IEEE P802.11
Wireless LANs

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| PDT MAC MAPC Signaling and Protocol aspects |
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|  |  |  |  |  |

Abstract

This document contains Proposed Draft Text (PDT) for the multi-AP coordination (MAPC) framework 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:

MAPC CIDs:

147, 148, 152, 153, 160, 161, 181, 669, 775, 1318, 1319, 1320, 1324, 1395, 1398, 1399, 1428, 1491, 1494, 1739, 1788, 1789, 2466, 3254, 3438, 3606, 3735, 3779, 3780, 3781.

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

# 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.* Edited definition of multi-AP coordination in 3.2 to match first paragraph in 37.8.1.1 (General)
* Updated Table 9-X2 (clarified variants definitions)
* Updated Table 9-K2 (clarified subelements definitions)
* Clarified text and moved from above Table 9-K1 to below Table 9-K2 to improve clarity
* Edited third paragraph of 37.8.1.2 (MAPC discovery) to provide details of Dialog Token setting
* Renamed fields in Figures 9-J1, 9-J1, 9-J3
 |
| 4 | Revised subclause 9.4.2.aa3.3 to satisfy comments and remodel the signaling to better follow MLO (e.g., added Status Code field, introduced Per-Scheme Profile subelement, introduced CoBF profile, CoSR profile, Co-TDMA profile, Co-RTWT profile, etc.) |
| 5 | Addition of Discussion section with summary of MAPC element design |

# 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.

### Comments (CIDs) resolved:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **Clause** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 147 | Jay Yang | 37.8.1.2 | 71.35 | it will be more efficient to define a Trigger based solution in MAPC disovery. | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID147. |
| 148 | Jay Yang | 37.8.1.2 | 71.35 | the details of MAPC discovery procedure is missing, please add it. | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID148. |
| 152 | Jay Yang | 9.6.7.55a | 63.26 | The details of MPAC Request frame format is missing, and the TBD should be fixed | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID152. |
| 153 | Jay Yang | 9.6.7.55b | 63.33 | The details of MPAC Response frame format is missing, and the TBD should be fixed | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID153. |
| 160 | Jay Yang | 37.8.1.3.2 | 72.08 | If one AP can be sharing AP of Co-SR,Co-BF or Co-TDMA , it may assign the AP ID in MAPC request or MAPC response frame, such AP should advice it's sharing AP's capability is discovery phase. | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID160. |
| 161 | Jay Yang | 37.8.1.3 | 71.43 | The MAPC parameter can be updated due to any reason, we need to define a MAPC parameter update procedure | the commenter will provide a solution on this. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID161. |
| 181 | Jay Yang | 9.6.10 | 63.38 | in Table 9-516, all itemts have the prefix "Protected", please add prefix "Protected" in MAPC Request, and MAPC Response | change "MAPC Request" to "Protected MAPC Request"; change "MAPC Response" to "Protected MAPC Response" | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID181. |
| 669 | Jungjun Kim | 37.8.1.3.1 | 71.48 | MAPC agreement negotiation process should cover not only the establishment but also update of an agreement. | Change "to establish" to "to establish or update". To elaborate difference between the intial agreement establishment and agreement updates, we may add "37.8.1.3.2 Inital agreement establishment" and "37.8.1.3.3 Agreement update". | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID669. |
| 775 | Seongho Byeon | 37.8.1.3 | 71.50 | Suggest changing from "in addition to the specific rules for Multi-AP coordination scheme used for this agreement" to "in addtion to the specific rules for Multi-AP coordiniation scheme(s) used for this agreement", if one agreemment can contain multiple MAPC schemes. | As in comment. | Agree in principle.TGbn editor: please implement changes as shown in this document tagged CID147. |
| 1318 | Jonghoe Koo | 9.6.10 | 63.38 | No motion to use Protected Dual of Public Action frames for MAPC | Remove Section 9.6.10 | RejectedThe comment fails to identify a technical issue. Not all contents in the draft is required to have a motion in the SFD. |
| 1319 | Jonghoe Koo | 9.6.7.55a | 63.26 | No motion to use Protected Dual of Public Action frames for MAPC | Remove Section 9.6.7.55a | RejectedThe comment fails to identify a technical issue. Not all contents in the draft is required to have a motion in the SFD. |
| 1320 | Jonghoe Koo | 9.6.7.55b | 63.32 | No motion to use Protected Dual of Public Action frames for MAPC | Remove Section 9.6.7.55b | RejectedThe comment fails to identify a technical issue. Not all contents in the draft is required to have a motion in the SFD. |
| 1324 | Jonghoe Koo | 37.8.1.2 | 71.37 | We need to specifiy which Management frames can be used for MAPC discovery to address "TBD Management frames". | Specify which Management frames to be used for MAPC discovery, e.g., Beacon frame, a new Action frame, one of existing Action frame with a new Action value, and etc. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1324. |
| 1395 | Renlong Zhou | 37.8.1.3 | 71.43 | A standardized procedure for updating MAPC parameters needs to be established to accommodate dynamic operational requirements. | As it says in the comment | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1395. |
| 1398 | Insun Jang | 37.8.1.2 | 71.38 | TBD frame for advertising MAPC capabilties should be defined | It can be Beacon and/or other Action frames1) In case of Action frame, its periodicity or when it is transmitted should be considered2) The information of MAPC capabilities should be defined (e.g., possible MAPC type) | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1398. |
| 1399 | Insun Jang | 37.8.1.3.1 | 71.54 | TBD frame for negotiatinig agreements should be defined | 1) It should be new Action frames (e.g., MAPC Request/Response frame)2) It allows to negotiate the agreements of one or more MAPC scheme(s) and therefore it should include an element for MAPC that consists of Common Info across all requested MAPC schemes and per-requested MAPC scheme info3) In response frame, Status code has to be introduced at least per MAPC scheme (especially for Co-RTWT, per schedule (i.e., Broadcast TWT ID)) | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1399. |
| 1428 | Akira Kishida | 37.8.1.3 MAPC agreement negotiation | 71.55 | The frame types for establishing the MAPC agreement by the MAPC initiating AP should not be limited to the management frame(s). | Consider there is room for using other frame types, such as control frame(s). | RejectedThere are passing motions for Management frames that provide a complete solution. The comment fails to identify the technical need of using Control frames for the purpose. |
| 1491 | Kotaro NAGANO | 37.8.1.3 MAPC agreement negotiation | 71.55 | The maximum number of APs in "... MAPC agreement with the one or more UHR APs." is unclear. | The maximum number of APs in the MAPC should be specified to determine the number of octets in the AP ID. | RevisedPassing motions underline pair-wise negotiations between APs to establish agreements. Clarifications are provided.TGbn editor: please implement changes as shown in this document tagged CID1491. |
| 1494 | Kotaro NAGANO | 37.8.1.2 MAPC discovery | 38.38 | The timing or trigger of frame exchange in the "UHR APs participating in MAPC may transmit TBD Management frames..." is unclear. | If the capabilities of Multi-AP coordination schemes and parameters vary depending on the environment and conditions, the timing and conditions under which management frames must be sent should be described. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1494. |
| 1739 | Kosuke Aio | 37.8.1.3.1 | 71.48 | For detailed negotiations on MAPC, it is necessary to cover cases where multiple APs have different primary channels set. | Please define the procedure to set the same primary channel for MAPC in the negotiation. | RejectedThe comment fails to identify a technical issue. |
| 1788 | Junichi Iwatani | 37.8.1.3.1 | 71.48 | Need to clarify the conditions of APs that can establish an agreement of MAPC, such as the conditions of the primary channel or bandwidth. | As in comment. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID1788. |
| 1789 | Junichi Iwatani | 37.8.1.3.1 | 71.55 | The procedures for canceling an agreement of MACP should be described. (e.g., an agreeement may be canceled by using Management frame(s)) | As in comment. | Agree in principle.TGbn editor: please implement changes as shown in this document tagged CID1789. |
| 2466 | Yanjun Sun | 9.6.10 | 63.53 | There is no motion yet on protected frames for MAPC, so it's premature to include protected dual for MAPC Request and Response. It looks that this can be resolved in one of the two ways: 1) delete them from 9.6.10 for now. 2) get a motion passed to support this and make sure the protection also applies to control frames among the APs, which are likely sent over the air more frequently. | as in comment | RejectedThe comment fails to identify a technical issue. Not all contents in the draft is required to have a motion in the SFD. |
| 3254 | GEORGE CHERIAN | 37.8.1.2 | 71.38 | Define the management frame for MAC discovery | As in the comment | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID3254. |
| 3438 | Muhammad Kumail Haider | 37.8.1.3.1 | 71.46 | The framework should allow negotiation of multiple MAPC schemes with a single management frame if the two (or more) APs support the same (sub)set of MAPC schemes |   | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID3438. |
| 3606 | kaiying Lu | 37.8.1.2 | 71.35 | Describe the MAPC discovery procedure in details | As in comment. | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID3606. |
| 3735 | Jiayi Zhang | 37.8.1.3.1 | 71.58 | How does the cooridnating AP select one MAPC scheme of multiple schemes negotiated with the coordinated AP? The coordinated AP may indicate its preferred/recommnended scheme to the coordinating AP, and then the coordinating AP can consider the preferred scheme indicated by the coordinated AP when the coordinating AP selects the MAPC scheme | Define a mechanism for the coordinating AP to select one MAPC scheme of multiple schemes negotiated with the coordinated AP. | RejectedThe coordination scheme for TXOP based coordination (like Co-BF, Co-SR, Co-TDMA) are selected based on the general objective of the TXOP holder (i.e., reduce interference, or share portion of unused TXOP). The comment fails to identify the technical need for adding the proposed mechanism. |
| 3779 | Yongho Seok | 37.8.1.2 | 71.41 | "Details are TBD."MAPC discovery should be simple, and it is not necessary to broadcast it in the Beacon frame | As in the comment | RevisedAgree in principle.TGbn editor: please implement changes as shown in this document tagged CID3779. |
| 3780 | Yongho Seok | 37.8.1.3.1 | 71.54 | "...and may transmit TBD individually addressed Management frame(s) to establish a MAPC agreement with the one or more UHR APs."The negotiation can be performed over the DS. Please clarify that the negotiation procedure over the air is not an only way for the MAPC. | As in the comment | RevisedAgree in principleTGbn editor: please implement changes as shown in this document tagged CID3780. |
| 3781 | Yongho Seok | 37.8.1.3.2 | 72.03 | "A UHR AP shall follow the rules defined in this subclause additionally to the rules defined in 37.8.1.3 (MAPC agreement negotiation) to assign an AP ID to another AP with which it establishes a MAPC agreement."Since the negotiation can be performed over the DS (i.e., Multi-AP Coordination Over-the-DS), 'shall' should be changed to 'may'. | As in the comment | RevisedAgree in principle that the following the rules of this subclause is conditional to be establishing a new agreement. A clarification is provided.TGbn editor: please implement changes as shown in this document tagged CID3781. |

# Discussion:

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



# 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:***

**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.aa3 MAPC element

***TGbn editor: Please modify the body of subclause 9.4.2.aa3 (MAPC element) as follows:***

9.4.2.aa3.1 General

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 B2 | B3 B7 |
|  | MAPC Type | Presence Bitmap |
| Bits: | 3 | 5 |

Figure 9-X1—MAPC Control field

The MAPC Type field is defined in Table 9-X2 (MAPC Type field encoding) and is used to differentiate the variants of the MAPC element. The format of each variant of the MAPC element is defined in the subclauses below.

**Table 9-X2—MAPC Type field encoding**

|  |  |
| --- | --- |
| **MAPC Type field value** | **MAPC element variant name** |
| 0 | MAPC Discovery element |
| 1 | MAPC Negotiation element  |
| **2-7** | Reserved |

The Presence Bitmap field is used to indicate the presence of various fields in the MAPC Common Info field and has the format defined in Figure 9-X3 (Presence Bitmap field format).

|  |  |  |
| --- | --- | --- |
|  | B0 | B1 B4 |
|  | AP ID Present | Reserved |
| Bits: | 1 | 4 |

Figure 9-X3— Presence Bitmap field format

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.

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 responds with a non-TB PPDU to a Trigger frame.

The Co-BF Supported field indicates whether an AP supports Co-BF and is set to 1 if the AP has dot11CoBfOptionImplemented set to true. Otherwise, the Co-BF Supported field is set to 0.

The Co-SR Supported field indicates whether an AP supports Co-SR and is set to 1 if the AP has dot11CoSrOptionImplemented set to true. Otherwise, the Co-SR Supported field is set to 0.

The Co-TDMA Supported field indicates whether an AP supports Co-TDMA and is set to 1 if the AP has dot11CoTdmaOptionImplemented set to true. Otherwise, the Co-TDMA Supported field is set to 0.

The Co-RTWT Supported field indicates whether an AP supports Co-RTWT and is set to 1 if the AP has dot11CoRTWTOptionImplemented set to true. 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 B7 |
|  | MAPC Agreement Establishment Enabled | Reserved |
| Bits: | 1 | 7 |

Figure 9-X6— MAPC Parameters field format

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

The AP ID field is used to assign an AP ID to another AP that is participating in the coordination. The AP ID field is optionally included in the MAPC Common Info field of a Negotiation 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

The MAPC Schemes Info field carries information specific to one or more MAPC schemes and is optionally present. The MAPC Schemes Info field is not present in the Discovery MAPC element. The MAPC Schemes Info field is present in the Negotiation MAPC element. 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 |  |

If the MAPC Schemes Info field is present, it consists of one or more Per-Scheme Profile subelements along with other optional subelements in Table 9-K0 (Optional subelement IDs of the MAPC Schemes Info field).

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 Information Set |
| Octets: | 1 | 1 | 1 | 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 ID | Reserved |
| Bits: | 4 | 4 |

Figure 9-K1b— MAPC Scheme Control field format

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

**Table 9-K2—** **MAPC Scheme ID 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 at most a single Co-BF profile, Co-SR profile, Co-TDMA profile, and Co-RTWT profile.

The MAPC Scheme Information Set field carried in a Co-BF, Co-SR, or Co-TDMA profile contains a single MAPC Scheme Information field. The MAPC Scheme Information Set field carried in a Co-RTWT profile contains one or more MAPC Scheme Information fields, each corresponding to an R-TWT schedule.

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

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

Figure 9-K3— MAPC Scheme Information field format

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, 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 frame** | **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 is optionally included (see Table 9-K5). The formats of the MAPC Operation Parameters field and the MAPC Request Parameter Set field are 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).

9.4.2.aa3.2.2 Co-BF profile

The MAPC Scheme ID 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.

The format of the MAPC Request Parameter Set field of the Co-BF profile is TBD.

9.4.2.aa3.2.3 Co-SR profile

The MAPC Scheme ID 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.

The format of the MAPC Request Parameter Set field of the Co-SR profile is TBD.

9.4.2.aa3.2.4 Co-TDMA profile

The MAPC Scheme ID 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.

The format of the MAPC Request Parameter Set field of the Co-TDMA profile is TBD.

9.4.2.aa3.2.5 Co-RTWT profile

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

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

* The MAPC Info field carries 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 Information field that follows this MAPC Scheme Information field. The Last MAPC Request field is set to 1 to indicate that this is the last MAPC Scheme Information field in the Co-RTWT profile.

The format of the MAPC Request Parameter Set field of the Co-RTWT profile is TBD.

9.6.7 Public Action frame details

***TGbn editor: Please modify the body of subclause 9.6.7 (Public Action frame details) as follows:***

[M#358]

9.6.7.1 Public Action field

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

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

9.6.7.x MAPC Discovery frame format

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

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

Figure 9-J1— MAPC Discovery 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 frame.

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

9.6.7.55a MAPC Negotiation Request frame format

[CID152]

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 Negotiation MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

9.6.7.55b MAPC Negotiation Response frame format

[CID153]

The MAPC Negotiation Response frame is used by an AP to respond to 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 Negotiation MAPC element as defined in 9.4.2.aa3.1 (MAPC element).

9.6.10 Protected Dual of Public Action frame details

***TGbn editor: Please modify the body of subclause 9.6.10 (Protected Dual of Public Action frame details) as follows:***

[M#358, CID181]

**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 ) |
| … | … |  |

37.8 Multi-AP coordination (MAPC) framework

***TGbn editor: Please apply the following changes to the body of subclause 37.8 (Multi-AP coordination framework):***

37.8.1 Common procedures for all multi-AP coordination schemes

37.8.1.1 General

[CID1788]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.

[CID3780]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 37.8.1.3 or via other means out of the scope of this standard.

NOTE —An AP can enable the use of MAPC schemes by using the rules for MAPC Discovery and MAPC agreement negotiation defined in this subclause. Alternatively, an AP can enable the use of MAPC schemes via other means such as backhaul coordination and programming by a network controller.

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).

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

[CID3606, CID3779, M#359]

This subclause defines MAPC discovery procedures for APs to advertise and discover their MAPC capabilities and common MAPC parameters.

[CID147, CID148, CID1324 CID1398, CID3254] An AP may advertise its MAPC capabilities and common MAPC parameters by transmitting a MAPC Discovery frame (see 9.6.7.x (MAPC Discovery frame format)) to the broadcast address, or as an individually addressed frame to another AP.

If an AP receives a soliciting individually addressed MAPC Discovery frame from a transmitting AP, the AP shall send an individually addressed MAPC Discovery frame as a response to the transmitting AP. The value of the Dialog Token field of the MAPC Discovery frame (see Figure 9-J1) sent as a response by the AP shall be set to match the value of the Dialog Token field of the soliciting MAPC Discovery frame.

[CID1494] NOTE —An AP that receives a frame including MAPC Capabilities field from another AP does not expect the setting of the MAPC Capabilities field to change in subsequently received frames from the same AP. An AP that receives a frame including MAPC Parameters field from another AP expects that the setting of the MAPC Parameters field may change in subsequently received frames from the same AP. For example, a transmitting AP sets the Co-BF Supported field of the MAPC Capabilities field to 1 in any frame containing the MAPC Capabilities field it transmits. Conversely, when a transmitting AP sets the MAPC Agreement Establishment Enabled field of the MAPC Parameters field to 1, the AP may toggle the parameter’s value to 0 in a subsequent frame that includes the MAPC Parameters field.

37.8.1.3 MAPC agreement negotiation

[M#360, M#361]

37.8.1.3.1 General

[CID1399]

This subclause defines procedures for MAPC agreement negotiation. An AP shall follow the rules defined in this subclause to establish, update, [M#342]or teardown MAPC agreement(s) via negotiation, in addition to the specific rules for specific multi-AP coordination scheme[CID775]s defined in 37.8.2 (Procedures for specific multi-AP coordination schemes).

A MAPC requesting AP is an AP that initiates a MAPC negotiation [CID775, CID3438]for one or more MAPC schemes with [CID1491]another AP.

[CID1494]A MAPC requesting AP may initiate a negotiation for a set of MAPC schemes with another AP only if it has received from that AP a MAPC Discovery frame or a MAPC Negotiation Request frame including a MAPC element that carries the MAPC Capabilities field in the MAPC Common Info field, where support for the set of MAPC schemes is indicated.

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

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 Negotiation MAPC element including at least one Per-Scheme Profile subelement in the MAPC Schemes Info field. Additionally, the MAPC requesting AP may include the Per-Scheme Profile subelement for a specific MAPC scheme in the Negotiation MAPC element (see Table 9-K2) only if it indicates support for that MAPC scheme in the MAPC Capabilities field carried in the Negotiation MAPC element (see Figure 9-X5).

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)). Each MAPC Scheme Information field carried in the Per-Scheme Profile subelement corresponds to a specific request. A MAPC requesting AP can include at most one Per-Scheme Profile subelement per MAPC scheme in the MAPC Schemes Info field. The Co-BF, Co-SR, and Co-TDMA profiles can carry a single MAPC Scheme Information field, which carries a MAPC Operation Type defining the type of request (agreement establishment, update or teardown). The Co-RTWT profile can carry one or more MAPC Scheme Information fields (one for each R-TWT schedule), each of which carries a single MAPC Operation Type defining the type of request.

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 to match 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 Negotiation MAPC element including a Per-Scheme Profile subelement in the MAPC Schemes Info field corresponding to each Per-Scheme Profile subelement included by the MAPC requesting AP in the MAPC Negotiation Request frame. In the MAPC Negotiation Response frame, each Per-Scheme Profile subelement shall include a MAPC Scheme Information field with MAPC Operation Type field set to 3 (see Table 9-K5) and including a Status Code field for each corresponding MAPC Scheme Information 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).

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 Request Parameter Set field in the MAPC Scheme Information field that carries the request.[CID1494]A MAPC requesting AP shall not request to establish a new agreement for a specific MAPC scheme if the MAPC responding 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 of the MAPC element format)) of a MAPC element reported in the most recently received MAPC Discovery frame or a MAPC Negotiation Request frame to 0.

[CID1494] A MAPC requesting AP shall not request to establish a new agreement for any MAPC scheme if the MAPC responding AP has set the MAPC Agreement Establishment Enabled field (see Figure 9-X6) in the most recently transmitted MAPC Discovery frame or a MAPC Negotiation Request frame to 0.

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 Information field for a new agreement establishment request (MAPC Operation Type is set to 0) and the Co-RTWT profile includes three MAPC Scheme Information 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 Information field indicating whether the new agreement establishment request is accepted or rejected and the Co-RTWT profile includes three MAPC Scheme Information 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 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

[CID3781] 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 another AP with which it 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— 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.

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 Negotiation MAPC element (see 9.4.2.aa3 (MAPC element)).

[CID160] A MAPC requesting AP shall include the AP ID field in the Negotiation MAPC element carried in the transmitted MAPC Negotiation Request frame only if it has not established any MAPC agreement for any one of Co-BF, Co-SR, or Co-TDMA with the MAPC responding AP and it 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.

The AP ID assignment from the MAPC requesting AP to the MAPC responding AP shall be valid only if there is at least one established agreement for any one of Co-BF, Co-SR, or Co-TDMA between the two APs.

A MAPC responding AP shall include the AP ID field in the Negotiation 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, 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 shall be 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

[CID161, CID1395]

To request parameters 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 Information 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

[CID1789, M#342]

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 Information 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 can be reassigned.

# Text to be adopted ends here.

**References:**