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| Proposed Draft Text for DMG sensing procedure |
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Abstract

## This document includes proposed draft text for the “DMG sensing (SENS) procedure” sub-clause as defined in TGbf’s SFD. The DMG sensing procedure is defined in the SFD by 7.3 DMG sensing (SENS) procedure.

## *TGbf Editor: Insert the following text after 11.21.17*

## 11.21.18.3 DMG sensing (SENS) procedure

### 11.21.18.3.1 Overview (Motion 55, 21/2015r4)

DMG sensing types include monostatic, bistatic, multistatic, monostatic sensing with coordination, bistatic sensing with coordination, and passive sensing

In monostatic sensing, the transmitter and the receiver of the sensing PPDU locate in the same STA (collocated).

In bistatic sensing, the transmitter and the receiver of the sensing PPDU locate in two separate STAs.

In multi-static sensing, the transmitters and the receivers of the sensing PPDU locate in at least three separate STAs, for example, one transmitter STA and multiple receivers STA or one receiver STA and multiple transmitters STA.

In passive sensing, the receiving STA uses for sensing any non-sensing PPDUs transmitted by one or more other STAs.

Monostatic sensing with coordination is an extension of monostatic to coordinate monostatic devices. Bistatic sensing with coordination is an extension of bistatic type to coordinate multiple sensing responders by one sensing initiator.

In the monostatic sensing with coordination sensing type, the transmissions of one or more devices that perform monostatic sensing are coordinated by a PCP/AP (Motion 40, 21/1914r0).

The DMG sensing procedure defines all DMG sensing types.

The behavior of each type of DMG sensing type is defined separately (Motion 56, 22/0031r0).

A DMG sensing procedure is a subset of the WLAN sensing procedure. Unless otherwise noted, the rules for WLAN SENS apply to DMG SENS.

DMG sensing procedure defines the behavior of a single sensing initiator with one or more sensing responders (Motion 56, 22/0031r0).

A DMG sensing procedure is composed of one or more of the following: DMG sensing session setup, DMG measurement setup, DMG sensing burst, DMG sensing instance, DMG measurement setup termination, and DMG sensing session termination.

A DMG sensing procedure may be comprised of multiple DMG sensing bursts. A DMG sensing burst may be comprised of multiple DMG sensing instances.

NOTE – Measurements over a certain time period are needed to compute the Doppler frequency shift. The occupancy time per link access cannot exceed the TXOP limit. If a longer measurement time is needed, then the approach of the DMG sensing burst allows scheduling of the multiple link accesses to collect measurements for the Doppler frequency shift computation.

One sensing responder may participate in multiple DMG sensing bursts and DMG sensing instances associated with different DMG measurement setups.

A sensing initiator may maintain multiple sensing responders in multiple DMG sensing bursts and DMG sensing instances associated with different DMG measurement setups.

A sensing initiator may instruct the sensing responder in the sensing receiver role or in the sensing receiver and sensing transmitter role to report at the DMG sensing instance, and/or it may instruct the sensing responder to accumulate the results and report once per DMG sensing burst.

Examples of DMG SENS are shown in Figures 4-10.



**Figure 4: DMG sensing procedure with one sensing responder.**



**Figure 5: DMG sensing instances of one DMG sensing burst with PCP/AP as sensing initiator and a single monostatic sensing device as sensing responder. Per DMG sensing instance delayed reporting.**



**Figure 6: DMG sensing instances with PCP/AP as sensing initiator and single monostatic sensing device as sensing responder. Per DMG sensing burst delayed delivery of the aggregated report.**



**Figure 7: DMG sensing instances of one DMG sensing burst of bistatic DMG sensing with the sensing initiator in the sensing transmitter role. Per DMG sensing instance delayed delivery of the report. NOTE: The BRP frame is an Action No Ack frame.**



**Figure 8: DMG sensing procedure with three sensing responders.**



**Figure 9: DMG sensing instances with PCP/AP as sensing initiator and two monostatic sensing devices as sensing responders. The sounding phase of both monostatic devices in the instance may happen in parallel. Two illustrated instances belong to two different DMG measurement setups.**



**Figure 10: DMG sensing instances of multistatic sensing. The PCP/AP is the sensing initiator in the role of sensing transmitter and two sensing responders are in the role of sensing receivers. Two illustrated instances belong to two different DMG measurement setups.**

### 11.21.18.3.2 DMG sensing session setup (Motion 56, 22/0031r0)

In a DMG sensing session setup of a DMG sensing procedure, the sensing initiator and the sensing responder exchange DMG sensing capabilities. The capabilities include the types of DMG sensing and the roles the STA may assume for each of the supported DMG sensing types.The DMG Sensing Short Capabilities element (9.4.2.x1) [2], and the DMG Sensing Capabilities element (9.4.2.x) [1] contain the sensing capabilities of the DMG STA.

The sensing capable (TBD MIB) AP/PCP STA shall convey the DMG Sensing Short Capabilities element in the DMG beacon and Announce frames.

The sensing capable (TBD MIB) DMG STA s shall include the DMG Sensing Capabilities element (9.4.2.x) in the probe frames and the association frames.

The AP/PCP STA may set up the DMG measurement with the non-AP/PCP STA capable of one of the DMG sensing types once the non-AP/PCP STA is associated with the AP/PCP.

The AP/PCP STA shall not initiate the DMG measurement setup with the unassociated non-AP/PCP STA if the STA is not capable of at least one of the DMG sensing types. The non-AP/PCP STA shall initiate the Probe frames exchange with the AP/PCP STA to inform about the DMG sensing capabilities.

To coordinate more than one sensing responder, the sensing initiator of DMG sensing shall be a PCP/AP STA.

The sensing initiator may be capable of the roles of sensing transmitter, sensing receiver, both sensing transmitter and sensing receiver, or none of them.

A sensing responder may be capable of one or more of the following roles: Sensing receiver, sensing transmitter, and both sensing transmitter and sensing receiver.

A sensing initiator of the DMG sensing types monostatic and coordinated monostatic shall be capable of the roles of both sensing transmitter and sensing receiver, or neither of them.

A sensing responder of the DMG sensing types monostatic and coordinated monostatic shall be capable of the roles of both sensing transmitter and sensing receiver.

A sensing initiator of the DMG sensing types bistatic and coordinated bistatic shall be capable of the sensing transmitter and/or the sensing receiver role.

A sensing responder of the DMG sensing types bistatic and coordinated bistatic shall be capable of the sensing transmitter and/or the sensing receiver role.

The sensing initiator of the DMG sensing type multistatic shall be capable of the sensing transmitter and/or the sensing receiver role.

The sensing responder of the DMG sensing type multistatic shall be capable of the sensing transmitter and/or the sensing receiver role.

### 11.21.18.3.3 DMG measurement setup (Motion 56, 22/0031r0)

**11.21.18.3.3.1 General**

DMG measurement setup may require an accomplishment of beamforming training between the sensing initiator and the sensing responder(s) in advance. (10.42, 11.36)

An optional negotiation process in the DMG measurement setup is defined that allows for a sensing initiator and a sensing responder to exchange and agree on operational attributes associated with DMG sensing bursts and DMG sensing instances. The operational attributes may include intra-burst and inter-burst schedule, number of instances per burst, sensing initiator’s and sensing responder’s roles, DMG sensing type, DMG measurement report types, and other parameters.

The Measurement setup request and response frames are defined in (TBD). The information is conveyed in IE (TBD).

The negoriation rules are presented below (TBD)

More than one type of DMG sensing measurement result may be defined. The type of measurement result reported in a DMG sensing procedure shall be decided by its sensing initiator per sensing responder capabilities per DMG sensing types. The types of the measurement results are defined in 9.4.2.x [3]

The sensing initiator requests DMG measurement setup separately with each sensing responder. The set of the operational attributes and parameters established upon the negotiation is identified by the DMG Measurement Setup ID. The same DMG Measurement Setup ID may be asserted to the agreement with different sensing responders if the sensing initiator schedules to address the sensing responders in the same DMG measurement instance.

During a DMG measurement setup, the role(s) of the sensing initiator and sensing responder shall be determined as defined per DMG sensing types.

The sensing initiator and the sensing responder may proceed with the DMG positioning during a DMG measurement setup. They may exchange DMG positioning results such as ranging, AOA, and AOD. They may also exchange LCI and civic location.

**11.21.18.3.3.2 Setup for monostatic and coordinated monostatic DMG sensing type**

The sensing initiator of a coordinated monostatic DMG sensing measurement may be a STA not capable of monostatic DMG sensing.

**11.21.18.3.3.3 Setup for bistatic and coordinated bistatic DMG sensing type**

The sensing initiator of a bistatic DMG sensing measurement shall be capable of bistatic DMG sensing.

In DMG measurement instances of a DMG sensing procedure of sensing type bistatic, the sensing initiator shall interact with one sensing responder, and no more.

In DMG measurement instances belonging to the same DMG Measurement Setup ID, the sensing responder shall be in the sensing receiver role if the sensing initiator is in the sensing transmitter role, and vice versa.

**11.21.18.3.3.4 Setup for multistatic measurement DMG sensing type**

The sensing initiator of a multistatic DMG sensing measurement shall be capable of multistatic DMG sensing.

In DMG measurement instances of a DMG sensing procedure of sensing type multistatic, the sensing initiator may interact with one or more sensing responders.

In DMG measurement instances belonging to the same DMG Measurement Setup ID, all sensing responder(s) shall be in the sensing receiver role if the sensing initiator is in the sensing transmitter role. In DMG measurement instances belonging to the same DMG Measurement Setup ID, all sensing responder(s) shall be in the sensing transmitter role if the sensing initiator is in the sensing receiver role.

### 11.21.18.3.4 DMG sensing burst (Motion 56, 22/0031r0)

A DMG burst may be defined to include more than one sensing measurement instance. Each instance is limited by the TXOP limit.

A DMG burst is identified with the DMG Burst ID.

The DMG burst parameters defined at the measurement setup shall be identified by the DMG Measurement Setup ID.

A specific DMG burst may belong to not more than one DMG Measurement Setup ID.

All DMG sensing instances in the DMG burst shall belong to the same DMG Measurement Setup ID.

The sensing responder may aggregate the reports and report once per DMG burst if aggregated reporting is set in the DMG measurement setup.

### 11.21.18.3.5 DMG sensing instance (Motion 56, 22/0031r0)

**11.21.18.3.5.1 General**

A DMG sensing instance is limited to one TXOP.

A DMG sensing instance belongs to one DMG Measurement Setup ID.

A DMG sensing instance includes the following phases: initiation phase, sounding phase, and reporting phase. The sounding phase is mandatory, and the initiation and reporting phases are optional.

DMG measurement instances of the DMG sensing types monostatic and the bistatic may not contain the initiation phase.

DMG measurement instances of the DNG sensing types coordinated monostatic, coordinated bistatic, and multistatic shall contain the initiation phase.

The reporting phase is mandatory if the sensing responder is in the sensing receiver role and in the sensing transmitter and sensing receiver role.

A DMG sensing instance is identified with the DMG sensing instance number. The DMG sensing instance number shall be sequential in increasing order.

The DMG sensing instance number shall be unique in range (e.g. 0-31, the number is TBD).

The DMG sensing instance may belong to the DMG burst. The DMG sensing instance number shall be unique per the DMG Burst ID.

**11.21.18.3.5.2 Coordinated monostatic instance**

*11.21.18.3.5.2.1 Initiation*

In a coordinated monostatic instance of one or more sensing responders the following rules shall apply:

* The number of sensing responders in each instance of the same DMG Measurement Setup ID may be different
* The sensing initiator shall send a Coordinated Monostatic Instance Request frame to each sensing responder it requests to participate in the instance
* The sensing responder shall not respond with the Coordinated Monostatic Instance Response frame to the sensing initiator later than SIFS time after the request
* The sensing responder that responded to the sensing initiator shall proceed with monostatic sensing
* The order of sounding is indicated in the Coordinated Monostatic Instance Request frame
* The format of the Coordinated Monostatic Instance Request frame and the Coordinated Monostatic Instance Response frame is TBD

*11.21.18.3.5.2.2 Sounding*

The RA shall be set equal to the TA in the PSDU contained in the monostatic PPDU (name of this PPDU is TBD).

*11.21.18.3.5.2.3 Reporting*

* If the responses are configured to happen during the DMG measurement instance, each sensing responder shall respond in no longer than SIFS time after the monostatic PPDU, and
* If the polled responses are configured, each sensing responder shall respond in no longer than SIFS time after the polling by the sensing initiator.

**11.21.18.3.5.3 Bistatic and coordinated bistatic instance**

*11.21.18.3.5.3.1 Initiation*

In the coordinated bistatic instance of one or more sensing responders the following rules shall apply:

* Number of the sensing responders in each instance of the same DMG Measurement Setup ID may be different
* The sensing initiator shall send the Bistatic Instance Request frame to each sensing responder it invites to participate in the sensing instance
* The sensing responder shall not respond with the Bistatic Instance Response frame to the sensing initiator later than in SIFS time
* The sensing responder that responded to the sensing initiator shall remain active to receive the BRP PPDU
* The order of sounding is indicated in the Bistatic Instance Request Frame
* The format of the Bistatic Instance Request frame and of the Bistatic Instance Response frame is TBD

*11.21.18.3.5.3.2 Sounding*

(Motion 45, 21/1865r1) EDMG transmitter initiator bistatic sensing is based on a BRP Request frame in a BRP-RX/TX, BRP-TX, BRP-RX PPDU (as defined in Clause 28 of 802.11) and a BRP Response frame. Feedback for DMG sensing measurement is carried in the BRP Response frame:

* Feedback may be delayed
* Feedback may be aggregated (single feedback for some measurements, to facilitate Doppler measurement)

(Motion 46, 21/1865r1) EDMG/DMG sensing receiver initiator bistatic sensing is based on a BRP Request frame that includes a request for the sensing responder to transmit a BRP-RX/TX, BRP-TX, BRP-RX PPDU (as defined in Clause 28 of 802.11).

*11.21.18.3.5.3.3 Reporting*

In a measurement instance, the responses of the sensing responder in the DMG sensing receiver role to the sensing initiator in the sensing transmitter role may contain no more than one measurement report

**11.21.18.3.5.4 Mulstistatic instance**

*11.21.18.3.5.4.1 Initiation*

In a multistatic instance of one or more sensing responders the following rules shall apply:

* Number of sensing responders in each instance of the same DMG Measurement Setup ID may be different
* The sensing initiator shall send the Multistatic Instance Request frame to each sensing responder it invites to participate in the sensing instance
* The sensing responder shall not respond with the Multistatic Instance Response frame to the sensing initiator later than in SIFS time
* The sensing responder that responded to the sensing initiator shall remain active to receive the Multistatic PPDU (name of this PPDU is TBD)
* The format of the Multistatic Instance Request frame and the Multistatic Instance Response frame is TBD

*11.21.18.3.5.4.2 Sounding*

(Motion 58, 21/2023r0) A multi-static EDMG sensing measurement instance has the following parts:

* An Instance Request frame (frame type TBD) sent to each STA sequentially, and each STA responds to it.
* A multi-static EDMG sensing PPDU. The format of the EDMG sensing PPDU is TBD.
* A feedback part in which the sensing initiator polls each sensing responder for a report, and the sensing responders respond with a report.

*11.21.18.3.5.4.3 Reporting*

If the responses are configured to happen during the DMG measurement instance, each sensing responder shall respond in no longer than SIFS time after polling by the sensing initiator.

### 11.21.18.3.6 Passive DMG sensing (Motion 56, 22/0002r0) (11-22-0241-01-00bf-DMG-passive-sensing)

Passive DMG Sensing allows a STA to use beacon transmission for sensing by enabling a STA to acquire information about the beacons directions and the AP location.

A PCP/AP advertises the capability to perform passive sensing in the DMG Sensing Short Capabilities element. The PCP/AP shall set the Sensing Supported subfield of the Short Sensing Capabilities field to 1 to indicate it supports any type of sensing. The PCP/AP shall set the Passive Sensing Support subfield to 1 if it supports DMG passive sensing. The PCP/AP shall set the Accurate Timing of Beacons to 1 if the SBIFS between beacon transmission in the BTI is exactly where is defined in Table 20-4 (Timing related parameters). The PCP/AP shall set the Location Available subfield to 1 if it can provide an LCI field in a DMG Passive Sensing Beacon Info element.

A STA requests information about the beacon transmission from a PCP/AP by sending an Information Request frame with the Element Id of the DMG Passive Sensing Beacon Info element in the Request element field. The PCP/AP responds with an Information Report frame that includes a DMG Passive Sensing Beacon Info element and one or more DMG Beacon Sector Descriptors elements as defined in 11.28.1.

### 11.21.18.3.7 DMG sensing by proxy (DMG SBP) procedure (Motion 56, 22/0031r0)

DMG sensing by proxy (DMG SBP) is the DMG variant of the SBP procedure. The DMG SBP allows a non-AP and AP STA that is not the sensing initiator to request the sensing initiator to perform the measurement and report the results. The sensing initiator shall provide the DMG SBP service.

References:

1. 11-22-0240-00-00bf-DMG-Sensing-Capabilites
2. 11-22-0241-01-00bf-pdt-dmg-passive-sensing
3. 11-22-0251-00-00bf-PDT DMG Sensing Report IE