IEEE P802.11
Wireless LANs

|  |
| --- |
| Detailed Text Proposal on CR-TWT |
| Date: 2024-12-03 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Giovanni Chisci | Qualcomm Technilogies Inc. |  |  | gchisci@qti.qualcomm.com |
|  |  |  |  |  |
|  |  |  |  |  |

Abstract

This document presents detailed text proposals on CR-TWT. The intent of this document is to provide a view on the potential evolution of the CR-TWT PDT [2] and can be taken into consideration for the further work of the CR-TWT TTT members to prepare the official spec. text proposal.

# Revision information

The following is a summary of the important changes that occurred within each revision of this document:

|  |  |
| --- | --- |
| **Revision** | **Major changes** |
| 0 | Initial revision |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Introduction

This document presents detailed text proposals on CR-TWT. The intent of this document is to provide a view on the potential evolution of the CR-TWT PDT [2] and can be taken into consideration for the further work of the CR-TWT TTT members to prepare the official spec. text proposal.

***Editing notes formatted like this are intended to provide disclaimers on how the proposed text would be integrated with baseline documents.***

## Explanation of the proposed specification text considerations:

The proposed changes to the 802.11 TGbn draft within this document are based on the following motions adopted by the TGbn task group and on the referenced submissions [3]-[8].

### Relevant passing motions:

[Motion #48, [1]]

* Define mechanisms that enable APs to coordinate their rTWT schedule(s) and/or to ensure that one AP provides the protection of the rTWT schedule(s) of the other AP.
* NOTE – TBD mechanisms including negotiation between 2 APs and advertisement.

[Motion #50, [1]]

* 11bn defines a common framework of a M-AP Coordination for various coordination schemes.
	+ Note - Coordination schemes such as (but not limited to): Co-SR (TXOP-based with power control), Co-BF, Co-TDMA , C-RTWT, etc.

[Motion #51, [1]]

* 11bn defines a common framework of a M-AP Coordination that can enable the following procedures:
	+ M-AP Coordination Discovery procedure
	+ M-AP Coordination agreement negotiation procedure
* Note: Details of the procedures and whether the above procedures are mandatory/optional - TBD

[Motion #147, [1]]

* APs that intend to participate in M-AP coordination can use management frames to advertise/discover the capabilities and/or parameters of individual schemes.

[Motion #148, [1]]

* APs that discovered each other and want to establish agreement(s) for M-AP coordination scheme(s), can use individually addressed management frames to establish the agreement(s) and negotiate parameters
	+ Note: The management frame can be a Public Action and/or new Action frames, and so on.

[Motion #149, [1]]

* If an AP extends the protection of the rTWT schedule of another AP, following negotiation or through other means, then:
	+ The AP shall ensure its TXOP ends before the start time of the corresponding OBSS rTWT SP(s)
	+ The AP, if it has at least one associated STA that is capable of rTWT, shall advertise in the beacon frames it transmits the OBSS rTWT schedule so that its associated STAs supporting rTWT follow the baseline rTWT rules for the OBSS rTWT schedule.

# Detailed text proposal begins here:

***The following are additions to subclause 3.2 Definitions specific to IEEE Std 802.11:***

3.2 Definitions speficic to IEEE Std 802.11

coordinated restricted target wake time: [CR-TWT] a procedure that enables APs in the same neighborhood that belong to different BSSs to coordinate their R-TWT schedule(s) and extend the protection for the R-TWT schedule(s) of other AP(s).

coordinated restricted target wake time requesting access point (AP): [CR-TWT requesting AP] an AP that requests protection for one or more of its R-TWT schedule(s).

coordinated restricted target wake time coordinated access point (AP): [CR-TWT coordinated AP] an AP that extends the protection for the requested R-TWT schedule(s) of a CR-TWT requesting AP.

coordinated restricted target wake time responding access point (AP): [CR-TWT responding AP] an AP that responds to a CR-TWT requesting AP that initiates negotiations.

***The following are additions to subclause 9 Frame Formats:***

9 Frame Formats

9.4 Management and Extension frame body components

9.4.2 Elements

9.4.2.1 General

**Table 9-128—Element IDs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| … |  |  |  |  |
| M-AP Coordination (see [9.4.2.x (Multi-access point (M-AP) Coordination element)](#_bookmark180)) | TBD | TBD | Yes | No |

9.4.2.198 TWT element

***Change Table 9-349a – Restricted TWT Schedule Info subfield values as follows:***

**Table 9-349a—Restricted TWT Schedule Info subfield values**

|  |  |
| --- | --- |
| **Restricted TWT Schedule Info subfield value** | **Description when included in a Restricted TWT Parameter Set field** |
| … | … |
| 3 | Indicates that the advertised R-TWT schedule is active and is for an AP corresponding to a nontransmitted BSSID that is a member of the same multiple BSSID set or co-hosted BSSID set as the AP transmitting the Restricted TWT Schedule Info subfield or for a CR-TWT requesting AP. |

***The following is the new subclause 9.4.2.x Multi-access point (M-AP) coordination element:***

9.4.2.x Multi-access point (M-AP) coordination element

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element ID | Length | Element ID Extension | M-AP Capability | M-AP Parameters |

Octets: 1 1 1 1 TBD

**Figure 9-A—M-AP Coordination element format**

The Element ID, Length, and Element ID Extension fields are defined in [9.4.2.1 (General)](#_bookmark127).

The format of the M-AP Capability field is defined in Figure 9-B (M-AP Capability field format).

***The reserved bits in Figure 9-B can be used to signal enablement of other M-AP coordination features:***

|  |  |  |
| --- | --- | --- |
|  | B0 | B1 B7 |
|  | CR-TWT Negotiations Enabled | Reserved |
| Bits: | 1 | 7 |

Figure 9-B—M-AP Capability field format

The CR-TWT Negotiations Enabled subfield is set to 1 if the UHR AP is willing to participate in CR-TWT negotiations by following the rules defined in 37.x.2 (CR-TWT negotiations) and is set to 0 otherwise.

The format of the M-AP Parameters field is defined in Figure 9-C (M-AP Parameters field format).

***The reserved bits in Figure 9-C can be used to for other M-AP coordination features parameters:***

|  |  |  |
| --- | --- | --- |
|  | B0 BX |  BY BZ |
|  | CR-TWT Parameters | Reserved |
| Bits: | TBD | TBD |

Figure 9-C—M-AP Parameters field format

**9.4.2.330 TWT Information Extension element**

***Change Figure 9-1074bk as follows:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Control | B-TWT Info | B-TWT Parameters Sets Info |
| Octets: | 1 | 1 | 1 | 1 | 0 or 1 |  0 or N |

Figure 9-1074bk—TWT Information Extension element format

***Change Figure 9-1074bl as follows:***

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 | B1 | B2 B7 |
|  | B-TWT Info Present | B-TWT Parameters Sets Info Present | Reserved |
| Bits: | 1 | 1 | 6 |

Figure 9-1074bl—Control field format

***Add the following text after the first paragraph after Figure 9-1074bl:***

The B-TWT Parameters Sets Info Present subfield indicates the presence of N octets of the B-TWT Parameters Sets Info field. A recipient of the element determines N according to the value of the Length field and the presence of other fields indicated in the Control field. The B-TWT Parameters Set Info Present subfield is set to 1 when at least B-TWT Parameters Set Info field is present, otherwise, the subfield is set to 0.

***Add the following text after the last paragraph of the subclause:***

The B-TWT Parameters Sets Info field carries one or more B-TWT Parameters sets, where for each set, the first K octes (K is TBD) of a Restricted TWT Parameters Set field are reported, according to Figure 9-791 (Broadcast TWT Parameters Set field format).

***The following is the new subclause 37.x Coordinated Restricted TWT (CR-TWT):***

37.x Coordinated Restricted TWT (CR-TWT)

37.x.1 General

Coordinated restricted target wake time (CR-TWT) operations described in subclause 37.x (Coordinated Restricted TWT (CR-TWT)) enable APs in the same neighborhood that belong to different BSSs to coordinate their R-TWT schedule(s) and/or extend the protection for the R-TWT schedule(s) of other AP(s).

A CR-TWT requesting AP is an AP with dot11CRTwtOptionImplemented equal to true that requests protection for one or more of its R-TWT schedule(s). A CR-TWT coordinated AP is an AP with dot11CRTwtOptionImplemented equal to true that extends the protection for the requested R-TWT schedule(s) of a CR-TWT requesting AP either by establishing agreement(s) through negotiations or by other means. The rules for a CR-TWT coordinated AP to extend the protection for the requested R-TWT schedule(s) of a CR-TWT requesting AP are defined in 37.x.3 (CR-TWT announcement rules) and 37.x.4 (Channel access rules for CR-TWT SPs). A CR-TWT responding AP is an AP with dot11CRTwtOptionImplemented equal to true that responds to a CR-TWT requesting AP that initiates CR-TWT negotiations to establish agreement(s) by following the rules defined in 37.x.2 (CR-TWT negotiations). After establishing agreement(s) for one or more R-TWT schedule(s) of the CR-TWT requesting AP through negotiations as defined in 37.x.2 (CR-TWT negotiations), a CR-TWT responding AP becomes a CR-TWT coordinated AP and shall extend the protection for the R-TWT schedule(s) according to the rules defined in 37.x.3 (CR-TWT announcement rules) and 37.x.4 (Channel access rules for CR-TWT SPs).

37.x.2 CR-TWT negotiations

If an AP with dot11CRTwtOptionImplemented equal to true is willing to participate in CR-TWT negotiations, then it shall use TBD Management frames to advertise its willingness to participate in CR-TWT negotiations and other TBD CR-TWT parameters. To advertise its willingness to participate in CR-TWT negotiations, the AP shall set the CR-TWT Negotiations Enabled subfield in the M-AP Coordination element (see 9.4.2.x (Multiaccess point (M-AP) Coordination element)) it transmits in a TBD Management frame to 1 and set it to 0 otherwise. To advertise other TBD CR-TWT parameters, the AP shall set the bits in the CR-TWT Parameters subfield in the M-AP Coordination element (see 9.4.2.x (Multiaccess point (M-AP) Coordination element)) it transmits in a TBD Management frame.

NOTE—An AP with dot11CRTwtOptionImplemented equal to true can participate in CR-TWT as a CR-TWT requesting AP or as a CR-TWT coordinated AP by means that do not involve negotiations.

A CR-TWT requesting AP may request another AP that sets the CR-TWT Negotiations Enabled subfield in the M-AP Coordination element in a transmitted TBD Management frame to 1 to extend the protection of one or more of its R-TWT schedule(s) via negotiations by including the R-TWT schedule(s) in a transmitted TBD individually addressed Management frame used to initiate the negotiation. How to include the R-TWT schedules for which the protection is requested in the TBD individually addressed Management frame is TBD.

A CR-TWT responding AP that sets the CR-TWT Negotiations Enabled subfield in the M-AP Coordination element in a transmitted TBD Management frame to 1 and receives a request from a CR-TWT requesting AP for establishing agreement(s) for one or more R-TWT schedule(s) in a TBD individually addressed Management frame shall respond with a TBD individually addressed Management frame by following the rules defined in this subclause.

The rules to establish agreement(s) are TBD.

Each R-TWT schedule is uniquely identified by the <B-TWT ID, MAC address> tuple, where the B-TWT ID is the value of the B-TWT ID subfield and is greater than 0 and the MAC address is the address of the CR-TWT requesting AP.

Negotiations to establish an agreement for the protection of a requested R-TWT schedule, identified by a B-TWT ID subfield greater than 0, are performed with an exchange of TBD individually addressed Management frames that carry R-TWT schedules with the Negotiation Type subfield set to a TBD value. The rules to set the Negotiation Type subfield to a TBD value are TBD.

A CR-TWT requesting AP can request a CR-TWT responding AP to extend the protection of one or more of its R-TWT schedule(s) via negotiations by including one or more TWT Information Extension element(s) in the transmitted TBD individually addressed Management frame used to initiate the negotiation. The CR-TWT requesting AP shall include at least one R-TWT parameters set of the R-TWT schedules it requests to protect in the B-TWT Parameters Sets Info field (see 9.4.2.330 (TWT Information Extension element)). The B-TWT ID in the R-TWT parameters set reported in the TWT Information Extension element should match the B-TWT ID of the corresponding R-TWT parameters set reported in a TWT element of a transmitted Beacon frame.

The contents and the values carried in the TBD individually addressed Management frame are TBD.

37.x.3 CR-TWT announcement rules

When a CR-TWT coordinated AP extends the protection for one or more R-TWT schedule(s) of a CR-TWT requesting AP, if the CR-TWT coordinated AP has at least one associated STA that supports R-TWT, the CR-TWT coordinated AP shall advertise the R-TWT schedule(s) by including one or more Restricted TWT Parameter Set field(s) in the broadcast TWT element defined in 9.4.2.198 (TWT element) carried in transmitted Management frame(s) as specified in 26.8.3 (Broadcast TWT operation), so that the CR-TWT coordinated AP’s associated STA(s) that support R-TWT follow the rules defined in 35.8.4.1 (TXOP and backoff procedure rules for R-TWT SPs) for the R-TWT schedule(s).

How to announce multiple R-TWT schedules is TBD.

When a CR-TWT coordinated AP advertises active R-TWT schedule(s) of CR-TWT requesting AP(s) by including one or more Restricted TWT Parameter Set field(s), then it shall advertise such schedule(s):

* With the Restricted TWT Schedule Info subfield set to 3,
* With the Broadcast TWT ID subfield set to 31.

37.x.4 Channel access rules for CR-TWT SPs

When a CR-TWT coordinated AP extends the protection for one or more R-TWT schedule(s) of a CR-TWT requesting AP, the CR-TWT coordinated AP as a TXOP holder shall ensure that its TXOP ends before the start time of any active R-TWT SP for which the protection is extended (see Table 9-349a).

In addition, before starting transmission of any PPDU, the CR-TWT coordinated AP shall check if there is enough time for the frame exchange to complete prior to the start of any R-TWT SP for which the protection is extended and, if there is not enough time, then the CR-TWT coordinated AP shall defer transmission by selecting a random backoff count using the present CW[AC] (without advancing to the next value of CW[AC]). The QSRC[AC] for the MSDU or A-MSDU is not affected.

# Detailed text proposal ends here.

**References:**

1. [11-24-0171r21](https://mentor.ieee.org/802.11/dcn/24/11-24-0171-21-00bn-tgbn-motions-list-part-1.pptx): 11-24-0171-21-00bn-tgbn-motions-list-part-1, Alfred Asterjadhi (Qualcomm Inc.)
2. [11-24-1966r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1966-00-00bn-pdt-mac-crtwt.docx): 11-24-1966-00-00bn-pdt-mac-crtwt, Giovanni Chisci (Qualcomm Technologies Inc.) et al.