IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Multi-band discovery assistance normative text | | | | |
| Date: 2018-03-06 | | | | |
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Abstract

This document provides suggested changes to solve a concern raised in 802.11ay comment collection (CID 1771).

# Comment:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CID** | **PP.LL** | **Comment** | **Proposed Change** | **Suggested Resolution** |
| 1771 | 135.2 | If TDD channel access is operated as shown in 11-17/1321, DMG Beacon frames are not transmitted periodically, and it would be hard for STAs to discover operating BSS. We need a procedure to enable network discovery for this mode of operation. | Please consider to add a network discovery method for TDD channel access mode that operates similar to 11-17/1321. There should be a way to enable it leveraging existing framework such as multiband operation. | REVISED:   Adopt changes proposed in doc11-18/491 |

# Discussion:

This submission proposes suggested normative text to include multi-band discovery assistance procedure as discussed in 11-18/486 “Multi-band discovery assistance”.

This proposal provides the following benefits:

1. By using multi-band discovery assistance, a new STA joining a distribution network can obtain operational parameter for the TDD beamforming. Also, AP/PCP can obtain when a new STA is trying to join the BSS and trigger beamforming procedure for the new STA, only relying on 802.11 protocol.
2. By using multi-band discovery assistance, AP/PCP can obtain when a new STA is trying to join the BSS. As a result, on-demand exhaustive DMG beacon transmission will be possible. AP/PCP can eliminate unnecessary DMG beacon transmissions when it is not necessary. It will be helpful to reduce beaconing overhead and to shorten Data frame blackout duration within a beacon interval.

# Summary of the suggested change:

1. Include multi-band discovery assistance procedure as an enhancement to DMG STA
2. Add introductory descriptions to clause 4 (General description)
3. Amend MLME-SCAN primitives and elements in the Probe Request/Response frames to accommodate multi-band discovery assistance signaling
4. Add MLME-MB-DISCOVERY-ASSIST primitives and MLME-START-DMG-DISCOVERY-ASSISTANCE primitives under subclause 6.3.91 (Multi-band operation)
5. Amend Multi-band element to signal multi-band discovery assistance capability
6. Define Multi-band Discovery Assistance Request element and Multi-band Discovery Assistance Response element
7. Define Discovery Assistance Request Action frame and Multi-band Discovery Assistance Response Action frame under FST category
8. Add normative behavior of multi-band discovery assistance procedure under subclause 11.31 (Multi-band operation)

# Proposed changes:

Apply the following changes.

Corresponding changes to 802.11ay D1.0 and 802.11md D1.0 are indicated in the following text with “Track Changes” on, to clarify the direction to the editor.

**4. General description**

* 1. **Components of the IEEE 802.11 architecture**

4.3.22 DMG STA

***To TGay Editor: Change the 3rd paragraph in subclause 4.3.22 as follows:***

A DMG STA supports MAC features that provide channel access in an environment in which transmissions use a directional antenna pattern. A DMG STA has MAC features that include frame aggregation, block ack features, service periods, contention based access periods, DMG protected period, AP or PCP clustering, dynamic channel time management, reverse direction, spatial sharing, beamforming, and operations in a multi-band device such as fast session transfer and discovery assistance. A DMG STA is not a mesh STA. A DMG STA does not use any of the following: HCCA, power save multi-poll (PSMP), DLS, TDLS, HT-delayed block ack, GCR.

**4.9 Reference model**

4.9.4 Reference model for multi-band operation

***To TGay Editor: Insert the following new paragraph after 7th paragraph in subclause 4.9.4:***

By using the multi-band discovery assistance procedure described in 11.31.6 (Multi-band discovery assistance procedure), the SME of a multi-band capable device can trigger one of its MLME to start the discovery assistance procedure at its operating band upon reception of a discovery assistance request from another MLME of the same multi-band capable device. The SME of a multi-band capable device can trigger one of its MLME to start scanning at its operating band upon reception of a discovery assistance response from another MLME of the same multi-band capable device. This enables multi-band capable devices to trigger the discovery assistance and scanning procedure on one band upon completion of the Multi-band Discovery Assistance Request frame and Multi-band Discovery Assistance Response frame exchanges on another band. Typically, multi-band discovery assistance procedure is used to ease scanning procedure of a DMG STA, and multi-band discovery assistance capable device (see 11.31.1 (General)) has DMG STA and non-DMG STA.

**6. Layer management**

**6.3 MLME SAP interface**

**6.3.3 Scan**

**6.3.3.2 MLME-SCAN.request**

6.3.3.2.2 Semantics of the service primitive

***To TGay Editor: Change the argument of MLME-SCAN.request() primitive as follows in 6.3.3.2.2:***

The primitive parameters are as follows:

MLME-SCAN.request(

BSSType,

BSSID,

SSID,

ScanType,

ActiveScanType,

ProbeDelay,

ChannelList,

MinChannelTime,

MaxChannelTime,

RequestInformation,

SSID List,

ChannelUsage,

AccessNetworkType,

HESSID,

MeshID,

DiscoveryMode,

FILSRequestParameters,

ReportingOption,

APConfigurationSequenceNumber,

S1GRelayDiscovery,

PV1ProbeResponseOption,

S1GCapabilities,

ChangeSequence,

ELOperation,

MaxAwayDuration,

MultiBand,

DMGCapabilities,

MMS,

MultibandDiscoveryAssistanceRequest,

VendorSpecificInfo

)

***To TGay Editor: Insert the following new row to the end of the Table specifying “MLME-SCAN.request primitive parameters” in 6.3.3.2.2:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** |
| Multiband | Multi-Band element | As defined in 9.4.2.137 (Multi-band element) | Specifies the parameters within the Multi-band element containing configurations supported by the local MAC entity. The parameter is present if dot11MultibandImplemented is true and is absent otherwise. |
| DMG Capabilities | DMG Capabilities element | As defined in 9.4.2.127 (DMG Capabilities element) | Specifies the parameters within the DMG Capabilities element containing configurations supported by the local MAC entity. The parameter is present if dot11DMGOptionImplemented or dot11MultiBandDiscoveryAssistanceActivated is true and is absent otherwise. |
| MMS | Multiple MAC Sublayers element | As defined in  9.4.2.151 (Multiple  MAC Sublayers  (MMS) element) | Specifies the parameters within the Multiple MAC Sublayers element that are supported by the MAC entity. The parameter is present if dot11MultipleMACActivated is true and is absent otherwise. |
| Multiband Discovery Assistance Request | Multi-Band Discovery Assistance Request element | As defined in 9.4.2.269 (Multi-band Discovery Assistance Request element) | Specifies the parameters within the Multi-band Discovery Assistance Request element containing configurations supported by the local MAC entity. The parameter may present if dot11MultiBandDiscoveryAssistanceActivated is true and is absent otherwise. |

**6.3.3.3 MLME-SCAN.confirm**

**6.3.3.3.2 Semantics of the service primitive**

***To TGay Editor: Insert the following new row to the end of the Table specifying “BSSDescription” in 6.3.3.3.2:***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Type** | **Valid range** | **Description** | **IBSS adoption** |
| Multi-band Discovery Assistance Response | Multi-Band Discovery Assistance Response element | As defined in 9.4.2.270 (Multi-band Discovery Assistance Response element) | The values from the Multi-band Discovery Assistance Response element if such an element was present in the Probe Response frame, else null. | Do not adopt |

6.3.91 Multi-band operation

***To TGay Editor: Insert the following new subclauses after 6.3.91.12 (MLME-FST-INCOMING.request):***

6.3.91.13 MLME-MB-DISCOVERY-ASSIST.request

6.3.91.13.1 Function

This primitive requests transmission of a Multi-band Discovery Assistance Request element in Multi-band Discovery Assistance Request frame.

6.3.91.13.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MB-DISCOVERY-ASSIST.request(

PeerSTAAddress,

DMGCapabilities,

DiscoveryAssistanceRequest

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| PeerSTAAddress | MAC Address | Any valid individual MAC address | Specifies the MAC address of the STA to which the Multi-band Discovery Assistance Request frame is transmitted. |
| DMGCapabilities | DMG Capabilities element | As defined in 9.4.2.127 (DMG Capabilities element) | Specifies the parameters within the DMG Capabilities element containing configurations supported by a local MAC entity of the multi-band capable device to which the discoery assistance is requested. |
| DiscoveryAssistanceRequest | Multi-band Discovery Assistance Request element | As defined in 9.4.2.269 (Multi-band Discovery Assistance Request element) | Specifies parameters of the requesting discovery assistance. |

6.3.91.13.3 When generated

This primitive is generated by the SME to request that a Multi-band Discovery Assistance Request frame be sent to another STA.

6.3.91.13.4 Effect on receipt

On receipt of this primitive, the MLME constructs and attempts to transmit a Multi-band Discovery Assistance Request frame.

6.3.91.14 MLME-MB-DISCOVERY-ASSIST.indication

6.3.91.14.1 Function

This primitive indicates that a Multi-band Discovery Assistance Request frame was received.

6.3.91.14.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MB-DISCOVERY-ASSIST.indication(

PeerMACAddress,

DMGCapabilities,

DiscoveryAssistanceRequest

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| PeerMACAddress | MAC Address | Any valid individual MAC address | Specifies the MAC address of the STA from which the Multi-band Discovery Assistance Request frame was received. |
| DMGCapabilities | DMG Capabilities element | As defined in 9.4.2.127 (DMG Capabilities element) | Specifies the parameters within the DMG Capabilities element containing configurations supported by a local MAC entity of the multi-band capable device to which the discoery assistance is requested. |
| DiscoveryAssistanceRequest | Multi-band Discovery Assistance Request element | As defined in 9.4.2.269 (Multi-band Discovery Assistance Request element) | Specifies parameters of the requested discovery assistance. |

6.3.91.14.3 When generated

This primitive is generated by the MLME when a Multi-band Discovery Assistance Request frame is received.

6.3.91.14.4 Effect on receipt

On receipt of this primitive, the MLME operates discovery assistance according to the procedure in described in 11.31.6 (Multi-band discovery assistance procedure).

6.3.91.15 MLME-MB-DISCOVERY-ASSIST.response

6.3.91.15.1 Function

This primitive requests that a Multi-band Discovery Assistance Response frame be transmitted to a STA that requests discovery assistance.

6.3.91.15.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MB-DISCOVERY-ASSIST.response(

PeerMACAddress,

DiscoveryAssistanceResponse

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| PeerMACAddress | MAC Address | Any valid individual MAC address | Specifies the MAC address of the STA to which the Multi-band Discovery Assistance Response frame is transmitted. |
| DiscoveryAssistanceResponse | Multi-band Discovery Assistance Response element | As defined in 9.4.2.270 (Multi-band Discovery Assistance Response element) | Specifies parameters of the discovery assistance. |

6.3.91.15.3 When generated

This primitive is generated by the SME to request that a Multi-band Discovery Assistance Response frame be transmitted to the STA that requested discovery assistance.

6.3.91.15.4 Effect on receipt

On receipt of this primitive, the MLME constructs and attempts to transmit a Multi-band Discovery Assistance Response frame.

6.3.91.16 MLME-MB-DISCOVERY-ASSIST.confirm

6.3.91.16.1 Function

This primitive indicates that a Multi-band Discovery Assistance Response frame was received.

6.3.91.16.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-MB-DISCOVERY-ASSIST.confirm(

PeerMACAddress,

DiscoveryAssistanceResponse

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| PeerMACAddress | MAC Address | Any valid individual MAC address | Specifies the MAC address of the STA from which the Multi-band Discovery Assistance Response frame was received. |
| DiscoveryAssistanceResponse | Multi-band Discovery Assistance Response element | As defined in 9.4.2.270 (Multi-band Discovery Assistance Response element) | Specifies the parameters of the discovery assistance. |

6.3.91.16.3 When generated

This primitive is generated by the MLME when a Multi-band Discovery Assistance Response frame is received.

6.3.91.16.4 Effect on receipt

On receipt of this primitive, the MLME operates discovery assistance according to the procedure in described in 11.31.6 (Multi-band discovery assistance procedure).

6.3.94 DMG beamforming

***To TGay Editor: Insert the following new subclauses after 6.3.94.4 (MLME-BF-TRAINING.indication):***

6.3.94.5 MLME-START-DMG-DISCOVERY-ASSISTANCE.request

6.3.94.5.1 Function

This primitive requests to start exhaustive sector sweep that helps discovery and beamforming training to a new STA that is joining the BSS.

6.3.94.5.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-START-DMG-DISCOVERY-ASSISTANCE.request(

ScanType,

BTILength,

ABFTLength,

LocalNumberOfTxSectors,

PeerNumberOfTxSectors,

DiscoveryAssitsanceWindow

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ScanType | Enumeration | ACTIVE, PASSIVE | Specifies scan type of discovery assistance that the STA performs. |
| BTILength | Integer | 1-65 535 | Specifies time duration for BTI during the discovery assistance window in unit of microseconds. |
| ABFTLength | Integer | 1-65 535 | Specifies time duration for A-BFT during the discovery assistance window in unit of microseconds |
| LocalNumberOfTxSectors | Integer | 1-255 | Specifies number of sectors that the STA transmits for discovery assistance and beamforming training. |
| PeerNumberOfTxSectors | Integer | 1-255 | Specifies number of sectors for which a STA that is joining the BSS will perform transmit beamforming training. |
| DiscoveryAssistanceWindow | Integer | 1-65 535 | Specifies the time length when the discovery assistance is enabled in unit of TU. |

6.3.94.5.3 When generated

This primitive is generated by the SME to request exhaustive sector sweep that helps discovery and beamforming training to a new STA that is joining the BSS.

6.3.94.5.4 Effect on receipt

On receipt of this primitive, the MLME invokes the MAC sublayer exhaustive sector sweep procedures defined in 10.37.2 (Access periods within a beacon interval)

6.3.94.6 MLME-START-DMG-DISCOVERY-ASSISTANCE.confirm

6.3.94.6.1 Function

This primitive reports the outcome of a requested exhaustive sector sweep procedure.

6.3.94.6.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-START-DMG-DISCOVERY-ASSISTANCE.confirm(

ResultCode

)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| ResultCode | Enumeration | SUCCESS, FAILURE | Indicates the result of the exhaustive sector sweep procedure. |

6.3.94.6.3 When generated

This primitive is generated by the MLME to report the result of exhaustive sector sweep.

6.3.94.6.4 Effect on receipt

The SME is notified of the result of the procedure.

**9. Frame formats**

**9.3 Format of individual frame types**

**9.3.3 Management frames**

**9.3.3.10 Probe Request frame format**

***To TGay Editor: Change the row of “DMG Capabilities” in Table 9-37 in subclause 9.3.3.10 as follows:***

**Table 9-37—Probe Request frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| 15 | DMG Capabilities | The DMG Capabilities element is present if dot11DMGOptionImplemented is true or both dot11MultibandImplemented and dot11MultiBandDiscoveryAsssitanceActivated are true. |

***To TGay Editor: Insert the following new row before “Vendor Specific Request” in Table 9-37 in subclause 9.3.3.10:***

**Table 9-37—Probe Request frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| XX | Multi-band Discovery Assistance Request | The Multi-band Discovery Assistance Request element is optionally present if both dot11MultibandImplemented and dot11MultiBandDiscoveryAsssitanceActivated are true. |

**9.3.3.11 Probe Response frame format**

***To TGay Editor: Insert the following new row before “Vendor Specific” in Table 9-38 in subclause 9.3.3.11:***

**Table 9-38—Probe Response frame body**

|  |  |  |
| --- | --- | --- |
| **Order** | **Information** | **Notes** |
| XX | Multi-band Discovery Assistance Response | The Multi-band Discovery Assistance Response element is optionally present if both dot11MultibandImplemented and dot11MultiBandDiscoveryAsssitanceActivated are true. |

**9.4 Management and Extension frame body components**

**9.4.2 Elements**

**9.4.2.1 General**

***To TGay Editor: Insert the following new rows before “Reserved for elements using the Element ID Extension field” in Table 9-87 in subclause 9.4.2.1:***

**Table 9-87—Element IDs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Element** | **Element ID** | **Element ID Extension** | **Extensible** | **Fragmentable** |
| Multi-band Discovery Assistance Request (see 9.4.2.269 (Multi-band Discovery Assistance Request element)) | 255 | <ANA> | Yes | No |
| Multi-band Discovery Assistance Response (see 9.4.2.270 (Multi-band Discovery Assistance Response element)) | 255 | <ANA> | Yes | No |

**9.4.2.137 Multi-band element**

***To TGay Editor: Change the Figure 9-562 (Multi-band Control field format) as follows:***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 B2 | B3 | B4 | B5 | ~~B5~~ B6 B7 |
|  | STA Role | STA MAC Address Present | Pairwise Cipher Suite Present | Discovery Assistance Enabled | Reserved |
| Bits: | 3 | 1 | 1 | 1 | ~~3~~ 2 |

Figure 9-558--Multi-band Control field format

***To TGay Editor: Insert the following new paragraph after the 6th paragraph in subclause 9.4.2.134 (Multi-band element):***

Discovery Assistance Enabled subfield indicates whether the STA operates multi-band discovery assistance procedures for the BSS defined by the BSSID field on the channel defined by the Band ID field, the Operating Class field, and the Channel Number field. The Discovery Assistance Enabled subfield is set to 1 if dot11MultiBandDiscoveryAssistanceActivated is true and is set to 0 otherwise.

***To TGay Editor: Insert the following new subclauses in subclause 9.4.2:***

**9.4.2.269 Multi-band Discovery Assistance Request element**

The Multi-band Discovery Assistance Request element indicates parameters and attributes of the discovery assistance that the STA transmitting this element is requesting. If present, the Band ID, Operating Class, Channel Number, and BSSID fields indicate the BSS to which the discovery assistance is requested. This element is present in Multi-band Discovery Assistance Request frame and is optionally present in Probe Request frame. The format of the Multi-band Discovery Assistance Request element is shown in Figure 9-708a (Multi-band Discovery Assistance Request element format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Discovery Assistance Request Control | STA MAC Address |
| Octets: | 1 | 1 | 1 | 1 | 6 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Band ID (Optional) | Operating Class (Optional) | Channel Number (Optional) | BSSID (Optional) |
| Octets: | 1 | 1 | 1 | 6 |

**Figure 9-708a Multi-band Discovery Assistance Request element format**

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

The format of the Discovery Assistance Request Control field is shown in Figure 9-708b (Discovery Assistance Request Control field format).

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 | B1 B2 | B3 B7 |
|  | BSS Information Present | Scanning Mode | Reserved |
| Bits: | 1 | 2 | 5 |

**Figure 9-708b Discovery Assistance Request Control field format**

The BSS Information Present subfield indicates whether the Band ID, Operating Class, Channel Number and BSSID fields are present in the Multi-band Discovery Assistance Request element. The BSS Information Present subfield is set to 1, if the Band ID, Operating Class, Channel Number and BSSID fields are present in the Multi-band Discovery Assistance Request element. Otherwise this subfield is set to 0.

The Scanning Mode subfield indicates requesting scanning mode. A value of 00 (binary) indicates that the STA does not specify requesting scanning mode. A value of 01 (binary) indicates that the STA requests passive scanning. A value of 10 (binary) indicates that the STA requests active scanning. A value 11 (binary) indicates that the STA requests scanning for TDD channel access.

The STA MAC Address field contains the MAC address of the STA that is used at the channel that the STA is requesting discovery assistance.

The Band ID field provides the identification of the frequency band related to the Operating Class and Channel Number fields. The Band ID field is defined in 9.4.1.46 (Band ID field).

The Operating Class indicates the channel set to which the discovery assistance is requested. Valid values of Operating Class are shown in Annex E.

The Channel Number field indicates the number of the channel to which the discovery assistance is requested.

The BSSID field specifies the BSSID of the BSS operating on the channel and frequency band indicated by the Channel Number and Band ID fields.

**9.4.2.270 Multi-band Discovery Assistance Response element**

The Multi-band Discovery Assistance Response element indicates confirmed parameters and attributes of the discovery assistance that the STA transmitting this element will be performing. The Band ID, Operating Class, Channel Number, and BSSID fields indicate the BSS that the discovery assistance will be performed. This element is present in Multi-band Discovery Assistance Response frame and is optionally present in Probe Response frame. The format of the Multi-band Discovery Assistance Response element is shown in Figure 9-708c (Multi-band Discovery Assistance Response element format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Discovery Assistance Response Control | STA MAC Address |
| Octets: | 1 | 1 | 1 | 1 | 6 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Band ID | Operating Class | Channel Number | BSSID | Discovery Assistance Window Length |
| Octets: | 1 | 1 | 1 | 6 | 2 |

**Figure 9-708c Multi-band Discovery Assistance Response element format**

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

The format of the Discovery Assistance Response Control field is shown in Figure 9-708d (Discovery Assistance Response Control field format)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B3 | B4 B5 | B6 B7 |
|  | Discovery Assistance Response Map | Reserved | Scanning Mode | Reserved |
| Bits: | 2 | 2 | 2 | 2 |

**Figure 9-708d Discovery Assistance Response Control field format**

The Discovery Assistance Response Map subfield indicates response to the discovery assistance request. The possible values of the Discovery Assistance Response Map subfield are specified in Table 9-302a (Discovery assistance state).

**Table 9-302a Discovery assistance state**

|  |  |
| --- | --- |
| **Value (binary)** | **Discovery assistance state** |
| 00 | Accept the discovery assistance request at the BSS specified by the Band ID, Operating Class, Channel Number, and BSSID fields in the Multi-band Discovery Assistance Response element |
| 10 | Reject the discovery assistance request. Reason: unauthorised access |
| 01 | Reject the discovery assistance request. Reason: requested scanning mode not supported |
| 11 | Reject the discovery assistance request. Reason: other |

The Scanning Mode subfield indicates scanning mode that is confirmed by the transmitter of this element. A value of 01 (binary) indicates that the STA transmitting this element performs discovery assistance for passive scanning. A value of 10 (binary) indicates that the STA transmitting this element performs discovery assistance for active scanning. A value 11 (binary) indicates that the STA transmitting this element performs discovery assistance for TDD channel access. A value of 00 (binary) is reserved.

The STA MAC Address field contains the MAC address of the STA that is used at the channel that the STA will be performing discovery assistance.

The Band ID field provides the identification of the frequency band related to the Operating Class and Channel Number fields. The Band ID field is defined in 9.4.1.46 (Band ID field).

The Operating Class indicates the channel set at which the discovery assistance will be performed. Valid values of Operating Class are shown in Annex E.

The Channel Number field indicates the number of the channel at which the discovery assistance will be performed.

The BSSID field specifies the BSSID of the BSS operating on the channel and frequency band indicated by the Channel Number and Band ID fields.

The Discovery Assistance Window Length field indicates the discovery assistance window length confirmed by the STA transmitting this element in unit of TU.

**9.6 Action frame format details**

**9.6.20 FST Action frame details**

**9.6.20.1 FST Action field**

***To TGay Editor: Insert the following new rows to the end of Table 9-450 in subclause 9.6.20.1:***

**Table 9-450—FST Action field values**

|  |  |
| --- | --- |
| **FST Action field value** | **Meaning** |
| 6 | Multi-band Discovery Assistance Request |
| 7 | Multi-band Discovery Assistance Response |

***To TGay Editor: Insert the following new subclauses to the end of subclause 9.6.20:***

**9.6.20.8 Multi-band Discovery Assistance Request frame format**

The format of the Multi-band Discovery Assistance Request frame Action field is shown in Table 9-456a.

**Table 9-456a— Multi-band Discovery Assistance Request frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | FST Action |
| 3 | DMG Capabilities |
| 4 | Multi-band Discovery Assistance Request |

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

The FST Action field is defined in 9.6.20.1 (FST Action field).

The DMG Capabilities field contains the DMG Capabilities element of the DMG STA to which the discovery assistance is requested. The DMG Capabilities element is defined in 9.4.2.127 (DMG Capabilities element),

The Multi-band Discovery Assistance Request field contains the Multi-band Discovery Assistance Request element containing requesting discovery assistance parameters and attributes. The Multi-band Discovery Assistance Request element is defined in 9.4.2.269 (Multi-band Discovery Assistance Request element.

**9.6.20.9 Multi-band Discovery Assistance Response frame format**

The format of the Multi-band Discovery Assistance Response frame Action field is shown in Table 9-456b.

**Table 9-456b— Multi-band Discovery Assistance Response frame Action field format**

|  |  |
| --- | --- |
| **Order** | **Information** |
| 1 | Category |
| 2 | FST Action |
| 4 | Multi-band Discovery Assistance Response |

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

The FST Action field is defined in 9.6.20.1 (FST Action field).

The Multi-band Discovery Assistance Response field contains the Multi-band Discovery Assistance Response element indicating confirmed discovery assistance parameters and attributes. The Multi-band Discovery Assistance Response element is defined in 9.4.2.270 (Multi-band Discovery Assistance Response element.

**10. MAC sublayer functional description**

**10.37 DMG channel access**

**10.37.2 Access periods within a beacon interval**

***To TGay Editor: Insert the following new paragraph after the 4th paragraph in subclause 10.37.2:***

When dot11MultiBandDiscoveryAssistanceActivated is true, AP and PCP that do not operate TDD channel access shall allocate enough duration for BTI and A-BFT to accommodate necessary DMG Beacon frame and SSW frame transmissions to perform multi-band discovery assistance per reception of the MLME-START-DMG-DISCOVERY-ASSISTANCE.request (see 6.3.94.5 (MLME-START-DMG-DISCOVERY-ASSISTANCE.request)). AP and PCP that operate TDD channel access shall start scheduling beam training signals per reception of the MLME-START-DMG-DISCOVERY-ASSISTANCE.request.

**11. MLME**

**11.31 Multi-band operation**

**11.31.1 General**

***To TGay Editor: Change the 1st and 2nd paragraph in subclause 11.31.1 as follows:***

A device is multi-band capable if the value of dot11MultibandImplemented is true. A multi-band capable device is said to be a member of a BSS when one or more of the STAs in the device is a member of the BSS. A STA that is part of a multi-band capable device advertises the capability by including the Multi-band element in Beacon, DMG Beacon, (Re)Association Request, (Re)Association Response, Information Request, Information Response, Probe Request, Probe Response, Announce, FST Setup Request, FST Setup Response, Multi-band Discovery Assistance Request, Multi-band Discovery Assistance Response, TDLS Discovery Request, TDLS Discovery Response, TDLS Setup Request, and TDLS Setup Response frames.

Except for the Multi-band Discovery Assistance Request, Multi-band Discovery Assistance Response, FST Setup Request and FST Setup Response frames, which shall not include more than one Multi-band element, a STA may include more than one Multi-band element in any one of these frames if it is part of a device that supports more than two bands or channels. If an AP or PCP includes one or more Multi-band elements within a (Re)Association Response frame with Status Code equal to DENIED\_WITH\_SUGGESTED\_BAND\_AND\_CHANNEL or a Probe Response frame, the order in which these elements appear in the frame indicate the order, in terms of frequency band and channel number, that the device that includes the STA addressed by the frame should attempt join the BSS following the rules applicable to the respective frequency band and channel (see 11.1 (Synchronization)). For each Multi-band element contained in the frame starting from the first one and proceeding in increasing order, the STA should attempt to join the BSS using the BSSID indicated by the BSSID field, frequency band indicated by the Band ID field and channel number indicated by the Channel Number field provided the Beacon Interval and the Channel Number fields in the Multi-band element are both nonzero.

NOTE—The first Multi-band element in the frame can refer to the current operating frequency band and channel.

***To TGay Editor: Insert the following new paragraphs to the end of subclause 11.31.1:***

When dot11MultiBandDiscoveryAssistanceActivated is true, the multi-band capable device is multi-band discovery assistance capable and shall operate multi-band discovery assistance procedure. Multi-band discovery assistance procedure is used to ease discovery of DMG BSSs using a STA of a multi-band capable device that operate on a band other than DMG STA uses.

When a DMG STA that is part of a multi-band discovery assistance capable device tries to discover DMG BSS nearby, SME of the device may trigger non-DMG STA that is part of the device to send multi-band discovery assistance request to a STA that is part of another multi-band discovery assistance capable device. Upon reception and acceptance of the discovery assistance request, SME of the STA shall trigger its DMG AP or PCP to schedule a series of DMG Beacon and/or SSW frame transmissions to assist scanning procedure of the STA that requested the multi-band discovery assistance. Details of the multi-band discovery assistance procedure is described in 11.31.6 (Multi-band discovery assistance procedure).

***To TGay Editor: Insert the following new subclause to the end of subclause 11.31:***

**11.31.6 Multi-band discovery assistance procedure**

A device is multi-band discovery assistance capable if the value of both dot11MultibandImplemented and dot11MultiBandDiscoveryAssistanceActivated are true. A STA that is part of a multi-band discovery assistance capable device shall advertise the capability of multi-band discovery assistance by setting the Discovery Assistance Enabled subfield in the Multi-band Control field in the Multi-band element that is contained in Beacon, DMG Beacon, (Re)Association Request, (Re)Association Response, Information Request, Information Response, Probe Request, Probe Response, Announce, FST Setup Request, FST Setup Response, Multi-band Discovery Assistance Request, Multi-band Discovery Assistance Response, TDLS Discovery Request, TDLS Discovery Response, TDLS Setup Request, and TDLS Setup Response frames.

Multi-band discovery assistance procedure allows discovery of BSSs using a STA of a multi-band capable device that operate on a band other than its intended band of communication. The intended band of communication is referred to as the Communication Band and the MLME associated with it is referred to as the Communication MLME. The other band that is used for discovery is referred to as the Discovery Band and the MLME associated with it is referred to as the Discovery MLME. The Multi-band Discovery Assistance operation may be used in conjunction with or independent from FST setup protocol and OCT operation.

Figure 11-47a (Multi-band discovery assistance procedure) depicts the overall multi-band discovery assistance procedure.

The SME of a multi-band capable device that intends to join a DMG BSS issues an MLME-SCAN.request to the Discovery MLME of the device. The Discovery MLME receiving an MLME-SCAN.request shall scan the Discovery Band to discover other STAs that support multi-band discovery assistance. After the scanning procedure completes, the Discovery MLME issues MLME-SCAN.confirm to SME of the STA. The MLME-SCAN.confirm contains information indicating which STAs support multi-band discovery assistance for which band.

If a multi-band discovery assistance capable device is found and the device operates a DMG BSS or an EDMG BSS, as a result of the scanning, the SME of a device that performed scanning may issue MLME-MB-DISCOVERY-ASSIST.request (see 6.3.91.13 (MLME-MB-DISCOVERY-ASSIST.request)) to the Discovery MLME of the device to request the discovered device to start discovery assistance procedure with its DMG STA. The Discovery MLME receiving an MLME-MB-DISCOVERY-ASSIST.request shall transmit a Multi-band Discovery Assistance Request frame addressed to the peer STA specified in the MLME-MB-DISCOVERY-ASSIST.request primitive. Within the Multi-band Discovery Assistance Request frame, the Multi-band Discovery Assistance Request element contains parameters of the requesting discovery assistance (see 9.4.2.269 (Multi-band Discovery Assistance Request element)).

NOTE— If the recipient of the Multi-band Discovery Assistance Request frame is an AP (or a mesh STA), the STA transmitting the Multi-band Discovery Assistance Request frame needs to complete association (or mesh peering) and authentication process before transmitting the frame.

A Discovery MLME receiving a Multi-band Discovery Assistance Request frame shall issue an MLME-MB-DISCOVERY-ASSIST.indication (see 6.3.91.14 (MLME-MB-DISCOVERY-ASSIST.indication) to its SME. The SME determines if it accepts requested discovery assistance with a DMG STA that is part of the device. The SME shall issue MLME-MB-DISCOVERY-ASSIST.response (see 6.3.91.15 (MLME-MB-DISCOVERY-ASSIST.response) to the Discovery MLME of the device to respond back with the result of the determination. Logic for this determination is beyond the scope of the standard. The determination result is contained in the Multi-band Discovery Assistance Response element (see 9.4.2.270 (Multi-band Discovery Assistance Response element)). The Discovery MLME receiving an MLME-MB-DISCOVERY-ASSIST.response shall transmit a Multi-band Discovery Assistance Response frame addressed to the peer Discovery MLME which is specified in the primitive.

When the SME issues MLME-MB-DISCOVERY-ASSIST.response with acceptance of the discovery assistance for TDD channel access, the SME shall issue an MLME-TDD-BF-TRAINING.request (see 6.3.XX.2 (MLME-TDD-BF-TRAINING.request)) to a Communication MLME of the device specifying parameters for the discovery assistance and shall start TDD beamforming procedure specified in 10.38.10 (TDD Beamforming)). The STA shall continue the discovery assistance at least for the duration specified by the DiscoveryAssitsanceWindow.

When the SME issues MLME-MB-DISCOVERY-ASSIST.response with acceptance of the discovery assistance for active scanning or passive scanning, the SME shall issue an MLME-START-DMG-DISCOVERY-ASSISTANCE.request (see 6.3.94.5 (MLME-START-DMG-DISCOVERY-ASSISTANCE.request)) to a Communication MLME of the device specifying parameters for the discovery assistance. The SME shall set consistent parameters with the Multi-band Discovery Assistance Response element that the device has sent. Upon reception of the primitive, the Communication MLME shall start discovery assistance using given parameters. If the ScanType is PASSIVE, the Communication MLME shall start transmitting DMG Beacon or SSW frames. If the ScanType is ACTIVE, the Communication MLME shall listen for a Probe Request or DMG Beacon frames. The STA shall schedule DMG Beacon or SSW frame transmissions based on BTILength, ABFTLenth, LocalNumberOfTxSectors and PeerNumberOfTxSectors. The STA shall continue the discovery assistance at least for the duration specified by the DiscoveryAssitsanceWindow. After the expiration of the discovery assistance window, the Communication MLME shall issue MLME-START-DMG-DISCOVERY-ASSISTANCE.confirm (see 6.3.94.6 (MLME-START-DMG-DISCOVERY-ASSISTANCE.confirm)) to indicate the result of the discovery assistance.

A Discovery MLME receiving the Multi-band Discovery Assistance Response frame shall issue an MLME-MB-DISCOVERY-ASSIST.confirm to its SME to report on the response to the discovery assistance request that it has issued. If the Discovery Assistance State Map subfield in the Discovery Assistance Response Control field contained in the received Multi-band Discovery Assistance Response element indicates that the discovery assistance is accepted, the SME shall issue an MLME-SCAN.request to its Communication MLME setting BSSID, ScanType, ChannelList, and MinChannelTime to values captured from fields in the Multi-band Discovery Assistance element contained in the received Multi-band Discovery Assistance Response element. When TDD channel access is used on the Communication Band, the STA shall process TDD beamforming procedure specified in 10.38.10 (TDD Beamforming)).

A Communication MLME receiving an MLME-SCAN.request shall perform scanning on the Communication Band. The Communication MLME respond back with MLME-SCAN.cofirm to its SME notifying the result of the scanning on the Communication Band.



**Figure 11-47a — Multi-band discovery assistance procedure**

**Annex C**

**C.3 MIB Detail**

***To TGay Editor: Change the definition of “Dot11DMGSTAConfigEntry” in C.3 as follows:***

Dot11DMGSTAConfigEntry ::=

SEQUENCE {

dot11DMGOptionImplemented TruthValue,

dot11RelayActivated TruthValue,

dot11REDSActivated TruthValue,

dot11RDSActivated TruthValue,

dot11MultipleMACActivated TruthValue,

dot11ClusteringActivated TruthValue,

dot11MultiBandDiscoveryAssistanceActivated TruthValue

}

***To TGay Editor: Insert the definition of the new MIB variable (dot11MultiBandDiscoveryAssistanceActivated) to the end of dot11DMGSTAConfigTable in C.3 as follows:***

dot11MultiBandDiscoveryAssistanceActivated OBJECT-TYPE

SYNTAX TruthValue

MAX-ACCESS read-write

STATUS current

DESCRIPTION

"This is a control variable.

It is written by the SME or external management entity.

Changes take effect as soon as practical in the implementation.

This attribute, when true, indicates that the station supports Multi-band discovery assistance procedures."

::= { dot11DMGSTAConfigEntry 7 }

-- \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

-- \* End of dot11DMGSTAConfigTable TABLE

-- \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

***To TGay Editor: Change the definition of “dot11DMGComplianceGroup” in C.3 as follows:***

dot11DMGComplianceGroup OBJECT-GROUP

OBJECTS {dot11MultibandImplemented, dot11DMGOptionImplemented,

dot11RelayActivated, dot11REDSActivated, dot11RDSActivated,

dot11RSNAProtectedManagementFramesActivated,

dot11MultipleMACActivated,

dot11ClusteringActivated,

dot11LowPowerSCPHYImplemented,

dot11LowPowerSCPHYActivated,

dot11MultiBandDiscoveryAssistanceActivated

}

STATUS current

DESCRIPTION

"Attributes that configure the DMG Group for IEEE Std 802.11."

::= { dot11Groups 64 }

# Reference:

[1] Draft P802.11REVmd\_D1.0.

[2] Draft P802.11ay\_D1.0.

[3] 11-18/179r3 “Beamforming for mmWave distributed network”

[4] 11-18/486, “Multi-band discovery assistance”