IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Comment resolutions for miscellaneous CIDs in clause 26.8 | | | | |
| Date: 2020-06-01 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Alfred Asterjadhi | Qualcomm Inc. | 5775 Morehouse Dr, San Diego, CA 92109 | +1-858-658-5302 | aasterja@qti.qualcomm.com |
| Abhishek Patil | Qualcomm Inc. |  |  |  |
| George Cherian | Qualcomm Inc. |  |  |  |

Abstract

This submission proposes resolutions for multiple comments related to TGax D6.0 with the following CIDs (16 CIDs):

* 24104, 24268, 24276, 24277, 24278, 24341, 24342, 24343, 24436, 24437,
* 24440, 24441, 24451, 24452, 24548, 24569

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Includes suggestions received from Mark. Changes highlighted in green.

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.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 24104 | Kim, Youhan | 410.15 | If an 80 MHz operating HE SST non-AP STA operates in the Secondary 80 MHz, which 20 MHz (within the Secondary 80 MHz) should be used to detect packets? For example, let 20\_1, 20\_2, ..., 20\_8 be the eight 20 MHz channels comprising an 160 MHz channel, with 20\_1 being the 20 MHz channel lowest in frequency, and 20\_8 being the one highest in frequency. Let 20\_1 be the Primary 20 MHz. The HE SST non-AP STA is in Secondary 80, i.e., 20\_5 + 20\_6 + 20\_7 + 20\_8. AP does not know which of these four 20 MHz channels is used by the STA to detect the preamble. Suppose the AP transmits an HE MU PPDU which the 20\_5 punctured, and that happens to be the 20 MHz used by the STA to detect the packet. Then the packet cannot be received by the STA.  Also, suppose somehow the AP/STA negotiated that STA would use 20\_5 to detect the preamble. What if the AP sends an HE MU PPDU with 20\_2 (Secondary 20) and 20\_8 punctured? What value should be used for the Bandwidth field in the HE-SIG-A? For Primary 80, value 6 makes sense, but for Secondary 80, value 7 makes sense. But an HE MU PPDU cannot have different HE-SIG-A content per 20 MHz. | State that an AP shall not use preamble puncturing when transmitting packets to 80 MHz operating HE SST non-AP STA. Also, consider updating SST protocol to have the AP and 80 MHz SST STA negotiate which 20 MHz is used for preamble detection in the Secondary 80. Or, remove 80 MHz mode from SST. | ??? |
| 24268 | Fischer, Matthew | 407.38 | The TWT Information frame is a management frame for which reception and parsing at the receiving STA can be incovenient but is currently the only effective means for a STA to cause an early termination of a TWT SP, even though it is not listed in the early termination events! There needs to be a more convenient mechanism for a STA to cause a TWT SP early termination. Suggest using an A control value to signal a STA state transition with timing information. Also, the receipt of a TWT information frame at the TWT responding STA is not currently included in the early termination events. | Add the receipt of a TWT information frame with certain conditions/values as an early termination event of a TWT SP that is initiated by the TWT requesting STA. Also, include a mechanism for signaling STA state transition which can be used by a STA to create an early termination of a TWT SP, such as is described in 11-18-1821 | Rejected—  Disagree in principle regarding the definition of yet another mechanism to provide the same functionality that TWT Information frame already provides. This is because adding another mode simply adds to the complexity. Also, the term “inconvenient” is extremely ambiguous and it makes it impossible to determine what(if any) makes a certain frame inconvenient. Regarding the claim that TWT Information frames sent by non-AP STAs being not part of the early TWT SP termination events, that is not quite correct because there are explicit references to the subclasues where these additional events are defined. Quoting:  “Additional TWT SP termination events for a TWT requesting STA occur after the acknowledgment of a TWT Information frame as defined in 26.8.4.2 (TWT Information frame exchange for individual TWT) and in 26.8.4.4 (TWT Information frame exchange for flexible wake time). |
| 24276 | Levy, Joseph | 388.51 | TWT operation is not defined as a PS mode it is orthogonal to the PS mode. It is my understanding that a STA need not be in PS mode to have a TWT schedule. | "Replace: ""to reduce the required amount of time that a STA in PS mode needs to be awake.""  With: ""may allow a non-AP STA to conserve power.""" | Rejected –  TWT operation is also a power save mode because a STA that is in PS mode wakes in pre-defined schedules that it has negotiated with the AP. Agree that the STA need not be in PS mode to have a TWT schedule, hence the reason for specifying that it helps to reduce the required amount of time that a STA in PS mode needs to be awake (in the cited text). |
| 24277 | Levy, Joseph | 390.57 | In the example the STAs may go to doze state during the indicated times, but they are not required to. Also, this doze period only applies to this particular individual TWT agreement, and a STA may have additional TWT agreements. This should be clear in the specification. | Insert "may" after "and" and before "go to doze state" | Rejected –  This particular paragraph is providing some description for the figure above, wherein the STAs are shown as effectively going to doze state. Please note that from a normative behavior that is correct, i.e., that there is no requirement for the STA to do so. But for correctly describing what is being reflected in the figure there should not be added a “may”. |
| 24278 | Levy, Joseph | 393.17 | This paragraph is very confusing and should be clarified. I understand that a TWT responding STA can receive a PS-Poll frame or a U-APSD trigger frame at any time as state of the responding STA may be either doze or awake at any time. But, if the responding STA is following the TWT schedule it may be in doze state prior to the TWT SP - if so how can it receive a frame? If it does receive a PS-Poll frame or a U-APSD trigger frame from the TWT requesting STA how does it determine that the TWT requesting STA will be awake? Also, how will it determine if the TWT requesting STA has not entered the doze state? | Please clarify the STA behavior. | Rejected—  The commenter is asking several questions, the answers to which are as follows: 1) The TWT responding STA in this particular subclause is the AP which by default does not go to doze state. There is one mode that would allow the AP to be in doze state outside of TWT SPs (when Responder PM bit is set to 1) but even in that case the AP would be receiving the frame only if it is in the awake state. So the answer is the responding STA may receive the frame if it is in the awake state. 2) Just by receiving the frame the TWT responding STA can determine that the TWT requesting STA is awake (since it sent the frame). 3) The TWT requesting STA that has declared to be in the awake state cannot enter the doze state unless explicitly allowed to or the TWT SP ends. Hence an explicit indication or termination of a TWT SP is sufficient to determine that the STA has entered (or not) the doze state. |
| 24341 | RISON, Mark | 407.00 | "It is not clear whether a non-AP STA might set the EOSP bit in the QoS Control field, in the context of ax TWT.  The following suggest it can:  407.40 ""The transmission by the TWT requesting STA or TWT scheduled STA of an acknowledgment  in response to an individually addressed QoS Data or QoS Null frame sent by the \*\*\*TWT  responding STA\*\*\* or TWT scheduling AP, respectively, that had the EOSP subfield equal to 1.""  407.50 ""The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by  the \*\*\*TWT responding STA\*\*\* or TWT scheduling AP, that does not solicit an immediate response  and with the EOSP subfield equal to 1.""  In both cases the ""TWT something STA or TWT scheduling AP"" indicates that the TWT something STA  is not an AP.  Indeed, the first of these is equivalent to (by distributing the ""respectively):  ""... an individually addressed QoS Data sent by the TWT responding STA or QoS Null frame sent  by the TWT scheduling AP, that had the EOSP subfield equal to 1""  i.e. only the TWT scheduling AP can send a QoS Null, not the TWT responding STA.  However, discussions with some TGax participants have suggested that they think a  non-AP STA can never set the EOSP bit in the context of ax TWT." | As it says in the comment | Rejected –  Only APs can set the EOSP subfield to 1 (inherited from baseline PS modes). In this particular sentence both TWT scheduling AP and TWT responding STA are APs. And the non-AP STAs are the ones that generate the acknowledgment in response to those frames that contain the EOSP field (if an ack is solicited). Hence, there is no ambiguity as to which entity sets the EOSP bit to 1 (the AP). |
| 24342 | RISON, Mark | 407.00 | "It is not clear whether a non-AP STA might set the EOSP bit in the QoS Control field, in the context of ax TWT.  The following suggest it can:  407.40 ""The transmission by the TWT requesting STA or TWT scheduled STA of an acknowledgment  in response to an individually addressed QoS Data or QoS Null frame sent by the \*\*\*TWT  responding STA\*\*\* or TWT scheduling AP, respectively, that had the EOSP subfield equal to 1.""  407.50 ""The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by  the \*\*\*TWT responding STA\*\*\* or TWT scheduling AP, that does not solicit an immediate response  and with the EOSP subfield equal to 1.""  In both cases the ""TWT something STA or TWT scheduling AP"" indicates that the TWT something STA  is not an AP.  Indeed, the first of these is equivalent to (by distributing the ""respectively):  ""... an individually addressed QoS Data sent by the TWT responding STA or QoS Null frame sent  by the TWT scheduling AP, that had the EOSP subfield equal to 1""  i.e. only the TWT scheduling AP can send a QoS Null, not the TWT responding STA.  However, discussions with some TGax participants have suggested that they think a  non-AP STA can never set the EOSP bit in the context of ax TWT." | "Change the cited text at 407.40 to ""The transmission by the TWT scheduled STA of an acknowledgment  in response to an individually addressed QoS Null frame sent by the TWT scheduling AP that had the EOSP subfield equal to 1.""  Change the cited text at 407.50 to ""The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by  the TWT scheduling AP, that does not solicit an immediate response  and with the EOSP subfield equal to 1.""" | Rejected –  Only APs can set the EOSP subfield to 1 (inherited from baseline PS modes). In this particular sentence both TWT scheduling AP and TWT responding STA are APs. And the non-AP STAs are the ones that generate the acknowledgment in response to those frames that contain the EOSP field (if an ack is solicited). Hence, there is no ambiguity as to which entity sets the EOSP bit to 1 (the AP). |
| 24343 | RISON, Mark | 407.00 | "It is not clear whether a non-AP STA might set the EOSP bit in the QoS Control field, in the context of ax TWT.  The following suggest it can:  407.40 ""The transmission by the TWT requesting STA or TWT scheduled STA of an acknowledgment  in response to an individually addressed QoS Data or QoS Null frame sent by the \*\*\*TWT  responding STA\*\*\* or TWT scheduling AP, respectively, that had the EOSP subfield equal to 1.""  407.50 ""The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by  the \*\*\*TWT responding STA\*\*\* or TWT scheduling AP, that does not solicit an immediate response  and with the EOSP subfield equal to 1.""  In both cases the ""TWT something STA or TWT scheduling AP"" indicates that the TWT something STA  is not an AP.  Indeed, the first of these is equivalent to (by distributing the ""respectively):  ""... an individually addressed QoS Data sent by the TWT responding STA or QoS Null frame sent  by the TWT scheduling AP, that had the EOSP subfield equal to 1""  i.e. only the TWT scheduling AP can send a QoS Null, not the TWT responding STA.  However, discussions with some TGax participants have suggested that they think a  non-AP STA can never set the EOSP bit in the context of ax TWT." | "Change the cited text at 407.40 to ""The transmission by the TWT scheduled STA of an acknowledgment  in response to an individually addressed QoS Data or QoS Null frame sent by the TWT scheduling AP that had the EOSP subfield equal to 1.""  Change the cited text at 407.50 to ""The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by  the TWT scheduling AP, that does not solicit an immediate response  and with the EOSP subfield equal to 1.""" | Rejected –  Only APs can set the EOSP subfield to 1 (inherited from baseline PS modes). In this particular sentence both TWT scheduling AP and TWT responding STA are APs. And the non-AP STAs are the ones that generate the acknowledgment in response to those frames that contain the EOSP field (if an ack is solicited). Hence, there is no ambiguity as to which entity sets the EOSP bit to 1 (the AP). |
| 24436 | RISON, Mark | 410.06 | There are references to SST STAs (181.58) but it is not clear whether HE SST STAs are SST STAs | At 410.6 add "An HE STA with dot11HESubchannelSelectiveTransmissionImplemented true is an HE SST STA. An HE SST STA is not an SST STA." | Rejected –  SST STAs are S1G STAs, and HE STAs are not S1G STAs, as such HE STAs are not SST STAs. However they are HE SST STAs. |
| 24437 | RISON, Mark | 410.01 | There are definitions of HE SST non-AP STA and HE SST AP, but not HE SST STA, a term which is used elsewhere | At 410.6 add "An HE STA with dot11HESubchannelSelectiveTransmissionImplemented true is an HE SST STA. An HE SST STA is not an SST STA." | Revised –  Proposed resolution is to explicitly call out HE SST non-AP STA and HE SST AP every time so that it is not needed to define another term for the generic STA case.  TGax editor to make the changes shown in 11-20/0819r1 under all headings that include CID 24437. |
| 24440 | RISON, Mark |  | "26.8.2 says ""NOTE 2--The Trigger frame can be replaced by a frame carrying a TRS Control subfield provided that the frame is car-  ried in a DL MU PPDU and 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. In this case, the AP 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."". 26.8.3.2 says ""NOTE 3--The Trigger frame can be replaced by a frame carrying a TRS Control subfield provided that the frame is car-  ried in a DL MU PPDU and 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. In this case it is recommended to allocate enough resources in subse-  quent Trigger frames sent during the TWT SP so that the STA can send as much as possible of the data reported in the  BSR."" The second one nearly duplicates the first, and the first is better (clearer ""AP"" v ""it"")" | Copy the text of the NOTE from 26.8.2 to the corresponding NOTE in 26.8.3.2 | Accepted |
| 24441 | RISON, Mark | 392.55 | "NOTE 2--The Trigger frame can be replaced by a frame carrying a TRS Control subfield" -- since this is a NOTE, it is not normative | Change "Trigger frame" to "triggering frame" throughout Subclause 26.8 | Rejected –  The MPDU containing a TRS Control field is a particular case for the operation which has limited functionality, while using the Trigger frame is the generic case for the operation. TRS Control fields can only solicit MPDUs that do not solicit Ack, while Trigger frame (more in particular Basic Trigger frame) can solict MPDUs that solicit Ack, as such referring to the generic case Trigger frame, and having a note to specify the exception of MPDU containing the TRS Control field is appropriate. |
| 24451 | RISON, Mark | 393.18 | "during or before an announced TWT SP" -- "during or before" a periodic event is equivalent to "always", since the time after instance n of the event is before instance n+1 of the event. The "but after the end of the most recent TWT SP" does not help, because everything is always preceded by a TWT SP (well, OK, not for the very first one) | "Delete ""during or before an announced TWT SP but after the end of  the most recent TWT SP,"" in the referenced subclause and in 26.8.3.2" | Rejected –  It is unclear what the issue under the discussion is by the comment. The current text is clear and technically correct in expressing the intention. Removing that particular phrase does not clarify things but rather brings more ambiguity. |
| 24452 | RISON, Mark | 393.18 | "during or before an announced TWT SP" -- "during or before" a periodic event is equivalent to "always", since the time after instance n of the event is before instance n+1 of the event. The "but after the end of the most recent TWT SP" does not help, because everything is always preceded by a TWT SP (well, OK, not for the very first one) | "Change ""during or before an announced TWT SP but after the end of  the most recent TWT SP,"" to ""in the interval of time between the end of the TWT SP that has most recently ended, and the end of the TWT SP that next follows"" in the referenced subclause and in 26.8.3.2" | Rejected –  It is unclear what the issue under the discussion is by the comment. The current text is clear and technically correct in expressing the intention. Replacing that particular phrase does not clarify things since they are essentially the same. Also it is not clear why the same comment twice and two different proposed changes (see CID 24451 as well). |
| 24548 | Hamilton, Mark | 393.18 | What is an "announced TWT SP"? Also, what is an "unannounced TWT SP"? Both terms appear to be used with technical meaning critical to understanding the enclosing sentence. | Define these terms. | Rejected –  These terms are already defined in the baseline. For example, please refer to P1396L1-10:  “The Flow Type subfield indicates the type of interaction between the TWT requesting STA and the TWT responding STA at a TWT. Setting the Flow Type subfield to 0 indicates an announced TWT in which the TWT requesting STA will send a PS-Poll or an APSD trigger frame (see 11.2.3.5 (Power management with APSD)) to signal its awake state to the TWT responding STA before a frame is sent from the TWT responding STA to the TWT requesting STA. Setting the Flow Type subfield to 1 indicates an unannounced TWT in which the TWT responding STA will send a frame to the TWT requesting STA at TWT without waiting to receive a PS-Poll or an APSD trigger frame from the TWT requesting STA.” |
| 24569 | Sun, Li-Hsiang | 401.18 | """A broadcast TWT schedule is either created or  already exists and is using the TWT parameters  identified in the resp"" is not consistent with the same row in Table 10-31" | Make them consistent | Revised –  Agree in principle with the comment. Proposed resolution makes them consistent as per suggestion.  TGax editor to make the changes shown in 11-20/0819r1 under all headings that include CID 24569. |

**Discussion: *None.***

* TWT operation
* General

Target wake time (TWT) allows an AP to manage activity in the BSS in order to minimize contention between STAs and to reduce the required amount of time that a STA in PS mode needs to be awake. This is achieved by allocating STAs to operate at nonoverlapping times and/or frequencies, and concentrate the frame exchanges in predefined service periods.

An HE STA negotiates individual TWT agreements, as defined in 10.47 (Target wake time (TWT)), subject to the additional rules and restrictions that are defined in 26.8.2 (Individual TWT agreements) and 26.8.7 (HE subchannel selective transmission). A non-AP HE STA establishes membership in broadcast TWT schedules, as defined in 26.8.3 (Broadcast TWT operation), which are used as defined in 26.8.3.3 (Rules for TWT scheduled STA), 26.14.2 (Power save with UORA and TWT), and 26.14.3 (Opportunistic power save). An HE AP delivers broadcast TWT parameter sets to non-AP HE STAs as described in 26.8.3.2 (Rules for TWT scheduling AP), 26.14.2 (Power save with UORA and TWT) and 26.14.3 (Opportunistic power save).

A STA does not need to be aware of the values of TWT parameters of the TWT agreements of other STAs in the BSS of the STA or of TWT agreements of STAs in other BSSs. A STA does not need to be aware that a TWT service period (SP) is used to exchange frames with other STAs. Frames transmitted during a TWT SP are carried in any PPDU format supported by the pair of STAs that have established the TWT agreement corresponding to that TWT SP, including HE MU PPDU, HE TB PPDU, etc.

An HE STA with dot11TWTOptionImplemented equal to true shall set:

* The TWT Requester Support subfield to 1 in the HE Capabilities element that it transmits if it supports operating in the role of a TWT requesting STA; otherwise set to 0.
* The TWT Responder Support subfield to 1 in the HE Capabilities elements that it transmits if it supports operating in the role of a TWT responding STA; otherwise set to 0.
* The Broadcast TWT Support subfield to 1 in the HE Capabilities element that it transmits if it supports operating in the role of a TWT scheduled STA or in the role of a TWT scheduling AP; otherwise set to 0.

An HE AP shall set the TWT Responder Support subfield of the Extended Capabilities element and HE Capabilities element to 1.

An HE AP may request TWT participation by all associated STAs that have declared support for TWT. A non-AP STA declares support for the role of TWT requesting STA by setting the TWT Requester Support subfield in the Extended Capabilities element or in the HE Capabilities element to 1 and declares support for the role of TWT scheduled STA by setting the Broadcast TWT Support subfield in the HE Capabilities element to 1. The HE AP makes the request for TWT participation by setting the TWT Required subfield to 1 in HE Operation elements it transmits. A STA that supports TWT and that has received an HE Operation element with the TWT Required subfield equal to 1 from the HE AP with which it is associated shall either negotiate individual TWT agreements, as defined in 26.8.2 (Individual TWT agreements), or participate in broadcast TWT operation, as defined in 26.8.3 (Broadcast TWT operation).

NOTE—The AP sets the TWT Required subfield to 1 if it is not available outside TWT SPs (see 26.8.2 (Individual TWT agreements) and 26.8.3 (Broadcast TWT operation)). The AP might not be available outside TWT SPs if it sets the Responder PM Mode subfield to 1 (see 10.47.7 (TWT Sleep Setup)).

* Individual TWT agreements

An HE STA may negotiate individual TWT agreements with another HE STA as defined in 10.47.1 (TWT overview), except that the STA:

* May set the Responder PM Mode subfield to 1 if it is a TWT responding STA that intends to go to doze state outside of TWT SPs.
* If the TWT responding STA is an AP then it may set the Responder PM Mode subfield to 1 only if all non-AP STAs that are associated to it indicate support of TWT and the AP has set the TWT Required subfield to 1 in the HE Operation element it transmits; otherwise it shall set the Responder PM Mode subfield to 0.
* An AP that sets the Responder PM Mode subfield to 1 follows the rules defined in 10.47.7 (TWT Sleep Setup).
* Shall set the Implicit subfield to 1 and the NDP Paging Indicator subfield to 0 in all TWT elements that it transmits during the TWT setup.
* May set the Trigger subfield to 1 in the TWT element it transmits during the TWT setup to negotiate a trigger-enabled TWT.
* A successful TWT agreement whose Trigger subfield in the TWT response sent by the AP is 1 is a trigger-enabled TWT; otherwise it is not a trigger-enabled TWT.
* Shall set the TWT Channel subfield in the TWT element it transmits to 0 unless the HE STA sets up a subchannel selective transmission operation as defined in 26.8.7 (HE subchannel selective transmission).
* May set the TWT Protection field to 1 to indicate that TXOPs within the TWT SPs shall be initiated with a NAV protection mechanism, such as (MU) RTS/CTS, or CTS-to-self frame; otherwise it shall set it to 0.
* An HE STA shall not use the RAW mechanism for protection of TWT SPs.

An HE STA that successfully sets up a TWT agreement with another HE STA shall follow the rules defined in 10.47.1 (TWT overview) and 10.47.4 (Implicit TWT operation), except that all the additional rules defined in 26.8 (TWT operation) supersede all the respective rules defined in 10.47.1 (TWT overview) and 10.47.4 (Implicit TWT operation). A TWT or TWT SP that is set up under an implicit TWT agreement is an implicit TWT or implicit TWT SP, respectively (see 10.47.1 (TWT overview)). A TWT or TWT SP that is set up under a trigger-enabled TWT agreement is a trigger-enabled TWT or trigger-enabled TWT SP, respectively.

An example of individual TWT operation is shown in Figure 26-8a (Example of individual TWT operation), where the AP is the TWT responding STA and STA 1 and STA 2 are the TWT requesting STAs.

|  |
| --- |
|  |
| * Example of individual TWT operation |

In this example, STA 1 sends a TWT request to the TWT responding STA to setup a trigger-enabled TWT agreement. The TWT responding STA accepts the TWT agreement with STA 1 and confirms the acceptance in the TWT response sent to STA 1. Subsequently, the TWT responding STA sends an unsolicited TWT response to STA 2 to setup a trigger-enabled TWT agreement with STA 2. Both these TWT agreements are setup as announced TWTs. During the trigger-enabled TWT SP, the TWT responding STA sends a Trigger frame to which the TWT requesting STAs indicate that they are awake during the TWT SP. STA 1 indicates that it is awake by sending a PS-Poll frame 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 TWT responding STA and go to doze state outside of this TWT SP.

An HE STA may execute the individual TWT setup exchanges defined in Table 26-5 (TWT setup exchange for unsolicited TWT and recommended broadcast TWT switch) in addition to the exchanges defined in 10.47 (Target wake time (TWT)). An HE STA that intends to set up an individual TWT shall set the Negotiation Type subfield to 0 as defined in 10.47 (Target wake time (TWT)) or as defined in Table 26-5 (TWT setup exchange for unsolicited TWT and recommended broadcast TWT switch). The HE STA may respond to the TWT request with a TWT response that has the Negotiation Type subfield equal to 3 as indicated in Table 26-5 (TWT setup exchange for unsolicited TWT and recommended broadcast TWT switch) to provide recommended broadcast TWT schedules for the requesting STA.

|  |  |  |
| --- | --- | --- |
| * TWT setup exchange for unsolicited TWT and recommended broadcast TWT switch | | |
| TWT Setup Command field in an initiating frame | TWT Setup Command field in a response frame | TWT condition after the completion of the exchange |
| Request TWT or Suggest TWT or Demand TWT with Broadcast subfield = 0 | Accept TWT with Broadcast subfield = 1 | This response is not allowed. |
| Request TWT, Suggest TWT or Demand TWT with Broadcast subfield = 0 | Dictate TWT with Broadcast subfield = 1 | No individual TWT agreement exists with the associated TWT Flow identifier. One or more broadcast TWT schedule exists that uses the TWT parameters identified in the response frame including a Broadcast TWT IDs. The broadcast TWT schedules are not necessarily newly created. The responding STA will not create any new individual TWT agreement with the requester at this time. The STA transmitting the initiating frame is not a member of the broadcast TWT, however the STA is recommended to join any of the broadcast TWT schedules. |
| Accept TWT with Broadcast subfield set to 0 | No frame transmitted | The STA receiving this frame now has an individual TWT agreement with the transmitter of the frame where the parameters of the individual TWT agreement are identified by the initiating frame. |
| Alternate TWT or Dictate TWT with Broadcast subfield = 0 | No frame transmitted | The STA receiving this frame is not, through the receipt of this frame, a member of the TWT identified by the initiating frame but can use the information provided to create a request to set up a TWT in a subsequent initiating frame that it transmits. |
| NOTE 1—The Negotiation Type subfield in the TWT element contained in these frames is 0 if the Broadcast subfield is 0 and is 3 if the Broadcast subfield is 1.  NOTE 2—The initiating frame and response frame settings not listed in the tables in 10.47 (Target wake time (TWT)) or 26.8 (TWT operation) are not allowed. The initiating frame is a TWT request if the TWT element carried in the frame has the TWT Request field set to 1; otherwise it is a TWT response (see Table 9-297 (TWT Setup Command field values)). The response frame is a TWT response if the TWT element contained in the frame has the TWT Request field equal to 0. | | |

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 11.2.3.1 (General). The HE STA follows the rules in 11.2.3 (Power management in a non-DMG infrastructure network) to receive group-addressed frames.

NOTE 1—An HE AP sets 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 11.2.3.7 (Receive operation for STAs in PS mode)).

NOTE 2—The TWT responding STA might inform the TWT requesting STA, if it supports TIM Broadcast,(M972) of any critical update (as defined in 11.2.3.15 (TIM Broadcast)) by sending a Management frame to the TWT requesting STA when the STA is in the awake state.

An HE STA may tear down an individual TWT agreement by sending a TWT Teardown frame with the Negotiation Type subfield set to 0. An HE STA may tear down all individual TWT agreements by sending a TWT Teardown frame with the Teardown All TWT field set to 1.

An HE AP may send an unsolicited TWT response with the Trigger subfield equal to 1 to a non-AP HE STA that has set the TWT Requester Support subfield to 1 in the HE Capabilities elements that it transmits to the AP. The TWT response shall have one of these values in the TWT Setup Command field: Accept TWT, Alternate TWT or Dictate TWT. An unsolicited TWT response with TWT Setup Command field of 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 the TWT Setup Command field of Accept TWT creates a TWT agreement between the two STAs. A STA that received an unsolicited TWT response with the TWT Setup Command field of Accept TWT may transmit a TWT Teardown frame to delete the unsolicited individual TWT agreement.

NOTE—The HE AP might send an unsolicited TWT response to a non-AP HE STA with a TWT Flow Identifier that corresponds to an existing TWT agreement. The unsolicited TWT response with TWT Setup Command field of Accept TWT will indicate new TWT parameters that are different from the previously negotiated TWT parameters for that TWT agreement.

An HE STA shall not transmit BAT, TACK, or STACK frames, which are allowed in 10.47.2 (TWT acknowledgment procedure)).

A TWT requesting STA should not transmit frames to the TWT responding STA outside of negotiated TWT SPs and should not transmit frames that are not contained within HE TB PPDUs to the TWT responding STA within trigger-enabled TWT SPs.

NOTE—The TWT requesting STA decides which frames to transmit within or outside a TWT SP and while it is recommended that the TWT requesting STA not transmit using EDCA within or outside TWT SPs the TWT requesting STA might still do so(#22334). If the STA decides to transmit then the STA might contend for access to the medium as defined in 10.23.2 (HCF contention based channel access (EDCA)) and in 26.2.7 (EDCA operation using MU EDCA parameters).

The TWT responding STA of a trigger-enabled TWT agreement shall schedule for transmission a Trigger frame for the TWT requesting STA, as described in 26.5.2 (UL MU operation), within each TWT SP for that TWT agreement. The TWT responding STA should solicit buffer status reports from the TWT requesting STA at the start of the TWT SP following the procedure described in 26.5.3 (MU cascading sequence) or as described in 26.5.7 (NDP feedback report procedure). The TWT responding STA 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 responding STA 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 TWT SP.

NOTE 1—The TWT responding STA can cancel the transmission of a scheduled Trigger frame if the STA gains access to the wireless medium outside of the TWT SP. The TWT responding STA does not schedule for transmission a Trigger frame for the TWT requesting STA when the TWT agreement is not a trigger-enabled TWT agreement or when the TWT requesting STA has sent an OM Control subfield that has the UL MU Disable subfield equal to 1 (see 26.9 (Operating mode indication).

NOTE 2—The Trigger frame can be replaced by a frame carrying a TRS Control subfield provided that the frame is carried in a DL MU PPDU and 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. In this case, the AP 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.(#22277, #22278)

A TWT requesting STA transmits an HE TB PPDU as a response to a Trigger frame that identifies it and is sent during a trigger-enabled TWT SP (see 26.5.2 (UL MU operation)). A TWT requesting STA that is in PS mode and is awake shall include a PS-Poll frame or a U-APSD trigger frame in the HE TB PPDU if the TWT is an announced TWT unless the STA has already transmitted a PS-Poll or U-APSD trigger frame or transmitted any other indication that the STA is in the awake state within that TWT SP or has, previous to the start of the TWT SP but after the end of the most recent TWT SP, indicated to the AP that it is currently in the awake state. 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 Trigger frame identifies a TWT requesting STA if it is sent by the AP with which the STA is associated and the frame contains the 12 LSBs of the STA’s AID in any of its User Info fields. The Trigger frame can have multiple recipients, each of which is identified by the presence of the 12 LSBs of the recipient’s AID in any of its User Info fields (see 26.5.2 (UL MU operation)), and can have in the TA field the MAC address of the AP or the transmitted BSSID under the conditions defined in 26.5.2.2.4 (Allowed settings of the Trigger frame fields and TRS Control subfield).

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 (STA power management modes)).

A TWT responding STA that receives a PS-Poll frame or a U-APSD trigger frame or any other indication from a TWT requesting STA that is in PS mode during or before an announced TWT SP but after the end of the most recent TWT SP, that the TWT requesting STA is in the awake state during the TWT SP shall follow the rules defined in 11.2.3.6 (AP operation during the CP) except that the TWT responding STA should deliver to the TWT requesting STA as many buffered BUs as are available at the TWT responding STA, provided that the BU delivery does not exceed the duration of the TWT SP, the TWT requesting STA has indicated that it is in the awake state for that TWT SP and as long as the TWT requesting STA has not entered the doze state (see 26.8.4.2 (TWT Information frame exchange for individual TWT) and 26.8.5 (Power save operation during TWT SPs)).

NOTE—The indication that the TWT requesting STA is in the awake state for that TWT SP might be a PS-Poll, U-APSD trigger frame, or any frame for which an immediate response is solicited and that follows the rules in 11.2.3.2 (Non-AP STA power management modes) but the corresponding immediate response frame is not received by the TWT requesting STA. 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)).

A TWT responding STA that sends frames to a TWT requesting STA that is in PS mode during an unannounced TWT SP shall follow the rules defined in 11.2.3.6 (AP operation during the CP) except that the TWT responding STA should deliver to the TWT requesting STA as many buffered BUs as are available at the TWT responding STA, provided that the BU delivery does not exceed the duration of the TWT SP and as long as the TWT requesting STA has not entered the doze state (see 26.8.4.2 (TWT Information frame exchange for individual TWT) and 26.8.5 (Power save operation during TWT SPs)).

NOTE—The TWT responding STA can deliver the buffered BUs in A-MPDUs sent under a block ack agreement if the TWT is an announced TWT and the TWT requesting STA is awake for that TWT SP, or if the TWT is an unannounced TWT (at the start of which the TWT requesting STA is assumed to already be awake). The buffered BUs can be delivered in multiple PPDUs transmitted within the TWT SP. The TWT responding STA can transmit frames to TWT requesting STA after the end of the TWT SP if the STA is in Active mode.

A TWT responding STA may transmit to a TWT requesting STA that is in Active mode at any time (see 11.2.3.2 (STA power management modes)). A TWT responding STA may transmit to a TWT requesting STA that is in PS mode and awake outside of a TWT SP following the rules in 11.2.3.6 (AP operation).

* 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 periodic(#22223) opportunistic power save(#22311) 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). An AP corresponding to a nontransmitted BSSID in a multiple BSSID set shall follow the rules in 11.1.3.8.4 (Inheritance of element values).

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.

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 11.1.3.8.4 (Inheritance of element values) to determine the TWT parameter values.

A TWT scheduled STA is a 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.

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), and, in addition, the rules in 26.14.2 (Power save with UORA and TWT) if the STA supports the UORA procedure, and the rules in 26.14.3 (Opportunistic power save) if the STA supports OPS operation. 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 26-10 (Example of broadcast TWT operation with optional TBTT negotiation), where the AP is the TWT scheduling AP and STA 1 and STA 2 are the TWT scheduled STAs.

|  |
| --- |
|  |
| * Example of broadcast TWT operation with optional TBTT negotiation |

The TWT scheduling AP includes a broadcast TWT element in the Beacon frame that indicates a broadcast TWT SP during 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 frame to 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.

Negotiations to become a member of or terminate membership in a broadcast TWT, 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 Command field: Accept TWT, Alternate TWT, or Dictate TWT. An unsolicited TWT response with TWT Setup 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 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 Command field that indicates Accept TWT may transmit a TWT Teardown frame or a TWT response with TWT Setup 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 10.47.7 (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.

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 announcements are broadcast TWT schedules advertised in broadcast TWT elements contained in broadcast Management frames (see Table 26-6 (Broadcast TWT announcements)).

The TWT scheduling AP shall set the Broadcast TWT Persistence subfield for each broadcast TWT to 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.

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 and switch the TWT Setup Command subfield from Alternate TWT to Accept TWT at that TBTT. 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.

NOTE—TWT scheduled STAs follow the broadcast TWT parameters that are included in the current broadcast TWT parameter set and only switch to following the broadcast TWT parameters in the future broadcast TWT parameter set if the TWT Setup Command field is equal to Accept TWT in the Broadcast TWT Parameter Set field that contains the future broadcast TWT parameter set.

A TWT scheduling AP should indicate Alternate TWT or Reject TWT in the TWT Setup Command 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 frame preceding the beacon interval that contains this TWT SP (see 26.8.6 (Negotiation of wake TBTT and wake interval)).

The TWT scheduling AP that schedules 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 if the Trigger frame is the last scheduled Trigger frame of the TWT SP or if 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.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24440):***

NOTE 3—The Trigger frame can be replaced by a frame carrying a TRS Control subfield provided that the frame is carried in a DL MU PPDU and 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. In this case, the AP 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. *(#24440)* (#22279, #22280)

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 9-297a (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.

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 addressed to a TWT scheduled STA whose TIM bit in the Beacon frame is 1 and that is not a member of any nonzero broadcast TWT during this beacon interval.
* 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.

The TWT parameters are valid for each successive TWT of a periodic TWT and for the only TWT of an aperiodic TWT.

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 field 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 field 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.

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 during or before an announced TWT SP but after the end of the most recent TWT SP, that the TWT scheduled STA is in the awake state during the 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 are available at the AP, provided that the BU delivery does not exceed the duration of the TWT SP, the TWT scheduled STA has indicated that it is 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 frame exchange for broadcast TWT) and 26.8.5 (Power save operation during TWT SPs)).

NOTE—The indication that the TWT scheduled STA is in the awake state for that TWT SP might be a PS-Poll, U-APSD trigger frame, or any frame for which an immediate response is solicited and that follows the rules in 11.2.3.2 (Non-AP STA power management modes) but the corresponding immediate response frame is not received by the TWT scheduled STA. 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)).

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 frame exchange for broadcast TWT) and 26.8.5 (Power save operation during TWT SPs).

NOTE—The TWT scheduling AP can deliver the buffered BUs in A-MPDUs sent 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 buffered BUs can be delivered in multiple PPDUs transmitted within the TWT SP. 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 (Non-AP STA power management modes)). A TWT scheduling AP may transmit to a TWT scheduled STA that is in PS mode and awake outside of a TWT SP following the rules in 11.2.3.6 (AP operation).

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 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 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.

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).

|  |  |  |
| --- | --- | --- |
| * 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 frame 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 subfield 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 10.47 (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 should not transmit frames that are not contained within HE TB PPDUs to the TWT scheduling AP 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 using EDCA within or outside TWT SPs, the TWT scheduled STA might still do so(#22334). If the STA decides to transmit then the STA might contend for accessing the medium as defined in 10.23.2 (HCF contention based channel access (EDCA)) and 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 Setup 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 subfield set to 3 and the TWT Setup Command field set to Reject TWT or by transmitting a TWT Teardown frame that has the Negotiation Type subfield 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 Setup 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 that 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 Setup 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).

**TGax Editor: *Change the table below of this subclause as follows (#CID 24569):***

|  |  |  |
| --- | --- | --- |
| * Broadcast TWT membership exchanges | | |
| 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 | 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. The TWT scheduling AP indicates that it is not willing to accept any other TWT parameters from the TWT scheduled STA at this time.  The TWT scheduled STA can send a new request, but will receive an Accept TWT only if it uses the dictated TWT parameters. *(#24569)* |
| 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 subfield 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 10.47 (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 9-297 (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 11.2.3.7 (Receive operation for STAs in PS mode)) 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 start of the TWT SP but after the end of the most recent TWT SP, 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 11.2.3.7 (Receive operation for STAs in PS mode)).

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)).

A TWT scheduled STA should not send frames that do not satisfy the Broadcast TWT Recommendation subfield recommendations in Table 9-297a (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).

* Use of TWT Information frames
* General

An HE STA may transmit a TWT Information frame to its peer STA during an individual TWT agreement, broadcast TWT schedule, or at any time as defined in 26.8.4.2 (TWT Information frame exchange for individual TWT), 26.8.4.3 (TWT Information frame exchange for broadcast TWT) and 26.8.4.4 (TWT Information frame exchange for flexible wake time), respectively.

NOTE—An HE AP might include multiple TWT Information frames, each addressed to a different peer STA, in an HE MU PPDU (see 26.5.1 (HE DL MU operation)).

The TWT Information frame shall have the Response Requested subfield equal to 0, the Next TWT Request subfield equal to 0, and one of the following:

* A nonzero value in the Next TWT subfield if the frame is transmitted by a TWT responding STA, a TWT scheduling AP, or by any HE STA to a peer STA that has set the Flexible TWT Schedule Support field to 1 in the HE Capabilities element it transmits.
* The value of the Next TWT subfield shall be selected from existing TWT values for an individual TWT agreement if the Flexible TWT Schedule Support field in the HE Capabilities element received from the peer STA is 0 and shall be selected from existing TWT values for a broadcast TWT schedule regardless of the value of the Flexible TWT Schedule Support field received from the peer STA.
* The Next TWT subfield may contain any nonzero value if Flexible TWT Schedule Support field in the HE Capabilities element received from the peer STA is 1.
* The All TWT field is 1 if the resumption applies to all broadcast TWT schedules followed by the TWT scheduled STA and/or to all individual TWT agreements followed by the TWT responding STA.
* A Next TWT subfield that is present if the frame is transmitted by a TWT requesting STA, a TWT scheduled STA, or if the frame is transmitted by any HE STA to a peer STA that has set the Flexible TWT Schedule Support field to 1 in the HE Capabilities element it transmits.
* The Next TWT subfield indicates the earliest TWT at which the individual TWT agreement or broadcast TWT schedule is resumed and shall be selected from existing TWT values for that TWT agreement or broadcast TWT schedule if the Flexible TWT Schedule Support field in the HE Capabilities element received from the peer STA is 0.
* The All TWT field is 1 if the resumption applies to all broadcast TWT schedules followed by the TWT scheduled STA and/or to all individual TWT agreements followed by the TWT requesting STA.
* The Next TWT subfield may contain any nonzero value if Flexible TWT Schedule Support field in the HE Capabilities element received from the peer STA is 1.
* A Next TWT subfield that is not present if the frame is transmitted by a TWT requesting STA or a TWT scheduled STA to indicate suspension of the individual TWT agreement or broadcast TWT schedule.
* The All TWT subfield is 1 if the suspension applies to all broadcast TWT schedules followed by the TWT scheduled STA and/or to all individual TWT agreements followed by the TWT requesting STA.
* The Next TWT subfield may contain any nonzero value if Flexible TWT Schedule Support field in the HE Capabilities element received from the peer STA is 1.

The use of TWT Information frames for suspending and/or resuming existing individual TWT agreements is described in 26.8.4.2 (TWT Information frame exchange for individual TWT). The use of TWT Information frames for suspending and/or resuming existing broadcast TWT schedules is described in 26.8.4.3 (TWT Information frame exchange for broadcast TWT). The use of TWT Information frames for providing a flexible TWT that is independent of any existing TWT agreements or TWT schedules is described in 26.8.4.4 (TWT Information frame exchange for flexible wake time).

* TWT Information frame exchange for individual TWT

An HE STA that has an individual TWT agreement may transmit a TWT Information frame to a peer STA with which it has the agreement if the peer STA has set the TWT Information Frame Disabled field to 0 in the TWT element sent during TWT setup; otherwise the HE STA shall not transmit a TWT Information frame to the peer STA. The HE STA sets the fields of the TWT Information frame as defined in 26.8.4.1 (General).

A TWT requesting STA that receives a TWT Information frame containing a Next TWT subfield follows the rules in 10.47.4 (Implicit TWT operation) and the rules below.(#22111)

A TWT requesting STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA:

* That does not contain a Next TWT subfield shall consider the corresponding TWT agreement suspended until the TWT session is resumed.
* That contains a Next TWT subfield shall consider the corresponding TWT agreement suspended and shall resume the TWT agreement starting from the value indicated in the Next TWT subfield of the transmitted TWT Information frame.
* Assumes that any other individual TWT agreements, broadcast TWT schedules (see 26.8.3 (Broadcast TWT operation)), are not affected by the transmission of this frame except when the All TWT subfield of the TWT Information frame is equal to 1. Other default PS procedures are not affected by the transmission of this frame (see 11.2 (Power management)).

NOTE—The TWT Flow Identifier, together with the MAC addresses of the TWT requesting STA and TWT responding STA identifies the TWT agreement for which the TWT Information frame is sent (see 10.47.1 (TWT overview)).

If the TWT Information frame contains an All TWT subfield equal to 1 then the above rules apply to all individual TWT agreements, except that the resumptions of the respective TWTs shall occur at the first TWT of the respective TWT agreement that occurs not earlier than the Next TWT value contained in the TWT Information frame, regardless of the value of the Flexible TWT Schedule Support field in the HE Capabilities element exchanged between the two STAs.

A TWT requesting STA that is in PS mode and that transmits a TWT Information frame to a TWT responding STA shall suspend the corresponding TWT agreement and may transition to doze state after receiving the acknowledgment even if it has previously transmitted a PS-Poll or U-APSD trigger frame and has not yet received the expected frames from the AP in response and shall resume TWT operation for the corresponding TWT agreement at the specified TWT indicated (if any) in the TWT Information frame. A TWT requesting STA that is in PS mode and that receives a TWT Information frame from a TWT responding STA shall suspend the TWT agreement and may go to doze state after transmitting the acknowledgment even if it has previously transmitted a PS-Poll or U-APSD trigger frame and has not yet received the expected frames from the TWT responding STA in response and shall resume TWT operation for the corresponding TWT agreement at the specified TWT indicated (if any) in the TWT Information frame.

* TWT Information frame exchange for broadcast TWT

An HE STA that is a TWT scheduling AP may transmit a TWT Information frame to any of the members of a broadcast TWT schedule if the member has set the TWT Information Frame Disabled field to 0 in the TWT element sent when joining the broadcast TWT schedule. An HE STA that is a TWT scheduled STA may transmit a TWT Information frame to the TWT scheduling AP corresponding to a broadcast TWT schedule established by that STA if the AP has set the TWT Information Frame Disabled field to 0 in the broadcast TWT element it transmits. The HE STA sets the fields of the TWT Information frame as defined in 26.8.4.1 (General).

A TWT scheduled STA that receives a TWT Information frame that contains an All TWT subfield equal to 1 follows the rules defined in 26.8.3.3 (Rules for TWT scheduled STA), except that the TWT scheduled STA shall consider all the broadcast TWT schedules as suspended and shall resume each broadcast TWT schedule at the first TWT that occurs not earlier than the Next TWT subfield value contained in the received TWT Information frame.

A TWT scheduled STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA that contains an All TWT subfield equal to 1 and that does not contain a Next TWT subfield shall consider all broadcast TWT schedules suspended, and can follow the default PS procedure defined in 11.2 (Power management) until the broadcast TWT schedules are resumed.

A TWT scheduled STA that receives an acknowledgment in response to a TWT Information frame transmitted by the STA that contains an All TWT subfield equal to 1 and that contains a Next TWT subfield shall suspend all broadcast TWT schedules and shall resume the broadcast TWT schedules at the first scheduled TWT for each respective broadcast TWT schedule that occurs not earlier than the value indicated in the Next TWT subfield contained in the transmitted TWT Information frame, regardless of the values of the Flexible TWT Schedule Support field in the HE Capabilities element exchanged between the two STAs.

NOTE—TWT suspension and resumption as indicated by a TWT Information frame with the All TWT subfield equal to 1 applies to all broadcast TWT schedules of the TWT scheduling AP.

A TWT scheduled STA that is in PS mode and that transmits a TWT Information frame to a TWT scheduling AP shall suspend the corresponding broadcast TWT schedule and may transition to doze state after receiving the acknowledgment, even if it has previously transmitted a PS-Poll or U-APSD trigger frame and has not yet received the expected frames from the TWT scheduling AP in response, and shall resume TWT operation for the corresponding broadcast TWT schedule at the specified TWT indicated (if any) in the TWT Information frame. A TWT scheduled STA that is in PS mode and that receives a TWT Information frame from a TWT scheduling AP shall suspend the corresponding broadcast TWT schedule and may transition to doze state after transmitting the acknowledgment, even if it has previously transmitted a PS-Poll or U-APSD trigger frame and has not yet received the expected frames from the TWT scheduling AP in response, and shall resume TWT operation for the corresponding broadcast TWT schedule at the specified TWT indicated (if any) in the TWT Information frame.

* TWT Information frame exchange for flexible wake time

An HE STA may transmit a TWT Information frame that contains a flexible TWT to a peer STA if the peer STA has set the Flexible TWT Schedule Support field of the HE Capabilities it transmits to 1; otherwise the HE STA shall not transmit a TWT Information frame that contains a flexible TWT to the peer STA.

A flexible TWT is a nonzero value indicated in the Next TWT subfield of a TWT Information frame with All TWT subfield equal to 0, which is independent from any existing TWT values of TWT agreements that the HE STA might be following (if any). The HE STA sets the fields of the transmitted TWT Information frame as defined in 26.8.4.1 (General).

NOTE—Flexible TWT support does not depend on the STA’s TWT capabilities, i.e., the STA can use flexible TWT without being required to set up an individual TWT agreement or broadcast TWT schedule.

An HE STA that receives acknowledgment for a TWT Information frame with flexible TWT and that contains a TWT Flow Identifier that identifies an existing individual TWT agreement shall replace the next TWT SP start time for that TWT agreement with the value contained in the Next TWT subfield of the TWT Information frame.

A non-AP HE STA that receives acknowledgment for a TWT Information frame with flexible TWT and that contains a TWT Flow Identifier that does not identify any existing individual TWT agreement preserves the PM mode from the time the TWT Information frame was sent to the time indicated in the Next TWT subfield of the TWT Information frame as described below.

NOTE—If the TWT Information frame has the All TWT field equal to 1 then the TWTs are suspended and resumed as described in 26.8.4.2 (TWT Information frame exchange for individual TWT) and 26.8.4.3 (TWT Information frame exchange for broadcast TWT).

A non-AP HE STA that transmits a TWT Information frame that contains a flexible TWT to a peer STA may go to doze state after receiving the acknowledgment sent in response to the TWT Information frame if it is in PS mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 1) and may be unavailable if it is in active mode (i.e., the PM subfield of the Frame Control field of the TWT Information frame is 0) and shall be in the awake state at the time it indicated in the Next TWT subfield of the TWT Information frame and shall be in the PS mode if the PM subfield of the TWT Information frame was 1 and in active mode if the PM subfield of the TWT Information frame was 0. The STA, once in the awake state, shall follow the rules that correspond to the power management mode of the STA, which are defined in 11.2.3 (Power management in a non-DMG infrastructure network) for the Active and PS mode, and in 26.8 (TWT operation) when the STA operates within TWT SPs.

NOTE—An HE AP delivers DL BUs to the STA at or after the flexible TWT indicated in the flexible TWT by following the rules in 11.2.3.6 (AP operation) if the STA does not follow TWT, and by following the rules in 26.8 (TWT operation) if the STA follows TWT and the delivery falls within a TWT SP. The STA is not required to send a frame at or after the flexible TWT to indicate its awake state to the AP. If the STA is following U-APSD then the operation is resumed at a time that occurs at the flexible TWT and if the STA is following an APSD schedule then the operation is resumed at a time that occurs at or after the flexible TWT.

A non-AP HE STA that receives a TWT Information frame that contains a flexible TWT from a peer STA may go to doze state after transmitting the acknowledgment if it is in PS mode and may be unavailable if it is in active mode and shall be in the awake state at the time it indicated in the Next TWT subfield of the TWT Information frame and shall be in the PS mode if the STA was in PS mode when it received the TWT Information frame and in active mode if the STA was in active mode when it received the TWT Information frame. The STA, once in the awake state, shall follow the rules that correspond to the power management mode of the STA, which are defined in 11.2.3 (Power management in a non-DMG infrastructure network) for the Active and PS mode, and in 26.8 (TWT operation) when the STA operates within TWT SPs.

* Power save operation during TWT SPs

The following rules apply to TWT SPs for both broadcast TWT schedules and individual TWT agreements where the TWT SP of a broadcast TWT is uniquely identified by the <broadcast TWT ID, MAC address of TWT scheduling AP> tuple and the TWT SP of an individual TWT is uniquely identified by the <TWT flow identifier, MAC address of TWT requesting STA, MAC address of TWT responding STA> triple.

A TWT requesting STA or a TWT scheduled STA that is not in PS mode and that transmits a frame with the Power Management subfield set to 1 during a TWT SP shall remain in the awake state until the AdjustedMinimumTWTWakeDuration time has elapsed from the TWT SP start time or until a TWT SP termination event is detected, whichever occurs first for that particular TWT SP.

A TWT requesting STA or a TWT scheduled STA in PS mode that is in the awake state for a TWT SP may transition to the doze state after AdjustedMinimumTWTWakeDuration time has elapsed from the TWT SP start time even if it has previously transmitted a PS-Poll frame or U-APSD trigger frame and has not yet received the expected frames from the AP in response. For a trigger-enabled TWT SP, if the AdjustedMinimumTWTWakeDuration time has elapsed from the scheduled TWT SP start time and no Trigger frames are received by the STA, the HE STA may enter doze state if no other condition requires the STA to remain awake.

When a TWT SP termination event is detected within a TWT SP by a STA in PS mode that is participating in the TWT SP, the STA may transition to the doze state without waiting for the expiration of the AdjustedMinimumTWTWakeDuration time as described in 10.47.1 (TWT overview), even if it has previously transmitted a PS-Poll frame or U-APSD trigger frame and has not yet received the expected frames from the AP in response.

A TWT requesting STA or a TWT scheduled STA shall classify any of the following events as a TWT SP termination event:

* The transmission by the TWT requesting STA or TWT scheduled STA of an acknowledgment in response to an individually addressed QoS Data or QoS Null frame sent by the TWT responding STA or TWT scheduling AP, respectively, that had the EOSP subfield equal to 1.
* The transmission by the TWT requesting STA or TWT scheduled STA of an acknowledgment in response to an individually addressed frame that is neither a QoS Data frame nor a QoS Null frame, sent by the TWT responding STA or TWT scheduling AP, respectively, with the More Data field equal to 0.
* The reception of an individually addressed or broadcast QoS Data or QoS Null frame sent by the TWT responding STA or TWT scheduling AP, that does not solicit an immediate response and with the EOSP subfield equal to 1.
* The reception of an individually addressed frame that is neither a QoS Data frame nor a QoS Null frame, sent by the TWT responding STA or TWT scheduling AP, that does not solicit an immediate response and with the More Data field equal to 0.
* The reception of a Trigger frame sent by the TWT responding STA or TWT scheduling AP that has the More TF field equal to 0 and is not addressed to the TWT requesting STA or TWT scheduled STA provided that the TWT requesting STA or TWT scheduled STA is either awake for an announced trigger-enabled TWT SP but did not transmit an indication that it is in the awake state to the TWT responding STA or TWT scheduling AP or is awake for an unannounced trigger-enabled TWT SP.

The classification of a More Data field equal to 0 in an Ack, BlockAck and individually addressed Multi-STA BlockAck frame as an event that terminates a TWT SP is only possible when both STAs have indicated support of transmitting or receiving the frame with a nonzero More Data subfield, which is indicated in the More Data Ack subfield of the QoS Info field of frames they transmit (see 11.2.3 (Power management in a non-DMG infrastructure network)).

NOTE 1—A STA participating in multiple TWT SPs that overlap in time stays in the awake state until the latest AdjustedMinimumTWTWakeDuration time of all of the TWT SPs expires, except that a TWT SP termination event causes all of the overlapping TWT SPs to terminate.

NOTE 2—A Trigger frame is addressed to the STA if the Trigger frame contains the AID of the STA in one of its User Info fields (see 26.5.2 (UL MU operation)), and has in its TA field either the MAC address of its associated AP or the transmitted BSSID (see 26.5.2.2.4 (Allowed settings of the Trigger frame fields and TRS Control subfield)). Otherwise, the Trigger frame is not addressed to the STA. If the Trigger frame contains one or more RA-RUs for which the STA can gain access according to 26.5.4 (UL OFDMA-based random access (UORA)) then the STA can follow the rules defined in 26.14.2 (Power save with UORA and TWT) to determine an early TWT SP termination event.

Additional TWT SP termination events for a TWT requesting STA occur after the acknowledgment of a TWT Information frame as defined in 26.8.4.2 (TWT Information frame exchange for individual TWT) and in 26.8.4.4 (TWT Information frame exchange for flexible wake time).

Additional TWT SP termination events for a TWT scheduled STA occur after the acknowledgment of a TWT Information frame as defined in 26.8.4.3 (TWT Information frame exchange for broadcast TWT) and in 26.8.4.4 (TWT Information frame exchange for flexible wake time).

* Negotiation of wake TBTT and wake interval

A TBTT scheduled STA that intends to operate in power save mode (see 11.2.3.2 (Non-AP STA power management modes)) may transmit a TWT request to the TBTT scheduling AP that identifies the wake TBTT of the first Beacon frame and the wake interval between subsequent Beacon frames it intends to receive. The TWT request shall contain:

* The Negotiation Type subfield equal to 1 and the TWT Setup Command field to Suggest TWT or Demand TWT
* The requested first wake TBTT in the Target Wake Time field
* The requested wake interval between consecutive TBTTs in the TWT Wake Interval Mantissa and TWT Wake Interval Exponent fields
* The requested TBTT wake duration in the Nominal Minimum TWT Wake Duration field
* All other fields in the TWT element are reserved.

A TBTT scheduling AP that receives a TWT request from a STA whose value of the Negotiation Type subfield is 1 shall respond with a TWT response that contains either Accept TWT, Alternate TWT, or Reject TWT in the TWT Setup Command field and, in the case of an Accept TWT, it shall also contain:

* The Negotiation Type subfield equal to 1
* The allocated first wake TBTT in the Target Wake Time field
* The allocated wake interval between consecutive TBTTs in the TWT Wake Interval Mantissa and TWT Wake Interval Exponent fields
* The allocated TBTT wake duration in the Nominal Minimum TWT Wake Duration field
* All other fields in the TWT element are reserved

After successfully completing the negotiation, the TBTT scheduled STA may go to doze state until its TSF matches the next negotiated wake TBTT provided that the STA is in power save mode, and no other condition requires the STA to remain awake. The TBTT scheduled STA shall be in the awake state to listen to Beacon frames transmitted at negotiated wake TBTTs and shall operate as described in 26.8.3.3 (Rules for TWT scheduled STA).

If the TBTT scheduled STA receives a Beacon frame from the TBTT scheduling AP at or after TBTT, the TBTT scheduled STA may go to doze state until the next wake TBTT if no other condition requires the STA to remain awake. The TBTT scheduled STA may go to doze state after a nominal minimum TBTT wake duration time has elapsed from the TBTT start time if no other condition requires the STA to remain awake.

Either STA that is a party to an established wake TBTT agreement can tear down the wake TBTT agreement by following the tear down procedure described in 10.47.8 (TWT Teardown) and by setting the Negotiation Type subfield to 1 in the TWT Teardown frame.

Table 26-8 (Wake TBTT negotiation exchanges) summarizes the interactions between devices that negotiate a Wake TBTT agreement.

|  |  |  |
| --- | --- | --- |
| * Wake TBTT negotiation exchanges | | |
| TWT Setup Command field in an initiating frame | TWT Setup Command field in a response frame | Condition after the completion of the exchange |
| Request TWT | Accept TWT or Alternate TWT or Dictate TWT or Reject TWT or no response | This exchange is not allowed. |
| Demand TWT or Suggest TWT | Accept TWT | A Wake TBTT agreement has been created with the Wake TBTT parameters indicated in the initiating frame. |
| Demand TWT or Suggest TWT | Reject TWT | No Wake TBTT agreement has been created. |
| Demand TWT or Suggest TWT | Alternate TWT | No Wake TBTT agreement has been created. The TBTT scheduling AP is offering an alternative set of parameters vs. those indicated in the initiating frame. The TBTT scheduled STA can send a new request with any set of Wake TBTT parameters and the responder might create a Wake TBTT agreement using those parameters.  The TBTT scheduled STA is unlikely to send a new request if the TWT Setup Command is Demand TWT and is very likely to send a new request if the TWT Setup Command is Suggest TWT. |
| NOTE 1—The Negotiation Type subfield of the TWT element contained in these frames is equal to 1.  NOTE 2—The initiating frame and response frame settings not listed in the tables in 10.47 (Target wake time (TWT)) or 26.8 (TWT operation) are not allowed. The initiating frame is a TWT request and the response frame is a TWT response. | | |

* HE subchannel selective transmission
* General

An HE STA that supports HE subchannel selective transmission (SST) operation shall set dot11HESubchannelSelectiveTransmissionImplemented to true and shall set the HE Subchannel Selective Transmission Support field in the HE Capabilities element it transmits to 1. An HE STA that does not support HE SST operation shall set the HE Subchannel Selective Transmission Support field in the HE Capabilities element it transmits to 0.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24437):***

A non-AP HE STA(#22155) with dot11HESubchannelSelectiveTransmissionImplemented equal to true is a HE SST non-AP STA. *(#24437)* (#22150)

An HE AP with dot11HESubchannelSelectiveTransmissionImplemented equal to true is an HE SST AP. *(#24437)*

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24437):***

An HE SST non-AP STA and an HE SST AP may set up SST operation by negotiating a trigger-enabled TWT as defined in 26.8.2 (Individual TWT agreements) except that:*(#24437)*

* The TWT request may have a TWT Channel field with up to one bit set to 1 to indicate the secondary channel requested to contain the RU allocations addressed to the HE SST non-AP STA(#22150) that is a 20 MHz operating STA
* The TWT request may have a TWT Channel field with all the four LSBs or all the four MSBs set to 1 to indicate whether the primary 80 MHz channel or the secondary 80 MHz channel is requested to contain the RU allocations addressed to the HE SST non-AP STA(#22150) that is an 80 MHz operating STA
* The TWT response shall have a TWT Channel field with up to one bit set to 1 to indicate the secondary channel that will contain the RU allocations addressed to the HE SST non-AP STA(#22150) that is a 20 MHz operating STA
* The TWT response shall have a TWT Channel field with all the 4 LSBs or all the 4 MSBs to indicate whether the primary 80 MHz channel or the secondary 80 MHz channel will contain the RU allocations addressed to the HE SST non-AP STA(#22150) that is a 80 MHz operating STA.
* SST operation

An HE SST non-AP STA(#22150) and HE SST AP that successfully sets up SST operation shall follow the rules defined in this subclause.

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 24437):***

If an HE SST AP causes its operating channel or channel width to change and if any(#22151) secondary channel of a trigger-enabled TWT(#22231) is not within the new operating channel or channel width, then the HE SST AP and the HE SST non-AP STA implicitly terminate the trigger-enabled TWT(#22231).*(#24437)* (#Ed)(#22147, #22153)

The HE SST AP follows the rules in 26.8.2 (Individual TWT agreements) to exchange frames with the HE SST non-AP STA(#22150) during trigger-enabled TWT SPs(#22231), except that the AP shall ensure the following:(#Ed)

* The individually addressed RUs allocated in DL MU PPDUs and in Trigger frames addressed to the HE SST non-AP STA(#22150) are within the subchannel indicated in the TWT Channel field of the TWT response and follows the RU restriction rules defined in 27.3.2.8 (RU restrictions for 20 MHz operation) if the HE SST non-AP STA is a 20 MHz operating STA and in 27.3.2.9 (80 MHz operating non-AP HE STAs) if the HE SST non-AP STA(#22150) is an 80 MHz operating STA.*(#24437)*
* The trigger-enabled TWT SPs do not overlap with TBTTs at which DTIM Beacon frames are sent.
* The same subchannel is used for all trigger-enabled TWT SPs with the same HE SST non-AP STA(#22150) that overlap in time.

An HE SST non-AP STA(#22150) operating on the secondary channel shall not conduct OMI operation as defined in 26.9 (Operating mode indication) or OMN operation as defined in 11.41 (Notification of operating mode changes) to change the operating bandwidth.

The HE SST non-AP STA(#22150) follows the rules in 26.8.2 (Individual TWT agreements) to exchange frames with the HE SST AP during trigger-enabled TWT SPs(#22231), except that the STA:

* Shall be available in the subchannel indicated in the TWT Channel field of the TWT response at TWT start times
* Shall not access the medium in the subchannel using DCF or EDCAF
* Shall not respond to Trigger frames addressed to it (see 26.5 (MU operation) and 26.8.2 (Individual TWT agreements)) unless it has performed CCA until a frame is detected by which it can set its NAV, or until a period equal to NAVSyncDelay has transpired, whichever is earlier.
* Shall update its NAV according to 26.2.4 (Updating two NAVs) if it receives a PPDU in the subchannel

An HE SST non-AP STA(#22150) may include a Channel Switch Timing element in (Re-)Association Request frames it transmits to an HE SST AP to indicate the time required by the STA to switch between different subchannels. The received channel switch time informs the HE SST AP of the duration of time that the HE SST non-AP STA(#22150) might not be available to receive frames before the TWT start time and after the end of the trigger-enabled TWT SP.

NOTE—An HE SST non-AP STA in PS mode is not required to move to the primary channel after the end of the trigger-enabled TWT SP. *(#24437)*

**9.2.4.6a.2 OM Control**

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24437):***

The Channel Width subfield indicates the operating channel width supported by the STA for both reception and transmission. It is set to 0 for 20 MHz, 1 for primary 40 MHz, 2 for primary 80 MHz, and 3 for 160 MHz and 80+80 MHz. The value 0 indicates a primary 20 MHz, unless the STA has negotiated SST operation in which case it indicates any of the negotiated 20 MHz subchannels of the SST operation (see 26.8.7 (HE subchannel selective transmission)). *(#24437)*

**26.15.7 Additional rules for group addressed frames in an HE MU PPDU**

**TGax Editor: *Change the bullet below of this subclause as follows (#CID 24437):***

* The SST subchannel if the group addressed frame is addressed to one or more HE SST non-AP STAs, the primary 20 MHz channel does not coincide with the subchannel assigned to the HE SST non-AP STAs and the frame is not addressed to any STAs other than the HE SST non-AP STAs in that subchannel (see 26.8.7.2 (SST operation)). The broadcast RU size shall not exceed 106 subcarriers if the SST subchannel is 20 MHz.*(#24437)*

**10.47.1 TWT overview**

**TGax Editor: *Change the row below of this table as follows (#CID 24569):***

**Table 10-31a—TWT setup exchange command interpretation**

|  |  |  |
| --- | --- | --- |
| Demand TWT or Suggest  TWT | Dictate TWT | No individual TWT agreement exists with the associated TWT flow identifier. The responder offers an alternative set of parameters vs. those indicated in the TWT request. The responder indicates that it is not willing to accept any other TWT parameters for the requesting STA at this time. The requesting STA can send a new request, but will only receive an Accept TWT if it uses the dictated TWT parameters. *(#24569)* |