IEEE P802.11  
Wireless LANs

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| PDT MAC Co-RTWT Signaling and Protocol aspects | | | | |
| Date: 2025-05-13 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Giovanni Chisci | Qualcomm Technologies Inc. |  |  | gchisci@qti.qualcomm.com |
| Liwen Chu | NXP |  |  | liwen.chu@NXP.COM |
| Xiangxin Gu | Spreadtrum |  |  | Xiangxin.Gu@UNISOC.COM |
| Yajun Cheng | Xiaomi |  |  | chengyajun@xiaomi.com |
| Shawn Kim | WILUS |  |  | shawn.kim@WILUSGROUP.COM |
| Zhanjing Bao | TCL |  |  | baozhanjing@GMAIL.COM |
| Yingqiao Quan | Spreadtrum |  |  | yingqiao.quan@UNISOC.COM |
| Jiyang Bai | TCL |  |  | jiyangbai@GMAIL.COM |
| Yuxin Lu | TCL |  |  | eeluyx@GMAIL.COM |
| Frank Hsu | Mediatek Inc. |  |  | frank.hsu@mediatek.com |
| Pascal Viger | Canon |  |  | Pascal.Viger@CRF.CANON.FR |
| Gwangho Lee | KNUT |  |  | gwangho.lee@a.at.uc.kr |
| Patrice Nezou | Canon |  |  | Patrice.Nezou@CRF.CANON.FR |
| Qing Xia | Sony |  |  | Qing.Xia@SONY.COM |
| Brian Hart | Cisco Systems |  |  | brianh@cisco.com |
| Binita Gupta | Cisco Systems |  |  | bingupta.ieee@GMAIL.COM |
| Muhammad Kumail Haider | Meta |  |  | kumail.ieee@GMAIL.COM |
| Jeongki Kim | Ofinno |  |  | jeongki.kim.ieee@GMAIL.COM |
| Hanqing Lou | InterDigital |  |  | hanqing.lu@interdigital.com |
| Insun Jang | LG Electronics |  |  | insun.jang@LGE.COM |
| Gaius Wee | Panasonic |  |  | yaohuang.wee@SG.PANASONIC.COM |
| Liuming Lu | OPPO |  |  | luliuming@oppo.com |
| Yanchun Li | Huawei |  |  | liyanchun@huawei.com |
| Qisheng Huang | ZTE |  |  | huang.qisheng@ZTE.COM.CN |
| Yurong Qian | ZTE |  |  | qian.yurong@ZTE.COM.CN |
| Li Quan | ZTE |  |  | quan.li@ZTE.COM.CN |
| Salvatore Talarico | Nokia |  |  | salvatore.talarico@nokia.com |
| Yun Li | ZTE |  |  | yun3@zte.com.cn |
| Inaki Val Beitia | MaxLinear |  |  | ival@maxlinear.com |
| Shuyu Shi | TP-Link Technologies Co., Ltd |  |  | shishuyu@tp-link.com.hk |
| Sangho Seo |  |  |  | ttiseo.sangho@GMAIL.COM |
| Kerstin Johnsson | Nokia |  |  | kerstin.johnsson@nokia.com |
| Alfred Asterjadhi | Qualcomm Technologies Inc. |  |  | asterjadhi@GMAIL.COM |
| Abhishek Patil | Qualcomm Technologies Inc. |  |  | appatil@qti.qualcomm.com |
| Jason Yuchen Guo | Huawei |  |  | guoyuchen@huawei.com |
| Yunbo Li | Huawei |  |  | liyunbo@huawei.com |
| Hui Che | Ruijie Networks Co., Ltd. |  |  | chehui@RUIJIE.COM.CN |
| Jonghoe Koo | Samsung Electronics |  |  | jh89.koo@SAMSUNG.COM |
| Gaurav Patwardhan | HPE |  |  | gauravpatwardhan1@gmail.com |
| Rishabh Roy | Samsung Electronics |  |  | rishabh.roy@samsung.com |
| Laurent Cariou | Intel |  |  | laurent.cariou@INTEL.COM |
| Ming Gan | Huawei |  |  | ming.gan@huawei.com |
| Woojin Ahn | KNUT |  |  | woojin.ahn@ut.ac.kr |
| Dibakar Das | Intel |  |  | dibakar.das@INTEL.COM |
| Yue Qi | Samsung Electronics |  |  | yue.qi@IEEE.ORG |
| Behnam Dezfouli | Nokia |  |  | behnam.dezfouli@nokia.com |
| Peshal Nayak | Samsung |  |  | p.nayak@SAMSUNG.COM |
| SunHee Baek | LG Electronics |  |  | sunhee.baek@LGE.COM |
| Rubayet Shafin | Samsung Electronics |  |  | r.shafin@SAMSUNG.COM |
| Xiaofei Wang | InterDigital |  |  | xiaofei.wang@interdigital.com |
| Sanket Kalamkar | Qualcomm Technologies Inc. |  |  | sankal@qti.qualcomm.com |
| Ross Jian Yu | Huawei |  |  | ross.yujian@huawei.com |
| Pei Zhou | TCL |  |  | zhoupei36@GMAIL.COM |
| Yue Zhao | Huawei |  |  | zhaoyue122@huawei.com |
| John Wullert | Peraton Labs |  |  | jwullert@PERATONLABS.COM |
| Aditi Singh | Charter |  |  | c-aditi.singh@CHARTER.COM |
| Leonardo Lanante | Ofinno |  |  | llanante@OFINNO.COM |
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Abstract

This document contains Proposed Draft Text (PDT) for the multi-AP coordination (MAPC) framework and Coordinated TWT (Co-RTWT) of the proposed TGbn (UHR, Ultra High Reliability) amendment to the 802.11 standard.

The PDT incorporates the latest passing motions in TGbn and resolution for the following CIDs marked in black color:

Co-RTWT CIDs:

202, 277, 439, 714, 742, 780, 781, 830, 831, 832, 880, 901, 994, 1050, 1321, 1322, 1381, 1408, 1409, 1410, 1411, 1412, 1413, 1414, 1415, 1416, 1417, 1418, 1419, 1420, 1435, 1436, 1437, 1438, 1439, 1562, 1599, 1714, 1715, 1716, 1717, 1718, 1719, 1720, 1721, 1806, 1832, 1867, 1868, 1906, 1907, 1908, 1909, 1910, 1911, 1995, 1996, 2117, 2118, 2119, 2206, 2210, 2519, 2674, 2695, 3175, 3176, 3177, 3178, 3179, 3180, 3181, 3257, 3258, 3259, 3420, 3445, 3446, 3447, 3448, 3449, 3450, 3451, 3452, 3567, 3582, 3583, 3584, 3710, 3711, 3752, 3754, 3794, 3795, 3854, 3884 ,3885, 3886, 3887, 3888, 3889.

***TGbn editor:Baselines for this document are 11bn D0.2, 11be D7.0, REVme D7.0, and [1].***

# 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 |
| 1 | Editorials |
| 2 | Editorials |
| 3 | Incorporates members’ comments and other editorials   * Table 9-K7 is updated * Subclause 37.8.2.4.3 (Co-RTWT announcement rules) is edited to clarify dynamic and parameters of the announcement * Subclause 9.4.2.198 (TWT element) is edited to clarify the announcement time domain-granularity for UHR APs (fix for an outstanding issue in mismatch granularity between request and announcement) * Edit of paragraph under Figure 9-K6 * Revised 37.8.2.4.3 (Co-RTWT announcement rules) * Revision of 3.2 (Definitions specific to IEEE 802.11) * Moved a paragraph from 37.8.1.3.1 to second last paragraph in 37.8.2.4.2 * Revised definition of Co-RTWT in 3.2 * Renamed ‘Co-RTWT Persistence field’ to ‘Broadcast TWT Persistence field’ |
| 4 | Aligning with baseline document [1] and other editorials |
| 5 | Addition of Discussion section with summary of MAPC element design |
| 6 | Incorporates members’ comments and other editorials   * Introduced MAPC Scheme Parameter Set field with TBD content and format for Co-RTWT in 9.4.2.aa3.2.5 (Co-RTWT profile) to provision for Co-RTWT parameters that are valid across the schedules that may be requested. This is to align with other MAPC schemes (e.g., Co-BF may need to indicate # of spatial streams or other general parameters alike, and each of the two APs participating in the exchange may want to provide it, so it is separated from the specific “request’s parameters”, which is rather something that is provided by the requestor and either accepted/rejected by the responder). If in the case of Co-RTWT no such parameters are identified, the MAPC Scheme Parameter Set field will be made optionally present in 9.4.2.aa3.2.1 (General), and it is going to be said that it is not carried in the CO-RTWT profile in 9.4.2.aa3.2.5 (Co-RTWT profile). * Added tuple for identifying a Co-RTWT agreement (for a schedule) in the paragraph just above 37.8.2.4.3 (Co-RTWT announcement rules) |
| 7 | Alignment with 25/0599r7, incorporates members’ comments and other editorials |
| 8 | Alignment with 25/0599r8, incorporates members’ comments and other editorials |
| 9 | Alignment with 25/0599r9, incorporates members’ comments and other editorials   * Solved the TSF resolution issue: added a paragraph in 35.8.3.1 and 35.8.3.2 to allow populating the Nominal Minimum TWT Wake Duration field (redefined as Nominal Minmimum TWT Wake Duration/Target Wake Time Extension in 9.4.2.198) with bits 8:9 of TSFref of the start of the R-TWT schedule (granularity of start time is 256 us). Also added parallel text in 37.8.2.4.3. For this also modified 9.4.2.198 to introduce the flexible field “Nominal Minimum TWT Wake Duration/Target Wake Time Extension field”. * Removed parts about announcement of Nominal Minimum TWT Wake Duration (a Note in 37.8.2.4.3, and ‘A UHR AP sets the Wake Duration Unit subfield to 0’ in 9.4.2.198), which are unnecessary since the field is being repurposed for when Restricted TWT Schedule Info = 3. |
| 10 | Reverted definition of Co-RTWT to the following and updated related comment resolutions:  Coordinated restricted target wake time (Co-RTWT) operations described in subclause 37.8.2.4 (Coordinated Restricted TWT (Co-RTWT)) enable an AP to coordinate its R-TWT schedule(s) with OBSS AP(s) and/or obtain extended protection for its R-TWT schedule(s) from OBSS APs and their BSSs. |
| 11 | Incorporated some members’ comments and small editorials. |
| 12 | Small editorials |
| 13 | Removal of ordering of ‘requests’ in 37.8.2.4.2 Co-RTWT negotiations (Yanchun)  Replaced ‘rightmost bits’ -> ‘MSBs’ and ‘leftmost bits’ -> ‘LSBs’ (Mark) |

# Introduction

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 TGbn Draft. The abstract, revision information, introduction, explanation of the proposed changes, and references sections are not part of the adopted material.

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

## Explanation of the proposed changes:

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 CIDs collected during CC50 on D0.1.

### Relevant Passing Motions

[Motion #50]

* 11bn defines a common framework of a Multi-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, Co-RTWT, etc.

[Motion #51]

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

[Motion #120]

* A UHR AP shall indicate to another AP its capability to respond in a TB PPDU or not

[Motion #135]

* The sharing AP, that transmits a Trigger frame as part of a transmission sequence in a Multi-AP coordinated transmission scheme, identifies the shared AP via an AP ID carried in the AID12 field of the User Info field of the frame
  + Note: the name of "sharing AP" and "shared AP" are TBD
  + Note: Multi-AP coordinated transmission schemes are Co-SR, Co-BF and Co-TDMA

[Motion #147]

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

[Motion #148]

* APs that discovered each other and want to establish agreement(s) for Multi-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 #185]

* Define a mechanism in 11bn that defines:
  + AP-to-AP frame formats to enable interoperable MAPC across APs and including MLME primitive(s) so that a pair of AP’s SMEs can orchestrate the over-the-air transmission and reception of these frames
  + MLME primitive(s) so that a pair of AP’s SMEs may send the content of the non-real-time instances of such AP-to-AP frames over-the-DS between peer AP-MLMEs (rather than over-the-air via peer AP MACs)

[Motion #265]

* As a part of M-AP coordination agreement procedure, an AP may assign an AP ID to another AP with the following constraints:
  + The AP ID is used for the AP to identify another AP as a coordinated AP, when necessary.
  + The AP ID field has the same size and the field value has a range as defined in AID field (see 9.4.1.8)
  + The AP shall ensure that the AP ID value is not assigned by the AP or by its affiliated MLD to any other STA (e.g., STA is an associated non-AP STA, an unassociated non-AP STA that has been allocated a (Ranging session Identifier) RSID , or any other coordinated AP), or a non-AP MLD that is associated with the AP MLD
  + It's TBD whether the AP ID value is greater than 2^n where n is the maximum of the value carried in the MBSSID Indicator (n) field of the Multiple BSSID element for any AP affiliated with the AP MLD that belongs to a multiple BSSID set

[Motion #342]

* Established coordination between two APs can be terminated by an explicit teardown performed by one of the two APs.

[Motion #358]

* TGbn defines new actions for Public Action frames for MAPC communications such as discovery and negotiations
  + An action is defined for MAPC Discovery
  + An action is defined for MAPC Negotiation Request
  + An action is defined for MAPC Negotiation Response
  + Others are TBD

[Motion #359]

* When an AP use Management frames to discover the capabilities and/or parameters of individual M-AP coordination schemes, the AP shall use the defined MAPC Public Action frame with the following setting:
  + The action field is set to MAPC Discovery

[Motion #360]

* When an AP (AP1) uses an individually addressed Management frame to initiate a negotiation to establish agreements for M-AP coordination schemes (if enabled by another AP (AP2)), the AP (AP1) shall use the defined MAPC Public Action frame with the following setting:
  + The Action field is set to MAPC Negotiation Request
  + If new negotiations are disabled by another AP (AP2) the AP (AP1) shall not send a negotiation request to the other AP (AP2)
  + TBD details of ‘new negotiations disabled

[Motion #361]

* When an AP (AP2) receives an individually addressed Management frame that initiates a negotiation to establish agreements for M-AP coordination schemes, the AP (AP2) shall respond by using the defined MAPC Public Action frame with the following setting, if negotiations are enabled:
  + The Action field is set to MAPC Negotiation Response

[Motion #48]

* 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 #149]

* 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.

[Motion #281]

* For negotiation over the wireless medium, an AP that requests protection for its R-TWT schedule(s) via negotiations with another AP includes information carried in TBD fields of the Broadcast TWT Parameter Set field corresponding to each R-TWT schedule being negotiated in a TBD individually addressed Management frame that it transmits to the other AP.

[Motion #362]

* A Co-RTWT requesting AP shall include one or more Co-RTWT Parameter Set fields corresponding to each requested R-TWT schedule in the TBD individually addressed Management frame used for the request to the Co-RTWT Responding AP. The Co-RTWT Parameter Set field includes the following:
  + Target Wake Time field
  + Broadcast TWT ID field
  + Broadcast TWT Persistence
  + TWT Wake Interval Mantissa
  + TWT Wake Interval Exponent
  + Nominal Minimum TWT Wake Duration
  + TBD other fields

### Comments (CIDs) resolved:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 202 | Chunyu Hu | 37.8.2.4 | 75.24 | The RTWT schedule sharing needs to make sure the time represented in each BSS's TSF can be well aligned otherwise it'll be difficult to protect the medium access. | Address the concern raised in the coomment. | Revised  Clarified which TSF is used as reference and how to map into local TSF when announcing in OBSS.  TGbn editor: please implement changes as shown in this document tagged CID202. |
| 277 | Sigurd Schelstraete | 3.2 | 21.61 | "The value of the timing synchronization function (TSF) at the beginning of a Co-RTWT SP". Which AP's TSF? | Clarify | Revised  Clarified which TSF is used as reference and how to map into local TSF when announcing in OBSS.  TGbn editor: please implement changes as shown in this document tagged CID277 |
| 439 | Shuang Fan | 37.8.2.4.3 | 75.21 | EHT or UHR STAs associated with Co-RTWT coordinated AP can not identify the R-TWT schedule(s) advertised in beacon are from its own BSS or OBSS. As a result, these associated STA(s) may request to join the Co-RTWT schedule(s). | Please add an indication in the beacon frame that enables STAs to identify whether the RTWT schedule(s) belong to its own BSS or OBSS. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID439. |
| 714 | Chien-Fang Hsu | 37.8.2.4.2 | 75.08 | There are two possibilites of the R-TWT SP status of the requesting AP. 1. the RTWT SP has been set up in the requesting AP's BSS and the requesting AP intends to negotiate Co-RTWT with OBSS APs. 2. the RTWT SP with known parameters has not been set up in the requesting AP's BSS and the requesting AP intends to negotiate the Co-RTWT with other OBSS APs before setting up the R-TWT SP. For the second case, the negotiation process may need additional process to inform the OBSS APs when the R-TWT SP is to be active either by an additional frame transmission after the negotiation or by timing information during the negotiation. | Address the different status of RTWT SP in the requesting AP's BSS with different rules as the comments. | Reject  The comment fails to address the technical need of the proposed mechanism. The fact that AP1 has set up an R-TWT schedule in its own BSS is transparent to AP2. |
| 742 | Junbin Chen | 3.2 | 21.47 | In the definition of "Co-RTWT requesting AP", it seems unclear that who is requested to provide the protection. Such ambiguity might confuse the concepts of "Co-RTWT AP in 11bn" and "R-TWT AP in 11be" | change to "An AP that requests other AP(s) to provide protection for one or more of its R-TWT schedules" | Revised  Agree in principle  TGbn editor: please implement changes as shown in this document tagged CID742. |
| 780 | Seongho Byeon | 37.8.2.4.1 | 74.35 | According to this paragraph, Co-RTWT supporting AP is able to adjust its own R-TWT schedule and/or to protect the R-TWT schedule of OBSS. But the below context is missing at the sentence: Adjusting the R-TWT schedule of OBSS through negotiation. Suggest changing the text: "... enable an AP to coordinate and adjust R-TWT schedule(s) with OBSS AP(s) and/or extend protection to R-TWT schedule(s) of OBSS AP(s) and its own." | As in comment. | Rejected  There is no supporting text in the subclause to justify emphasizing ‘adjustment’ of schedules. |
| 781 | Seongho Byeon | 37.8.2.4.1 | 74.40 | According to the definition in the first paragraph, Co-RTWT is a mechasnim 1) to coordinate R-TWT schedule(s) and/or 2) to extend protection of R-TWT schedule(s). However, in the second and third paragraphs, only requesting protection is mentioned. | Therefore, a description of the procedure for adjusting R-TWT schedule(s) is required. Or we may remove the context of adjusting / coordinating R-TWT schedule in the first paragraph. | Rejected  The comment fails to identify a technical issue with the draft. (1) is an outcome of the process of achieving (2) and doesn’t need additional normative text. |
| 830 | Oren Kedem | 37.8.2.4 | 74.34 | Does the Shared and Sharing APs participating in Coordinated R-TWT should have the same TBTT ? | TBTT should be the same and the Beacons transmission must be shifted from each other | Revised  Same TBTT is not assumed. Instead rules for conversion are provided.  TGbn editor: please implement changes as shown in this document tagged CID830. |
| 832 | Oren Kedem | 37.8.2.4.3 | 74.21 | Please explain the term "Extended Protection" ? | Please clarify | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID832. |
| 880 | John Wullert | 37.8.3.4.3 | 75.08 | The text in clause 37.8.3.4.3 indicates that that there will be procedures for negotiating to establish Co-RTWT protection. There should also be some means of negotiating or tearing down that protection when an RTWT is terminated | Add indication that negotiation process will address the termination of coordinated protection from an RTWT. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID880. |
| 901 | Pascal VIGER | 37.8.2.4.4 | 75.31 | The section 37.8.2.4.4 Channel access rules for Co-RTWT SPs does not propose a channel access rule inside a Co-RTWT SP as title suggests. There is a need to restrict channel access by each coordinated BSS in order to protect the coordinating/requesting AP. | document 11-24/742 proposed some alternatives to raise the issue. Commenter will provide additional proposals | Revised  Agree in principle that the title is misleading. Provided a revision.  TGbn editor: please implement changes as shown in this document tagged CID901. |
| 994 | Arik Klein | 37.8.2.4.4 | 75.32 | Need to clarify what is the expected behavior from the Co-RTWT coordinated AP as TXOP responder: Can it transmit any response PPDU (to the TXOP holder) during an active Co-RTWT SP for which protection is extended as part of a Co-RTWT agreement that it has established with the Co-RTWT requesting AP? | As in comment | Revised  Responses during an OBSS Co-RTWT SP are not precluded so no restriction in the form of new rules is needed at this time. Nevertheless, agree in principle that text to clarify how to handle transmissions just before the Co-RTWT SP boundary is needed, and a CR is added for this.  TGbn editor: please implement changes as shown in this document tagged CID994. |
| 1050 | Matthew Fischer | 37.8.2.4.1 | 74.47 | How does a Co-RTWT Requesting AP know which other APs can/will act as Co-RTWT Responding APs? Does an AP just blindly broadcast its RTWT information and hope that someone responds? | Provide the detail to describe if the set of APs that a Requesting AP can exchange Co-RTWT frames with is limited somehow, and what the discovery process is for determining what the limited set of responding APs is. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1050. |
| 1321 | Jonghoe Koo | 37.8.2.4.1 | 74.41 | No particular reason to specify "via other means" only for Co-RTWT. It should be general to other MAPC schemes. Or we need to specify which MAPC scheme can use "other means" for its agreement/negotiation. | Remove "via other means" | Rejected  The text is required to support the text describing that an AP can become a Co-rTWT coordinated AP after completing a negotiation by accepting an agreement request, or more generally because it just ‘coordinated via other means’, but it still behaves as a Co-RTWT coordinated AP and is subject to the rules defined in 37.8.2.4.3 and 37.8.2.4.4 |
| 1322 | Jonghoe Koo | 37.8.2.4.3 | 74.22 | There is no clear motion that Co-RTWT coordinated AP's associated STAs suppoting R-TWT shall protect the R-TWT schedules requested by Co-RTWT requesting AP. | ...the Co-RTWT coordinated AP 'shall' advertise ..."-> 'may' | Rejected  In Motion #149 it is stated that ‘its associated STAs supporting rTWT follow the baseline rTWT rules for the OBSS rTWT schedule’.  Therefore baseline R-TWT rules shall be followed. |
| 1381 | Renlong Zhou | 37.8.2.4.4 | 75.32 | Completely prohibiting data transmission of Co-RTWT coordinated APs within Co-RTWT SPs is not conducive to low-latency data transmission within the BSS of Co-RTWT coordinated APs. | Reserve the transmission opportunities of Co-RTWT coordinated APs within Co-RTWT SPs and only allow low-latency data to be sent | Rejected  Currently there is no specified rule that prohibits data transmissions from Co-RTWT coordinated AP during the Co-RTWT requesting AP’s Co-RTWT SP. |
| 1408 | SunHee Baek | 37.8.2.4.2 | 74.64 | To negotiate Co-RTWT between Co-RTWT requesting AP and Co-RTWT responding AP, the frame type needs to be clarified to either the Management frame is divided into two types of frame like request frame and response frame, or has one type of frame like TWT setup frame. | as in the comment. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1408. |
| 1409 | SunHee Baek | 37.8.2.4.2 | 74.64 | If there are two types of frame, a frame transmitting from Co-RTWT requesting AP can be the Co-RTWT request frame that includes the Broadcast TWT Parameter Set fields corresponding to each R-TWT schedule, and the other frame transmitting from Co-RTWT responding AP can be the Co-RTWT response frame including negotiation result about each R-TWT schedule. | as in the comment. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1409. |
| 1410 | SunHee Baek | 37.8.2.4.2 | 75.01 | The "other TBD Co-RTWT parameters" should clarify what information it is based on. | The Co-RTWT requesting AP shall include one or more Broadcast TWT Parameter Set fields corresponding to each R-TWT schedule. That is, the fields to indicate the schedule information of R-TWT within the Broadcast TWT Parameter Set field shall be used. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1410. |
| 1411 | SunHee Baek | 37.8.2.4.2 | 75.09 | When a Co-RTWT requesting AP requests protection for its R-TWT schedule to a Co-RTWT responding AP, please clarify when the schedule information for the R-TWT is set based on which TSF of either Co-RTWT requesting AP or Co-RTWT responding AP? | The Co-RTWT requesting AP sets the Target Wake Time field within the Broadcast TWT Parameter Set field based on the TSF of Co-RTWT responding AP to indicate the start time of R-TWT within the BSS of the Co-RTWT requesting AP. | Revised  Clarified which TSF is used as reference and how to map into local TSF when announcing in OBSS.  TGbn editor: please implement changes as shown in this document tagged CID1411 |
| 1412 | SunHee Baek | 37.8.2.4.2 | 75.09 | The TWT setup command and the TWT request fields need to be clarified while the Co-RTWT Request/Response frame is used. | as in the comment. | Rejected  Currently the Co-RTWT parameters in the Negotiation MAPC element are added only when necessary, so the parameters discussed in the comment are not currently present in the Co-RTWT request. |
| 1413 | SunHee Baek | 37.8.2.4.2 | 75.09 | When a Co-RTWT requesting AP transmits the request including the Broadcast TWT Parameter Set fields to Co-RTWT responding AP, the value of the Broadcast TWT ID field is set to distinguish each of the Broadcast TWT Parameter Set field. | A Co-RTWT requesting AP shall set the Broadcast TWT ID field to the Broadcast TWT ID that the Co-RTWT requesting AP uses to announce the R-TWT schedule to associated STAs supporting R-TWT. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1413. |
| 1414 | SunHee Baek | 37.8.2.4.2 | 75.09 | We need to define a tear-down mechanism for the agreed Co-RTWT parameters. | It can be enabled by using the value of the Broadcast TWT Persistence field and/or explicit tear-down frame. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1414. |
| 1415 | SunHee Baek | 37.8.2.4.2 | 75.09 | When a Co-RTWT requesting AP transmits the request including the Broadcast TWT Parameter Set fields to the Co-RTWT responding AP, some fields within the Broadcast TWT Parameter Set field don't need to be shared with the Co-RTWT responding AP. | The some fields within the Broadcast TWT Parameter Set field are set to reserved. The fields could be Trigger field, Aligned field, Restricted TWT Traffic Info Present field and Restricted TWT Schedule Info field. | Revised  Agree in principle. Although the Co-RTWT parameters set to be added in the Negotiation MAPC element are selected ‘by addition’, so there is no need use reserved fields.  TGbn editor: please implement changes as shown in this document tagged CID1415. |
| 1416 | SunHee Baek | 37.8.2.4.2 | 75.14 | When a Co-RTWT responding AP responds to the request of a Co-RTWT requesting AP, how to indicate the negotiation result about the Co-RTWT request either accept or reject? | To indicate the negotiation result, new field (e.g., Status code) can be used. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1416. |
| 1417 | SunHee Baek | 37.8.2.4.2 | 75.14 | It should be clarified how the Co-RTWT responding AP will consist of the coordination response frame to Co-RTWT requesting AP. | It can be defined as a tuple format of Broadcast TWT ID and Status code. Or it can be possible to list status codes in order of parsing the Broadcast TWT Parameter Set field of coordination request frame without Broadcast TWT ID. | Revised  Agree in principle with the first proposed resolution.  TGbn editor: please implement changes as shown in this document tagged CID1417. |
| 1418 | SunHee Baek | 37.8.2.4.2 | 75.14 | We need to clarify whether the Co-RTWT responding AP will indicate the negotiation result either accept or reject or among accept, reject, or suggestion. | If the negotiation result (e.g., status code) can indicate either accept or reject, the Broadcast TWT Parameter Set fields contained to the coordination request frame are not included in the cooridnation response frame. If the negotiation result (e.g., status code) can indicate among accept, reject, or suggestion, the Broadcast TWT Parameter Set field can be included in the coordination response frame maybe in case of suggestion . | Revised  Agree in principle with the first proposed resolution.  TGbn editor: please implement changes as shown in this document tagged CID1418. |
| 1419 | SunHee Baek | 37.8.2.4.3 | 75.22 | A Co-RTWT responding AP can include the Co-RTWT schedule in the Beacon frame, but it must be specified in which the Beacon frame it is transmitted at which point. | Right after the Co-RTWT negotiation, the Co-RTWT responding AP shall include this in the first Beacon frame transmitted, so that the Co-RTWT protection can be performed within the BSS of the Co-RTWT responding AP based on the negotiation. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1419. |
| 1420 | SunHee Baek | 37.8.2.4.3 | 75.22 | There is no content on how Co-RTWT responding AP sets the Broadcast TWT ID field and Restricted TWT Schedule Info field when informing the Co-RTWT schedules to the associated STAs supporting R-TWT. | The Broadcast TWT ID field can be set to 31 and the Restricted TWT Schedule Info field can be set to 3. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1420. |
| 1435 | Akira Kishida | 37.8.2.4 Coordinated R-TWT (Co-RTWT) | 74.35 | Regarding the sentence "protection to R-TWT schedule(s) of OBSS AP(s)." does the term "protection" mean coordination scheduling R-TWT SPs among APs or protecting R-TWT SPs by setting NAV, for example? | It should be clarified what and how to protect by this feature. | Revised  Agree in principle that clarity can be improved. A CR is provided.  TGbn editor: please implement changes as shown in this document tagged CID1435. |
| 1436 | Akira Kishida | 37.8.2.4.4 Channel access rules for Co-RTWT SPs | 75.33 | There is no definition for "Co-RTWT SP." | The definition of "Co-RTWT SP" should be clarified. Does Co-RTWT SP mean a specific SP for the whole Co-RTWT operation, or does it simply define a combination of each R-TWT SP from coordinating APs? | Rejected  The comment fails to identify a technical issue with the current draft. In fact, there is a definition in 3.2 of D0.1. |
| 1439 | Akira Kishida | 37.8.2.4.3 Co-RTWT announcement rules | 75.19 | Regarding the sentence "the Co-RTWT coordinated AP shall advertise the R-TWT schedule(s) in its transmitted Beacon frames," the channels utilized by Co-RTWT member APs should be the same. This limitation should be specified. | As in the comment. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID1439. |
| 1562 | Zisheng Wang | 37.8.2.4 | 75.17 | The rules to establish to Co-rTWT agreements should consider the conflictions between rTWT SPs | as the comments | Rejected  The comment fails to identify a technical issue. |
| 1599 | Yuchen Guo | 37.8.2.4.3 | 75.19 | The announcement of the TWT of another AP is not accurate since the granularity of the TWT field is one TU, which is so large that a backoff procedure can be finished. | Provide a way for the reporting AP to indicate the gap between the indicated time and the actual time of the other AP's RTWT start time | Revised  Agree in principle. A CR is provided where the TSF from the CO-RTWT requesting AP side is provided at granularity 256 us.  TGbn editor: please implement changes as shown in this document tagged CID1599 |
| 1715 | Gaius Wee | 37.8.2.4.1 | 74.39 | "dot11CoRTwtOptionImplementated" should capitalize "TWT" to be consistent with other TWT and R-TWT dot11 attributes | Replace "dot11CoRTwtOptionImplemented" with "dot11CoRTWTOptionImplemented" throughout | Accepted  TGbn editor: please implement changes as shown in this document tagged CID1715. |
| 1716 | Gaius Wee | 37.8.2.4.1 | 74.41 | If "via other means" is ambiguous. Suggest to add a "TBD" tag if not defined. | Insert "TBD" in red font before "other means" | Revised  The other means are out of the scope of the standard (e.g., programming by a network controller via backhaul). Added some text to clarify.  TGbn editor: please implement changes as shown in this document tagged CID1716. |
| 1717 | Gaius Wee | 37.8.2.4.2 | 74.60 | Use singular form to cover single negotiation as well | Replace "negotiations" with "negotiation". Modify also references to this section and other relevant uses of "negotations" where applicable | Revised  Enablement of (any) negotiation is covered with the current language, so the change to singular is unnecessary. A revised text for clarifying the use of an indication for disabling new agreement establishment is provided.  TGbn editor: please implement changes as shown in this document tagged CID1717. |
| 1718 | Gaius Wee | 37.8.2.4.2 | 74.63 | "enablement of ... negotiations" seems oddly phrased | Replace "enablement of" with "support for" | Revised  The intent is to signal an enablement (as opposed as a support, since the AP is assumed to support negotiation if it sends the MAPC discovery frame). A revised text for clarifying the use of an indication for disabling new agreement establishment is provided.  TGbn editor: please implement changes as shown in this document tagged CID1718. |
| 1719 | Gaius Wee | 37.8.2.4.2 | 75.06 | This note does not provide sufficient information about the means that do no involve negotiations. An example or more descriptions would be helpful. Do the roles make sense if there is no negotiation? | Provide more description and an example about means that do not involve negotiations | Revised  The other means are out of the scope of the standard (e.g., pre-configuration). Added some text to clarify.  TGbn editor: please implement changes as shown in this document tagged CID1719. |
| 1720 | Gaius Wee | 37.8.2.4.3 | 75.25 | This is a repeat of existing rules for STAs that supports R-TWT. It should be included as informative or as a note since it is not introducing new normative behaviour. Also, it is not behaviour related to Co-RTWT anouncement rules section so being in a note is appropriate. | Change the last sentence into a NOTE form and remove the "shall" | Accepted  TGbn editor: please implement changes as shown in this document tagged CID1720. |
| 1721 | Gaius Wee | 37.8.2.4 | 74.34 | The text in 37.8.2.4.2-3 does not convey the understanding that a Co-RTWT SP is set up to extend protection of the OBSS R-TWT schedule (this is based on the defintion in 3.2 and implication of section 37.8.2.4.4). The text needs to describe the relationship between Co-RTWT SP and the negotiation and announcement protocol. | Add descriptions of the Co-RTWT SP in 37.8.2.4.2-3 in relation to the specific section | Revised  Agree in principle.  Text is provided to tie together negotiations (where one or more Co-RTWT parameters set are operated) and announcement (how to sed an R-TWT in the OBSS that complies with the C-RTWT agreement and its related Co-RTWT parameter set).  TGbn editor: please implement changes as shown in this document tagged CID1721. |
| 1806 | Patrice Nezou | 37.8.2.4.2 | 75.01 | The co-RTWT parameters should be exchanged thanks to the current TWT element. | Please extend the TWT element to carry co-RTWT parameters to enable share the co-RTWT parmeters within any management frames. | Revised  Agree on the need to provide details on how to provide the Co-RTWT parameter set for each schedule. A MAPC element is defined for this purpose.  TGbn editor: please implement changes as shown in this document tagged CID1806. |
| 1832 | Gwangho Lee | 37.8.2.4.3 | 75.19 | Using Beacon for R-TWT SP Protection has issues such as Beacon bloating and overprotection. Therefore, an alternative R-TWT SP protection method other than using Beacon signaling is required. | As in comment | Rejected  Co-RTWT coordinated AP using beacon to announce to its STA the R-TWT schedule of the Co-RTWT requesting AP is the only method agreed in Motion #149. |
| 1867 | Sanghyun Kim | 37.8.2.4.1 | 74.35 | It is not clear what "coordinate its R-TWT schedule(s) with OBSS AP(s)" means. Does it mean that multiple BSSs use the same period of time for an R-TWT SP within their BSSs? | Please clarify it. | Rejected  The comment fails to identify a technical issue with the draft. (1) ‘coordinate R-TWT schedules’ is an outcome of the process of achieving (2) (requesting to extend protection for R-TWT schedules) and doesn’t need additional normative text. The answer to the question in the comment is No. |
| 1910 | Hyeonjun Sung | 37.8.2.4 | 74.29 | Need to define a method to indicate the Co-RTWT SP termination to Co-RTWT coordinated AP and its associated non-AP STAs.  To prevent an overprotection on remaining Co-RTWT SP when its TWT SP is early terminated, Co-RTWT requesting AP shall signal the information about the termination to Co-RTWT coordinated AP. | Please define a method to indicate Co-RTWT SP Termination and its announcement rule. | Rejected  The protection rule currently involve TXOP termination at the SP boundary. So there is currently no restriction for OBSS AP and its STA for transmitting in such SP. The comment fails to identify a technical issue. |
| 2117 | Vishnu Ratnam | 37.8.2.4.1 | 74.41 | It is good to add at note to clarify what "via other means" alludes to. | As in comment. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID2117. |
| 2118 | Vishnu Ratnam | 37.8.2.4.2 | 74.63 | The current text reads: "An AP with dot11CoRTwtOptionImplemented equal to true may advertise the enablement of Co-RTWT negotiations and ...". Please clarify what enablement of Co-RTWT means: (i) the AP can now send Co-RTWT requests to a neighbor AP or (ii) the AP can support receiving Co-RTWT requests or (iii) both. Also clarify if the AP can support one of the two features. | As in comment. | Revised  Agree in principle on the need to clarify these aspects. Text to clarify is provided as part of the MAPC negotiation procedure with the following rationale: 1) A capability for Co-RTWT indicates generally that an AP supports Co-RTWT, 2) A parameter indicates that new agreements can be requested.  TGbn editor: please implement changes as shown in this document tagged CID2118. |
| 2119 | Vishnu Ratnam | 37.8.2.4.4 | 75.33 | The current text suggests that only the AP ends TXOP before the protected RTWT SP. Clarify what the non-AP STA behavior is as well. Note that if it is only the coordinated AP that ends it TXOP, there may not be a need to advertise the R-TWT schedules by the coordinated AP. | As in comment. | Revised  The text related for the non-AP STA of the OBSS is mentioned in 27.8.2.4.3 ‘The Co-RTWT coordinated AP's associated STA(s) that support R-TWT shall follow the rules defined  in 35.8.4.1 (TXOP and backoff procedure rules for R-TWT SPs) for the R-TWT schedule(s).’. In practice the rules are defined in the 11be R-TWT subclause and there are no new rules since as of now OBSS STAs will protect the Co-RTWT SP via their own AP (Co-RTWT coordinated AP) setting up an 11be R-TWT. To setup that R-TWT, the Co-RTWT coordinated AP will follow the rules in 37.8.2.4.3 (Co-RTWT announcement rules).  TGbn editor: please implement changes as shown in this document tagged CID2119. |
| 2519 | Inaki Val | 37.8.2.4.3 | 75.19 | Does the Co-RTWT announcement, sent by the coordinated AP, be using the its own time reference (TSF) and taking into account the time difference between the two time domains? That would requiere at least to calculate mutual clock drifting. | See comment and clarify | Revised  Clarification text is provided for which TSF to use when AP2 announces for AP1, how to convert based on the value in the MAPC Negotiation request from AP1.  TGbn editor: please implement changes as shown in this document tagged CID2519. |
| 2674 | Xiaofei Wang | 37.8.2.4.1 | 74.41 | "via other means" should be clearly defined since this is a specific case "request protection for its R-TWT schedule". | clearly indicate which other means should be used or remove this phrase. | Revised  Agree in principle. Added clarification text.  TGbn editor: please implement changes as shown in this document tagged CID2674. |
| 3175 | Yunbo Li | 37.8.2.4.1 | 74.42 | If "via other means" means some ways out of the scope of standard, please clarify it. | as in comment. | Revised  Agree in principle. Added clarification text.  TGbn editor: please implement changes as shown in this document tagged CID3175. |
| 3176 | Yunbo Li | 37.8.2.4.1 | 74.44 | not match well with the previous paragraph. The previous paragraph mentions a Co-RTWT requesting AP may request protection via other means besides Co-RTWT negotiation, but here the Co-RTWT responding AP must reponds to Co-RTWT negotiation. | modify this or the previous paragraph to match with each other. | Revised  Agree in principle. Since text for MAPC negotiation procedure is added (with its own rules for requesting/responding APs, see 37.8.1.3), and since there is currently no text specific to a Co-RTWT responding AP (the rules defined for a MAPC responding AP are sufficient to characterize the actions of the responding AP in a Co-RTWT negotiation, see 37.8.2.4.2) the ‘Co-RTWT responding AP’ is removed from spec. (might be re-introduced if there is a necessity).  TGbn editor: please implement changes as shown in this document tagged CID3176. |
| 3177 | Yunbo Li | 37.8.2.4.1 | 74.55 | This paragraph is redudant,no new information is provided. | as in comment. | Revised  Agree in principle. Since text for MAPC negotiation procedure is added (with its own rules for requesting/responding APs, see 37.8.1.3), and since there is currently no text specific to a Co-RTWT responding AP (the rules defined for a MAPC responding AP are sufficient to characterize the actions of the responding AP in a Co-RTWT negotiation, see 37.8.2.4.2) the ‘Co-RTWT responding AP’ is removed from spec. (might be re-introduced if there is a necessity).  TGbn editor: please implement changes as shown in this document tagged CID3177. |
| 3178 | Yunbo Li | 37.8.2.4 | 74.30 | when a Co-RTWT requesting AP suspend a R-TWT, it needs to inform this information to Co-RTWT coordinated AP, so that the coordinated AP and its association STAs don't need to respect the suspended R-TWT anymore. | Add texts to describe the situation when a Co-RTWT requesting AP informs to Co-RTWT coordinated AP that a R-TWT is suspended. | Revised  Agree in principle. A CR is provided to provide the Restricted TWT Schedule Info field value in negotiations.  TGbn editor: please implement changes as shown in this document tagged CID3178. |
| 3179 | Yunbo Li | 37.8.2.4.2 | 75.01 | The capability of C0-RTWT should be carried in the UHR Capabilities element, while the other Co-RTWT parameters be carried in a TBD Management frame.Change "capability" to "enablement". | as in comment. | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3179. |
| 3180 | Yunbo Li | 37.8.2.4.2 | 75.05 | change "can" to "might" | as in comment. | Rejected  The intention of the note is to say that an AP ‘can’ as in ‘is able to’ be a Co-RTWT requesting or Co-RTWT coordinated AP even without negotiations. The intent is not to say that ‘might be the one or the other’. |
| 3181 | Yunbo Li | 37.8.2.4.3 | 75.25 | The Co-RTWT schedules shall be transparent to associated EHT STAs, so the associated STAs of the Co-RTWT coordinated AP don't need to recognize Co-RTWT schedules. Seems the last sentence of this paragraph is not needed. | Delete the last sentence of this paragraph. | Revised  Whether the STA needs to distinguish is under discussion. Agree in principle that the text related to the comment is not new normative text. Hence, it is transformed into a note.  TGbn editor: please implement changes as shown in this document tagged CID3181 |
| 3257 | GEORGE CHERIAN | 37.8.2.4.1 | 74.48 | Replace TBD in "exchanging TBD individually addressed Management frames | As in the comment | Revised  Management frames for negotiations are specified.  TGbn editor: please implement changes as shown in this document tagged CID3257 |
| 3258 | GEORGE CHERIAN | 37.8.2.4.1 | 0.00 | What is the granularity of the service periods here? TU may be too big, and as a tradeoff, suggest to make it 256 micro seconds | As in the comment | Revised  Agree in principle. A CR is provided where the TSF from the CO-RTWT requesting AP side is provided at granularity 256 us.  TGbn editor: please implement changes as shown in this document tagged CID3258 |
| 3259 | GEORGE CHERIAN | 37.8.2.4.1 | 0.00 | Resolve several TBDs in this section | As in the comment | Revised  TBDs are resolved by introducing specification text.  TGbn editor: please implement changes as shown in this document tagged CID3259 |
| 3420 | Qing Xia | 37.8.2.4.1 General | 74.40 | "one or more of its R-TWT schedules". Suggest to modify schedules to schedule(s) | same as comment | Rejected  In the draft the current convention is using ‘one or more R-TWT schedules’ or just ‘R-TWT schedule(s)’. In short it is assumed correct using the plural when paired with ‘one or more’. |
| 3445 | Muhammad Kumail Haider | 37.8.2.4.1 | 74.52 | Too many terms to describe the same type of entity should be avoided, in this case Co-RTWT responding AP and Co-RTWT coordinated AP. | "a Co-RTWT responding AP becomes a Co-RTWT coordinated AP" -> "the AP that sends the response becomes a Co-RTWT coordinated AP" | Revised  Agree in principle. Since text for MAPC negotiation procedure is added (with its own rules for requesting/responding APs, see 37.8.1.3), and since there is currently no text specific to a Co-RTWT responding AP (the rules defined for a MAPC responding AP are sufficient to characterize the actions of the responding AP in a Co-RTWT negotiation, see 37.8.2.4.2) the ‘Co-RTWT responding AP’ is removed from spec. (might be re-introduced if there is a necessity).  TGbn editor: please implement changes as shown in this document tagged CID3445. |
| 3446 | Muhammad Kumail Haider | 37.8.2.4.1 | 75.05 | "NOTE-An AP with dot11CoRTwtOptionImplemented equal to true can participate in Co-RTWT as a Co- RTWT requesting AP or as a Co-RTWT coordinated AP by means that do not involve negotiations." I agree this scenario should be allowed. However, this note is not consistent with the definition of Co-RTWT coordinated AP as the definitions requires and explicit request as currently stated. | Definition of Co-RTWT coordinated APs should be amended to incorporate scenarios when negotiations are not involved. | Revised  Agree in principle. Since text for MAPC negotiation procedure is added (with its own rules for requesting/responding APs, see 37.8.1.3), and since there is currently no text specific to a Co-RTWT responding AP (the rules defined for a MAPC responding AP are sufficient to characterize the actions of the responding AP in a Co-RTWT negotiation, see 37.8.2.4.2) the ‘Co-RTWT responding AP’ is removed from spec. (might be re-introduced if there is a necessity).  TGbn editor: please implement changes as shown in this document tagged CID3446. |
| 3447 | Muhammad Kumail Haider | 37.8.2.4.2 | 75.10 | "by including the R-TWT schedule(s)"->"by including information about R-TWT schedule(s)", as schedules are defined by the parameters/information contained in fields and frames. | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3447 |
| 3448 | Muhammad Kumail Haider | 37.8.2.4.2 | 75.10 | The negotiation framework should allow the flexibility of containers used to define R-TWT schedules being shared and coordinated. Existing R-TWT parameter fields may be included in TWT element or a new element, or these fields may be carried in another element (e.g., specifically designed for schedule coordination between APs). Further, R-TWT parameter set field may be modified to exclude subfields that are not relevant for schedule coordination between APs, or a new type of parameter set field may be defined for this purpose. | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3448 |
| 3449 | Muhammad Kumail Haider | 37.8.2.4.2 | 75.10 | The negotiation framework should allow the flexibility that a requesting AP may request coordination/protection for multiple R-TWT schedules in a single frame/element and the responding AP may agree to extend protection for all or a subset of schedules | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3449 |
| 3450 | Muhammad Kumail Haider | 37.8.2.4.4 | 75.10 | Spec needs to define what "extending protection" means. There should be flexibility that an AP may decide to either only end its TXOP for coordinated schedules, or to also extend protection to its BSS by announcing the schedules in its BSS as well (subject to if it has associated R-TWT supporting STAs). Further, the mode or extent of "extending protection" may be negotiated between the APs, and may apply to all schedules or may be negotiated per schedule. | As in comment | Revised  Agree in principle that the definition of ‘extending protection should be reinforced’, a CR is added for that. Nevertheless, currently there are no agreements on doing less than: a) AP2 terminates TXOP, b) AP2 announces in its BSS as well (conditional to having associated R-TWT capable STAs), so additions to spec text on ‘modes’ that allow to do either or is not performed at this time.  TGbn editor: please implement changes as shown in this document tagged CID3450 |
| 3582 | Malcolm Smith | 37.8.2.4 | 74.30 | Co-RTWT operation (i.e. start-time-protection-rules between APs) has been shown to provide latency CDF tail benefits even if there are no STA in the BSSs supportive of R-TWT. This is key as the expected market adoption of R-TWT (WiFi7 R2) is low and so to to be market rellevant, this capability needs to be supported for a CoRTWT AP with no releted STA R-TWT SPs where the BSS protection is met in other ways (e.g. TUA-O w/ appropriate MU-EDCA) . | Remove the struct requirement for a CoRTWT supportive AP to have one or more R-TWT supportive STA in its BSS e.g. optional | Revised  Agree in principle that when a Co-RTWT coordinated AP (AP2) extends protection for R-TWT schedule of a Co-RTWT requesting AP (AP1), the TXOP interruption from AP2 is not impacted by having associated R-TWT capable STAs, but only announcing such R-TWT in its own BSS might be. A CR is provided to clarify this aspects.  TGbn editor: please implement changes as shown in this document tagged CID3582 |
| 3710 | Li-Hsiang Sun | 37.8.2.4.2 | 75.17 | Is there a restriction that co-RTWT requesting AP and responding AP need to have the same Primary channel? | Please clarify | Revised  Agree in principle that it should be clarified that the APs have the same Primary channel. A CR is provided.  TGbn editor: please implement changes as shown in this document tagged CID3710 |
| 3795 | Yongho Seok | 37.8.2.4.3 | 75.26 | "The Co-RTWT coordinated AP's associated STA(s) that support R-TWT shall follow the rules defined in 35.8.4.1 (TXOP and backoff procedure rules for R-TWT SPs) for the R-TWT schedule(s)." While a legacy STA that supports the R-TWT schedule is expected to respect this information, the specification does not need to explicitly state this. Because the legacy STA des not understand Co-RTWT. | As in the comment | Revised  Agree in principle that legacy requirements for an R-TWT STA apply by means of other sections. The normative text is converted to a note.  TGbn editor: please implement changes as shown in this document tagged CID3795 |
| 3854 | Abhishek Patil | 9.4.2.198 | 58.11 | Update the row corresponding to value 3 in Table 9-349a (Restricted TWT Schedule Info subfield value) [9.4.2.198 (TWT element)]. Update the corresponding description text in the subclause and add/update corresponding normative text to include non-collocated OBSS APs with whom the transmitting AP has established a Co-RTWT agreement. See motion 149. | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3854 |
| 3884 | Abhishek Patil | 37.8.2.4.1 | 74.40 | Clarify that these are rTWT schedules advertised by the AP that have Restricted TWT Schedule Info subfield set to 1 or 2. In other words, these are active schedules. | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3884. |
| 3885 | Abhishek Patil | 37.8.2.4.1 | 74.42 | Provide an example of what the other means could be - for example add a NOTE that APs that hear each other and belonging to the same ESS can listen to each other's Beacon frames to determine the rTWT schedules of the other AP that are active (i.e., have Restricted TWT Schedule Info subfield set to 1 or 2) and need to be protected. Similar considerations for content on line 6 of pg 75 | As in comment | Revised  Agree in principle. Added clarification text.  TGbn editor: please implement changes as shown in this document tagged CID3885. |
| 3886 | Abhishek Patil | 37.8.2.4.1 | 74.48 | The neogtiation can be performed using the MAPC Request and MAPC Response frames (see 9.6). Address the TBD by calling out the frames. | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3886. |
| 3887 | Abhishek Patil | 37.8.2.4.2 | 75.09 | Address the TBD. Can this be a MAPC Request frame? | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3887. |
| 3888 | Abhishek Patil | 37.8.2.4.2 | 75.15 | Address the TBD. Can this be a MAPC Response frame? | As in comment | Revised  Agree in principle.  TGbn editor: please implement changes as shown in this document tagged CID3888. |

# Discussion:

### MAPC element in 25/0600r5

The structure of the MAPC element defined in subclause 9.4.2.aa3 (MAPC element) of 25/0600r5 is summarized in the figure below.

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AI-generated content may be incorrect.

### MAPC element in 25/0600r6 and beyond

The structure of the MAPC element defined in subclause 9.4.2.aa3 (MAPC element) of 25/0600r6 is summarized in the figure below.

A diagram of a document

AI-generated content may be incorrect.

# Text to be adopted begins here:

3.2 Definitions specific to IEEE 802.11

***TGbn editor: Please modify the body of subclause 3.2 (Definitions specific to IEEE 802.11) as follows:***

Coordinated restricted target wake time (TWT): [Co-RTWT] A procedure that enables an AP to coordinate its R-TWT schedule(s) with OBSS AP(s) and/or obtain extended protection for its R-TWT schedule(s) from OBSS APs and their BSS.

Coordinated restricted target wake time (Co-RTWT) agreement: [Co-RTWT agreement] An agreement established via a successful Co-RTWT negotiation between two APs.

Coordinated restricted target wake time (Co-RTWT) coordinated access point (AP): [Co-RTWT coordinated AP] An AP that extends protection for the R-TWT schedule(s) for which protection is requested by a Co-RTWT requesting AP.

Coordinated restricted target wake time (Co-RTWT) negotiation: [Co-RTWT negotiation] A procedure that enables a Co-RTWT requesting AP as a MAPC requesting AP to establish Co-RTWT agreement(s) with a MAPC responding AP.

Coordinated restricted target wake time (Co-RTWT) parameter set: [Co-RTWT parameter set] A set of parameters specifying an R-TWT schedule operated by a Co-RTWT requesting AP.

Coordinated restricted target wake time (Co-RTWT) requesting access point (AP): [Co-RTWT requesting AP] An AP that requests [CID742]other AP(s) to protect one or more of its R-TWT schedules.

[CID3176, CID3177]

Coordinated restricted target wake time (Co-RTWT) service period (SP): [Co-RTWT SP] A period of time for which Co-RTWT coordinated APs extend protection for a corresponding R-TWT schedule of a Co-RTWT requesting AP.

Coordinated restricted target wake time (Co-RTWT) service period (SP) start time: [Co-RTWT SP start time] The value of the timing synchronization function (TSF) [CID277, CID1411]of the Co-RTWT requesting AP at the beginning of a Co-RTWT SP.

**Multi-AP coordination:** [MAPC] a framework that includes a set of schemes (Co-BF, Co-SR, Co-TDMA, and Co-RTWT) and procedures in which APs operating their BSSs on the same primary 20 MHz channel coordinate to reduce interference levels and to improve network performance such as medium utilization efficiency, communication reliability, and latency.

**Multi-AP coordination (MAPC) requesting AP:** [MAPC requesting AP] An AP that initiates a MAPC negotiation with a MAPC responding AP for one or more MAPC schemes.

**Multi-AP coordination (MAPC) responding AP:** [MAPC responding AP] An AP that responds to a MAPC requesting AP.

**9.4.2 Elements**

**9.4.2.1 General**

9.4.2.198 TWT element

***TGbn editor: Please modify the body of subclause 9.4.2.198 (TWT element) as follows:***

[CID1599, CID3258]

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Request Type | Target Wake Time | Nominal Minimum TWT Wake Duration/Target Wake Time Extension | TWT Wake Interval Mantissa | Broadcast TWT Info | Restricted TWT Traffic Info (optional) |
| Octets: | 2 | 2 | 1 | 2 | 2 | 0 or 3 |

Figure 9-791— Broadcast TWT Parameter Set field format

The Nominal Minimum TWT Wake Duration/Target Wake Time Extension field indicates:

* If the Restricted TWT Schedule Info subfield is reserved or set to a value different from 3, the Nominal Minimum TWT Wake Duration, that is the minimum amount of time, in the unit indicated by the Wake Duration Unit subfield, that the TWT requesting STA or TWT scheduled STA is expected to be awake in order to complete the (#109)frame exchange sequences for the period of TWT wake interval, where TWT wake interval is the average time that the TWT requesting STA or TWT scheduled STA expects to elapse between successive TWT SPs.(11ax),
* If the Restricted TWT Schedule Info subfield is set to the value 3, the Target Wake Time Extension, that is bit 6 to 9 of the TSF corresponding to the start time of the R-TWT SP scheduled for this Restricted TWT parameter set as the four MSBs of the Nominal Minimum TWT Wake Duration/Target Wake Time Extension field. The four LSBs of the Nominal Minimum TWT Wake Duration/Target Wake Time Extension field are reserved.

[CID3854]

**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 Co-RTWT requesting AP. |

9.4.2.aa3 MAPC element

9.4.2.aa3.1 General

[CID3448]

The format of the MAPC element is defined in Figure 9-aa7 (MAPC element format). The usage of this element is described in 37.8 (Multi-AP coordination framework).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension |  | MAPC Control | MAPC Common Info | MAPC Schemes Info |
| Octets: | 1 | 1 | 1 |  | 1 | variable | variable |

Figure 9-aa7—MAPC element format

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

The format of the MAPC Control field is defined in Figure 9-X1 (MAPC Control field).

|  |  |  |
| --- | --- | --- |
|  | B0 | B1 B7 |
|  | AP ID Present | Reserved |
| Bits: | 1 | 7 |

Figure 9-X1—MAPC Control field

The AP ID Present field is set to 1 if the AP ID field is present in the MAPC Common Info field, and it is set to 0 otherwise.

The MAPC Common Info field carries information that is common to all the MAPC schemes. The format of the MAPC Common Info field is defined in Figure 9-X4 (MAPC Common Info field format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | MAPC Common Info Length | MAPC Capabilities | MAPC Parameters | AP ID |
| Octets: | 1 | 1 | 1 | 0 or 2 |

Figure 9-X4— MAPC Common Info field format

The MAPC Common Info Length field indicates the number of octets in the MAPC Common Info field including one octet for the MAPC Common Info Length field.

[CID2118, CID3179]The format of the MAPC Capabilities field is defined in Figure 9-X5 (MAPC Capabilities field format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 | B5 B7 |
|  | AP TB PPDU Response Supported | Co-BF Supported | Co-SR Supported | Co-TDMA Supported | Co-RTWT Supported | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 1 | 3 |

Figure 9-X5— MAPC Capabilities field format

The AP TB PPDU Response Supported field is set to 1 if the AP supports transmitting a TB PPDU in response to a Trigger frame. Otherwise, the AP TB PPDU Response Supported field is set to 0 to indicate that the AP does not support transmitting a TB PPDU in response to a Trigger frame..

[CID3179]The Co-BF Supported field is set to 1 if the AP supports Co-BF. Otherwise, the Co-BF Supported field is set to 0.

[CID3179]The Co-SR Supported field is set to 1 if the AP supports Co-SR. Otherwise, the Co-SR Supported field is set to 0.

[CID3179]The Co-TDMA Supported field is set to 1 if the AP supports Co-TDMA. Otherwise, the Co-TDMA Supported field is set to 0.

[CID2118, CID3179]The Co-RTWT Supported field is set to 1 if the AP supports Co-RTWT. Otherwise, the Co-RTWT Supported field is set to 0.

The format of the MAPC Parameters field is defined in Figure 9-X6 (MAPC Parameters field).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 B7 |
|  | Co-BF Agreement Establishment Enabled | Co-SR Agreement Establishment Enabled | Co-TDMA Agreement Establishment Enabled | Co-RTWT Agreement Establishment Enabled | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 4 |

Figure 9-X6— MAPC Parameters field format

The Co-BF Agreement Establishment Enabled field is set to 1 if the AP has enabled MAPC negotiations for establishing new MAPC agreements for Co-BF. Otherwise, the Co-BF Agreement Establishment Enabled field is set to 0.

The Co-SR Agreement Establishment Enabled field is set to 1 if the AP has enabled MAPC negotiations for establishing new MAPC agreements for Co-SR. Otherwise, the Co-SR Agreement Establishment Enabled field is set to 0.

The Co-TDMA Agreement Establishment Enabled field is set to 1 if the AP has enabled MAPC negotiations for establishing new MAPC agreements for Co-TDMA. Otherwise, the Co-TDMA Agreement Establishment Enabled field is set to 0.

[CID2118]The Co-RTWT Agreement Establishment Enabled field is set to 1 if the AP has enabled MAPC negotiations for establishing new MAPC agreements for Co-RTWT. Otherwise, the Co-RTWT Agreement Establishment Enabled field is set to 0.

The AP ID field is used to assign an AP ID to another AP. The AP ID field is optionally included in the MAPC Common Info field of a MAPC element (see Table 9-X2) as defined in 37.8.1.3.2 (AP ID assignment).

9.4.2.aa3.2 MAPC Schemes Info field

9.4.2.aa3.2.1 General

[CID1409, CID1416]

The MAPC Schemes Info field carries information specific to one or more MAPC schemes and is optionally present. When the MAPC Schemes Info field is present, it contains one or more subelements. The Subelement ID field values for the subelements are shown in Table 9-K0 (Optional subelement IDs of the MAPC Schemes Info field).

**Table 9-K0—** **Optional subelement IDs of the MAPC Scheme Info field**

|  |  |  |
| --- | --- | --- |
| **Subelement ID** | **Subelement name** | **Extensible** |
| 0 | Per-Scheme Profile | Yes |
| 1-220 | Reserved |  |
| 221 | Vendor Specific | Vendor defined |
| 222-253 | Reserved |  |
| 254 | Fragment | No |
| 255 | Reserved |  |

The format of the Per-Scheme Profile subelement is defined in Figure 9-K1 (Per-Scheme Profile subelement format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Subelement ID | Length | MAPC Scheme Control | MAPC Scheme Parameter Set | MAPC Scheme Request Set |
| Octets: | 1 | 1 | 1 | variable | variable |

Figure 9-K1— Per-Scheme Profile subelement format

The format of the MAPC Scheme Control field is defined in Figure 9-K1b (MAPC Scheme Control field format).

|  |  |  |
| --- | --- | --- |
|  | B0 B2 | B3 B7 |
|  | MAPC Scheme Type | Reserved |
| Bits: | 4 | 4 |

Figure 9-K1b— MAPC Scheme Control field format

The MAPC Scheme Type field indicates a value that identifies a MAPC scheme as defined in Table 9-K2 (MAPC Scheme Type field values).

**Table 9-K2—** **MAPC Scheme Type field values**

|  |  |
| --- | --- |
| **Value** | **Meaning** |
| 0 | Co-BF profile |
| 1 | Co-SR profile |
| 2 | Co-TDMA profile |
| 3 | Co-RTWT profile |
| 4-15 | Reserved |

The MAPC Schemes Info field contains zero or one Co-BF profile, Co-SR profile, Co-TDMA profile, and Co-RTWT profile.

The MAPC Scheme Parameter Set field carries parameters specific to the AP for the MAPC scheme indicated by the MAPC Scheme Type field. The MAPC Scheme Parameter Set field is optionally included and it has a format defined for each MAPC scheme in 9.4.2.aa3.2.2 (Co-BF profile), 9.4.2.aa3.2.3 (Co-SR profile), 9.4.2.aa3.2.4 (Co-TDMA profile), and 9.4.2.aa3.2.5 (Co-RTWT profile), respectively.

The MAPC Scheme Request Set field is optionally included. The MAPC Scheme Request Set field is included and carries request(s) for MAPC agreement(s) specific to the MAPC scheme indicated by the MAPC Scheme Type field when the MAPC elementPer-Scheme Profile subelement is carried in a MAPC Negotiation Request frame. The MAPC Scheme Request Set field is included and carries response(s) to request(s) for MAPC agreement(s) specific to the MAPC scheme indicated by the MAPC Scheme Type field when the Per-Scheme Profile subelement is carried in a MAPC Negotiation Response frame. The MAPC Scheme Request Set field is not included when the Per-Scheme Profile subelement is carried in MAPC Discovery Request frame or a MAPC Discovery Response frame. The MAPC Scheme Request Set field carried in a Co-BF, Co-SR, or Co-TDMA profile contains a single MAPC Scheme Request field. [CID1417, CID3449, M#281, M#362]The MAPC Scheme Request Set field carried in a Co-RTWT profile contains one or more MAPC Scheme Request fields, each corresponding to an R-TWT schedule.

The format of the MAPC Scheme Request field is defined in Figure 9-K3 (MAPC Scheme Request field format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | MAPC Request Control | Status Code | MAPC Request Parameter Set |
| Octets: | 1 | 0 or 2 | variable |

Figure 9-K3— MAPC Scheme Request field format

[CID1417, CID1418]The MAPC Request Control field format is defined in Figure 9-K4 (MAPC Request Control field format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 B1 | B2 B6 | B7 |
|  | MAPC Operation Type | MAPC Info | Last MAPC Request |
| Bits: | 2 | 5 | 1 |

Figure 9-K4— MAPC Request Control field format

[M#342]

The MAPC Operation Type field indicates the type of operation to be carried out. Table 9-K5 (MAPC Operation Type field values) shows the values and meaning of the MAPC Operation Type field, [CID1418]the frame that carries the MAPC element with this MAPC Operation Type value, the presence of the Status Code field, and the presence of the MAPC Request Parameter Set field for this operation type.

**Table 9-K5—** **MAPC Operation Type field values**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Value** | **Meaning** | **Contained in** | **Status Code field present** | **MAPC Request Parameter Set field present** |
| 0 | Agreement Establishment | MAPC Negotiation Request frame | No | Yes |
| 1 | Agreement Update | MAPC Negotiation Request frame | No | Yes |
| 2 | Agreement Teardown | MAPC Negotiation Request frame | No | No |
| 3 | Response | MAPC Negotiation Response frame | Yes | No |

The MAPC Info field is reserved except when carried in a Co-RTWT profile. The MAPC Info field in a Co-RTWT profile is defined in 9.4.2.aa3.2.5 (Co-RTWT profile).

The Last MAPC Request field is reserved except when carried in a Co-RTWT profile. The Last MAPC Request field in a Co-RTWT profile is defined in 9.4.2.aa3.2.5 (Co-RTWT profile).

The Status Code field is defined in 9.4.1.9 (Status Code field) and is optionally present (see Table 9-K5). The Status Code field indicates the status of a MAPC negotiation as indicated in Table 9-80 (Status codes) and following the rules defined in 37.8.1.3 (MAPC agreement negotiation).

The MAPC Request Parameter Set field carries parameters specific to a request and is optionally included as defined in Table 9-K5. The format of the MAPC Request Parameter Set field is defined for each MAPC scheme in 9.4.2.aa3.2.2 (Co-BF profile), 9.4.2.aa3.2.3 (Co-SR profile), 9.4.2.aa3.2.4 (Co-TDMA profile), and 9.4.2.aa3.2.5 (Co-RTWT profile), respectively.

9.4.2.aa3.2.2 Co-BF profile

The MAPC Scheme Type field is set to the value for Co-BF as indicated in Table 9-K2.

The MAPC Info field and the Last MAPC Request field are reserved.

9.4.2.aa3.2.3 Co-SR profile

The MAPC Scheme Type field is set to the value for Co-SR as indicated in Table 9-K2.

The MAPC Info field and the Last MAPC Request field are reserved.

9.4.2.aa3.2.4 Co-TDMA profile

The MAPC Scheme Type field is set to the value for Co-TDMA as indicated in Table 9-K2.

The MAPC Info field and the Last MAPC Request field are reserved.

9.4.2.aa3.2.5 Co-RTWT profile

***TGbn editor: Please modify the body of subclause 9.4.2.aa3.2.5 (Co-RTWT profile) as follows:***

[CID1409, CID1410, CID1415, CID1806, M#281, M#362]

The MAPC Scheme Type field is set to the value for Co-RTWT as indicated in Table 9-K2.

For each MAPC Scheme Request field, carried in the Co-RTWT profile:

* The MAPC Info field includes a Broadcast TWT ID field carrying the identifier of a specific R-TWT schedule.
* The Last MAPC Request field is set to 0 to indicate that the Co-RTWT profile carries another MAPC Scheme Request field that follows this MAPC Scheme Request field. The Last MAPC Request field is set to 1 to indicate that this is the last MAPC Scheme Request field in the Co-RTWT profile.
* The MAPC Scheme Parameter Set is not included.
* [CID3447]The MAPC Request Parameter Set field contains a Co-RTWT Parameter Set field with format defined in Figure 9-K6 (Co-RTWT Parameter Set field format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Target Wake Time | Nominal Minimum TWT Wake Duration | TWT Wake Interval Mantissa | Service Period Info |
| Octets: | 8 | 1 | 2 | 2 |

Figure 9-K6—Co-RTWT Parameter Set field format

[CID277, CID1411, CID1599, CID2519, CID3258]The Target Wake Time field contains an unsigned integer corresponding to the Co-RTWT SP start time expressed in terms of the TSF of the Co-RTWT requesting AP.

The Nominal Minimum TWT Wake Duration field indicates the nominal duration of the Co-RTWT SPs, in units of 256 .

The TWT Wake Interval Mantissa field is set to the value of the mantissa of the TWT wake interval value in microseconds, base 2.

[CID3178]The format of the Service Period Info field is defined in Figure 9-K7 (Service Period Info format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 B4 | B5 B12 | B13 B14 | B15 |
|  | TWT Wake Interval Exponent | Broadcast TWT Persistence | Restricted TWT Schedule Info | Reserved |
| Bits: | 5 | 8 | 2 | 1 |

Figure 9-K7— Service Period Info field format

The TWT Wake Interval Exponent field is set to the value of the exponent of the TWT wake interval value in microseconds, base 2. The TWT wake interval is the time between successive Co-RTWT SPs start times and is equal to (TWT Wake Interval Mantissa) × .

The Broadcast TWT Persistence field indicates the number of TBTTs of the Co-RTWT requesting AP during which the Co-RTWT SPs corresponding to this Co-RTWT Parameter set are present. The number of TBTTs of the Co-RTWT requesting AP during which the Co-RTWT SPs are present is equal to the value in the Broadcast TWT Persistence field plus 1, except that the value 255 indicates that the Co-RTWT SPs are present until explicitly terminated.

[CID3178]The Restricted TWT Schedule Info field is defined in Table 9-349a (Restricted TWT Schedule Info field values).

9.6.7 Public Action frame details

9.6.7.1 Public Action field

[CID1408]

**Table 9-471—Public Action field values**

|  |  |
| --- | --- |
| **Public Action field value** | **Description** |
| … | … |
| <ANA> | MAPC Discovery Request |
| <ANA> | MAPC Discovery Response |
| <ANA> | MAPC Negotiation Request |
| <ANA> | MAPC Negotiation Response |
| … | … |

9.6.7.x MAPC Discovery Request frame format

The MAPC Discovery Request frame is used by an AP to advertise its capabilities and common parameters for MAPC. The format of the MAPC Discovery Request frame is defined in Figure 9-J1 (MAPC Discovery Request frame format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Category | Public Action | Dialog Token | MAPC Discovery Info |
| Octets: | 1 | 1 | 1 | variable |

Figure 9-J1— MAPC Discovery Request frame format

The Category field is defined in 9.4.1.11 (Action field).

The Public Action field is defined in 9.6.7.1 (Public Action field).

The Dialog Token field is set to a nonzero value chosen by the AP sending the MAPC Discovery Request frame.

The MAPC Discovery Info field carries a MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

NOTE —When a MAPC element carrying per-scheme profiles is included in a MAPC Discovery Request frame, the MAPC Scheme Request Set field is not included in the reported per-scheme profiles.

9.6.7.y MAPC Discovery Response frame format

The MAPC Discovery Response frame is used by an AP to advertise its capabilities and common parameters for MAPC. The format of the MAPC Discovery Response frame is defined in Figure 9-J1b (MAPC Discovery Response frame format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Category | Public Action | Dialog Token | MAPC Discovery Info |
| Octets: | 1 | 1 | 1 | variable |

Figure 9-J1b— MAPC Discovery Response frame format

The Category field is defined in 9.4.1.11 (Action field).

The Public Action field is defined in 9.6.7.1 (Public Action field).

The Dialog Token field is set to a nonzero value chosen by the AP sending the MAPC Discovery Response frame.

The MAPC Discovery Info field carries a MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

NOTE —When a MAPC element carrying per-scheme profiles is included in a MAPC Discovery Response frame, the MAPC Scheme Request Set field is not included in the reported per-scheme profiles.

9.6.7.55a MAPC Negotiation Request frame format

[CID1408]

The MAPC Negotiation Request frame is used by an AP to request to establish, update, [M#342]or teardown agreement(s) for MAPC scheme(s). The format of the MAPC Negotiation Request frame is defined in Figure 9-J2 (MAPC Negotiation Request frame format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Category | Public Action | Dialog Token | MAPC Negotiation Info |
| Octets: | 1 | 1 | 1 | variable |

Figure 9-J2— MAPC Negotiation Request frame format

The Category field is defined in 9.4.1.11 (Action field).

The Public Action field is defined in 9.6.7.1 (Public Action field).

The Dialog Token field is set to a nonzero value chosen by the AP sending the MAPC Negotiation Request frame.

The MAPC Negotiation Info field carries a MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

NOTE —When a MAPC element carrying per-scheme profiles is included in a MAPC Negotiation Request frame, the MAPC Scheme Request Set field is included in the reported per-scheme profiles.

9.6.7.55b MAPC Negotiation Response frame format

[CID1408]

The MAPC Negotiation Response frame is used by an AP to respond to another AP that transmits a MAPC Negotiation Request frame. The format of the MAPC Negotiation Response frame is defined in Figure 9-J3 (MAPC Negotiation Response frame format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Category | Public Action | Dialog Token | MAPC Negotiation Info |
| Octets: | 1 | 1 | 1 | variable |

Figure 9-J3— MAPC Negotiation Response frame format

The Category field is defined in 9.4.1.11 (Action field).

The Public Action field is defined in 9.6.7.1 (Public Action field).

The Dialog Token field is set to a nonzero value chosen by the AP sending the MAPC Negotiation Response frame.

The MAPC Negotiation Info field carries a MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

NOTE —When a MAPC element carrying per-scheme profiles is included in a MAPC Negotiation Response frame, the MAPC Scheme Request Set field is included in the reported per-scheme profiles.

9.6.10 Protected Dual of Public Action frame details

**Table 9-516—Public Action field values defined for Protected Dual of Public Action frames**

|  |  |  |
| --- | --- | --- |
| **Public Action field value** | **Description** | **Defined in** |
| … | … |  |
| <ANA> | Protected MAPC Negotiation Request | 9.6.7.55a (MAPC Negotiation Request frame format ) |
| <ANA> | Protected MAPC Negotiation Response | 9.6.7.55b (MAPC Negotiation Response frame format ) |
| … | … |  |

35.8.3 R-TWT announcement

35.8.3.1 Rules for R-TWT scheduling AP

***TGbn editor: Please add a paragraph between the second to last and the last paragraph in 35.8.3.1 (Rules for R-TWT scheduling AP) as shown below:***

An R-TWT scheduling AP when announcing an R-TWT schedule, shall set the Target Wake Time field in the TWT element in transmitted Management frames to TSF [10:25], where TSF corresponds to the first R-TWT SP start time of the corresponding R-TWT schedule.

[CID1599, CID3258]A UHR R-TWT scheduling AP when announcing an R-TWT schedule with the Restricted TWT Schedule Info subfield set to 3, shall set the four MSBs of the Nominal Minimum TWT Wake Duration/Target Wake Time Extension field in the TWT element in transmitted Management frames to TSF [6:9], where TSF corresponds to the start time of the R-TWT SP scheduled for this Restricted TWT parameter set. When the UHR R-TWT scheduling AP announces an R-TWT schedule with the Restricted TWT Schedule Info subfield set to 3, the TSF timer at which that R-TWT is scheduled has bits 0 to 5 equal to 0 and bits 26 to 63 equal to the same value as the respective bits in the current value of the TSF timer of the UHR R-TWT scheduling AP.

The R-TWT scheduling AP shall determine the start time of R-TWT SPs that happen after the first R-TWT SP (next R-TWT SP start time) in a periodic R-TWT schedule based on the start time of the first R-TWT SP and the TWT wake interval of the corresponding R-TWT schedule.

35.8.3.2 Rules for R-TWT scheduled STA

***TGbn editor: Please add the following at the end of subclause 35.8.3.2 (Rules for R-TWT scheduled STA):***

[CID1599, CID3258]When Restricted TWT Schedule Info subfield set to 3, a UHR non-AP STA obtains the start time of the R-TWT SP as follows: the TSF timer at which that R-TWT is scheduled has bits 0 to 5 equal to 0, bits 6 to 9 equal to the four MSBs of the Nominal Minimum TWT Wake Duration/Target Wake Time Extension field, bits 10 to 25 equal to the value of the Target Wake Time field, and bits 26 to 63 equal to the same value as the respective bits in the current value of the TSF timer of the UHR R-TWT scheduling AP.

37.8 Multi-AP coordination (MAPC) framework

37.8.1 Common procedures for all multi-AP coordination schemes

37.8.1.1 General

[CID3710, CID1439] The MAPC framework includes a set of schemes (Co-BF, Co-SR, Co-TDMA, and Co-RTWT) and procedures in which APs operating their BSSs on the same primary 20 MHz channel coordinate to reduce interference levels and to improve network performance such as medium utilization efficiency, communication reliability, and latency.

An AP may use a MAPC scheme with another AP if it has established an agreement for that MAPC scheme by following the procedures defined in 37.8.1 or via other means out of the scope of this standard.

This subclause details the common procedures applicable for all the coordination schemes. The MAPC discovery procedure is defined in 37.8.1.2 (MAPC discovery). The MAPC agreement negotiation procedure is defined in 37.8.1.3 (MAPC agreement negotiation).

NOTE — For example, two APs that belong to the same ESS can enable the use of MAPC schemes via other means than the MAPC discovery and MAPC agreement negotiation procedures defined in this subclause.

All other procedures that are specific to each coordination scheme are detailed in 37.8.2 (Procedures for specific multi-AP coordination schemes).

37.8.1.2 MAPC discovery

This subclause defines MAPC discovery procedures for APs to advertise and discover MAPC capabilities and parameters of other APs.

An AP may advertise its MAPC capabilities, common MAPC parameters, and parameters specific to MAPC schemes by transmitting a MAPC Discovery Request frame (see 9.6.7.x (MAPC Discovery Request frame format)) to the broadcast address, or as an individually addressed frame to another AP.

If an AP receives a soliciting MAPC Discovery Request frame from a transmitting AP, the AP shall respond by sending a MAPC Discovery Response frame to the broadcast address or as an individually addressed Management frame to the transmitting AP. The value of the Dialog Token field of the MAPC Discovery Response frame (see Figure 9-J1b) by the AP shall be set equal to the value of the Dialog Token field of the soliciting MAPC Discovery Request frame.

An AP that transmits a MAPC Discovery Request frame or a MAPC Discovery Response frame may include a Per-Scheme Profile subelement in the reported MAPC element for each MAPC scheme for which it signals a capability (see Figure 9-X5). The AP shall not include the MAPC Scheme Request Set field in the reported Per-Scheme Profile subelements.

37.8.1.3 MAPC agreement negotiation

37.8.1.3.1 General

[CID1408]

This subclause defines procedures for MAPC agreement negotiation. An AP shall follow the rules defined in this subclause to establish[CID669], update, or teardown MAPC agreement(s) via negotiation, in addition to the specific rules for specific multi-AP coordination schemes defined in 37.8.2 (Procedures for specific multi-AP coordination schemes).

A MAPC requesting AP is an AP that initiates a MAPC negotiation for one or more MAPC schemes with another AP.

[CID1050, CID2118, CID3179]A MAPC requesting AP shall not initiate a MAPC negotiation for a specific MAPC scheme with a peer AP if the peer AP has set the corresponding field for the support of that MAPC scheme in the MAPC Common Info field (see Figure 9-X5 (MAPC Capabilities field format)) reported in the MAPC Discovery Request frame, MAPC Discovery Response frame, or MAPC Negotiation Request frame most recently received by the MAPC requesting AP to 0.

A MAPC responding AP is an AP that responds to a MAPC requesting AP.

[CID3257] A MAPC requesting AP may initiate a MAPC negotiation for one or more MAPC schemes by sending an individually addressed MAPC Negotiation Request frame (see 9.6.7.57 (MAPC Negotiation Request frame format)) to a MAPC responding AP. The MAPC Negotiation Request frame shall include a MAPC element including at least one Per-Scheme Profile subelement in the MAPC Schemes Info field. Additionally, the MAPC requesting AP shall not include the Per-Scheme Profile subelement for a specific MAPC scheme in the MAPC element (see Table 9-K2) if it has not indicated support for that MAPC scheme in the MAPC Capabilities field carried in the MAPC element (see Figure 9-X5). If a Per-Scheme Profile subelement is included in the MAPC element, it shall carry the MAPC Scheme Request Set field including at least one MAPC Scheme Request field.

NOTE —Each Per-Scheme Profile subelement of the MAPC Schemes Info field in a MAPC Negotiation Request frame carries request(s) for a specific MAPC scheme (see 9.4.2.aa3.2 (MAPC Schemes Info field)).

[CID3257]A MAPC responding AP that receives an individually addressed MAPC Negotiation Request frame from a MAPC requesting AP shall respond by sending an individually addressed MAPC Negotiation Response frame to the MAPC requesting AP. The value of the Dialog Token field of the MAPC Negotiation Response frame (see Figure 9-J3) shall be set equal to the value of the Dialog Token field of the MAPC Negotiation Request frame (see Figure 9-J2). The MAPC Negotiation Response frame shall include a MAPC element including one Per-Scheme Profile subelement in the MAPC Schemes Info field for each Per-Scheme Profile subelement included by the MAPC requesting AP in the MAPC Negotiation Request frame. [CID1416]In the MAPC Negotiation Response frame, each Per-Scheme Profile subelement shall include a MAPC Scheme Request field with MAPC Operation Type field set to 3 (see Table 9-K5) and including a Status Code field for each corresponding MAPC Scheme Request field received in the MAPC Negotiation Request frame. If the AP accepts a request, the corresponding Status Code field shall be set to SUCCESS. If the AP rejects a request, it shall set the corresponding Status field to indicate an appropriate rejection status code as per Table 9-80 (Status codes).

After two APs establish a MAPC agreement, any of the two APs may initiate a MAPC negotiation as MAPC requesting AP to update or teardown the MAPC agreement.

37.8.1.3.2 MAPC agreement establishment

To request for a new agreement establishment, the MAPC requesting AP shall set the MAPC Operation Type field to 0 (see Table 9-K5) and shall include the MAPC Scheme Parameters Set field in the MAPC Scheme Request field that carries the request.

[CID1050, CID1717, CID1718, CID2118]A MAPC requesting AP shall not request to establish a new agreement for a specific MAPC scheme if the MAPC responding AP has set to 0 the corresponding field for enabling MAPC agreement establishment for that MAPC scheme (see Figure 9-X6) in the MAPC Discovery Request frame, MAPC Discovery Response frame, or MAPC Negotiation Request frame most recently received by the MAPC requesting AP.

To accept or reject a MAPC agreement establishment, the MAPC responding AP shall follow the rules defined in 37.8.1.3.1 (General).

If the MAPC responding AP has accepted the request to establish a new MAPC agreement for a specific MAPC scheme, the MAPC requesting AP and the MAPC responding AP have established a MAPC agreement for that specific MAPC scheme.

NOTE —If, for example, a MAPC requesting AP transmits a MAPC Negotiation Request frame including a Co-BF profile and a Co-RTWT profile, where the Co-BF profile includes a MAPC Scheme Request field for a new agreement establishment request (MAPC Operation Type is set to 0) and the Co-RTWT profile includes three MAPC Scheme Request fields for three new agreement establishment requests, the MAPC responding AP responds with a MAPC Negotiation Response frame including a Co-BF profile and a Co-RTWT profile, where the Co-BF profile includes a MAPC Scheme Request field indicating whether the new agreement establishment request is accepted or rejected and the Co-RTWT profile includes three MAPC Scheme Request fields each indicating whether a new agreement establishment request is accepted or rejected. In this example the MAPC requesting AP and the MAPC responding AP can establish up to one Co-BF agreement, and up to three Co-RTWT agreements (one for each R-TWT schedule).

A MAPC requesting AP and a MAPC responding AP may establish up to one MAPC agreement for each one of Co-BF, Co-SR, and Co-TDMA, and up to one MAPC agreement per R-TWT schedule for Co-RTWT.

37.8.1.3.2.1 AP ID assignment

When an AP participates in a MAPC negotiation to establish new MAPC agreement(s) as defined in 37.8.1.3.2 (MAPC agreement establishment), the AP shall additionally follow the rules defined in this subclause to assign an AP ID to a peer AP with which the AP establishes a MAPC agreement.

The AP ID is as described in 9.4.1.8 (AID field).

The same AP ID value shall not be assigned by the AP or by its affiliated MLD to any other STA.

NOTE— The STA is an associated non-AP STA, an unassociated non-AP STA that has been allocated a (Ranging session Identifier) RSID, any other coordinated AP, or a non-AP MLD that is associated with the AP MLD.

The same AP ID value shall not be assigned by any other AP within the same multiple BSSID set to any other STA.

The AP ID value shall not be assigned by any other AP MLD that has any affiliated AP within the same multiple BSSID set to any other non-AP MLD.

The AP ID value shall be greater than 2n where n the value carried in the MBSSID Indicator (n) field of the Multiple BSSID element if the AP belongs to a multiple BSSID set.

To assign an AP ID to another AP, an AP shall include the AP ID field in a MAPC element (see 9.4.2.aa3 (MAPC element)).

A MAPC requesting AP shall include the AP ID field in the MAPC element carried in the transmitted MAPC Negotiation Request frame only if the MAPC requesting AP has not established any MAPC agreement for any one of Co-BF, Co-SR, or Co-TDMA with the MAPC responding AP and the MAPC requesting AP is requesting to establish a new MAPC agreement for any one of Co-BF, Co-SR, or Co-TDMA by following the rules defined in 37.8.1.3.2.

A MAPC responding AP shall include the AP ID field in the MAPC element carried in the transmitted MAPC Negotiation Response frame, only if it has not established any MAPC agreement for any one of Co-BF, Co-SR, or Co-TDMA with the MAPC requesting AP and it is accepting a new MAPC agreement for any one of Co-BF, Co-SR, or Co-TDMA by following the rules defined in 37.8.1.3.2.

NOTE —For example, if the MAPC responding AP rejects all the requests for new agreements establishment, and there are no previously existing agreements, then the AP ID assignment from the MAPC requesting AP is considered void, and the MAPC responding AP does not assign an AP ID in the MAPC Negotiation Response frame.

The AP IDs assigned to the MAPC requesting AP and the MAPC responding AP remain valid until at least one established agreement among Co-BF, Co-SR, and Co-TDMA is in existence between the two APs.

37.8.1.3.3 MAPC agreement update

To request a parameter update for an established MAPC agreement, the MAPC requesting AP shall set the MAPC Operation Type field to 1 (see Table 9-K5) and shall include the corresponding MAPC Request Parameter Set field in the MAPC Scheme Request field that carries the request.

To accept or reject an update of an existing MAPC agreement, the MAPC responding AP shall follow the rules defined in 37.8.1.3.1 (General). If the MAPC responding AP rejects the update, the agreement update procedure fails and the parameters of the MAPC agreement are not updated.

37.8.1.3.4 MAPC agreement teardown

[CID1414]

To request the teardown of an existing agreement, the MAPC requesting AP shall set the MAPC Operation Type field to 2 (see Table 9-K5) in the MAPC Scheme Request field that carries the request.

The MAPC responding AP shall accept the request to teardown an existing MAPC agreement by following the rules defined in 37.8.1.3.1 (General).

NOTE —When a MAPC requesting AP tears down the last MAPC agreement among Co-BF, Co-SR, and Co-TDMA with a MAPC responding AP, the mutually assigned AP IDs are released and their values can be reassigned.

37.8.2 Procedures for specific multi-AP coordination schemes

**37.8.2.4 Coordinated R-TWT (Co-RTWT)**

***TGbn editor: Please apply the following changes to the body of subclause 37.8.2.4 (Coordinated R-TWT (Co-RTWT)):***

**37.8.2.4.1 General**

[CID3259]

Coordinated restricted target wake time (Co-RTWT) operations described in subclause 37.8.2.4 (Coordinated Restricted TWT (Co-RTWT)) enable an AP to coordinate its R-TWT schedule(s) with OBSS AP(s) and/or obtain extended protection for its R-TWT schedule(s) from OBSS APs and their BSSs.

A Co-RTWT requesting AP is an AP with [CID1715]dot11CoRTWTOptionImplemented equal to true that requests protection for one or more of its R-TWT schedules. A Co-RTWT requesting AP may request protection for its R-TWT schedule(s) either via Co-RTWT negotiations or via other means [CID1716, CID1719, CID2117, CID2674, CID3175, CID3885]out of the scope of this standard.

[CID3176, CID3177, CID3445, CID3446]

[CID3176, CID3177, CID3445, CID3446]A Co-RTWT coordinated AP is an AP with [CID1715]dot11CoRTWTOptionImplemented equal to true that extends protection for R-TWT schedule(s) that are requested by a Co-RTWT requesting AP, either via Co-RTWT negotiations or via other means [CID1716, CID1719, CID2117, CID2674, CID3175, CID3885]out of the scope of this standard, [CID832, CID3450, CID3582]by following the rules defined in 37.8.2.4.3 (Co-RTWT announcement rules) and 37.8.2.4.4 (TXOP and backoff procedure rules for Co-RTWT SPs).

Co-RTWT negotiation(s) to establish Co-RTWT agreement(s) are performed by following the rules defined in [CID1050, CID1408, CID1414, CID1416, CID1417, CID1717, CID1718, CID3257]37.8.1.3 (MAPC agreement negotiation procedure) and 37.8.2.4.2 (Co-RTWT negotiations).

[CID3176, CID3177, CID3445, CID3446]

[CID1716, CID1719, CID2117, CID2674, CID3175, CID3445, CID3446, CID3885]NOTE—An AP with dot11CoRTWTOptionImplemented set to 1 can participate in Co-RTWT by means that do not follow the protocol defined in 37.8.1 and are out of the scope of this standard. For example, an AP (Co-RTWT coordinated AP) can be configured by the network to extend protection for R-TWT schedules of another AP (Co-RTWT requesting AP) in the same ESS. In another example, an AP (Co-RTWT coordinated AP) might listen to the Beacon frame of another AP (Co-RTWT requesting AP) in the same ESS and extend protection for R-TWT schedules that are announced in that Beacon frame.

**37.8.2.4.2 Co-RTWT negotiations**

[M#281, M#362]

[CID3447][CID3710]

[CID1806, CID3179, CID3447, CID3448, CID3710, CID3886, CID3887, CID3888]A Co-RTWT requesting AP that follow the rules defined in 37.8.1.3 (MAPC agreement negotiation) to establish, update, or tear down Co-RTWT agreement(s) is also a MAPC requesting AP and additionally follows the rules defined in this subclause.

[CID1721, CID1806, CID3447, CID3448]The Co-RTWT requesting AP shall include a Co-RTWT profile in the MAPC element carried in a transmitted individually addressed MAPC Negotiation Request frame. [CID3449]The Co-RTWT profile shall include one or more MAPC Scheme Request fields where each corresponds to an R-TWT schedule. The Broadcast TWT ID field included in the MAPC Info field of the MAPC Request Control field identifies the R-TWT schedule, [CID1413]and shall be set equal to the value of the Broadcast TWT ID field of the Restricted TWT Parameter Set field corresponding to the R-TWT schedule that is announced by the Co-RTWT requesting AP in its own BSS (see 35.8.3.1 (Rules for R-TWT scheduling AP)). [CID880]The MAPC Operation Type shall be set to 0 to establish a new Co-RTWT agreement, to 1 to update an existing Co-RTWT agreement, [CID1414, M#342]or to 2 to teardown an existing Co-RTWT agreement (see Table 9-K5). If the MAPC Operation Type is set to 0 or 1, the MAPC Request Parameter Set field defined in 9.4.2.aa3.2.5 (Co-RTWT profile) shall be included in the MAPC Scheme Request field.

[CID1721, CID1806, CID3447, CID3448, CID3178]If the MAPC Request Parameter Set field is included in the MAPC Scheme Request field for an R-TWT schedule, the MAPC Request Parameter Set field shall specify the associated Co-RTWT parameter set as follows: the Target Wake Time field, the Nominal Minimum TWT Wake Duration field, the TWT Wake Interval Mantissa field, the TWT Wake Interval Exponent field, the Broadcast TWT Persistence field, and the Restricted TWT Schedule Info field shall be set equal to the value of the Target Wake Time field, Nominal Minimum TWT Wake Duration field, the TWT Wake Interval Mantissa field, the TWT Wake Interval Exponent field, the Broadcast TWT Persistence field, and the Restricted TWT Schedule Info field, respectively, as reported in the Restricted TWT Parameter Set field corresponding to the R-TWT schedule that is announced by the Co-RTWT requesting AP in its own BSS as defined in 35.8.3.1.

An AP that responds to a Co-RTWT requesting AP in a MAPC agreement negotiation for Co-RTWT agreement(s) is also a MAPC responding AP and responds by following the rules defined in 37.8.1.3.

An AP that has established one or more MAPC agreements for Co-RTWT with a Co-RTWT requesting AP is a Co-RTWT coordinated AP.

Each Co-RTWT agreement is uniquely identified by the <broadcast TWT ID, MAC address> tuple, where the broadcast TWT ID is the value of the Broadcast TWT ID field (see 9.4.2.aa3.2.5 (Co-RTWT profile)) and is greater than 0 and the MAC address is the address of the Co-RTWT requesting AP.

**37.8.2.4.3 Co-RTWT announcement rules**

[CID1435, CID3582, CID1419]As part of extending protection for R-TWT schedule(s) of a Co-RTWT requesting AP, the Co-RTWT coordinated AP shall advertise the [CID3884]active R-TWT schedule(s) in its transmitted Beacon frames if the Co-RTWT coordinated AP has at least one associated STA that supports R-TWT.

[CID1720, CID3181, CID3795, CID2119]NOTE —The Co-RTWT 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).

To advertise [CID3884]active R-TWT schedule(s) of a Co-RTWT requesting AP, the Co-RTWT coordinated AP shall announce R-TWT schedule(s) information by including Restricted TWT Parameter Set field(s) in the Broadcast TWT element defined in 9.4.2.198 (TWT element) and contained in transmitted Management frame(s) as specified in 26.8.3 (Broadcast TWT operation), 35.8 (Restricted TWT (R-TWT)), and by additionally following the rules defined in this subclause.

[CID439, CID1420]When a Co-RTWT coordinated AP advertises an [CID3884]active R-TWT schedule of a Co-RTWT requesting AP, the Co-RTWT coordinated AP shall include a Restricted Parameter Set field describing the R-TWT schedule in the Broadcast TWT element:

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

[CID439, CID1420]When a Co-RTWT coordinated AP in a co-hosted BSSID set advertises an [CID3884]active R-TWT schedule of a Co-RTWT requesting AP, then all the other APs in the same co-hosted BSSID set are Co-RTWT coordinated APs and shall advertise the same R-TWT schedule:

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

[CID1721]When a Co-RTWT coordinated AP advertises an [CID3884]active R-TWT schedule of a Co-RTWT requesting AP, the Co-RTWT coordinated AP shall set all the other parameters of the Restricted TWT Parameter Set field as follows:

* The TWT Wake Interval Exponent field, the TWT Wake Interval Mantissa field shall be set equal to the corresponding value in the Co-RTWT parameter set,
* [CID202, CID277, CID1411, CID2519] The Target Wake Time field shall be set to [10:25], where corresponds to the start time of the R-TWT scheduled for this Restricted TWT parameter set that will occur after the Co-RTWT coordinated AP has queued for transmission the frame that contains the TWT element. The value of is obtained by converting the value of the Target Wake Time field of the Co-RTWT parameter set received from the Co-RTWT requesting AP to the Co-RTWT coordinated AP’s local TSF.
* [CID1599, CID3258]The four MSBs of the Nominal Minimum TWT Wake Duration/Target Wake Time Extension field shall be set to [6:9].
* [CID1599, CID3258]The TSF timer at which that R-TWT is scheduled has bits 0 to 5 equal to 0 and bits 26 to 63 equal to the same value as the respective bits in the current value of the TSF timer of the Co-RTWT coordinated AP.
* The Broadcast TWT Persistence subfield for the R-TWT schedule shall be set to a value equal to the number of the Co-RTWT coordinated AP’s TBTTs for which the R-TWT schedule of the Co-RTWT requesting AP is expected to be in existence, counting forward from the current Co-RTWT coordinated AP’s TBTT. [CID830]The value shall be determined by the Co-RTWT coordinated AP to include the TBTT immediately following the time at which the R-TWT schedule of the Co-RTWT requesting AP ceases to exist, that is obtained by the Broadcast TWT Persistence field of the most recent Co-RTWT parameter set. The Co-RTWT coordinated AP may change the value of the Broadcast TWT Persistence subfield for any Broadcast TWT within any transmitted TWT element.

NOTE —A non-AP STA does not request to establish membership in an R-TWT schedule advertised by the R-TWT scheduling AP with the Restricted TWT Schedule Info subfield set to 3 (see 35.8.3.2 (Rules for the R-TWT scheduled STA)).

**37.8.2.4.4 [CID901]TXOP and backoff procedure rules for Co-RTWT SPs**

[CID1435, CID3582]As part of extending protection for R-TWT schedule(s) of a Co-RTWT requesting AP, the Co-RTWT coordinated AP as a TXOP holder shall ensure that its TXOP ends before the start time of any active Co-RTWT SP for which protection is extended.

[CID994]In addition, before starting transmission of any PPDU, the Co-RTWT coordinated AP shall check if there is enough time for the frame exchange to complete prior to the start of the Co-RTWT SP and, if there is not enough time, then the Co-RTWT 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.

# Text to be adopted ends here.

**References:**

1. [11-25-0599r4](https://mentor.ieee.org/802.11/dcn/25/11-25-0599-04-00bn-pdt-mac-mapc-signaling-and-protocol-aspects.docx): 11-25-0599-04-00bn-pdt-mac-mapc-signaling-and-protocol-aspects, Giovanni Chisci (Qualcomm Technologies Inc.) et al.