IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 60GHz Direction Measurement Draft Text | | | | |
| Date: 2018-02-05 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Assaf Kasher | Qualcomm |  |  | akasher@qti.qualcomm.com |
| Solomon Trainin | Qualcomm |  |  | strainin@qti.qualcomm.com |
| Alecs Eitan | Qualcomm |  |  | strainin@qti.qualcomm.com |

Abstract

This document proposes the changes to the TGaz Draft for allowing 60GHz Direction Measurement.

The changes are in reference to TGaz Draft 0.1

**Capabilities:**

Discussion:

We propose to add the 60GHz direction measurement capabilities to the DMG capabilities element. This way it will be available for both DMGz and EDMGz devices.

***TGaz Editor: Add the following text before 9.4.2.246:***

**9.4.2.128.1 General**

***Editor in the* Figure 9-503—DMG Capabilities element format append new field** DMG Direction Measurement Capabilities of 1 octet length

***Editor: Insert the following text after 9.4.2.128.6***

**9.4.2.128.7 Direction Measurement Capabilities**

The Direction Measurement Capabilities field advertises capabilities for performing direction measurement as part of DMG or EDMG exchanges.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B1 | B2 | B3 | B4 | B5 | B6 | B7 B8 |
|  | AOA TX Capability | AOA RX Capability | AOD TX Capability | AOD RX Capability | AOD Feedback Best TRN subfield | AOD Channel Measurement Feedback | Reserved |
| bits: | 1 | 1 | 1 | 1 | 1 | 1 | 2 |

Table 9.233a - DMG Direction Measurement Capabilities

A DMG/EDMG STA sets the AOA TX Capability subfield to 1 to indicate the ability to attach a TRN field to an FTM frame for the purpose of allowing the receiver of that frame to perform Angle of Arrival (AOA) estimation.

A DMG/EDMG STA sets the AOA RX Capability subfield to 1 to indicate the ability to estimate the AOA based on a TRN field attached to an FTM frame.

A DMG/EDMG STA sets the AOD TX Capability subfield to 1 to indicate the ability to attach a TRN field, possibly with different antenna settings to different TRN subfields, to an FTM frame, for the purpose of allowing the responder to estimate the Angle of Departure (AOD) of the packet.

A DMG/EDMG STA sets the AOD RX Capability subfield to 1 to indicate the ability to estimate the AOD based on a TFN field attached to an FTM frame and send a report.

A DMG/EDMG STA sets the AOD Feedback Best TRN subfield to 1 to indicate the ability to send a best TRN subfield index, based on measurement on a TRN field sent by the receiver STA, for the purpose of AOD estimation.

A DMG/EDMG STA sets the AOD Channel Measurement Feedback subfield to 1 to indicate the ability to send a Channel Measurement Feedback element based on measurement on a TRN field sent by the receiver STA, for the purpose of AOD estimation.

**Parameters Exchange:**

***TGaz Editor: Replace subclauses 9.4.2.249 and 9.4.2.250 with the following text***

**9.4.2.249 DMGz Specific Parameters**

The DMGz Specific Parameters subelement is included in the initial FTM request to describe the requested set of parameters that the initiator proposes to use and in the initial FTM frame from the responder when either STA is a non-EDMG STA.

The format of the DMGz Specific Parameters subelement is as shown in Table 9-610e (DMGz Specific Parameters subelement format)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element ID (255) | Length | Element ID Extension | DMG Direction Measurement Parameters |
| Octets | 1 | 1 | 1 | 3 |

Table 610e - DMGz Specific Parameters

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

The DMG Direction Measurement Parameters field is shown in Table 9-610f

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B1 | B2 | B3 | B4 | B5 B10 | B11 B13 | B14 B16 |
|  | I2R AOA Request | R2I AOA Request | I2R AOD Request | R2I AOD Request | L-RX | Direction Measurement Density | Reserved |
| bits: | 1 | 1 | 1 | 1 | 6 | 3 | 3 |

Table 610f - DMG Direction Measurement Parameters

A value of 1 in the I2R AOA Request subfield indicates a request for FTM initiator to FTM responder Angle of Arrival measurement.

A value of 1 in the R2I AOA Request subfield indicates a request for FTM responder to FTM initiator Angle of Arrival measurement.

A value of 1 in the I2R AOD Request subfield indicates a request for FTM initiator to FTM responder Angle of Departure measurement.

A value of 1 in the R2I AOD Request subfield indicates a request for FTM responder to FTM initiator Angle of Departure measurement.

The L-RX field indicates how many TRN-units are requested by the sender for Angle of Arrival measurements. The interpretation of this field is explained in 9.5.4 (BRP Request field).

The Direction Measurement Density indicates how often in a burst a direction measurement is performed. The interpretation of the values is defined in Table 9-610g (Direction Measurement Density)

|  |  |
| --- | --- |
| Value | Interpretation |
| 0 | Only the first FTM measurement exchange in a burst is a direction measurement |
| 1 | Every measurement in a burst is a direction measurement |
| 2 | Every second measurement in a burst is a direction measurement |
| 3 | Every 4th measurement in a burst is a direction measurement |
| 4 | Every 8th measurement in a burst is a direction measurement |
| 5-7 | Reserved |

Table 9-610g – Direction Measurement Density field interpretation

**9.4.2.250 EDMGz Specific Parameters**

The EDMGz Specific Parameters subelement is included in the initial FTM request to describe the requested set of parameters that the initiator proposes to use and in the initial FTM frame from the responder when both STA are EDMG STAs.

The format of the EDMGz Specific Parameters subelement is as shown in Table 9-610h (DMGz Specific Parameters subelement format)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element ID (255) | Length | Element ID Extension | EDMG Direction Measurement Parameters |
| Octets | 1 | 1 | 1 | 3 |

Table 610h- DMGz Specific Parameters

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

The EDMG Direction Measurement Parameters field is shown in Table 9-610f

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B1 | B2 | B3 | B4 | B5 B12 | B13 B15 | B16 |
|  | R2I AOA Request | I2R AOA Request | I2R AOD Request | R2I AOD Request | L-RX | Direction Measurement Density | Reserved |
| bits: | 1 | 1 | 1 | 1 | 8 | 3 | 1 |

Table 1 - DMG Direction Measurement Parameters

All the fields definitions are the same as in 9.4.2.249 (DMGz Specific Parameters)

Measurement Results:

***TGaz Editor: Add the following text after 9.4.2.246***

***Editor: Add the following as a new element***

**9.4.2.nnn Direction Measurement Results element**

The Direction Measurement Results element is used to send Angle of Arrival and Angle of Departure measurement results. It is transmitted as part of the Location Measurement Report.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Element Id | Element Length | Element ID Extension | AoA Results |
| octets: | 1 | 1 | 1 | 5 |

Table 2 - Direction Measurement Results Element

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

The AoA Results field is defined in Table 3:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B1 B11 | B12 B22 | B23 B29 | B30 B36 | B37 B40 |
|  | AOA Azimuth | AOA Elevation | AOA Azimuth Accuracy | AOA Elevation Accuracy | Reserved |
| bits: | 11 | 11 | 7 | 7 | 4 |

Table 3 - AOA Results Field

The AOA Azimuth subfield contains the Angle of Arrival (AOA) azimuth result in degree/4 resolution. When this subfield is sent from an AP, the AOA is in earth coordinates (i.e. direction 0 is north).

The AOA Elevation subfield contains the AOA elevation result in degree/4 resolution.

When this subfield is sent from an AP, the AOA is in earth coordinates (i.e. elevation 0 is horizon).

The AOA Azimuth Accuracy subfield contains the AOA Azimuth result’s / estimated accuracy in degree/4 resolution. If the accuracy is greater or equal to 31.75 degrees the field saturates to 0xFF.

The AOA Elevation Accuracy subfield contains the AOA Elevation result’s estimated accuracy in degree/4 resolution. If the accuracy is greater or equal to 31.75 degrees the field saturates to 0xFF.

**Protocol**

***TGaz Editor: Modify the first two lines of 11.24.6.1 as follows:***

The FTM procedure allows a STA to determine its distance and its direction to or from another STA. In order for a STA to obtain its location, the STA may perform this procedure with multiple STAs whose locations are known.

***TGaz Editor: Modify paragraphs (c) and (d) in 11.24.6.2.***

1. DMGz Ranging, it shall set the DMG Range Measurement field of the Extended Capabilities element to 1. Otherwise it shall set the Multi User Range Measurement field of the Extended Capabilities element to 0. A STA that additionally supports Direction Measurement shall include a DMG Direction Measurement Capabilities field in the DMG Capabilities element and set one of the first 4 subfields of this field to 1

eDMGz Ranging, it shall set the EDMG Range Measurement field of the Extended Capabilities element to 1. Otherwise it shall set the Multi User Range Measurement field of the Extended Capabilities element to 0. A STA that additionally supports Direction Measurement shall include a DMG Direction Measurement Capabilities field in the DMG Capabilities element and set one of the first 4 subfields of this field to 1.

***TGaz Editor: Add the following subclause before 11.24.6.4***

**11.24.6.3.1 DMGz/EDMGz Direction measurement setup**

A DMGz/EDMGz ISTA may request that FTM exchanges will include direction measurement if both the ISTA and the RSTA indicated support for DMGz/EDMGz direction measurement by including the DMG Direction Measurement Capability field in the DMG capability element, and setting at least one of the first 4 subfields of this field to 1.

A DMGz/EDMGz ISTA may request initiator AOA measurement, responder AOA measurement, initiator AOD measurement and responder AOD measurement, by including a DMGz/EDMGz Specific Parameters subelement in the NGP Parameters Element transmitted in the FTM request frame. Valid combinations of AOA and AOD requests and the corresponding required capabilities are shown in Table 4. The L-RX field in the DMGz/EDMGz/ Specific Parameters element shall be set to the number of TRN units the ISTA needs for AOA estimation in case R2I AOA was requested, otherwise it shall be set to 0.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Requested Parameters | | | | Required Initiator Capabilities | | | | Required Responder Capabilities | | | |
| R2I  AOA | I2R  AOD | I2R  AOA | R2I  AOD | AOA  RX | AOA  TX | AOD  RX | AOD  TX | AOA  RX | AOA  TX | AOD  RX | AOD  TX |
| Y |  |  |  | Y |  |  |  |  | Y |  |  |
|  | Y |  |  |  |  |  | Y |  |  | Y |  |
|  |  | Y |  |  | Y |  |  | Y |  |  |  |
|  |  |  | Y |  |  | Y |  |  |  |  | Y |
| Y | Y |  |  | Y |  |  | Y |  | Y | Y |  |
|  |  | Y | Y |  | Y | Y |  | Y |  |  | Y |
| Y |  | Y |  | Y | Y |  |  | Y | Y |  |  |
|  | Y |  | Y |  |  | Y | Y |  |  | Y | Y |

Table 4 - Valid Combination of Direction Measurements request and the required capabilities at initiator and responder

The RSTA should respond within 10ms from the initial FTM request with an initial Fine Timing Measurement frame with an NGP Parameters Element with a DMGz/EDMGz Specific Parameters subelement. The requested AOA/AOD I2R/R2I parameters in the initial Fine Timing Measurement shall be the same as those requested in the initial FTM request. The L-RX field shall be set to the number of TRN units the RSTA needs for AOA estimation in case I2R AOA was requested. The RSTA sets the Direction Measurement Density field.

The AOA and AOD requests parameters in the FTM request and the initial Fine Timing Measurement frame shall be compatible with the corresponding AOA/AOD TX/RX capabilities as shown in the Table 4

***TGaz Editor: Add the following subclause before 11.24.6.4a***

**11.24.6.4.4 DMGz/EDMGz measurement exchange.**

A DMGz/EDMGz ISTA/RSTA performs an FTM exchange that does not require AOA or AOD measurements as defined in 11.24.6.4.1, with the trigger field set to 1 in the Fine Timing Measurement Request initiating the exchange.

An EDMGz ISTA may initiate an FTM measurement exchange using the first path AWV setting by setting the value of the trigger field of the Fine Timing Measurement Request frame that initiates the exchange to 2. An EDMGz ISTA may send a Fine Timing Measurement Request frame with the trigger set to 2 only if the RSTA has set the First Path Training Supported subfield to 1 in the Beamforming field of the EDGM capabilities element and the ISTA and RSTA have performed beamforming training for first path as defined in 10.39.9.6. The first path AWV settings shall be used transmission and reception of all frames sent by the ISTA and RSTA during the FTM burst.

11.24.6.4.4.1 DMGz/EDGMz AOA/AOD measurement exchange

In a DMGz/EDMGz ISTA/RSTA pair that has agreed on performing direction measurement by agreeing on either R2I AOA, I2R AOD, I2R AOA or R2I AOD, shall add TRN fields to FTM exchanges in the burst according to the Direction Measurement Density sent by the RSTA in the initial Fine Timing Measurement frame.

A DMGz/EDMGz ISTA/RSTA pair that has agreed on either R2I AOA, I2R AOD, I2R AOA or R2I AOD using the procedure described in 11.24.6.3.1, shall be denoted as Direction Measurement FTM pair.

In a Direction Measurement FTM pair, the first measurement in the burst shall include either R2I AOA, I2R AOD, I2R AOA or R2I AOD for all values for the Direction Measurement Density.

In a Direction Measurement FTM pair that agreed on R2I AOA, the ISTA shall add a TRN field to the FTM frames in the exchanges specified by the Direction Measurement Density field by setting the TRN\_LEN to the value of the L\_RX field sent by the RSTA and PACKET\_TYPE to 0.

In a Direction Measurement FTM pair that agreed on I2R AOA, the RSTA shall add a TRN field to the ACK frames in the exchanges specified by the Direction Measurement Density field by setting the TRN\_LEN to the value of the L\_RX field of the DMG Direction Measurement Parameters received from the ISTA and PACKET\_TYPE to 0. The RSTA shall provide the AOA measurement results in the Direction Measurement Result element included in the next FTM frame sent to the ISTA.

In a Direction Measurement FTM pair that agreed on R2I AOD, the RSTA shall add a TRN field to the FTM frames in the exchanges specified by the Direction Measurement Density field by setting the TRN\_LEN to a non-zero value and PACKET\_TYPE to 1.

In a Direction Measurement FTM pair that agreed on I2R AOD, the ISTA shall add a TRN field to the ACK frames in the exchanges specified by the Direction Measurement Density by setting the TRN\_LEN to a non-zero value and PACKET\_TYPE to 1.

If the trigger field in the FTM requests frame that initiated an FTM exchange in a Direction Measruement FTM pair is set to 2 all the preamble and PSDU parts of the PPDUs sent during the exchange shall be transmitted and received using the first path AWV setting. The TRN fields of these PPDUs shall also be transmitted and received using the first path AWV setting, except for AOD TRN fields which may be transmitted with changing AWV setting and AOA TRN fields which may be received with changing AWV setting.

**References:**