IEEE P802.11  
Wireless LANs

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| --- | --- | --- | --- | --- |
| Discovery Assistance for 802.11ay normative text | | | | |
| Date: 2018-05-08 | | | | |
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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 doc11-18/817 |

# Discussion:

This submission proposes suggested normative text to include discovery assistance procedure as discussed in 11-18/486 “Multi-band discovery assistance” and 11-18/816 “Discovery Assistance for 802.11ay”

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 reduce 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 discovery assistance procedure as an enhancement to DMG STA
2. Add introductory descriptions to clause 4 (General description)
3. Add arguments to the MLME-BF-TRAINING primitives under subclause 6.3.94 (DMG Beamforming)
4. Amend Multi-band element to signal multi-band discovery assistance capability
5. Define DMG Discovery Assistance Request element and DMG Discovery Assistance Response element
6. Define usage of the DMG Discovery Assistance Request element and DMG Discovery Assistance Response element, i.e., use them with FST Setup Request/Response frames
7. 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**

**4.3 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, discovery assistance and operation (fast session transfer) in a multi-band device. 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 discovery assistance feature in a multi-band device as 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 an FST Setup Request with DMG Discovery Assistance Request element 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 an FST Setup Response frame with a DMG Discovery Assistance Response element 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 exchanging the DMG Discovery Assistance Request and DMG Discovery Assistance Response elements 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**

6.3.95 DMG beamforming

6.3.95.2 MLME-BF-TRAINING.request

***To TGay Editor: Change the 6.3.95.2.2 (Semantics of the service primitive) as follows:***

6.3.95.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-BF-TRAINING.request(

PeerSTAAddress,

RequestBRP,

BRPRequest,

DMGBeamRefinement,

EDMGPartialSLS,

EDMGBRPRequest,

ScanType,

BTILength,

ABFTLength,

LocalNumberOfTxSectors,

PeerNumberOfTxSectors,

DiscoveryAssitsanceWindow

)

***Insert the following rows at the end of the table***

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Valid range | Description |
| BRPRequest | A set of information subfields | As defined in 9.5.4 | Specifies the parameters of a BRP request |
| DMGBeamRefinement | A set of elements | As defined in 9.4.2.130 | Zero or more elements |
| EDMGBRPRequest | A set of elements | As defined in 9.4.2.255 | Zero or more elements |
| EDMGPartialSLS | A set of elements | As defined in 9.4.2.258 | Zero or more elements |
| ScanType | Enumeration | ACTIVE, PASSIVE | Specifies scan type of discovery assistance that the STA performs. Present only when discovery assistance is requested |
| BTILength | Integer | 1-65 535 | Specifies time duration for BTI during the discovery assistance window in unit of microseconds. Present only when discovery assistance is requested |
| ABFTLength | Integer | 1-65 535 | Specifies time duration for A-BFT during the discovery assistance window in unit of microseconds. Present only when discovery assistance is requested |
| LocalNumberOfTxSectors | Integer | 1-255 | Specifies number of sectors that the STA transmits for discovery assistance and beamforming training. Present only when discovery assistance is requested |
| PeerNumberOfTxSectors | Integer | 1-255 | Specifies number of sectors for which a STA that is joining the BSS will perform transmit beamforming training. Present only when discovery assistance is requested |
| DiscoveryAssistanceWindow | Integer | 1-65 535 | Specifies the time length when the discovery assistance is enabled in unit of TU. Present only when discovery assistance is requested |

**9. Frame formats**

**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** |
| DMG Discovery Assistance Request (see 9.4.2.269 (DMG Discovery Assistance Request element)) | 255 | <ANA> | Yes | No |
| DMG Discovery Assistance Response (see 9.4.2.270 (DMG 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 the BSS specified in the element is DMG BSS and dot11DiscoveryAssistanceActivated is true. The subfield is set to 0 otherwise.

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

**9.4.2.269 DMG Discovery Assistance Request element**

The DMG 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 optionally present in FST Setup Request frame. The format of the DMG Discovery Assistance Request element is shown in Figure 9-708a (DMG Discovery Assistance Request element format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Discovery Assistance Request Control | Antenna Configuration  (Optional) |
| Octets: | 1 | 1 | 1 | 1 | 3 |

**Figure 9-708a DMG 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 | B4 B7 |
|  | Antenna Configuration Present | TDD Channel Access | STA Scanning Mode | Reserved |
| Bits: | 1 | 1 | 2 | 4 |

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

The Antenna Configuration Present subfield indicates whether the Antenna Configuration field is present in the DMG Discovery Assistance Request element. The Antenna Configuration Present subfield is set to 1, if the Antenna Configuration field is present in the DMG Discovery Assistance Request element. Otherwise, this subfield is set to 0.

The TDD Channel Access subfield indicates if the STA transmitting this element requests TDD Channel Access. The TDD Channel Access subfield is set to 1 if the STA requests TDD Channel Access. Otherwise, this subfield is set to 0.

The STA Scanning Mode subfield indicates scanning mode that the STA transmitting this element requests. 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) is reserved. This field is reserved if the TDD Channel Access subfield is 1.

The format of the Antenna Configuration field is shown in Figure 9-708c (Antenna Configuration field format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B0 B1 | B2 B8 | B9 B14 | B15 | B16 | B17 B23 |
|  | Number of RX DMG Antennas | Total Number of Transmit Sectors | Total Number of Receive Sectors | DMG Antenna Reciprocity | Antenna Pattern Reciprocity | Reserved |
| Bits: | 2 | 7 | 6 | 1 | 1 | 7 |

**Figure 9-708c Antenna Configuration field format**

The Number of RX DMG Antennas subfield indicates the total number of receive DMG antennas of the

STA. The value of this subfield is in the range 1 to 4, with the value being equal to the bit representation plus 1.

The Total Number of Transmit Sectors subfield indicates the total number of transmit sectors the STA uses in a transmit sector sweep combined over all DMG antennas, including any LBIFS required for DMG antenna switching (see 10.38). The value of this subfield is in the range 1 to 128, with the value being equal to the bit representation plus 1.

The Total Number of Receive Sectors subfield specifies the total number of receive sectors combined over all receive DMG antennas of the STA, including any LBIFS required for DMG antenna switching (see 10.38). The value represented by this subfield is in the range 2 to 128 and is given by (RXSS Length+1)×2.

DMG Antenna Reciprocity subfield is set to 1 to indicate that the best transmit DMG antenna of the STA is the same as the best receive DMG antenna of the STA and vice versa. Otherwise, this subfield is set to 0.

The Antenna Pattern Reciprocity subfield is set to 1 to indicate that the transmit antenna pattern associated with an AWV is the same as the receive antenna pattern for the same AWV. Otherwise, this subfield is set to 0.

**9.4.2.270 DMG Discovery Assistance Response element**

The DMG 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 optionally present in FST Setup Response frame. The format of the DMG Discovery Assistance Response element is shown in Figure 9-708c (DMG Discovery Assistance Response element format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Discovery Assistance Response Control | Discovery Assistance Window Length | Dwelling Time |
| Octets: | 1 | 1 | 1 | 1 | 2 | 2 |

**Figure 9-708c DMG 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 B7 |
|  | TDD Channel Access | STA Scanning Mode | Discovery Assistance Response Map | Reserved |
| Bits: | 1 | 1 | 2 | 4 |

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

The TDD Channel Access subfield indicates if the STA transmitting this element performs TDD beamforming (see 10.39.10 (TDD beamforming)). The TDD Channel Access subfield is set to 1 if the STA performs TDD beamforming. Otherwise, this subfield is set to 0. This subfield is reserved when the Discovery Assistance Response Map subfield is other than 0,

The STA Scanning Mode subfield indicates scanning mode that is confirmed by the STA transmitting this element. A value of 1 indicates that the STA transmitting this element performs discovery assistance for passive scanning. A value of 0 indicates that the STA transmitting this element performs discovery assistance for active scanning. This subfield is reserved when the Discovery Assistance Response Map subfield is other than 0,

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

The Dwelling Time field indicates the recommended time to sweep the received antenna pattern in scanning for beamforming or discovery signal in microseconds.

**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:***

If dot11DiscoveryAssistanceActivated is true, AP and PCP shall allocate enough duration for BTI and A-BFT to accommodate DMG Beacon frames and SSW frames when MLME-BF-TRAINING.request (see 6.3.95.2 (MLME-BF-TRAINING.request)) invoking discovery assistance is issued.

**11. MLME**

**11.31 Multi-band operation**

**11.31.1 General**

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

The multi-band discovery assistance request is managed by the FST setup protocol and is used in conjunction with a session transfer. State transition of the discovery assistance request is described in 11.31.2 (FST setup protocol), and details of the multi-band discovery assistance procedure is described in 11.31.6 (Multi-band discovery assistance procedure).A multi-band capable device shall include the DMG Discovery Assistance Request element in FST Setup Request frame when it requests discovery assistance to the recipient of the frame. A multi-band capable device shall include the DMG Discovery Assistance Response element in FST Setup Response frame that is transmitted in response to a multi-band discovery assistance request.

***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 dot11DiscoveryAssistanceActivated 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, 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 operates on a band other than its intended band of communication.

Figure 11-47a (Multi-band discovery assistance procedure) depicts an example of 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 Old Band MLME of the device. The Old Band MLME receiving an MLME-SCAN.request shall scan the Old Band to discover other STAs that support multi-band discovery assistance. After the scanning procedure completes, the Old Band 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-FST-SETUP.request (see 6.3.91.2 (MLME-FST-SETUP.request)) to the Old Band MLME of the device to request the discovered device to start discovery assistance procedure with its DMG STA. The Old Band MLME receiving the MLME-FST-SETUP.request shall transmit a FST Setup Request frame addressed to the discovered peer STA specifying parameters of the requesting discovery assistance in the DMG Discovery Assistance Request element (see 9.4.2.269 (DMG Discovery Assistance Request element)).

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

The two multi-band capable devices exchange FST Setup Request frame containing the DMG Discovery Assistance Request element and FST Setup Response frames containing the DMG Discovery Assistance Response element as described in 11.31.2 (FST setup protocol).

Upon reception of the MLME-FST-SETUP.indication (see 6.3.91.3 (MLME-FST-SETUP.indication), the SME of the device that received FST Setup Request frame determines if it accepts requested discovery assistance with a DMG STA that is part of the device. The SME shall issue MLME-FST-SETUP.response (see 6.3.91.4 (MLME-FST-SETUP.response) to the Old Band MLME of the device to respond back with the result of the determination. The determination result is contained in the DMG Discovery Assistance Response element (see 9.4.2.270 (DMG Discovery Assistance Response element)) in the FST Setup Response frame.

When the SME issues MLME-FST-SETUP.response with acceptance of the discovery assistance request for TDD channel access, it shall issue an MLME-TDD-BF-TRAINING.request (see 6.3.117.2 (MLME-TDD-BF-TRAINING.request)) to a New Band 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 Discovery Assistance Window Length contained in the Discovery Assistance Response element.

When the SME issues MLME-FST-SETUP.response with acceptance of the discovery assistance request for passive scanning, it shall issue an MLME-BF-TRAINING.request (see 6.3.95.2 (MLME-BF-TRAINING.request)) to New Band MLME of the device specifying parameters for the discovery assistance. The SME shall set consistent parameters with the DMG Discovery Assistance Response element that the device has sent. Upon reception of the primitive, the New Band MLME shall start discovery assistance using given parameters, i.e., the STA shall schedule DMG Beacon or SSW frame transmissions based on BTILength, ABFTLenth, LocalNumberOfTxSectors and PeerNumberOfTxSectors. When the SME accepts the discovery assistance request for active scanning, the New Band MLME shall listen for DMG Beacon frames and Probe Request frame. 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 New Band MLME shall issue MLME-BF-TRAINING.confirm (see 6.3.95.3 (MLME-BF-TRAINING.confirm)) to indicate the result of the discovery assistance.

An SME that received MLME-FST-SETUP.confirm including the DMG Discovery Assistance Response element shall determine if the Discovery Assistance State Map subfield in the Discovery Assistance Response Control field contained in the received DMG Discovery Assistance Response element indicates that the discovery assistance is accepted.

When the discovery assistance request has been accepted, the SME shall issue MLME-SCAN.request to its New Band MLME setting BSSID, ScanType, ChannelList, and MinChannelTime to values captured from fields in the DMG Discovery Assistance Response element contained in the FST Setup Response frame.

The New Band MLME that received the MLME-SCAN.request shall perform scanning on the New Band. After the scanning procedure, the New Band MLME respond back with MLME-SCAN.cofirm to its SME notifying the result of the scanning on the New Band.



**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,

dot11DiscoveryAssistanceActivated TruthValue

}

***To TGay Editor: Insert the definition of the new MIB variable (dot11DiscoveryAssistanceActivated) to the end of dot11DMGSTAConfigTable in C.3 as follows:***

dot11DiscoveryAssistanceActivated 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 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,

dot11DiscoveryAssistanceActivated

}

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”