IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| Restricted TWT Spec Text  Restricted TWT Announcement | | | | |
| Date: 2021-07-19 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Chunyu Hu | Meta Platform Inc. | 1 Hacker Way, Menlo Park, CA 95034 |  | chunyuhu07@gmail.com |
| Muhammad Kumail Haider |  |  |  |
| Chitto Ghosh |  |  |  |
| Morteza Mehrnoush |  |  |  |
| Payam Torab |  |  |  |
| Binita Gupta |  |  |  |
| Liuming Lu | Oppo |  |  |  |
| Brian Hart | Cisco |  |  |  |
| Saju Palayur | MaxLinear |  |  |  |
| Dave Cavalcanti | Intel |  |  |  |
| Laurent Cariou | Intel |  |  |  |

Abstract

This submission proposes resolutions for the following CIDs for TGbe CC36:

4156, 4433, 4783, 5938, 6412, 6414, 6746, 7858

Revisions:

* Rev 0: Initial version of the document
* Rev 1: Remove three CIDs (6415, 7429, 5273) to be addressed later, added discussion, fixed “agreement” (use membership or schedule), addressed some feedback.
* Rev 2: address various comments raised by Brian and Gaurav.
* Rev 3: change the element name to “Restricted TWT SPs”; revise the format of the bitmap; and revises text accordingly.
* Rev 4: address some editorial comments; and change interval to 256 usecs (same as time slice duration unit.)

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

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

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

***TGbe editor: The baseline for this document is 11be D1.2.***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Pg/Ln** | **Comment** | **Proposed Change** | **Resolution** |
| 4156 | Alfred Asterjadhi | 35.6.3 | 298.32 | The correct term is membership rather than agreement. Replace please, and specify what is actually modified in the B-TWT IE in this subclause rather than saying that it is a modified B-TWT IE. Also is the AP required to have a membership already setup before starting to announce these schedules? Can't the AP start advertising and the STAs join them? | As in comment. | **Agreed and revised.**  The original text has been replaced by the new text in which “membership” or “schedule” is used instead of “agreement.”  AP can advertise the r-TWT schedule even without any membership setup as described by the 35.7.2 (Restricted TWT setup), but will use a new IE to announce the SPs that have any membership setup as the new text proposed in this draft.  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 4433 | Arik Klein | 35.6.3 | 298.34 | the sentence refers to "the modified broadcast TWT element " - please clarify what is the format of this element? It is not specified in section 9.4.2.X... | As in comment | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 4783 | Chunyu Hu | 35.6.3 | 298.30 | The TBDs in this subclause per D0.4 was fixed with some brief description as temporary solution in order to move onto D1.0. There is a draft text pending to fix TBDs to solve a few problems: advertise the rTWT schedule only if there are agreement setup, share with the rTWT supporting STAs a consolidated view of rTWT SP schedule so they don't need to parse each rTWT schedule contained in each rTWT parameter set. | Will bring in contribution to solve the original TBDs in D0.4 | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 5938 | Li-Hsiang Sun | 35.6.3 | 298.34 | No definition of the "modified broadcast TWT element" | add definition | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 6412 | M. Kumail Haider | 35.6.3 | 298.30 | A PDT and motion(#2920) was passed to make changes to TWT element to accommodate restricted TWT schedule announcements and negotiations. Part of proposed changes is to introduce an r-TWT traffic info field to indicate latency sensitive TIDs. However, it is not specified whether such a field may be included in TWT announcements in broadcast frames | Traffic TID specification is part of r-TWT schedule negotiation between AP and STA and it should be allowed for the same r-SP to carry traffic for different TIDs for different member STAs, depending on their own negotiations. As such, traffic Info field should not be included in schedule announcements and the text should specify that TWT schedule announcements in broadcast frames shall not carry traffic info field. | **Revised.**  Agree with commenter. In the proposed announcement IE design, no traffic info (TID specifically as commenter requested) is included.  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 6414 | M. Kumail Haider | 35.6.3 | 298.30 | The text specifies that modified version of broadcast TWT element shall be used for restricted TWT schedule announcements in Management frames as specified in 26.8.3 (Broadcast TWT operation). A PDT and motion(#2920) was also passed to make changes to TWT element to accommodate restricted TWT announcements. However, broadcast TWT element does not convey occupancy information of SPs. For example, AP may announce r-SP schedule to invite membership but no STAs have established membership in such a schedule. In that case, EHT STAs supporting r-TWT operation should not have to end their TXOPs prior to such unoccupied SPs. Moreover, r-SP announcement via b-TWT element does not present a consolidated timeline view of future occurrence of r-SPs and r-SP start boundaries to be used by EHT STAs supporting r-TWT operation to end their TXOPs. | Additional signaling should be introduced to indicate r-SP occupancy information and present a consolidated channel-time view of r-SP occurrence and start boundaries | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 6746 | Rojan Chitrakar | 35.6.3 | 298.33 | It is not clear what is the "modified broadcast TWT element" referred in this sentence is; 26.8.3 does not specify "modified broadcast TWT element". | Provide a proper reference for "modified broadcast TWT element" | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |
| 7858 | Yonggang Fang | 35.6.3 | 298.34 | Suggest to delete "modified" broadcast TWT ... | See the comment | **Revised.**  **TGbe editor, please make change as shown in this doc 11-21/1147 tagged by 4156.** |

**Discussion:**

* As per Broadcast TWT operation defined in baseline, broadcast TWT element is advertised in the following broadcast frames and carries broadcast and/or restricted TWT parameter set field(s) with Negotiation Type 2:
  1. Beacon frames
  2. Broadcast Probe Response frames
  3. FILS Discovery frames

It doesn’t seem necessary to repeat this text/rule in this section.

Based on several comments in CC36, this document presents a new Restricted TWT SPs element to present a consolidated view of restricted SPs in time domain and convey additional information about SPs such as whether there is membership established by any non-AP STAs, which is not carried in bTWT element.

Doing so is also necessary: a r-TWT supporting STA but not a member will only need to monitor the new Restricted TWT SPs element to learn the start time of each SP that belongs to a restricted TWT schedule with at least one non-AP STA with membership established, and follows the corresponding channel rules.

The r-TWT STAs also benefit from this new IE by learning more information of a restricted TWT SP/schedule: whether it’s already full, e.g., and avoid extra overhead of requesting membership of a schedule that is likely been rejected by AP.

# 9. Frame formats

## 9.3.3 Management frames

***TGbe editor: insert a new row to Table 9-32 (Beacon frame body)***

**Table 9-32—Beacon frame body (#4156)**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned + 1> | Restricted TWT SPs | (#4156)The Restricted TWT SPs element is optional present if dot11RestrictedTWTOptionImplemented is true. |

***TGbe editor: insert a new row to Table 9-39 (Probe Response frame body)***

**Table 9-39—Probe Response frame body (#4156)**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| <Last assigned + 1> | Restricted TWT SPs | (#4156)The Restricted TWT SPs element is optional present if dot11RestrictedTWTOptionImplemented is true. |

## 9.4.2 Elements

TGbe editor: insert the following subclause as follows. Note: the subclause number 295d can be changed to applicable number in subclause (9.4.2 Element) and the figure numbers can be changed accordingly as well.

### 9.4.2.295d Restricted TWT SPs element (4156, 4433, 4783, 5938, 6412, 6414, 6746, 7858)

The Restricted TWT SPs element describes a consolidated view of the restricted TWT SPs schedule information. The format of the restricted TWT SPs element is shown in Figure 9-xxx-a (Restricted TWT SPs element format).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |  |
|  | Element ID | Length | Element ID Extension | SP Bitmap Control | Start Time | Interval | Persistence | SP Start Bitmap | SP Info Bitmap  (optional) |
| Octets: | 1 | 1 | 1 | 3 | 8 | 2 | 1 | Variable | variable |
| Figure 9-xxx-a −− Restricted TWT SPs element format | | | | | | | | | |

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

The format of the SP Bitmap Control field is shown in Figure 9-xxx-b (SP Bitmap Control field format).

|  |  |  |  |
| --- | --- | --- | --- |
| B0 B9 | B10 B17 | B18 | B19 B23 |
| Time Slice Count | Time Slice Duration | SP Info Bitmap Present | Reserved |
| 10 | 8 | 1 | 5 |

**Figure 9-xxx-b – SP Bitmap Control field format**

The Time Slice Count subfield specifies the number of time slices contained by the time duration that the SP Start Bitmap field describes. The term *time slice* used in this subclause refers to a period of time whose duration is specified by the Time Slice Duration subfield described next.

The Time Slice Duration subfield specifies the time duration of each time slice. The time duration is calculated by (1+ x) × 256 microseconds, where x is the value contained in the subfield.

The SP Info Bitmap Present subfield indicates if the SP Info Bitmap field is present. When this subfield is set to 1, the SP Info Bitmap field is present; and set to 0 otherwise.

The Start Time field specifies the TSF at the start time of the first time slice.

The Interval field is set to the value of the periodicity of the schedule in unit of 256 microseconds.

The Persistence field specifies the number of intervals during which the restricted TWT SPs corresponding to this restricted SP announcement are present. The number of intervals during which the restricted TWT SPs are present is equal to the value in the Persistence field plus 1 except that the value 255 indicates that the restricted TWT SPs are present until explicitly terminated. The interval value is equal to (Interval x Time Slice Duration x 256) microseconds.

The SP Start Bitmap field contains a bitmap with a bit in position *i* set to 1 to indicate the corresponding time slice is the first time slice in a restricted TWT SP belonging to an active restricted TWT schedule, and set to 0 otherwise. The length of this field in octets is calculated as Ceil (N/8), where N is the value in the Time Slice Count subfield described in Figure 9-xxx-b (SP Bitmap Control field format). The first N bits in this field correspond to time slices described by the Restricted TWT SPs element, and the remaining bits, if any, are padding bits and set to 0. Bit 0 of the first octet of the SP Start Bitmap field represents the first time slice.

The SP Info Bitmap field contains *N* number of SP Slice Information subfields as described in Figure 9-xxx-c (SP Slice Information subfield), where *N* is the value in the Time Slice Count field. Bit *k,* …, *k+3* in the SP Slice Information subfield describe the information for time slice *k/4*. The length in octets of the SP Info Bitmap field is calculated as Ceil (*N/2*). The first *4*×*N* bits in this field correspond to time slices described by the Restricted TWT SPs element, and the remaining bits, if any, are padding bits and are set to 0. Bits 0-3 of the first octet of the SP Info Bitmap describes the first time slice’s information.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Bk | Bk+1 | Bk+2 | Bk+3 |
|  | Active | OBSS | Full | Reserved |
| Bits: | 1 | 1 | 1 | 1 |
| Figure 9-xxx-c. SP Slice Information subfield format | | | | |

The Active subfield is set to 1 to indicate that the corresponding time slice is occupied by a restricted TWT SP belonging to an active restricted TWT schedule; and set to 0 otherwise.

The OBSS subfield is set to 1 to indicate the corresponding restricted TWT SP is setup by EHT STAs in a neighboring BSS; and set to 0 otherwise.

The Full subfield is set to 1 if the r-TWT scheduling AP is unlikely to accept a request to setup a new or revised restricted TWT schedule with any SP that is new or has increased duration, and overlaps with this time slice; otherwise, it is set to 0.

# 35. Extremely High Throughput (EHT) MAC specification

# 35.7 Restricted TWT

***TGbe editor: replace the following part shown in grey-highlighted text in Subclause 35.7.3 (Restricted TWT Service Periods announcement) with the text marked as NEW TEXT:***

## ~~35.7.3 Restricted TWT service periods announcement~~

~~If there is any restricted TWT agreement set up, the EHT AP shall announce the restricted TWT service period schedule information in the modified broadcast TWT element contained in transmitted Management frames, which are specified in 26.8.3 (Broadcast TWT operation).~~

***TGbe editor: NEW TEXT as follows:***

## 35.7.3 Announcements (4156, 4433, 4783, 5938, 6412, 6414, 6746, 7858)

There are two types of announcements that a r-TWT scheduling AP advertise for restricted TWT: broadcast TWT announcements that carry one or more Restricted TWT Parameter Set fields, as defined in 9.4.2.199 (TWT element), and active restricted TWT SP announcements that’ll be described in this subclause.

The r-TWT scheduling AP follows the rules described in 26.8.3 (Broadcast TWT operation) to include broadcast TWT set parameter set fields in any broadcast TWT element in its transmitted frames in general except the following case. When there is at least one active1 restricted TWT schedule, the r-TWT scheduling may2 include the corresponding Restricted TWT Parameter Set field(s) in the TWT element contained in its transmitted Beacon frames.

NOTE-1: an active broadcast TWT schedule refers to a broadcast TWT schedule that has at least one TWT scheduled STA establish the membership with the TWT scheduling AP.

NOTE-2: in the case that an active broadcast TWT schedule is not a restricted TWT schedule, a TWT scheduling AP shall include the corresponding Broadcast TWT Parameter Set(s) carried in a broadcast TWT element in its transmitted Beacon frames.

Active restricted TWT SP announcements are advertised by a r-TWT scheduling AP by including a Restricted TWT SPs element in broadcast management frames.

The Restricted TWT SPs element provides a consolidated view in time domain of the SPs that have at least one restricted TWT membership setup and that is not currently suspended. If there is any restricted TWT membership setup and not currently suspended, the r-TWT scheduling AP shall advertise the restricted TWT SP start time and optionally, other associated information by including a Restricted TWT SPs element in the following transmitted frames:

* Beacon frames
* Broadcast Probe Response frames
* FILS Discovery frames
* Individual Probe Response frames addressed to a non-AP EHT STA supporting the restricted TWT feature

The r-TWT scheduling AP may also include a Restricted TWT SPs element in frames that carry TWT elements with the Negotiation Type set to 3 and the TWT Setup Command subfield set to Accept TWT, Alternate TWT, or Reject TWT.

The r-TWT scheduling AP sets the value in each field of the Restricted TWT SPs element as described below.

The restricted TWT SPs schedule advertised by the Restricted TWT SPs element starts from a time offset specified by the Start Time field; and lasts for a duration specified by the fields: Interval, Persistence, and the Time Slice Count and the Time Slice Duration subfields in the SP Bitmap Control field as described in 9.4.2.295d (Restricted TWT SPs element).

The r-TWT scheduling AP may set a value of 0 in the Time Slice Count subfield in the SP Bitmap Control field of the Restricted TWT SPs element to announce the termination of all previously scheduled restricted TWT SPs. When the value is 0 in the Time Slice Count subfield, the r-TWT scheduling AP shall set a value of 0 in the SP Info Bitmap Present subfield and the SP Start Bitmap is zero-byte length. The r-TWT scheduling AP may use this value to indicate that all existing retricted TWT memberships setup with non-AP STAs have been suspended at the time of this announcement, and the suspension lasts for the time duration covered by this advertisement, where the value of 255 in the Persistence field indicates that all the memberships are terminated instead of suspension.

For each SP in the active restricted TWT schedule, the r-TWT scheduling AP shall set a value of 1 in the corresponding bit in the SP Start Bitmap field for the first time slice belonging to the SP; and otherwise, set the value to 0.

The r-TWT scheduling AP may optionally include the SP Info Bitmap field to provide additional information for the restricted SPs covered by the advertised duration, and sets the value in the SP Info Bitmap Present subfield to 1 if including the field. When the SP Info Bitmap field is included, for each SP in the active restricted TWT schedule,

⎯ the r-TWT scheduling AP shall set a value of 1 in the Active subfield in the corresponding SP Slice Information subfield for the time slices belonging to the SP and otherwise, set the value to 0.

⎯ the r-TWT scheduling AP may set a value of 1 in the OBSS subfield in the corresponding SP Slice Information subfield for the time slice in a restricted TWT SP based on the restricted TWT SP information carried in the Beacon frames the rTWT scheduling AP received from other neighboring APs operating on any overlapping channels.

An example of the Restricted TWT SPs element setting is shown in Figure 35-23 (Example of restricted TWT SPs element).

![Table

Description automatically generated]()

**Figure 35-23 – Example of Restricted TWT SPs element**

In this example, the r-TWT scheduling AP included a Restricted TWT SPs element in a Beacon frame transmitted at time T0. Included in the element, the Start Time field contains the TSF time of T1. In the SP Bitmap Control field, the value 16 in the Time Slice Duration subfield specifies that each time slice has duration of 4 TUs, the value of 16 in the Time Slice Count subfield indicates there are in total 16 time slices reported, covering a total duration of 64 TUs. The figure shows four different restricted TWT SPs: SP1-4, from the start time T1 belonging to four different restricted TWT schedules. Three of them are active with various STAs as members, while the fourth SP corresponds to a suspended schedule. SP1, SP2 and SP3 have duration of 8, 12 and 20 TUs, respectively, and they are sperated by 4 and 0 TUs, respectively. The resulted SP Start Bitmap field has value 0x0049. SP4 is suspended and hence the corresponding bits in the SP Start Bitmap and the SP Info Bitmaps have value 0’s.

The element includes an SP Info Bitmap field in this example indicated by the value 1 in the SP Info Bitmap Present subfield. Bits 0-3 in the SP Info bitmap field correspond to SP1’s first time slice: it has the Active subfield set to 1 and remaining bits set to 0’s. Specifically, the Full subfield has value 0, indicating that the r-TWT scheduling AP may accept request from more STAs to join the membership of this schedule. The values in bits 0-3 repeated a second time to cover the remaining time duration in SP1. Similarly, bits 0-3 for each time slice in SP2 have value set to 1 in the Active subfield, and value set to 0 in the rest subfields. For SP3, the r-TWT scheduling AP sets the Full subfield in the bits corresponding to each time slice to 1’s, indicating that it will likely not accept any new members to this schedule due to resource constraint.

A non-AP EHT STA with dot11RestrictedTWTOptionImplemented set to true obtains the latest restricted TWT SPs information from the Beacon frame it received most recently. A r-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 Restricted TWT SPs element, 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 Restricted TWT SPs element, where *n* is equal to 1 plus the floor of (the value obtained from the Persistence field therein x the interval value calculated from the parameters obtained from the element, divided by Beacon Interval converted to microseconds), except that *n* is infinite if the Persistence field is 255.