IEEE P802.11
Wireless LANs

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| DMG Sensing Report IE |
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|  |  |  |  |  |

Abstract

This submission presents the suggested IE formats that need to be added to support DMG Sensing Image Report and DMG Sensing Targets Report

In addition to the DMG Sensing Image Report IEs, there are additional IEs needed during the setup phase to define the axis interpretation.

(Motion 42, 21/1801r2) The 11bf amendment shall define at least one measurement report type for 2D, 3D and 4D filtered maps.

* This measurement report type is an optional feature.
* Supporting 2D, 3D and 4D are each optional feature
* The details of the measurement report format is TBD
* 2D is a two-dimensional map, where the two dimensions are any from: Range, Azimuth, Elevation & Doppler.
* 3D is a three-dimensional map, where the three dimensions are any from: Range, Azimuth, Elevation & Doppler.
* 4D is a four-dimensional map, where the four dimensions are: Range, Azimuth, Elevation & Doppler.

(Motion 43, 21/1801r2) The 11bf amendment shall define at least one measurement report type for targets.

* “Target” is a detected object
* This measurement report type is an optional feature.
* The details of the measurement report format is TBD.

**This submission has references to:**

* 11-22-0295-00-00bf-PDT-DMG-Measurement-Setup-frames.docx
* 11-22-0240-00-00bf-pdt-dmg-sensing-capability

**Name Change**

In the motion we voted to include “measurement report type for 2D, 3D and 4D filtered maps”

In this document it is named “DMG Sensing Image Report”

In the motion we voted to include “measurement report type for targets”

In this document it is named “DMG Sensing Targets Report”

***TGbf Editor: Insert the following clause at the end of 9.4.2 (P.L.)***

**9.4.2.A** **DMG Sensing Report element**

**9.4.2.A.1** General

The DMG Sensing Report element contains DMG sensing report. The format of the DMG Sensing Report

element is shown in Figure 9-a (DMG Sensing Report element format).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Element Length | Element IDExtention | DMG Measurement Setup ID | DMG Burst ID | DMG Sensing Instance ID |
| Octets: | 1 | 1 | 1 | TBD | TBD | TBD |

|  |  |  |  |
| --- | --- | --- | --- |
|  | DMG Sensing Report Type | DMG Sensing Report Control | DMG Sensing Report |
| Octets: | 1 | 3 | variable |

**Figure 9-a—** **DMG Sensing Report element format**

The DMG Measurement Setup ID, DMG Burst ID and DMG Sensing Instance ID fields are defined in TBD (TBD). The DMG Burst ID and DMG Sensing Instance ID values reported are of the last used DMG Burst ID and DMG Sensing Instance ID to compute this report.

The DMG Sensing Instance ID is reserved when one of the following conditions is met:

1. DMG Sensing Report Type equals DMG Sensing Image Report and,
Doppler Axis Present is set
2. DMG Sensing Report Type equals DMG Sensing Targets Report

The DMG Sensing Report Type field is set to a number that identifies the measurement report type. The DMG Sensing Report Types that have been allocated are shown in Table 9-a (DMG Sensing Report Type field definitions for DMG Sensing Report reports).

**Table 9-a—** **DMG Sensing Report Type field definitions**

|  |  |
| --- | --- |
| **Name** | **DMG Sensing Report Type** |
| DMG Sensing Image Report | 0 |
| DMG Sensing Targets Report | 1 |
|  |  |

The DMG Sensing Report Control field is defined in Figure 9-b (DMG Sensing Report Control subfield format)

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 B7 | B8 B22 | B23 |
|  | Report ID | Sequence Number | Last Report ID |
| Bits: | 8 | 15 | 1 |

**Figure 9-b—DMG Sensing Report Control subfield format**

The Report ID subfield uniquely identifies a measurement report that is segmented into multiple IEs.

The Sequence Number subfield contains the sequence number of this IE. First Sequence Number is 0 and it is incremented every DMG Sensing Report IE sent that belongs to the same Report ID.

The Last Report ID subfield is set to 1 in the last DMG Sensing Report IE sent that belongs to the same Report ID.

The DMG Sensing Report subfield contains one or more subelements. The subelements that can be included are: DMG Sensing Report Header Subelement (9.4.2.A.2), DMG Sensing Image Report Data subelements (9.4.2.A.3) and DMG Sensing Targets Report Data subelements (9.4.2.A.4)

STA sending a DMG Sensing Report shall send one or more DMG Sensing Report IE containing one DMG Sensing Report Header Subelement (9.4.2.A.2) and one or more DMG Sensing Image Report Data subelements (9.4.2.A.3) or, one or more DMG Sensing Targets Report Data subelements (9.4.2.A.4).

The DMG Sensing Report subelement ID field values for the defined subelements are shown in Table 9-b (Optional subelement IDs for DMG Sensing Report).

**Table 9-b—** **Optional subelement IDs for DMG Sensing Report**

|  |  |
| --- | --- |
| **Subelement ID** | **Name** |
| 0 | DMG Sensing Report Header |
| 1 | DMG Sensing Image Report Data |
| 2 | DMG Sensing Targets Report Data |
| 3-255 | Reserved |

The DMG Sensing Report Header subelement contains reporting STA location information. The DMG Sensing Report Header Subelement field format is presented in 9.4.2.A.2 (DMG Sensing Report Header subelement).

The DMG Sensing Image Report Data subelement contains measurements reported. The DMG Sensing Image Report Data Subelement field format is presented in 9.4.2.A.3 (DMG Sensing Image Report Data subelement).

The DMG Sensing Targets Report Data subelement contains the reported targets. The DMG Sensing Targets Report Data Subelement field format is presented in 9.4.2.A.4 (DMG Sensing Targets Report Data subelement).

**9.4.2.A.2 DMG Sensing Report Header subelement**

The DMG Sensing Report Header subelement carries a description of a DMG sensing image report. The format of the DMG Sensing Report Header subelement is shown in Figure 9-c (DMG Sensing Report Header element format).

|  |  |  |
| --- | --- | --- |
|  | Subelement ID | Element Length |
| Octets: | 1 | 1 |

|  |  |  |
| --- | --- | --- |
|  | ReferenceTimestamp | DMG Sensing Report Header Data Present |
| Octets: | 4 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | LCI(Optional) | Range(Optional) | AoA(Optional) |
| Octets: | 0 or 16 | 0 or 3 | 0 or 6 |

**Figure 9-c—** **DMG Sensing Report Header element format**

The Subelement ID field is defined in Table 9-b (Optional subelement IDs for DMG Sensing Report).

The Reference Timestamp field contains the lower 4 octets of the TSF timer value sampled at the instant that the last DMG Measurement Instance incorporated in this report was received.

The DMG Sensing Report Header Data Present field is as shown in Figure 9-d (DMG Sensing Report Header Data Present subfield format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 B7 |
|  | LCI Present | Range Present | AoA Present | Reserved |
| Bits: | 1 | 1 | 1 | 5 |

**Figure 9-d—DMG Sensing Report Header Data Present subfield format**

The LCI Present field indicates the presence or absence of the LCI subfield in the DMG Sensing Report Header element.

The Range Present field indicates the presence or absence of the Range subfield in the DMG Sensing Report Header element.

The AoA Present field indicates the presence or absence of the AoA subfield in the DMG Sensing Report Header element.

The LCI field is defined in Figure 9-300 (LCI field format) [IEEE P802.11-REVme/D1.0, December 2021]

The Range field is defined in Figure 9-e (Range subfield format)

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 B15 | B16 B21 | B22 B23 |
|  | Range | Range uncertainty | Reserved |
| Bits: | 16 | 6 | 2 |

**Figure 9-e—Range subfield format**

The Range field indicates the range of the Receiving STA relative to the Initiator STA in 1 mm units.

The Range Uncertainty subfield contains the range estimated uncertainty using the formula:

Where is the Range estimated uncertainty in 1 mm units.

The AoA subfield indicates the AoA measurement result done by the Receiver STA relative to the transmitter STA. AoA subfield is defined in Figure 9-788edq (AOA Results field format) [P802.11az/D4.0, August 2021]

**9.4.2.A.3 DMG Sensing Image Report Data subelement**

The DMG Sensing Image Report Data subelement is contains DMG sensing image report results. This element follows DMG Sensing Report Header subelement. The format of the DMG Sensing Image Report Data subelement is shown in Figure 9-f (DMG Sensing Image Report Data subelement format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Subelement ID | Element Length | Data Block SN | Axis Present | Reflection Power Bias |
| Octets: | 1 | 1 | 1 | 1 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Reflection Power Slope | Number of Reflection subelements in this IE | Reflection subelements | Reserved |
| Octets: |  |  | variable | variable |

**Figure 9-f—** **DMG Sensing Image Report Data element format**

The Subelement ID field is defined in Table 9-b (Optional subelement IDs for DMG Sensing Report).

The Data Block SN field contains the sequence number of this DMG Sensing Image Report Data element belonging to the same DMG Sensing Image Report.

The Axis Present field is as shown in Figure 9-g (Axis Present subfield format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 B7 |
|  | Range Axis Present | Doppler Axis Present | Receiver Beam Index Present | Transmitter Beam Index Present | Reserved |
| Bits: | 1 | 1 | 1 | 1 | 4 |

**Figure 9-g—** **Axis Present subfield format**

The Range Axis Present field indicates the presence Range axis index subfield in the Reflection subelements.

The Doppler Axis Present field indicates the presence Doppler axis index subfield in the Reflection subelements.

The Receiver Beam Index Present field indicates the presence of Receiver beam index subfield in the Reflection subelements. [related to 9.4.2.x Sensing Beam Description element in submission 22/0240r0] [TBD Reference]

The Transmitter Beam Index Present field indicates the presence of Transmitter beam index subfield in the Reflection subelements. [related to 9.4.2.x Sensing Beam Description element in submission 22/0240r0] [TBD Reference]

The Reflection Power Bias Subelement in this IE field contains the bias value to compute the reflection power. The value is in 1 dBm units representing the negated value. The bias represented is in the range of 0dBm to -255dBm, represented by value 0 to 255 in the subfield.

The Reflection Power Slope Subelement in this IE field contains the slope value to compute the reflection power. The value is in 1/64 dBm units representing the factor for the reported values.

The Number of Reflection subelements in this IE field contains the number of Reflection subelements that are reported in the following Reflection subelements.

The Reflection subelements contains multiple entries of Reflection subelement, where all have the same format that can be derived from the Axis Present field. There are 3 format options for 2 axis (Figure 9-h— Reflection subelement format for 2 axis), 3 axis (Figure 9-i— Reflection subelement format for 3 axis) and 4 axis (Figure 9-j— Reflection subelement format for 4 axis). The number of bits allocated for each axis is fixed and given by the axis type. The order of the axis in this subelement is given in Table 9-c.

The number of bits (s1, s2, s3, s4) in Figures 9-h, 9-i and 9-j is according to Table 9-c and the selected axis in Axis Present field.

The Axis #1, #2, #3 and #4 subfield in the Reflection Subelement represents the index of the axis according to the values defined in 9.4.2.B.3 (DMG Sensing Image Range Axis LUT element), 9.4.2.C.4 (DMG Sensing Image Doppler Axis LUT element), 9.4.2.x (Sensing Beam Description element).

The Reflection Power subfield in the Reflection Subelement represents the reflection received power in dBm units. The actual reflection received power value is given by:
 (Reflection received power [dBm]) = (-Reflection Power Bias) + (Reflection Power)x(Reflection Power Slope/64), where the Reflection Power Bias and Reflection Power Slope are the values in the DMG Sensing Image Report Data element.

Table 9-c – Order of the axis and allocated bits in Reflection Subelement

|  |  |
| --- | --- |
| **Axis** | **Allocated bits (S1, S2, S3, S4)** |
| Range | 16 |
| Doppler | 10 |
| Receiver Beam Index | 12 |
| Transmitter Beam Index | 12 |

In Monostatic sensing the Receiver Beam Index axis represents the Beam Index used by the STA to transmit and receive, and the Transmitter Beam Index axis will not be present. Beam Index is defined in TBD [related to 9.4.2.x3.1 and 9.4.2.x3.2 in 11-22-0295-00-00bf-PDT-DMG-Measurement-Setup-frames.docx]

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | Axis #1 | Axis #2 | Reflection Power |
| Bits: | S1 | S2 | 12 |

**Figure 9-h—** **Reflection subelement format for 2 axis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | Axis #1 | Axis #2 | Axis #3 | Reflection Power |
| Bits: | S1 | S2 | S3 | 12 |

**Figure 9-i—** **Reflection subelement format for 3 axis**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  | Axis #1 | Axis #2 | Axis #3 | Axis #4 | Reflection Power |
| Bits: | S1 | S2 | S3 | S4 | 12 |

**Figure 9-j—** **Reflection subelement format for 4 axis**

**9.4.2.A.4 DMG Sensing Targets Report Data subelement**

The DMG Sensing Targets Report Data subelement is contains DMG sensing targets report results. This element follows DMG Sensing Report Header subelement. The format of the DMG Sensing Targets Report Data subelement is shown in Figure 9-k (DMG Sensing Targets Report Data subelement format).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Subelement ID | Element Length | Data Block SN | Axis Present |
| Octets: | 1 | 1 | 1 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | Number of Targets | Target subelements | Reserved |
| Octets: | 1 | variable | variable |

**Figure 9-k—** **DMG Sensing Target Report Data element format**

The Subelement ID field is defined in Table 9-b (Optional subelement IDs for DMG Sensing Report).

The Data Block SN field contains the sequence number of this DMG Sensing Image Report Data element belonging to the same DMG Sensing Image Report.

The Axis Present field is as shown in Figure 9-l (Axis Present subfield format).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | B0 | B1 | B2 | B3 | B4 |
|  | Range Axis Present | Azimuth Axis Present | Elevation Axis Present | Radial velocity Axis Present | Azimuth velocity Axis Present |
| Bits: | 1 | 1 | 1 | 1 | 1 |

|  |  |  |
| --- | --- | --- |
|  | B5 | B6 B7 |
|  | Elevation velocity Axis Present | Reserved |
| Bits: | 1 | 2 |

**Figure 9-l—** **Axis Present subfield format**

The Range Axis Present field indicates the presence Range axis index subfield in the Reflection subelements.

The Azimuth Axis Present field indicates the presence Azimuth axis index subfield in the Reflection subelements.

The Elevation Axis Present field indicates the presence Elevation axis index subfield in the Reflection subelements.

The Radial velocity Axis Present field indicates the presence of Radial velocity axis index subfield in the Reflection subelements.

The Azimuth velocity Axis Present field indicates the presence of Azimuth velocity axis index subfield in the Reflection subelements.

The Elevation velocity Axis Present field indicates the presence of Elevation velocity axis index subfield in the Reflection subelements.

The Number of Targets field contains the number of Target subelements that are reported in the following Target subelements.

The Target subelements field contains one or multiple Target subelelent fields as defined in

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | Target Index | Range | Range Span |
| Bits: | 8 | 0 or 16 | 0 or 6 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  | Azimuth | Azimuth Span | Elevation | Elevation Span |
| Bits: | 0 or 11 | 0 or 5 | 0 or 10 | 0 or 5 |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | Radial Velocity | Azimuth Velocity | Elevation Velocity |
| Bits: | 0 or 12 | 0 or 12 | 0 or 12 |

**Figure 9-m—** **Axis Present subfield format**

The Target Index subfield indicates the ID of the target. The Receiver STA may allocate a non-zero value to each detected target and use the same value in different reports. Target Index of zero shall be used if the Receiver STA doesn’t allocate a persistent number to each target.

The Range subfield indicates the range of the target relative to the reporting STA in 1 mm units. This subfield is present if Range Axis Present field is set in Axis Present subfield, and not present otherwise.

The Range Span subfield indicates the range span (size) of the target relative to the reporting STA, using the formula:

Where is the Range Span in 1 mm units.

This subfield is present if Range Axis Present field is set in Axis Present subfield, and not present otherwise.

The Azimuth subfield indicates the Azimuth of the target relative to the reporting STA in 360/2048 degree units. This subfield is present if Azimuth Axis Present field is set in Axis Present subfield, and not present otherwise.

The Azimuth Span subfield indicates the Azimuth span (size) of the target relative to the reporting STA, using the formula:

Where is the Azimuth Span in 360/2048 degree units.

This subfield is present if Azimuth Axis Present field is set in Axis Present subfield, and not present otherwise.

The Elevation subfield indicates the Elevation of the target relative to the reporting STA in 360/2048 degree units. This subfield is present if Elevation Axis Present field is set in Axis Present subfield, and not present otherwise.

The Elevation Span subfield indicates the Elevation span (size) of the target relative to the reporting STA, using the formula:

Where is the Elevation Span in 360/2048 degree units.

This subfield is present if Elevation Axis Present field is set in Axis Present subfield, and not present otherwise.

The Radial Velocity subfield indicates the Radial Velocity of the target relative to the reporting STA in 1mm/sec units. This subfield is present if Radial velocity Axis Present field is set in Axis Present subfield, and not present otherwise.

The Azimuth Velocity subfield indicates the Azimuth Velocity of the target relative to the reporting STA in (360/2048 degree)/sec units. This subfield is present if Azimuth velocity Axis Present field is set in Axis Present subfield, and not present otherwise.

The Elevation Velocity subfield indicates the Elevation Velocity of the target relative to the reporting STA in (360/2048 degree)/sec units. This subfield is present if Elevation velocity Axis Present field is set in Axis Present subfield, and not present otherwise.

**9.4.2.B DMG Sensing Image Range Axis LUT element**

The DMG Sensing Image Range Axis LUT element carries the LUT for the Range Axis used in DMG Sensing Image Report Data element. This element is used in the measurement setup phase. The format of the DMG Sensing Image Range Axis LUT element is shown in Figure 9-n (DMG Sensing Image Range Axis LUT element format)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Element Length | Element IDExtention | DMG Measurement Setup ID | Total number of LUT entries |
| Octets: | 1 | 1 | 1 | TBD | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | First LUT entry index in this IE | Number of LUT entries in this IE (K) | LUT entries |
| Octets: | 2 | 1 | 2xK |

**Figure 9-n—** **DMG Sensing Image Range Axis LUT element format**

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

The DMG Measurement Setup ID field are defined in TBD (TBD).

The Total number of LUT entries subelements field contains the total number of LUT entries that the sender STA sends in one or multiple DMG Sensing Image Range Axis LUT IE.

The First LUT entry index in this IE subelements field contains the index of the first element in the LUT entries subfield. The LUT entries are numberd from zero.

The Number of LUT entries in this IE subelements field contains the number of LUT entries in this IE only.

The LUT entries Subelement field contains the Range values for each entry. Each value is 16 bits representing the Range in 1mm units.

**9.4.2.C DMG Sensing Image Doppler Axis LUT element**

The DMG Sensing Image Doppler Axis LUT element carries the LUT for the Doppler Axis used in DMG Sensing Image Report Data element. This element is used in the measurement setup phase. The format of the DMG Sensing Image Doppler Axis LUT element is shown in Figure 9-o (DMG Sensing Image Doppler Axis LUT element format)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Element ID | Element Length | Element IDExtention | DMG Measurement Setup ID | Total number of LUT entries |
| Octets: | 1 | 1 | 1 | TBD | 2 |

|  |  |  |  |
| --- | --- | --- | --- |
|  | First LUT entry index in this IE | Number of LUT entries in this IE (K) | LUT entries |
| Octets: | 2 | 1 | 2xK |

**Figure 9-o—** **DMG Sensing Image Doppler Axis LUT element format**

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

The DMG Measurement Setup ID field are defined in TBD (TBD).

The Total number of LUT entries subelements field contains the total number of LUT entries that the sender STA sends in one or multiple DMG Sensing Image Doppler Axis LUT IE.

The First LUT entry index in this IE subelements field contains the index of the first element in the LUT entries subfield. The LUT entries are numberd from zero.

The Number of LUT entries in this IE subelements field contains the number of LUT entries in this IE only.

The LUT entries Subelement field contains the Doppler values for each entry. Each value is 16 bits representing the Doppler in 1mm/sec units.