWT SP during*(#21078)* which the AP intends to send Trigger frames, or DL BUs to the TWT scheduled STAs. STA 1 and STA 2 wake to receive the Beacon determine the broadcast TWT. During the trigger-enabled TWT SP the AP sends a Trigger frame to which STA 1 and STA 2 indicate that they are awake during the TWT SP. STA 1 indicates that it is awake by sending a PS-Poll and STA 2 indicates that it is awake by sending a QoS Null frame in response to the Trigger frame. STA 1 and STA 2 receive their DL BUs in a subsequent exchange with the AP and go to doze state outside of this TWT SP.

Each broadcast TWT is uniquely identified by the <broadcast TWT ID, MAC address> tuple, where the broadcast TWT ID is the value of the Broadcast TWT ID subfield and is greater than 0 and the MAC address is the address of the TWT scheduling AP.

Broadcast TWT schedules are advertised by the TWT scheduling AP in frames that carry TWT elements with the Negotiation Type subfield set to 2 as described in 26.8.3.2 (Rules for TWT scheduling AP). Broadcast TWT schedules that are intended for member TWT scheduled STAs are identified by a Broadcast TWT ID subfield that is greater than 0 and broadcast TWT schedules that are intended for all TWT scheduled STAs are identified by a Broadcast TWT ID subfield equal to 0.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21079, 20400):***

Negotiations to become a member of or terminate membership in a broadcast TWT,*(#21079)* identified by a Broadcast TWT ID subfield greater than 0, are performed with an exchange of frames that carry TWT elements with the Negotiation Type subfield set to 3 as described in 26.8.3.3 (Rules for TWT scheduled STA).

The TWT scheduling AP may send an unsolicited TWT response with the Trigger subfield set to 1 to a non-AP HE STA that has set the Broadcast TWT Support subfield to 1 in the HE Capabilities elements that it transmits to the AP. The TWT response shall indicate one of the following values in the TWT Setup*(#ED)* Command field: Accept TWT, Alternate TWT, or Dictate TWT. An unsolicited TWT response with TWT Setup*(#ED)* Command field indicating Alternate TWT or Dictate TWT contains an advisory notification to the recipient of TWT parameters that are likely to be accepted by the AP if the recipient transmits a subsequent TWT request to the AP that includes those TWT parameters. An unsolicited TWT response with a TWT Setup*(#ED)* Command field that indicates Accept TWT allocates a broadcast TWT schedule to the receiving STA. A STA that receives an unsolicited TWT response with a TWT Setup*(#ED)* Command field that indicates Accept TWT may transmit a TWT Teardown frame or a TWT response with TWT Setup*(#ED)* Command field indicating Reject TWT to withdraw from the unsolicited broadcast TWT schedule.

* Rules for TWT scheduling AP

A TWT scheduling AP may include a broadcast TWT element in a Beacon frame that is scheduled at a TBTT (see 11.1.3.2 (Beacon generation in non-DMG infrastructure networks)). The TWT scheduling AP shall include one or more TWT parameter sets in the TWT element, and each TWT parameter set may indicate a periodic occurrence of TWTs. The TWT scheduling AP shall set the Last Broadcast Parameter Set subfield to 0 in each TWT parameter set except for that the last (or only) TWT parameter set of the TWT element that shall have the Last Broadcast Parameter Set subfield set to 1. The TWT scheduling AP shall set the NDP Paging Indicator subfield to 0 and the Negotiation Type subfield to 2, and may set the Responder PM Mode subfield to 0 in the TWT element (see 10.48.7 (TWT Sleep Setup)). Each TWT parameter set specifies the TWT parameters of a specific broadcast TWT that are valid within a broadcast TWT SP. Each specific broadcast TWT is identified as indicated in 26.8.3.1 (General). Individual STAs may have membership in broadcast TWTs as the result of negotiation with a TWT scheduling AP as described in 26.8.3.1 (General).

The TWT scheduling AP sets the TWT parameters of each TWT parameter set as described below.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21083):***

The TWT scheduling AP shall set the TWT Request subfield to 0 and the TWT Setup Command subfield as defined in Table 26-6 (Broadcast TWT announcements) and shall include the broadcast TWT element in the Beacon frames for as long as there is at least one active broadcast TWT schedule. Broadcast TWT announcement(s) are broadcast TWT schedule(s) advertised in broadcast TWT element(s) contained in broadcast Management frames (see Table 26-6 (Broadcast TWT announcements)).*(#21083)*

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21084):***

The TWT scheduling AP shall set the Broadcast TWT Persistence subfield for each Broadcast TWT to *(#21084)* the number of TBTTs for which the Broadcast TWT schedule will be in existence, counting forward from the current TBTT. The AP may change the value of the Broadcast TWT Persistence subfield for any Broadcast TWT within any transmitted TWT element. If the AP reduces the value of the subfield, it shall not reduce the value by more than one as compared to the value transmitted during the immediately preceding beacon interval. If the AP increases the value of the Broadcast TWT Persistence subfield, it may increase the value by any amount as compared to the value transmitted during the immediately preceding TBTT.

A TWT scheduling AP that sets the TWT Setup Command subfield to Reject TWT shall indicate the TBTT at which the periodic broadcast TWT will be terminated by setting the value of the Broadcast TWT Persistence subfield to indicate the number of TBTTs that remain until the broadcast TWT schedule is terminated. The broadcast TWT schedule terminates at the next TBTT that follows the TBTT at which the TWT scheduling AP transmits the broadcast TWT element with Broadcast TWT Persistence subfield for that broadcast TWT schedule equal to 0. A TWT scheduling AP may terminate the membership of a TWT scheduled STA in all broadcast TWTs by transmitting a TWT Teardown frame with the Teardown All TWT field set to 1.

**TGax Editor: *Please ignore the changes below as this CID is deferred (#CID 20400):***

A TWT scheduling AP that sets the TWT Setup Command subfield to Alternate TWT shall indicate the TBTT at which the periodic broadcast TWT parameter set will be modified by setting the Broadcast TWT Persistence subfield to indicate the number of TBTTs that remain until the broadcast TWT schedule is modified. The broadcast TWT schedule will be modified at the next TBTT, which follows the TBTT at which the TWT scheduling AP transmits the broadcast TWT element with Broadcast TWT Persistence subfield for that broadcast TWT schedule equal to 0. The AP shall include in the broadcast TWT element the future broadcast TWT parameter set that will take effect at that TBTT. The future broadcast TWT parameter set shall have the same values in the TWT Setup Command and Broadcast TWT ID subfields as the current broadcast TWT parameter set that is being modified. The future broadcast TWT parameter set shall be in a Broadcast TWT Parameter Set field that is located after the Broadcast TWT Parameter Set field that contains the current broadcast TWT parameter set. The AP shall remove the current broadcast TWT parameter set from the TWT element and shall switch the TWT Setup Command subfield of the future broadcast TWT parameter set from Alternate TWT to Accept TWT at the TBTT that follows the TBTT at which the Broadcast TWT Persistence subfield of that broadcast TWT parameter set reaches 0.*(#20400)*

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID ED):***

A TWT scheduling AP should indicate Alternate TWT or Reject TWT in the TWT Setup*(#ED)* Command Setup field of the broadcast TWT element for as many TBTTs as needed to exceed the longest interval any STA is expected to not receive Beacon frames either when the TWT parameters of a periodic TWT will change, or when the periodic TWT specified by that TWT parameter set will be terminated.

The TWT scheduling AP shall set the Trigger field to 1 to indicate a trigger-enabled TWT. Otherwise, it shall set the Trigger field to 0 (i.e., the TWT is not a trigger-enabled TWT). The AP is not expected to schedule for transmission Trigger frames during a non-trigger-enabled TWT SP and is expected to schedule Trigger frames during a trigger-enabled TWT SP as described below.

The TWT scheduling AP shall schedule for transmission of a Trigger frame addressed to one or more TWT scheduled STAs during a trigger-enabled TWT SP. A TWT scheduling AP should not include the 12 LSBs of the STA's AID in a User Info field of a Trigger frame transmitted within a broadcast TWT SP unless the STA is in the awake state, has established membership in the broadcast TWT with that Broadcast TWT ID, or has indicated to receive the Beacon preceding the beacon interval that contains this TWT SP (see 26.8.6 (Negotiation of wake TBTT and wake interval)).

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 20381):***

The TWT scheduling AP that intends to schedule for transmission additional Trigger frames during a trigger-enabled TWT SP shall set the More TF subfield in the Common Info field of the Trigger frame to 1 to indicate that it will schedule for transmission another Trigger frame within the same TWT SP. The TWT scheduling AP shall set the More TF subfield to 0 when the Trigger frame is the last scheduled Trigger frame of the TWT SP or when the Trigger frame is scheduled for transmission outside of a trigger-enabled TWT SP. The TWT scheduling AP should poll as many STAs as possible among TWT scheduled STAs that are members of that nonzero Broadcast TWT ID so that the STAs can perform a frame exchange with the TWT scheduling AP during that TWT SP.

NOTE 1—The TWT scheduling AP does not intend to schedule for transmission of a Trigger frame for the TWT scheduled STA when the broadcast TWT is not a trigger-enabled TWT or when the TWT scheduled STA has sent an OM Control subfield that has the UL MU disable bit equal to 1 (see 26.9 (Operating mode indication)).

NOTE 2—The TWT scheduling AP can cancel the transmission of a scheduled Trigger frame if the AP gains access to the wireless medium outside of the TWT SP.*(#20381)*

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 20125):***

NOTE 3—The Trigger frame can also be an TRS Control subfield contained in an MPDU carried in a DL MU PPDU, provided that the AP allocates enough resources in the HE TB PPDU for the STA to at least deliver its BSRs in response to the soliciting DL MU PPDU and is recommended to allocate enough resources in subsequent Trigger frames sent during the TWT SP so that the STA can send as much as possible of the data reported in the BSR.*(#20125)*

The TWT scheduling AP shall set the Flow Type field to 1 to indicate an unannounced TWT. Otherwise, it shall set the Flow Type field to 0 to indicate an announced TWT.

The TWT scheduling AP should schedule delivery of individually addressed DL BUs during unannounced TWT SPs with nonzero Broadcast TWT ID subfield.

The TWT scheduling AP shall set the Broadcast TWT Recommendation subfield according to Table 9-298a (Broadcast TWT Recommendation field for a broadcast TWT element). The TWT scheduling AP shall set the Trigger field to 1 if the Broadcast TWT Recommendation subfield is 1 or 2, and may set the Trigger field to any value if the Broadcast TWT Recommendation subfield is 0 or 3.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21086):***

A TWT scheduling AP that has advertised a broadcast TWT with a Broadcast TWT ID equal to 0 shall schedule the following:

* The delivery of group addressed DL BUs during the broadcast TWT SPs located within the beacon interval that follows the DTIM Beacon frame if the TWT parameter set indicated non-trigger enabled unannounced TWT SP and had the Broadcast TWT Recommendation subfield equal to 0.
* The transmission of a Trigger frame that does not contain an RA-RU during the broadcast TWT SPs if the TWT parameter set indicated trigger-enabled announced TWT SP and had the Broadcast TWT Recommendation subfield equal to 1. The Trigger frame shall contain at least one User Info field that is addressed to a TWT scheduled STA whose TIM bit in the Beacon is set to 1 and that is not a member of any nonzero broadcast TWT during this beacon interval.*(#21086)*
* The transmission of a Trigger frame that contains at least one RA-RU (see 26.5.4 (UL OFDMA-based random access (UORA))) during the broadcast TWT SPs if the TWT parameter set indicated a trigger enabled announced TWT SP and had the Broadcast TWT Recommendation subfield set to 2 (see 26.14.2 (Power save with UORA and TWT).
* The transmission of a TIM frame or FILS Discovery frame at the start of a broadcast TWT SP if the TWT parameter set indicated a non-trigger enabled unannounced TWT SP and had the Broadcast TWT Recommendation subfield set to 3 (see 26.14.3.2 (AP operation for opportunistic power save)).

A Trigger frame transmitted during a broadcast TWT SP whose TWT parameter set has the Broadcast TWT Recommendation subfield equal to 0 or 3 may contain zero or more RA-RUs (see 26.5.4 (UL OFDMA-based random access (UORA))). A Trigger frame transmitted during a broadcast TWT SP whose TWT parameter set has the Broadcast TWT Recommendation subfield equal to 1 shall contain no RA-RU.

The TWT scheduling AP shall set the TWT field to the TSF timer [10: 25] that corresponds to the next TWT that is scheduled for this TWT parameter set when it queues for transmission the frame that contains the TWT element. The TSF timer at which the next TWT is scheduled has bits 0 to 9 equal to 0 and bits 26 to 63 equal to the same value as the respective bits in the current TSF timer.

The TWT scheduling AP shall include a nonzero value for the TWT wake interval in the TWT Wake Interval Exponent and TWT Wake Interval Mantissa fields for a periodic TWT and a zero value for an aperiodic TWT.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21085):***

The TWT parameters are valid for each successive TWT of a periodic TWT and for the only TWT of a aperiodic TWT.*(#21085)*

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 20121):***

The TWT scheduling AP shall include a unique value in the Broadcast TWT ID subfield for each Broadcast TWT to allow identification of each Broadcast TWT unless the TWT Setup Command is Alternate TWT or the Broadcast TWT ID subfield is zero.

NOTE—The broadcast TWT element contains two Broadcast TWT Parameter Set fields with the same Broadcast TWT ID subfield value if the TWT Setup Command subfield indicates Alternate TWT in one of the Broadcast TWT Parameter Set fields. The broadcast TWT element might contain multiple Broadcast TWT Parameter Set fields with the Broadcast TWT ID subfield equal to 0.*(#20121)*

A TWT scheduling AP that receives a PS-Poll or a U-APSD trigger frame or any other indication from a TWT scheduled STA that is in PS mode that the STA is in the awake state during, or prior to the start of an announced TWT SP shall follow the rules defined in 11.2.3.6 (AP operation) except that the AP should deliver to the TWT scheduled STA as many buffered BUs as available at the AP, provided that the BU delivery does not exceed the duration of the TWT SP, the TWT scheduled STA has indicated to be in the awake state for that TWT SP and as long as the TWT scheduled STA has not entered the doze state (see 26.8.4.3 (TWT information for broadcast TWT) and 26.8.5 (Power save operation during TWT SPs)).

NOTE—Other indications that the STA is in the awake state are the transmission of an HE TB NDP PPDU in response to an NFRP Trigger frame (see 26.5.7 (NDP feedback report procedure)) or the transmission of a frame that indicates that the STA is in active mode (see 11.2.3.2 (Non-AP STA power management modes)).

A TWT scheduling AP that sends frames to a TWT scheduled STA that is in PS mode during an unannounced TWT SP shall follow the rules defined in 11.2.3.6 (AP operation) except that the AP should deliver to the TWT scheduled STA as many buffered BUs as available at the AP, provided that the BU delivery does not exceed the duration of the TWT SP and as long as the TWT scheduled STA has not entered the doze state (see 26.8.4.3 (TWT information for broadcast TWT) and 26.8.5 (Power save operation during TWT SPs).

NOTE—The TWT scheduling AP can deliver the buffered BUs in an A-MPDU under a BlockAck agreement if the TWT is an announced TWT and the TWT scheduled STA is awake for that TWT SP, or if the TWT is an unannounced TWT (at the start of which the TWT scheduled STA is assumed to already be awake). The TWT scheduling AP can exceed the duration of the TWT SP if the TWT scheduled STA is in Active mode.

A TWT scheduling AP may transmit to a TWT scheduled STA that is in Active mode at any time (see 11.2.3.2 (STA power management modes).

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID ED):***

A TWT scheduling AP that receives a TWT element with the TWT Request field equal to 1, the Negotiation Type subfield equal to 3 and the TWT Setup*(#ED)* Command field set to Suggest or Demand may respond with a frame containing a TWT element as shown in Table 26-7 (Broadcast TWT membership exchanges).

A TWT scheduling AP that receives a TWT element with the TWT Request field equal to 1, the Negotiation Type subfield equal to 3 and the TWT Setup*(#ED)* Command field set to Reject shall delete the membership of the STA corresponding to the TA of the MMPDU that contained the TWT element from the broadcast TWT schedule that has the Broadcast TWT ID value that is equal to the value of the Broadcast TWT ID field of the TWT element.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 21081):***

A TWT scheduling AP may transmit a broadcast TWT announcement at any time. Valid broadcast TWT announcements are described in Table 26-6 (Broadcast TWT announcements).*(#21081)*

|  |
| --- |
| * Broadcast TWT announcements
 |
| TWT Setup Command field in an initiating frame | TWT Setup Command field in a response frame | Condition after the completion of the exchange |
| Accept TWT |  No frame transmitted | Only an HE AP is permitted to transmit this sequence.TWT scheduled STAs that receive this frame use the provided TWT parameters to determine the broadcast TWT schedule.The broadcast TWT schedule is identified by the broadcast TWT ID and the TA of the initiating frame. |
| Alternate TWT |  No frame transmitted | When transmitted by a TWT scheduling AP, some of the parameters of the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the initiating frame will change at the TBTT that occurs after the Broadcast TWT Persistence field of that broadcast TWT parameter set reaches 0. The new parameters will be present in the first Beacon frame transmitted by the TWT scheduling AP at the TBTT, which has a broadcast TWT parameter set with the same broadcast TWT ID and same TA, but with the TWT command value set to Accept TWT. |
| Reject TWT |  No frame transmitted | When transmitted by a TWT scheduling AP, the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the initiating frame will be terminated at the TBTT that occurs after the Broadcast TWT Persistence field of that broadcast TWT parameter reaches 0. The termination occurs at the TBTT at which a Beacon is transmitted by the TWT scheduling AP that does not include a broadcast TWT parameter set with the same broadcast TWT ID and same TA as the initiating frame. |
| NOTE 1—The Negotiation Type field of the TWT element contained in these frames is 2. NOTE 2—The initiating frame and response frame settings not listed in the tables in 10.48 (Target wake time (TWT)) or 26.8 (TWT operation) are not allowed. The initiating frame is a TWT response.NOTE 3—MMPDUs that contain a broadcast TWT element generated by a TWT scheduling AP can be broadcast Probe Response, FILS Discovery, and Beacon frames. The TWT element has the TWT Request field equal to 0 and the Negotiation Type subfield equal to 2. The TWT scheduling AP can include a TWT parameter set with Broadcast TWT ID value 0 to indicate a TWT allocated for all STAs, and Broadcast TWT ID greater than 0 to indicate a TWT intended to TWT scheduled STAs that are members of that broadcast TWT. |

* Rules for TWT scheduled STA

A TWT scheduled STA that receives a broadcast TWT element in a Beacon frame shall follow the rules defined in this subclause to interact with the TWT scheduling AP.

A TWT scheduled STA should not transmit frames to the TWT scheduling AP outside of broadcast TWT SPs and within trigger-enabled broadcast TWT SPs, except that the STA can transmit frames within negotiated individual TWT SPs as defined in 26.8.2 (Individual TWT agreements).

NOTE—The TWT scheduled STA decides which frames to transmit within or outside a TWT SP and while it is recommended that the TWT scheduled STA not transmit outside the TWT SP the TWT scheduled STA might still do so(#20228). If the STA decides to transmit then the STA might contend for accessing the medium as defined in 26.2.7 (EDCA operation using MU EDCA parameters).

A TWT scheduled STA may request to become a member of a broadcast TWT by transmitting a frame to its associated AP that contains a TWT element with the Negotiation Type subfield set to 3 and the TWT command field set to Request TWT or Suggest TWT or Demand TWT. The TWT Parameter set indicates the Broadcast TWT ID of the broadcast TWT that the STA is requesting to join. See Table 26-7 (Broadcast TWT membership exchanges).

A TWT scheduled STA may terminate membership in a broadcast TWT by transmitting a frame to its associated AP that contains a TWT element with the Negotiation Type field set to 3 and the TWT Command field set to Reject TWT or by transmitting a TWT Teardown frame that has the Negotiation Type set to 3. A TWT scheduled STA may terminate membership in all broadcast TWTs by transmitting a TWT Teardown frame with the Teardown All TWT field set to 1.

A TWT scheduled STA that receives a TWT element with the TWT Request field equal to 0, the Negotiation Type subfield equal to 3 and the TWT Command field indicating Accept TWT is a member of the broadcast TWT identified by the <broadcast TWT ID, MAC address> tuple, where the broadcast TWT ID is the value of the Broadcast TWT ID subfield in the TWT element and the MAC address which is the TA of the MMPDU that contained the TWT element is equal to the MAC address of the AP with which the STA is associated, regardless of whether the TWT scheduled STA had previously transmitted a corresponding TWT element to the AP with the TWT Command field indicating Request TWT, Suggest TWT or Demand TWT.

Valid broadcast TWT membership exchanges are described in Table 26-7 (Broadcast TWT membership exchanges).

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| * Broadcast TWT membership exchanges
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| TWT Setup Command field in an initiating frame | TWT Setup Command field in a response frame | Condition after the completion of the exchange |
| Demand TWT | Accept TWT | A broadcast TWT schedule exists or has been created with the TWT parameters indicated in the initiating frame and repeated in the responding frame.The TWT scheduled STA transmitting the initiating frame is a member of the Broadcast TWT schedule identified by the Broadcast TWT ID and the TA of the response frame. |
| Request TWT or Suggest TWT | Accept TWT | A broadcast TWT schedule exists or has been created with the TWT parameters indicated in the response frame.The TWT scheduled STA transmitting the initiating frame is a member of the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the response frame. |
| Suggest TWT or Demand TWT | Alternate TWT | No new broadcast TWT schedule has been created with the TWT parameters indicated in the initiating frame.The TWT scheduling AP is offering an alternative set of parameters vs. those indicated in the initiating frame, as a means of negotiating TWT parameters with the TWT scheduled STA.The TWT scheduled STA can send a new request with any set of TWT parameters and the TWT scheduling AP might create a new broadcast TWT schedule using the parameters indicated in the responding frame. |
| Suggest TWT or Demand TWT | Dictate TWT | A broadcast TWT schedule is either created or already exists and is using the TWT parameters identified in the response frame, including a broadcast TWT ID.The TWT scheduling AP will not create any new broadcast TWT schedule with the TWT scheduled STA at this time.The TWT scheduled STA transmitting the initiating frame is not a member of the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the response frame.The TWT scheduled STA can send a new request, but will only receive an Accept TWT if it uses the dictated TWT parameters. |
| Request TWT or Suggest TWT or Demand TWT | Reject TWT | The TWT scheduled STA transmitting the initiating frame is a not a member of a broadcast TWT identified by the broadcast TWT ID and the TA of the response frame, if such a broadcast TWT exists.The TWT scheduling AP will not accept any new request from the TWT scheduled STA to join or create a broadcast TWT at this time. |
| Accept TWT |  No frame transmitted | Not permitted to be transmitted by a TWT scheduled STA.When transmitted by a TWT scheduling AP, the recipient STA's membership in the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the initiating frame is established. |
| Alternate TWT or Dictate TWT | No frame transmitted | Not permitted to be transmitted by a TWT scheduled STA.When transmitted by a TWT scheduling AP, the TWT scheduled STA receiving this frame is not, through the receipt of this frame, a member of the broadcast TWT identified by the initiating frame.The TWT scheduled STA can use the information provided to create a request to join a TWT in a subsequent initiating frame that it transmits.  |
| Reject TWT | No frame transmitted | When transmitted by a TWT scheduled STA, the transmitting STA's membership in the broadcast TWT schedule identified by the broadcast TWT ID and the RA of the initiating frame is terminated.When transmitted by a TWT scheduling AP, the receiving STA's membership in the broadcast TWT schedule identified by the broadcast TWT ID and the TA of the initiating frame is terminated. |
| NOTE 1—The Negotiation Type field of the TWT element contained in these frames is 3.NOTE 2—The initiating frame and response frame settings not listed in the tables in 10.48 (Target wake time (TWT)) or 26.8 (TWT operation) are not allowed. The initiating frame is a TWT request if the TWT element contained in the frame has the TWT Request field equal to 1 (see Table 9-298 (TWT Setup Command field values)); otherwise it is a TWT response. The response frame is a TWT response.NOTE 3—In addition to these exchanges, the TWT scheduling AP might respond to an initiating frame that solicits membership in a broadcast TWT schedule with an indication or solicitation of the establishment of an individual TWT agreement.NOTE 4—MMPDUs that contain a broadcast TWT element generated by a TWT scheduled STA can be (Re)Association Request, and TWT Setup frames with TWT Request field equal to 1. The TWT element has the Negotiation Type subfield equal to 3 and the Broadcast TWT ID(s) that the STA intends to join or withdraw. MMPDUs that contain a broadcast TWT element generated by a TWT scheduled AP can be (Re)Association Response, and TWT Setup frames with TWT Request field equal to 0. The TWT element has the Negotiation Type subfield equal to 3 and the Broadcast TWT ID(s) to which the STA is assigned or from which the STA is withdrawn. |

A TWT scheduled STA that is in PS mode may enter the doze state after receiving a Beacon frame with a TWT element indicating the existence of a broadcast TWT and shall be in the awake state at the broadcast TWT start times for which the STA has indicated it will be awake by any of the following means:

* Establishing a membership for the unannounced broadcast TWT with those broadcast TWT IDs
* Negotiating a wake TBTT and wake interval between Beacon frames that the STA receives, as defined in 26.8.6 (Negotiation of wake TBTT and wake interval)
* Having sent a PS-Poll or U-APSD trigger frame during the beacon interval
* Having sent another indication that it is in the awake state during that beacon interval

NOTE 1—Other indications that the STA is in the awake state are the transmission of an HE TB feedback NDP in response to an NFRP Trigger frame (see 26.5.7 (NDP feedback report procedure)) or the transmission of a frame that indicates that the STA is in active mode (see 11.2.3.2 (Non-AP STA power management modes)).

NOTE 2—The STA might indicate that it will not be awake at certain broadcast TWT start times by sending a TWT Information frame. The AP might indicate to a STA that it need not be awake at certain broadcast TWT start times by sending a TWT information frame (see 26.8.4 (Use of TWT Information frames)).

A TWT scheduled STA is not required to be in the awake state at broadcast TWT SP start times corresponding to the broadcast TWT that has the broadcast TWT ID value of 0.

A TWT scheduled STA that did not receive a Beacon frame at a TBTT shall act as if it had received the expected Beacon frame containing a TWT element for a broadcast TWT, if the missed beacon corresponds to a TBTT that is within the next *n* TBTTs beyond the most recently received Beacon frame that included a TWT element for that broadcast TWT, where *n* is equal to one plus the value obtained from the Broadcast TWT Persistence subfield of the corresponding Broadcast TWT, except that *n* is infinite if the Broadcast TWT Persistence subfield is 255.

A TWT scheduled STA transmits an HE TB PPDU as a response to a Trigger frame that is addressed to it and is sent during a trigger-enabled TWT SP (see 26.5.2 (UL MU operation)). A TWT scheduled STA that is in PS mode and is awake during an announced TWT SP shall include a PS-Poll frame or a U-APSD trigger frame in the HE TB PPDU if it intends to solicit buffered BUs from the TWT scheduling AP (see 11.2.2.8 (Receive operation for STAs in PS mode during the CP)) unless the STA has already transmitted within that TWT SP a PS-Poll or U-APSD trigger frame or has transmitted any other indication that the STA is in the awake state within that TWT SP, or has, previous to the TWT SP, otherwise indicated to the AP that it is currently in the awake state. A TWT scheduled STA that is in PS mode shall transition to the awake state at the start of an unannounced TWT SP of which it is a member. The STA may include other frames in the HE TB PPDU when other rules do not prohibit their inclusion (see 26.5.2 (UL MU operation))

NOTE 1—A TWT scheduling AP sets the bit in the TIM element of the Beacon frame that corresponds to the AID of the TWT scheduled STA to 1 to indicate that it expects the TWT scheduled STA to solicit available buffered BUs (see 11.2.2.8 (Receive operation for STAs in PS mode during the CP)).

NOTE 2—Other indications that the STA is in the awake state are the transmission of an HE TB feedback NDP in response to an NFRP Trigger frame (see 26.5.7 (NDP feedback report procedure)) or the transmission of a frame that indicates that the STA is in active mode (see 11.2.3.2 (Non-AP STA power management modes)).(#20845)

A TWT scheduled STA should only send frames that satisfy the Broadcast TWT Recommendation subfield recommendations in Table 9-298a (Broadcast TWT Recommendation field for a broadcast TWT element) during the corresponding TWT SP(s). Frames sent as a response to a Trigger frame are subject to further restrictions as defined in 26.5.2 (UL MU operation).

**26.8.2 Individual TWT agreements**

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 20843):***

An HE STA that successfully sets up an individual TWT agreement and operates in PS mode may listen to Beacon frames, but is exempt from the requirements for receiving Beacon frames as defined in 11.2.2.1 (General). The HE STA follows the rules defined in 11.2.3 (Power management in a non-DMG infrastructure network) to receive group-addressed frames.

NOTE—An HE AP might set the bit in the TIM element of the Beacon frame that corresponds to the AID of the
TWT requesting STA to 1 to indicate the presence of available buffered BUs for the STA (see
11.2.2.8 (Receive operation for STAs in PS mode during the CP)).*(#20843)*