IEEE P802.11  
Wireless LANs

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| Comment resolutions for miscellaneous CIDs in clause 10 | | | | |
| Date: 2020-03-01 | | | | |
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Abstract

This submission proposes resolutions for multiple comments related to TGax D6.0 with the following CIDs (5 CIDs):

* 24021, 24135, 24170, 24275, 24423

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Incorporated some suggestions received offline. 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.***

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 24021 | Seok, Yongho | 279.49 | "Other eligible modulation classes covers HT and VHT cases with any data rate.  It means that adding a new entry of {HE, any data rate} is not necessary. Because it is covered by the existing last entry." | Remove a new entry of {HE, any data rate} from Table 10-19 (Rate and modulation class of a final transmission in a TXOP). | Accepted |
| 24135 | Rolfe, Benjamin | 266.08 | "and the Control subfields included shall be supported by the receiving STAs" may not mean what you mean it to mean. As written it places a requirement on receiving STAL to support all possible Control subfileds, or to know what it will be sent beforehand (at implementation time). What I think is meant is that the transmtted frame should contain only control subfields that the recepient has declared it does support. | clarify e.g. change to "and the frame shall contain only Control subfields known to be supported by the receiving STAs". | Revised –  Agree in principle with the comment. Proposed resolution addresses the comment inline with the proposed change however with a different text organization.  TGax editor: Please replace “and the Control subfields included shall be supported by the receiving STAs” with “and the included Control subfields shall be those that are supported by the receiving STAs”. |
| 24170 | Kandala, Srinivas |  | The response control frame rates have not been specified when HE ER SU PPDU (with or without DCM) . The tricky situation is what a non-AP STA should use when it recieves HE SU PPDU with high power. I think it should be able to send HE ER SU PPDU, but that means the Duraiton/ID field (and TXOP duration) in HE ER SU PPDU should reflect correctly. In general it looks like there are some holes in the protocol | Discuss and if needed incorporate the necessary additions | Rejected –  It is not clear why the reception of a high powered HE SU PPDU would need to be responded to with an ER SU PPDU. Technically it would be the case when the PPDU is received at low power and the STA has generally an even lower power compared to the STA that sent the frame. There have already been discussions on allowing ER SU PPDUs for control response frames and as a result to those discussions several rules have been added to the standard that covers these use cases. Please refer to this contribution regarding some initial details on this aspect:  <https://mentor.ieee.org/802.11/dcn/16/11-16-1419-00-00ax-mcs-nss-bw-ppdu-selection-for-11ax.pptx>  and to rules defined in 26.15.2 (PPDU selection) for the rules that have been added for how to select the PPDU (non-HT/HE versus HE ER SU PPDU) and the rules defined in 26.15.3 (MCS, NSS, BW and DCM selection) for how to select the MCS (which includes the 106-RU and DCM). Hence no further changes are needed. |
| 24275 | Levy, Joseph | 288.34 | I am very confused how a STA that is not an S1G STA and is not an HE STA could have dot11TWTOptionActivated equal to true. Wasn't TWT introduced for S1G operation and extended for HE operation? How can a STA that doesn't support S1G or HE features support TWT operation? | Delete the paragraph: "A STA that is not an S1G STA and is not an HE STA and with dot11TWTOptionActivated equal to true and that operates in the role of TWT requesting STA shall set the TWT Requester Support subfield to 1 in all Extended Capabilities elements that it transmits. A STA that is not an S1G STA and is not an HE STA and with dot11TWTOptionActivated equal to true and that operates in the role of TWT responding STA shall set the TWT Responder Support subfield to 1 in all Extended Capabilities elements that it transmits." | Revised –  The comment is asking a question. A STA that doesn’t support S1G or HE features can indicate that it does support TWT by setting to 1 the TWT Requester Support or the TWT Responder Support (depending on which role it does support) subfield in the Extended Capabilities element it transmits. Hence, this way it is possible for example for a VHT STA to indicate that it supports TWT. The proposed change is proposing to remove the paragraph that actually enables this which is contrary to the intention.  Proposed resolution though is to amend baseline text in a couple of places to explicitly call out certain rules that are only applicable to S1G STAs.  TGax editor to make the changes shown in 11-20/0349r1 under all headings that include CID 24275. |
| 24423 | RISON, Mark | 265.61 | [Resubmission of comment withdrawn on D5.0] CID 20481. An HE STA conforming to the present amendment will have to ignore a Control field with Control ID above 6 anyway. So it is not necessary to specify that the payload has to be all-ones | In Table 10-11a--Conditions for including Control subfield variants delete "and Control Information subfield equal to all 1s and  whose content can be ignored by the HE recipient STA" | Revised –  Having a pre-defined sequence (all ones as the name states) simplifies the sequence generation and the sequence parsing. There is no technical reason to allow the payload to have any possible value.  On a second thought commenter suggested to replace “can be ignored” with “is ignored” in the cited text of the proposed change tab. Agree with the suggestion since it is inline with what the recipient HE STA is expected to do.  TGax editor: Please replace “can be ignored by” with “is ignored by” in P265L63. |

**Discussion: *None.***

* Termination of TXOP

**TGax Editor: *Change the table below of this subclause as follows (#CID 24021):***

|  |  |
| --- | --- |
| * Rate and modulation class of a final transmission in a TXOP | |
| Modulation class and data rate of immediately preceding frame in TXOP | Rate and modulation class of final transmission |
| DSSS or HR/DSSS with long preamble, data rate > 1 Mb/s | 1 Mb/s DSSS |
| HR/DSSS with short preamble, data rate > 2 Mb/s | 2 Mb/s HR/DSSS short preamble |
| Other eligible modulation classes, ~~data rate > 6 Mb/s~~ except 6 Mb/s OFDM | 6 Mb/s OFDM |

**10.8 HT Control field operation**

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24135):***

An HE STA that transmits a frame containing an A-Control subfield shall include at least one Control subfield in the A-Control subfield and the included Control subfields shall be those that are supported by the receiving STAs unless the Control ID subfield is 15.*(#24135)*

* Target wake time (TWT)(11ah)
* TWT overview

Target wake times (TWTs) allow STAs to manage activity in the BSS by scheduling STAs to operate at different times in order to minimize contention and to reduce the required amount of time that a STA utilizing a power management mode needs to be awake.

When performing the TWT operations described in 10.47.1 (TWT overview) to 10.47.8 (TWT Teardown), if management frame protection is negotiated and both STAs set the Protected TWT Operations Support field in the RSNXE that they transmit to 1, the STAs shall

* use individually addressed Protected TWT Setup, Protected TWT Teardown, and Protected TWT Information frames instead of TWT Setup, TWT Teardown, and TWT Information frames, respectively,
* not transmit BAT, STACK, or TACK frames, and
* discard any individually addressed TWT Setup, TWT Teardown, TWT Information, BAT, STACK, or TACK frame received from the peer STA, with which management frame protection is negotiated.

(#2715)STAs that exchange individually addressed Protected TWT Setup, Protected TWT Teardown, or Protected TWT Information frame shall follow the rules defined in 12.6.19 (Protection of robust Management frames).

(#2715)When management frame protection is not negotiated or the Protected TWT Operations Support field in the RSNXE transmitted by either STA is set to 0, the STAs shall not use any of the Protected TWT Setup frame, the Protected TWT Teardown frame, and the Protected TWT Information frame.

STAs that request a TWT agreement are called TWT requesting STAs and the STAs that respond to their requests are TWT responding STAs. A TWT requesting STA is assigned specific times to wake and exchange frames with the TWT responding STA. A TWT requesting STA communicates wake scheduling information to its TWT responding STA and the TWT responding STA devises a schedule and delivers TWT values to the TWT requesting STA when a TWT agreement has been established between them. When explicit TWT is employed, a TWT requesting STA wakes and performs a frame exchange and receives the next TWT information in a response from the TWT responding STA. When implicit TWT is used, the TWT requesting STA calculates the Next TWT by adding a fixed value to the current TWT value. STAs need not be made aware of the TWT values of other STAs.

The maximum number of active TWT agreements between any pair of STAs cannot exceed 8, since the TWT Flow Identifier field of the TWT element comprises 3 bits. TWT responding STAs may protect TWT times with protection mechanisms including, but not limited to NAV-setting frame exchanges. TWT responding STAs that are APs may additionally protect TWT times using RAW scheduling. TWT requesting STAs may wake at times other than TWT. An AP that is a TWT requesting STA shall not be in doze state(#2422) for a duration that exceeds the value of the dot11MaxAwayDuration during a beacon interval or short beacon interval, as defined in 11.2.3.18 (AP Power Management(11ah)).

A STA with dot11TWTOptionActivated equal to true and that operates in the role of TWT requesting STA shall set the TWT Requester Support subfield to 1 in all S1G Capabilities elements that it transmits. A STA with dot11TWTOptionActivated equal to true and that operates in the role of TWT responding STA shall set the TWT Responder Support subfield to 1 in all S1G Capabilities elements that it transmits.

If the TWT Responder Support subfield of the S1G Capabilities element received from its associated AP is equal to 1, a non-AP STA with dot11TWTOptionActivated equal to true may transmit a TWT element to the AP with a value of Request TWT, Suggest TWT or Demand TWT in the TWT Command field and with the TWT Request field equal to 1.

An AP with dot11TWTOptionActivated equal to true shall transmit a TWT element to a STA that is associated to the AP and from which it received a frame containing a TWT element that contained a value of Request TWT, Suggest TWT or Demand TWT in the TWT Command field and with the TWT Request field equal to 1. The transmitted TWT element shall be included in the frame that is the appropriate response frame to the received frame. The AP shall include a value of Accept TWT, Alternate TWT, Dictate TWT or Reject TWT in the TWT Command field of the response and shall set the TWT Request field to 0. If the AP response’s TWT Command field includes anything other than Accept TWT or Reject TWT, the STA should send a new request for a TWT value by sending another frame that contains a TWT element, modifying the parameters of the request to indicate, for example, an acceptance of a proposed alternate TWT or dictated TWT value. If the STA receives a TWT response to a TWT request with the TWT Command value of Accept TWT, then the STA has successfully completed a TWT setup with that STA for the TWT Flow Identifier indicated in the TWT response and the STA becomes a TWT requesting STA and the STA may enter the doze state(#2422) until the TSF matches the next TWT value of the STA, provided that the STA has indicated that it is in a power save mode and no other condition requires the STA to remain awake. The AP becomes a TWT responding STA of the TWT requesting STA.

The receipt of a TWT command value of Suggest TWT implies that the STA sending the command will consider accepting a proposed TWT that differs from the value found in the TWT field of the element. The receipt of a TWT command value of Demand TWT implies that the STA sending the command will not consider accepting a proposed TWT that differs from the value found in the TWT field of the element. The receipt of a TWT command value of Alternate TWT implies that the STA sending the command will consider accepting a proposed TWT that differs from the value found in the TWT field of the element. The receipt of a TWT command value of Dictate TWT implies that the STA sending the command will not consider accepting a proposed TWT that differs from the value found in the TWT field of the element.

The MAC addresses of the TWT requesting STA and the TWT responding STA and the TWT Flow Identifier indicated in the TWT Response of a successful TWT setup between those two STAs uniquely identifies a TWT agreement. A MAC variable AdjustedMinimumTWTWakeDuration is defined for each TWT of each TWT agreement and has a value equal to Nominal Minimum TWT Wake Duration minus the elapsed time from the scheduled start of the TWT SP to the actual start of the SP, where the scheduled and actual start times of the TWT SP are determined after any necessary TSF adjustment. Because the value of the AdjustedMinimumTWTWakeDuration depends on the actual TWT SP start time, it is computed for each TWT SP once the TWT SP begins.

The TWT Wake Interval of a TWT agreement is the value calculated as shown in 9.4.2.199 (TWT element(11ah)) from the TWT Wake Interval Mantissa and TWT Wake Interval Exponent of the TWT response that successfully completed the TWT agreement.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24275):***

An S1G AP may transmit a TWT element in an individually addressed TWT Setup frame with a value of Request TWT, Suggest TWT or Demand TWT in the TWT Command field and with the TWT Request field equal to 1 to an associated non-AP STA if the TWT Responder Support subfield in the S1G Capabilities element received from the STA is equal to 1. An AP may transmit TWT Setup frames to more than one of its associated non-AP STAs.*(#24275)*

A non-AP STA with dot11TWTOptionActivated equal to true shall transmit a frame containing a TWT element to the AP with which it is associated and from which it received an individually addressed frame containing a TWT element that contained a value of Request TWT, Suggest TWT or Demand TWT in the TWT Command field and with the TWT Request field equal to 1. The transmitted TWT element shall be included in the frame that is the appropriate response frame to the received frame. The non-AP STA shall include a value of Accept TWT, Alternate TWT, Dictate TWT or Reject TWT in the TWT Command field of the response and shall set the TWT Request field to 0. If the non-AP STA response’s TWT Command field includes anything other than Accept TWT or Reject TWT, the AP should send a new request for a TWT value by sending another frame that contains a TWT element, modifying the parameters of the request to indicate, for example an acceptance of a proposed alternate TWT or dictated TWT value. If the AP receives a TWT response to a TWT request with the TWT Command value of Accept TWT from an associated non-AP STA, then the AP has successfully completed a TWT setup with that STA for the TWT Flow Identifier indicated in the TWT response and the AP becomes a TWT requesting STA with respect to that STA.

A non-AP STA shall not transmit a frame containing a TWT element as a response to a group addressed frame with the TWT Request field equal to 1 that is transmitted by its associated AP.

If the NDP Paging field was not present in the TWT response corresponding to a TWT agreement, the TWT requesting STA shall be in the awake state following each TWT start time associated with each TWT agreement for the duration of the AdjustedMinimumTWTWakeDuration time associated with that TWT agreement even if no PS-Poll frame, NDP PS-Poll frame, or U-APSD trigger frame has been transmitted by the STA or until it has received an EOSP field equal to 1 from the TWT responding STA, whichever occurs first. If the NDP Paging field was present in the TWT response, the TWT requesting STA shall follow the operational rules defined in 10.47.6 (NDP Paging Setup).

If the Implicit bit is equal to 1 in the TWT response for a TWT agreement, the TWT associated with that TWT agreement is an implicit TWT and the TWT SP associated with that TWT is an implicit TWT SP. A TWT SP that is not an implicit TWT is an explicit TWT SP.

A TWT requesting STA that is a non-AP STA should transmit frames only within TWT SPs.

A TWT requesting STA that transmits a frame during a TWT SP is not granted any special medium access privileges, nor is there any guarantee that the TWT responding STA assigned the TWT SP to only one TWT requesting STA.

A single pair of STAs can create multiple TWT agreements. Each unique TWT agreement is identified by a TWT Flow Identifier and the MAC addresses of the TWT requesting STA and TWT responding STA. Because the TWT Flow Identifier field is 3 bits in length, the maximum number of TWTs per STA pair is 8. There are no explicit restrictions on the class of traffic (i.e., EDCA Access Category) that can be transmitted within any specific TWT SP when multiple TWT agreements have been set up by a single TWT requesting STA.

**TGax Editor: *Change the paragraph below of this subclause as follows (#CID 24275):***

A TWT requesting STA that is a non-AP STA may wake to receive Beacons that are transmitted outside of a TWT SP. A TWT requesting STA that is an S1G AP generates S1G Beacon frames as described in 11.1.3 (Maintaining synchronization) and operates in power save mode as described in 11.2.3.18 (AP Power Management(11ah)). *(#24275)*

A TWT responding STA should include a Pentapartial Timestamp field or a Tetrapartial Timestamp field or a Timestamp field in at least one frame transmitted to a TWT requesting STA during a TWT SP for that STA.

NOTE—When dot11TWTOptionActivated is true, a TWT responding STA might use the TWT Wake Interval in determining the lifetime of frames that it buffers for an TWT requesting STA.

The Flow Type field in the TWT response that successfully set up a TWT agreement indicates the type of interaction between the TWT requesting STA and the TWT responding STA within each TWT SP for that TWT agreement. Flow Type field equal to 0 indicates an announced TWT. The TWT responding STA of an announced TWT agreement shall not transmit a frame to the TWT requesting STA within a TWT SP until it has (#2604)received a PS-Poll frame or APSD trigger frame (see (M18)11.2.3.5 (Power management with APSD)) from the TWT requesting STA. Flow Type field equal to 1 indicates an unannounced TWT. The TWT responding STA of an unannounced TWT agreement may transmit a frame to the TWT requesting STA within a TWT SP before it has (#2604)received a frame from the TWT requesting STA.

NOTE—A TWT requesting STA that is an AP does not send PS-Poll frames, but it can send APSD trigger frames.

A TWT requesting STA indicates which single channel it desires to use as a temporary primary channel during a TWT SP by setting a single bit to 1 within the TWT Channel field of the TWT element, according to the mapping described for that field. A TWT responding STA indicates which single channel the TWT requesting STA is permitted to use as a temporary primary channel during a TWT SP by setting a single bit to 1 within the TWT Channel field of the TWT element, according to the mapping described for that field. During a TWT SP, access to a channel that is not the primary channel of the BSS shall be performed according to the procedure described in 10.52 (Subchannel selective transmission (SST)(#1071)(11ah)).

* TWT acknowledgment procedure

STAs need to be able to predict the duration of response transmissions for Duration field calculations and in addition, TWT requesting STAs might need TWT start times delivered in response frames. This subclause contains rules for TWT acknowledgments that allow both objectives to be satisfied at once by requiring specific responses to be transmitted in specific circumstances and by specifying the use of frames that provide both acknowledgment and next TWT information.

A TWT responding STA shall transmit a STACK frame in response to a frame received from a TWT requesting STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is not an A-MPDU and not an S-MPDU. A TWT responding STA shall transmit a TACK frame in response to a frame received from a TWT requesting STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is an S‑MPDU unless the S-MPDU contains a BlockAckReq frame(#2464), in which case, the response frame is a BAT frame. A TWT responding STA shall transmit a BAT frame in response to a frame received from a TWT requesting STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is an A-MPDU.

A TWT requesting STA with the transmitted TWT Responder Support subfield in the S1G Capabilities element equal to 1 shall transmit a STACK frame in response to a frame received from a TWT responding STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is not an A-MPDU and not an S-MPDU. A TWT requesting STA with the transmitted TWT Responder Support subfield in the S1G Capabilities element equal to 1 shall transmit a TACK frame in response to a frame received from a TWT responding STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is an S-MPDU unless the S-MPDU contains a BlockAckReq frame(#2464), in which case, the response frame is a BAT frame. A TWT requesting STA with the transmitted TWT Responder Support subfield in the S1G Capabilities element equal to 1 shall transmit a BAT frame in response to a frame received from a TWT responding STA, which has the value NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION and that is an A-MPDU.

A TWT requesting STA that transmits a frame containing a Pentapartial Timestamp field shall set the field to all 0s. A TWT requesting STA that transmits a frame containing a Tetrapartial Timestamp field shall set the field to all 0s. A TWT requesting STA that transmits a frame containing a Next TWT Info field shall set the field to all 0s. A TWT requesting STA that transmits a frame containing a Change Sequence field shall set the field to all 0s.

A TWT requesting STA with the transmitted TWT Responder Support subfield in the S1G Capabilities element equal to 0 that receives a frame that requires an immediate response shall transmit an appropriate response is determined in 10.3.2.17 (Response Indication procedure(11ah)).

If the intended recipient of a STACK or BAT frame is an AP, then the A1 field of the frame shall be set to 0.(M86)

If a TWT responding STA or a TWT requesting STA receives a frame within a TWT SP that has a value other than NORMAL\_RESPONSE in the RXVECTOR parameter RESPONSE\_INDICATION, the appropriate response is as determined in 10.3.2.17 (Response Indication procedure(11ah)).

* Explicit TWT operation

Each TWT SP start value for an explicit TWT is transmitted by the TWT responding STA to the TWT requesting STA in the Next TWT Info/Suspend Duration field of a frame that can contain the field as described in this subclause. The TWT responding STA for an explicit TWT may provide TWT SP start times that are related to one another in a periodic or aperiodic manner.

During an explicit TWT SP, if a TWT responding STA receives a frame from a TWT requesting STA that permits a BAT frame, TACK frame or STACK frame to be sent in response, then the TWT responding STA shall respond with a frame that includes a Next TWT Info/Suspend Duration field either if it is required to do so according to 10.47.2 (TWT acknowledgment procedure), or if it has not already transmitted a nonzero Next TWT Info/Suspend Duration field to the STA within this TWT SP. If the TWT responding STA has already transmitted a nonzero Next TWT Info/Suspend Duration field to the STA within this TWT SP, and is not otherwise required to respond with a BAT frame, TACK frame or STACK frame, the TWT responding STA may respond to the STA with a frame that contains a Next TWT Info/Suspend Duration field. When present in the response frame, the Next TWT Info/Suspend Duration field may contain the value of the TSF timer corresponding to the next scheduled TWT SP for the STA that is the intended recipient of the frame or may contain the value 0 to indicate that the Next TWT is not currently available for this TWT.

A TWT requesting STA awake for an explicit TWT SP shall not transmit a PS-Poll frame with the Poll Type subfield equal to any value other than 2.

A TWT requesting STA that is awake for an explicit TWT SP shall not enter doze state until it has received a nonzero Next TWT Info/Suspend Duration field from the TWT responding STA and has either been in the awake state for at least Nominal Minimum TWT Wake Duration time from the TWT SP start time as identified by the TWT responding STA or has received an EOSP field equal to 1 from the TWT responding STA. If more than one nonzero Next TWT Info/Suspend Duration field is received from the TWT responding STA during a TWT SP, the receiving STA shall discard all but the most recently received value. If no nonzero Next TWT Info/Suspend Duration field is received from the TWT responding STA during the TWT SP, then following the end of the TWT SP when not otherwise prohibited from transmitting, the TWT requesting STA may transmit a frame that is addressed to the TWT responding STA as a means to solicit a response frame that contains a Next TWT value. Examples of frames that will solicit a Next TWT Info/Suspend Duration field include

* A TWT Information frame with the TWT Flow Identifier subfield equal to the TWT Flow Identifier corresponding to the TWT agreement for which a Next TWT value is requested and with the Next TWT Size subfield equal to 0, soliciting a STACK frame response.
* An A-MPDU containing a TWT Information frame with the TWT Flow Identifier subfield equal to the TWT Flow Identifier corresponding to the TWT agreement for which a Next TWT value is requested and with the Next TWT Size subfield set to 0, soliciting a BAT frame response.
* An S-MPDU containing a TWT Information frame with the TWT Flow Identifier subfield equal to the TWT Flow Identifier corresponding to the TWT agreement for which a Next TWT value is requested and with the Next TWT Size subfield equal to 0, soliciting a TACK frame response.

A TWT requesting STA that transmits a PPDU containing a TWT Information frame receives a response frame that can include a Next TWT field, as indicated above, and therefore, is not required to set the value of the Next TWT Request subfield to 1 to solicit the response of a TWT Information frame that includes a Next TWT field.

During an explicit TWT SP, a TWT responding STA that has transmitted a frame containing a Next TWT subfield equal to 0 shall queue for transmission at least one frame to the same recipient containing the nonzero Next TWT corresponding to the TWT Flow Identifier indicated in the frame with the Next TWT subfield equal to 0.

If a TWT requesting STA has transmitted a frame soliciting a response that contains a Next TWT value and the STA is in a Power Save mode, the STA shall remain in the awake state following the transmission until it receives a response from the TWT responding STA that contains a nonzero Next TWT value. The TWT responding STA shall assume that the TWT requesting STA is in the doze state if the TWT requesting STA is in a Power Save mode, the TWT SP has ended and the TWT responding STA has not received a frame from the TWT requesting STA that solicits a response that contains a nonzero Next TWT value. If a TWT responding STA receives a TWT Information frame from a TWT requesting STA with the Next TWT Request subfield equal to 1, then the TWT responding STA shall queue for transmission a TWT Information frame that contains a nonzero Next TWT value corresponding to the TWT Flow Identifier of the received TWT Information frame and shall assume that the TWT requesting STA is in the awake state until the TWT responding STA has transmitted the frame containing the nonzero Next TWT value.

A TWT responding STA may include a nonzero Next TWT value in any TACK frame or STACK frame or BAT frame that is transmitted as a response to a TWT requesting STA.

The TWT responding STA shall include the initial TWT SP start time for an explicit TWT agreement in the Target Wake Time field of the TWT element, which contains a value of Accept TWT in the TWT Setup Command field, a value of 0 in the Implicit bit and the TWT Flow Identifier value corresponding to that TWT agreement in the TWT Flow Identifier subfield.

* Implicit TWT operation

The TWT values for an implicit TWT are periodic. A TWT requesting STA operating with an implicit TWT agreement shall determine the next TWT SP start time by adding the value of TWT Wake Interval associated with this TWT agreement to the value of the start time of the current TWT SP. A TWT requesting STA operating with an implicit TWT agreement with a TWT flow identifier that matches the TWT flow identifier of a received TWT Information frame from its TWT responding STA shall replace its next TWT SP start time value with the value from the Next TWT subfield of the TWT Information frame.

The TWT responding STA shall include the start time for a series of TWT SPs corresponding to a single TWT Flow Identifier of an Implicit TWT agreement in the Target Wake Time field of the TWT element which contains a value of Accept TWT in the TWT Setup Command field and the TWT Flow Identifier value corresponding to that TWT agreement in the TWT Flow Identifier subfield. The start time of the TWT SP series indicates the beginning time of the first TWT SP in the series. Subsequent TWT SPs start times are determined by adding the value of TWT Wake Interval to the current TWT SP start time.

A TWT requesting STA awake for an implicit TWT SP may transition to the doze state after AdjustedMinimumTWTWakeDuration time has elapsed from the TWT SP start time as identified by the TWT requesting STA or after receiving an EOSP field equal to 1 from the TWT responding STA, whichever occurs first.

A TWT responding STA that receives a frame from a TWT requesting STA with which it has established an implicit TWT agreement may respond to the STA with a frame that contains a Next TWT Info/Suspend Duration field (e.g., BAT frame, TACK frame, STACK frame). A TWT requesting STA that is awake for an implicit TWT SP and receives a frame with a Next TWT Info/Suspend Duration field from its TWT responding STA shall use the received Next TWT Info/Suspend Duration field value as the start of the next TWT, instead of the TWT value calculated by adding the value of TWT Wake Interval associated with the TWT SP to the current TWT. Subsequent TWT start times associated with the same TWT agreement are calculated based on the next TWT that was sent by the TWT responding STA.

* TWT grouping

An AP may include an S1G STA as a member of a TWT group if the STA indicated TWT requester support and indicated support for TWT grouping in the S1G Capabilities Information field in the S1G Capabilities element in its (Re)Association Request frame and may signal TWT times to that STA using the TWT Group Assignment field of the TWT element.

An AP shall not include a non-S1G STA within a TWT group.

When dot11TWTGroupingSupport is true, the AP may assign a TWT group ID to a TWT requesting STA when the TWT Grouping Support subfield is equal to 1 within the S1G Capabilities element received from that STA. The AP indicates the TWT value to the TWT requesting STA that supports TWT grouping by transmitting to the STA an individually addressed frame containing a TWT element, which includes

* The value of the assigned group ID in the TWT Group ID subfield.
* The lower 48 bits of a TSF value in the Zero Offset of Group subfield to indicate the TWT value corresponding to the first member of the TWT group that is identified by the TWT group ID.
* A TWT unit value in the TWT Unit (Ed)subfield (9.4.2.199 (TWT element(11ah))).
* A positive offset value indicated in the TWT Offset (Ed)subfield (9.4.2.199 (TWT element(11ah))). The allowed values in the TWT Unit subfield are given in Table 9-298 (TWT Unit subfield encoding(11ah)).

The intended recipient of the frame containing the TWT element calculates its TWT from the TWT Group Assignment field by multiplying the TWT Unit interpretation value with the value indicated in the TWT Offset subfield and adding the result to the value in the Zero Offset of Group field corresponding to the TWT Group ID subfield in the TWT Group Assignment field of the TWT element.

* NDP Paging Setup

This subclause defines a protocol for power saving at a STA by using the TWT protocol to set up scheduled wakeup intervals and by defining efficient signaling for the presence of BUs and synchronization.

A frame including a TWT element with the NDP Paging field present is referred to as NDP Paging Request or NDP Paging Response as clarified later. A STA sending an NDP Paging Request is referred to as NDP Paging requester. A STA sending an NDP Paging Response in a response to an NDP Paging Request is referred to as NDP Paging responder.

A STA requests an NDP Paging TWT by sending an NDP Paging Request. A non-S1G STA shall not transmit NDP Paging frames.

The setup procedure follows the protocol described in 10.47.1 (TWT overview), unless otherwise described in this subclause.

A non-AP STA sending an NDP Paging Request shall set the P-ID field of the NDP Paging Request to one of the partial AIDs assigned to it by the intended receiver of the NDP Paging Request (see 10.21 (Group ID, partial AID, Uplink Indication, and COLOR in S1G PPDUs(11ah))).

An AP sending an NDP Paging Request to a non-AP STA should set the P-ID field of the NDP Paging Request to the partial BSSID.

Upon receiving an NDP Paging Request, the recipient STA shall respond with an NDP Paging Response with the NDP Paging fields set as follows:

* The P-ID subfield should be set to the same value as the P-ID subfield of the NDP Paging Request.
* The Max NDP Paging Period subfield shall be set to any value that is less than or equal to the Max NDP Paging Period subfield of the NDP Paging Request.
* The Action subfield shall be set to one of the values in Table 9-299 (Action field(11ah)).
* The Partial TSF Offset subfield and Min Sleep Duration subfield are reserved.

The NDP Paging setup is successful if the TWT Setup Command subfield of the Request Type field in the NDP Paging Response is equal to 4 (Accept TWT), otherwise the setup is considered as failed.

A STA that has sent an NDP Paging Response with the TWT Setup Command field equal to 4 (Accept TWT) shall schedule an NDP Paging frame as the first frame for transmission at the TWTs indicated by the NDP Paging Response, if any of the following conditions is satisfied:

* There are BUs for the requesting STA.
* No NDP Paging frame was sent in the *N* consecutive preceding TWT(s), where *N* is equal to the value of the Max NDP Paging Period subfield in the NDP Paging Response.

The AP shall schedule an NDP Paging frame if there are critical updates to the S1G Beacon frame as defined in 10.46.2 (System information update procedure) and 11.2.3.15 (TIM Broadcast)(M18). An AP may additionally send an NDP Paging frame at any of the TWTs indicated by the NDP Paging Response.

If the NDP Paging frame is sent by the AP to the NDP Paging requester then this frame shall precede any frame that is sent by the AP to it during its indicated TWT SP and shall have the Direction field equal to 1.

If any frame is sent by a non-AP STA to an NDP Paging requester during its indicated TWT SP then the first frame sent shall be an NDP Paging frame with the Direction field equal to 0.

The P-ID field of the NDP Paging frame shall be set to the same value as P-ID field in the NDP Paging Response if and only if there are BUs for the STA identified by the partial AID indicated in the P-ID field of the NDP Paging Request. The P-ID field shall be set to 0 to indicate the presence of group addressed BUs.

NOTE—When a group AID is assigned to the corresponding group MAC address as described in 10.55 (Group AID(11ah)), then the P-ID field can be set to the partial AID that corresponds to the group AID as defined in 10.21 (Group ID, partial AID, Uplink Indication, and COLOR in S1G PPDUs(11ah)).

If the Direction field of the NDP Paging frame is equal to 1, the subfields of the APDI field of the NDP Paging frame shall be set as follows:

* The PTSF subfield is set to TSF[Partial TSF Offset+4: Partial TSF Offset+11] (inclusive), where TSF is the 8-octet(M101) value of the TSF timer and Partial TSF Offset is the value of the Partial TSF Offset field in the NDP Paging Request.
* The Check Beacon Flag subfield shall be set to the LSB of the Change Sequence field in the most recently transmitted S1G Beacon frame or of the Check Beacon field in the most recently transmitted TIM frame(M121), if any was sent before the NDP Paging frame.

If the Direction field of the NDP Paging frame is equal to 0, the Partial AID field of NDP Paging frame indicates the partial AID of the STA transmitting the NDP Paging frame.

If no NDP Paging frame is received during the TWT, the TWT requester STA may transition to doze state(#2422) at the end of the Nominal Minimum TWT Wake Duration for the TWT. If an NDP Paging frame is received, the TWT requester STA may transition to doze state(#2422) immediately after receiving the NDP Paging frame, unless Min Sleep Duration field was equal to 0 and Action subfield equal to 1 in the NDP Paging Response frame that successfully completed the NDP Paging setup, in which case the STA shall be in active mode.

Upon reception of an NDP Paging frame with the P-ID field matching the value of the P-ID field in the NDP Paging Response, the NDP Paging requester STA shall behave as follows:

* If the Action subfield of the NDP Paging Response is 0:
* If the NDP Paging requester STA is a non-AP STA, it shall send a (NDP) PS-Poll frame or uplink trigger frame addressed to the NDP Paging responder, after either SIFS or using EDCA within Nominal Minimum TWT Wake Duration.
* If the NDP Paging requester STA is an AP, it shall send an NDP CTS frame to self with the duration field equal to 0(M101) after either SIFS or using EDCA within Nominal Minimum TWT Wake Duration.
* If the Action subfield of the NDP Paging Response is 1, the STA shall be in the awake state(#2422) starting at a time indicated by the Min Sleep Duration field after the end of reception of the NDP Paging frame, and it shall remain in the awake state(#2422) until a frame is received from the NDP Paging responder with the EOSP subfield equal to 1.
* If the Action subfield of the NDP Paging Response is 2, the STA shall be in the awake state(#2422) at the first TBTT that occurs after a time indicated by the Min Sleep Duration field in the NDP Paging Response after the end of reception of the NDP Paging frame to receive the S1G Beacon frame.
* If the Action subfield of the NDP Paging Response is 3, the STA shall be in the awake state(#2422) at the first DTIM that happens after a time indicated by the Min Sleep Duration field in the NDP Paging Response after the end of reception of the NDP Paging frame to receive the DTIM Beacon frame.
* If the Action subfield of the NDP Paging Response is 4, the STA shall be in the awake state(#2422) starting at a time T after the end of reception of the NDP Paging frame and it shall remain in the awake state(#2422) until a frame is received from the NDP Paging responder with the EOSP subfield equal to 1. The value of T is in units of SIFS and is equal to the value of the Min Sleep Duration field of the NDP Paging Request plus the value of the ASD subfield in the APDI field of the NDP Paging frame.

If the NDP Paging requester is an AP, values 2-7 (inclusive) of the Action subfield are reserved.

A non-AP STA that has set up NDP Paging and receives an NDP Paging frame with Direction field equal to 1 and the Check Beacon Flag subfield value different from the LSB of the most recently received Change Sequence value shall either be awake to receive the next S1G Beacon frame that is transmitted at a TBTT or TSBTT or shall queue for transmission a Probe Request frame to obtain the updated system information as described in 10.46.2 (System information update procedure).

* TWT Sleep Setup

A Responder PM Mode bit in the Control field of the TWT response equal to 1 indicates that the Responder STA may be in doze state(#2422) outside the indicated TWT SP.

* TWT Teardown

Either STA that is a party to an established TWT agreement may delete the TWT agreement by successfully transmitting a TWT Teardown frame. The TWT Flow Identifier field of the TWT Teardown frame shall be set to the value of the TWT Flow Identifier field of the TWT element of the frame that successfully concluded the setup of the TWT agreement that is the subject of the teardown request.

When a TWT Teardown frame is successfully transmitted or received, the TWT agreement corresponding to the TWT Flow Identifier field, TWT requesting STA MAC address and TWT responding STA MAC address of the TWT Teardown frame shall be deleted.