IEEE P802.11
Wireless LANs

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| Multi-band Discovery Assistance for 802.11ay normative text(CR on CID 1771) |
| Date: 2018-07-09 |
| Author(s): |
| Name | Company | Address | Phone | email |
| Mohamed Abouelseoud | Sony |  |  | Mohamed.Abouelseoud (at) sony (dot) com  |
| Kazuyuki Sakoda | Sony |  |  | Kazuyuki.Sakoda (at) sony (dot) com |
| Dana Ciochina | Sony |  |  | Dana.Ciochina (at) sony (dot) com |

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 doc11-18/1203 |

# Discussion:

This submission proposes suggested normative text to include discovery assistance procedure as discussed in [4], [5] and [6].

This proposal provides the following benefits:

1. 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.
2. 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.

# 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. Amend Multi-band element to signal multi-band discovery assistance capability
4. Define DMG Discovery Assistance element
5. Define usage of the DMG Discovery Assistance element, i.e., use them with FST Setup Request/Response frames
6. 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 a multi-band discovery assistance request from another MLME of the same multi-band capable device. The multi-band discovery assistance request is an FST Setup Request frame with DMG Discovery Assistance element. 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 multi-band discovery assistance response from another MLME of the same multi-band capable device. The multi-band discovery assistance response is an FST Setup Response frame with a DMG Discovery Assistance element. This enables multi-band capable devices to trigger the discovery assistance and scanning procedure on one band upon receiving the DMG Discovery Assistance elements on another band. Typically, multi-band discovery assistance procedure is used to expedite scanning procedure of a multi-band discovery assistance DMG STA capable device (see 11.31.1) while minimizing the full beacon sweep overhead.

**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 (see 9.4.2.269 (DMG Discovery Assistance 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):***

The Discovery Assistance Present 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 element**

The DMG Discovery Assistance element indicates parameters and attributes of the discovery assistance. This element is optionally present in FST Setup Request and FST Setup Response frame. The format of the DMG Discovery Assistance element is shown in Figure 9-708c (DMG Discovery Assistance element format).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Element ID Extension | Discovery Assistance Control | Discovery Assistance Request Status Code | Discovery Assistance Window Length | Sector Sweep Start Time(Optional) | Temporary AID (Optional) | Dwelling Time(Optional) |
| Octets: | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 1 | 2 |

**Figure 9-708a DMG Discovery Assistance 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 Control field is shown in Figure 9-708d (Discovery Assistance Control field format). This field is reserved when the element is contained in FST Setup Request frame.

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0  | B1 | B2 B7 |
|  | Discovery Assistance Type | Dwelling Time Present | Reserved |
| Bits: | 1 | 1 | 6 |

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

The Discovery Assistance Type subfield is set to 0, to indicate that Sector Sweep Start Time field is present. When this field is set to 1, the discovery assistance signal schedule is indicated in the Extended Schedule element. This field is reserved when the Discovery Assistance Request Status Code subfield is not equal to SUCCESS.

Dwelling Time Present subfield is set to 1 to indicate that the Dwelling Time field is present in the DMG Discovery Assistance element and set to 0 otherwise.

The Discovery Assistance Request Status Code field contains the result of the discovery assistance request and is one of the status codes specified in Table 9-52 (Status codes) in 9.4.1.9 (Status Code field). This field is reserved when the element is contained in FST Setup Request frame.

The Discovery Assistance Window Length field indicates the discovery assistance window length value as confirmed by the STA transmitting this element in microseconds. This field is reserved when the element is contained in FST Setup Request frame.

The Sector Sweep Start Time field indicates the lower 4 octets of the TSF of the DMG BSS at the time the sector sweep transmission starts. This field is present if the Discovery Assistance Type subfield is 0. This field is reserved when the element is contained in FST Setup Request frame.

The Temporary AID field indicates a temporary AID assigned by an AP or PCP to the STA receiving this element. The Temporary AID is used for scheduling discovery assistance only. This field is present if the Discovery Assistance Type subfield is 1.

The Dwelling Time field indicates the recommended time to sweep the received antenna pattern in scanning for beamforming or discovery signal in microseconds. This field is present if the Dwelling Time Present subfield 1.

**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 may include the DMG Discovery Assistance element in FST Setup Request frame only if the recipient device set the Discovery Assistance Enabled field to 1. When DMG Discovery Assistance element is present it indicates a request for a discovery assistance from the recipient device. A multi-band capable device that supports discovery assistance procedure and receives a discovery assistance request shall include the DMG Discovery Assistance element in FST Setup Response frame transmitted in response to a multi-band discovery assistance request. When the Discovery Assistance Type subfield in the DMG Discovery Assistance element is set to 1, a multi-band capable device shall include also an Extended Schedule element in the FST Setup Response frame, and may include TDD Slot Structure and TDD Slot Schedule elements.

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

**11.31.6 Multi-band discovery assistance procedure**

**11.31.6.1 Multi-band discovery assistance request procedure**

Multi-band discovery assistance procedure allows discovery of DMG BSSs using a STA of a multi-band capable device that operates on a band other than its intended band of communication.

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.

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

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. 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, i.e., the Discovery Assistance Enabled subfield in the Multi-band Control field in the Multi-band element.

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 the device that performed scanning may issue 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.

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 and FST Setup Response frame containing the DMG Discovery Assistance element (see 9.4.2.269 (DMG Discovery Assistance element)) as described in 11.31.2 (FST setup protocol).

Upon reception of the MLME-FST-SETUP.indication, SME of the device that received discovery assistance request determines if it accepts requested discovery assistance with its DMG STA. The SME shall encode the determination results in the DMG Discovery Assistance element, and issue MLME-FST-SETUP.response to the Old Band MLME of the device to send back discovery assistance response.

SME that received MLME-FST-SETUP.confirm including the DMG Discovery Assistance element shall determine if the discovery assistance response indicates that the discovery assistance is accepted. If it has been accepted, the SME shall start its DMG STA on the channel specified in the Multi-band element. Further, the SME shall issue MLME-SCAN.request to its New Band MLME in accordance with the parameters contained in the elements in the received frame.

Upon the successful completion of the on-demand sector sweeping, the two multi-band device may complete the FST procedure as described in 11.31.2 (FST setup protocol).



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

**11.31.6.2 Discovery assistance action determination and on-demand sector sweeping**

When SME receiving the discovery assistance request accepts the request, it shall set the Discovery Assistance Request Status Code field of the DMG Discovery Assistance element contained in the transmitting discovery assistance response to SUCCESS and take one of the following actions with the corresponding DMG STA.

If the DMG STA operates non-TDD channel access:

1. The DMG STA schedules DMG Beacon frame transmissions sweeping all of its sectors so that the STA requesting discovery assistance discovers it. The SME sets fields in the DMG Discovery Assistance element as follows, and includes it in transmitting response:
2. Set the Discovery Assistance Type subfield in the Discovery Assistance Control field to 0
3. Set the Sector Sweep Start Time field to the TSF value indicating its TBTT when the discovery assistance starts
4. The DMG STA schedules SSW frame transmissions of its own or DMG Beacon transmission of discovery assistance requesting DMG STA. The DMG STA encodes the scheduled transmissions to Extended Schedule element and includes it to transmitting response. The SME sets fields in the DMG Discovery Assistance element as follows, and includes it in transmitting response:
5. Set the Discovery Assistance Type subfield in the Discovery Assistance Control field to 1
6. Set the Temporary AID field to a temporary value that is assigned to the requesting DMG STA. This temporary AID value is used to identify the requesting DMG STA in the Extended Schedule element

If the DMG STA operates TDD channel access:

1. The DMG STA schedules TDD SSW frame transmissions toward the STA requesting discovery assistance (see 10.38.10 (TDD Beamforming)). The SME sets fields in the DMG Discovery Assistance element as follows, and includes it to transmitting response:
2. Set the Discovery Assistance Type subfield in the Discovery Assistance Control field to 0
3. Set the Sector Sweep Start Time field to the TSF value when the STA starts TDD beamforming procedure
4. Set the Dwelling Time field to the recommended time to sweep the receive antenna pattern during the scanning
5. The DMG STA schedules TDD SSW frame transmissions toward the STA that requested discovery assistance. The DMG STA encodes the scheduled TDD SSW transmissions to Extended Schedule element and includes it to transmitting response. The DMG STA may include TDD Slot Structure element and TDD Slot Schedule element to transmitting response. The SME sets fields in the DMG Discovery Assistance element as follows, and includes it in transmitting response:
6. Set the Discovery Assistance Type subfield in the Discovery Assistance Control field to 1
7. Set the Temporary AID field to a temporary value that is assigned to the requesting DMG STA. This temporary AID value is used to identify the requesting DMG STA in the Extended Schedule element
8. Set the Dwelling Time field to the recommended time to sweep the receive antenna pattern during the scanning

In all cases, the Discovery Assistance Window Length field in the DMG Discovery Assistance element is set to the duration performing discovery assistance. The length of the discovery assistance window is set based on the DMG STA capabilities of the requesting and responding STAs.

SME receiving discovery assistance response with acceptance shall take one of the following actions with the corresponding DMG STA referring to received DMG Discovery Assistance element

* If the Discovery Assistance Type subfield is set to 0, the DMG STA shall start scanning at the time specified in the Sector Sweep Start Time field for a duration of time specified in the Discovery Assistance Window Length field. The DMG STA uses the Dwelling Time field if available to determine its receive antenna pattern sweeping for scanning.
* If the Discovery Assistance Type subfield is set to 1, the DMG STA shall start scanning in the scheduled period defined by the Allocation field in the received Extended Schedule element. The DMG STA uses the temporary AID contained in the Temporary AID field in the DMG Discovery Assistance element to identify its allocation in the Extended Schedule element. The DMG STA uses the Dwelling Time field if available to determine its receive antenna pattern sweeping for scanning.

**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”

[5] 11-18/816, “Discovery assistance for 802.11ay”

[6] 11-18/1202, “Multi-band discovery assistance for 802.11ay”