



**IEEE Standard for Information Technology—
Telecommunications and Information Exchange between Systems
Local and Metropolitan Area Networks—
Specific Requirements**

Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

Amendment 5: Enhancements for Next Generation V2X

IEEE Computer Society

Developed by the
LAN/MAN Standards Committee

IEEE Std 802.11bd™-2022

(Amendment to IEEE Std 802.11™-2020
as amended by IEEE Std 802.11ax™-2021,
IEEE Std 802.11ay™-2021,
IEEE Std 802.11ba™-2021,
IEEE Std 802.11™-2020/Cor 1-2022,
and IEEE Std 802.11az™-2022)

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Approved 3 December 2022
IEEE SA Standards Board

Abstract: This amendment defines modifications to both the IEEE 802.11 physical layer (PHY) and the medium access control (MAC) sublayer for next generation vehicle-to-everything (V2X) communication in the 5.9 GHz and 60 GHz frequency bands.

Keywords: amendment, IEEE 802.11™, IEEE 802.11bd™, MAC, medium access control, OCB, outside the context of BSS, PHY, physical layer, V2X, vehicular communication, vehicle-to-everything communication, wireless local area network, WLAN

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Introduction

This introduction is not part of IEEE Std 802.11bd-2022, IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications—Amendment 5: Enhancements for Next Generation V2X.

This amendment defines modifications to both the IEEE 802.11 physical layer (PHY) and the medium access control (MAC) sublayer for next generation vehicle-to-everything (V2X) communication in the 5.9 GHz and 60 GHz frequency bands.

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**IEEE Standard for Information Technology—
Telecommunications and Information Exchange between Systems
Local and Metropolitan Area Networks—
Specific Requirements**

**Part 11: Wireless LAN Medium Access Control
(MAC) and Physical Layer (PHY) Specifications**

**Amendment 5:
Enhancements for Next Generation V2X**

(This amendment is based on IEEE Std 802.11™-2020 as amended by IEEE Std 802.11ax™-2021, IEEE Std 802.11ay™-2021, IEEE Std 802.11ba™-2021, IEEE Std 802.11™-2020/Cor 1-2022, and IEEE Std 802.11az™-2022.)

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strike through~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editorial instructions, change markings and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.⁶

⁶ Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

3. Definitions, acronyms, and abbreviations

3.2 Definitions specific to IEEE Std 802.11

Change the definition for “dynamic bandwidth operation” in 3.2 as follows:

dynamic bandwidth operation: A feature of a very high throughput (VHT) station (STA) or a next generation vehicle-to-everything (NGV) STA in which the request-to-send/clear-to-send (RTS/CTS) exchange, using non-high-throughput (non-HT) duplicate physical layer (PHY) protocol data units (PPDUs) or non-NGV duplicate PPDUs, negotiates a potentially reduced channel width (compared to the channel width indicated by the RTS) for subsequent transmissions within the current transmission opportunity (TXOP).

Change the definition for “bandwidth signaling transmitter address (TA)” (as amended by IEEE Std 802.11ax-2021) in 3.2 as follows:

bandwidth signaling transmitter address (TA): A TA that is used by a very high throughput (VHT) station (STA), ~~or a high-efficiency (HE) STA, or a next generation vehicle-to-everything (NGV) STA~~ to indicate the presence of additional signaling related to the bandwidth to be used in subsequent transmission in an enhanced distributed channel access (EDCA) transmission opportunity (TXOP). It is the IEEE medium access control (MAC) individual address of the transmitting VHT STA but with the Individual/Group bit equal to 1.

Insert the following definitions in 3.2 in alphabetical order:

non-next generation vehicle-to-everything (V2X) (non-NGV) duplicate: A transmission format of the physical layer (PHY) that duplicates a 10 MHz non-NGV transmission in two adjacent 10 MHz channels and allows a station (STA) communicating outside the context of a basic service set (BSS)(OCB) on either of the 10 MHz channels to receive the transmission.

non-next generation vehicle-to-everything (V2X) (non-NGV) physical layer (PHY) protocol data unit (PPDU): A PPDU with 10 MHz channel width that is transmitted outside the context of a basic service set (BSS) (OCB) in the 5.9 GHz band and that is not a next generation V2X (NGV) PPDU.

non-next generation vehicle-to-everything (V2X) (non-NGV) station (STA): A STA that transmits or receives non-NGV physical layer (PHY) protocol data units (PPDUs) and that is not able to transmit next generation V2X (NGV) PPDUs.

next generation vehicle-to-everything (V2X) (NGV) physical layer (PHY) protocol data unit (PPDU): A Clause 32 PPDU with the TXVECTOR parameter FORMAT equal to NGV or NON_NGV_10.

outside the context of a basic service set (OCB) primary channel: A 10 MHz channel that is designated by a higher layer (via medium access control (MAC) sublayer management entity (MLME) primitives and/or management information base (MIB) parameters). The OCB primary channel and OCB secondary channel are contiguous and together form a 20 MHz channel for transmission of 20 MHz next generation vehicle-to-everything (V2X) (NGV) physical layer (PHY) protocol data units (PPDUs).

outside the context of a basic service set (OCB) secondary channel: A 10 MHz channel that is designated by a higher layer (via medium access control (MAC) sublayer management entity (MLME) primitives and/or management information base (MIB) parameters). The OCB secondary channel and the OCB primary channel are contiguous and together form a 20 MHz channel for the transmission of 20 MHz next generation vehicle-to-everything (V2X) (NGV) physical layer (PHY) protocol data units (PPDUs).

3.4 Abbreviations and acronyms

Insert the following abbreviations in 3.4 in alphabetical order:

NGV	next generation vehicle-to-everything (V2X)
V2X	vehicle-to-everything

4. General description

4.3 Components of the IEEE Std 802.11 architecture

4.3.17 STA transmission of Data frames outside the context of a BSS

Insert the following paragraphs after the fourth paragraph of 4.3.17 (beginning “Communication of Data frames ...”):

A STA with dot11OCBActivated equal to true might operate as a DMG STA. A DMG STA with dot11DMGOCBActivated equal to true supports the MAC and MLME functions defined in 31.3 in addition to the MAC functions defined in Clause 10 and the MLME functions defined in Clause 11 for DMG STAs. A DMG STA operating OCB might support EDMG features.

A STA whose MIB does not include the dot11DMGOCBActivated attribute operates as if the attribute is false.

Insert 4.3.17a after 4.3.17 as follows:

4.3.17a Next generation vehicle-to-everything (V2X) (NGV) STA

A next generation vehicle-to-everything (NGV) STA provides MAC and PHY features as defined in Clause 31 and Clause 32. An NGV STA supports at least twice the throughput and at least 3 dB better receiver minimum input sensitivity than a non-NGV STA when operating OCB in high mobility channel environments in the 5.9 GHz band as defined in E.2.3 and E.2.4. The double throughput and higher receiver minimum input sensitivity might not be supported simultaneously. In an NGV STA dot11NGVOptionImplemented is true. In a non-NGV STA with dot11NGVOptionImplemented, the attribute is false. A STA whose MIB does not include the dot11NGVOptionImplemented attribute operates as if the attribute is false.

An NGV STA might be co-located with a DMG STA for which dot11DMGOCBActivated is true in the 60 GHz frequency band (57 GHz to 71 GHz) as defined in E.1. The NGV STA might assist the DMG STA in performing DMG discovery OCB by communicating with a peer NGV STA to exchange the higher layer information that contains information of a peer DMG STA with which the peer NGV STA is co-located. The information is provided from/to a DMG STA through the MLME SAP interface. The protocol to exchange this higher layer information is outside the scope of this standard.

An NGV STA supports interoperability, coexistence, backward compatibility, and fairness in contending for the medium with non-NGV STAs when operating OCB in the 5.9 GHz band. An NGV STA is also a non-NGV STA that supports transmission and reception of non-NGV PHY PPDU when operating OCB in the 5.9 GHz band.

An NGV STA is capable of transmitting and receiving frames OCB as specified in 11.18.

The main PHY features of an NGV STA that are not present in a non-NGV STA are the following:

- Mandatory support for the 10 MHz NGV PPDU format and optional support for the 20 MHz NGV PPDU and 20 MHz non-NGV duplicate PPDU formats
- For the 20 MHz and 10 MHz NGV PPDU, mandatory support for LDPC coding, midambles, BPSK-DCM, and 256-QAM
- Mandatory support for transmit spectral mask C2 by a STA that transmits a 20 MHz NGV PPDU or 20 MHz non-NGV duplicate PPDU
- Mandatory support for repetitive NON_NGV_10 PPDU

- Mandatory support for coexistence with non-NGV STAs operating in the same channel
- Mandatory support for transmit spectral mask C by a STA that transmits a 10 MHz NGV PPDU and belongs to transmit power class C
- Optional support for transmission and reception of SU MIMO with two spatial streams

Additional NGV STA PHY features are:

- Mandatory support for a single spatial stream
- Mandatory support for Clause 17 10 MHz PPDU
- Optional support for Classes A, B, and D of spectrum mask requirement for 10 MHz bandwidth

The main MAC features of an NGV STA that are not present in a non-NGV STA are the following:

- Mandatory support for coexistence with non-NGV STAs operating in the same channel
- Mandatory support for extended MAC service interface to provide higher layers with the ability to control NGV transmissions and receive status regarding NGV receptions and the radio environment
- Mandatory support for NGV capability indication for non-NGV PPDU encoded in the Duration/ID field of the MAC header
- Mandatory support for block ack
- Mandatory support for reception of frame aggregation when communicating OCB
- Optional support for transmission of frame aggregation when communicating OCB
- Optional support for 20 MHz OCB communication
- For optional 20 MHz OCB communication an NGV STA supports 20 MHz channel access with 10 MHz primary and 10 MHz secondary channels
- Optional support for 20 MHz non-NGV duplicate operation

Additional NGV STA MAC features are:

- Mandatory support for 10 MHz OCB communication

An NGV STA might support positioning based on NGV ranging, which consists of a subset of fine timing measurement (FTM) functionalities as defined in 11.21.6 and P.3:

- Fine timing Measurement procedure negotiation and termination for non-TB ranging as defined in 11.21.6.3 and non-TB ranging as described in 11.21.6.4.4
- Differential distance computation as detailed in P.3

An NGV STA might be co-located with a STA operating outside the 5.9 GHz band that supports the fine timing measurement procedure as defined in 11.21.6.

4.3.22 DMG STA

Change the first paragraph of 4.3.22 as follows:

The IEEE 802.11 DMG STA provides PHY and MAC features that can support a throughput of 1 Gb/s and greater, as measured at the MAC data service access point (SAP). A DMG STA supports DMG features as identified in Clause 10, Clause 11, and Clause 20. Optionally, a DMG STA with dot11DMGOCBActivated equal to true supports features as identified in 31.3. A DMG STA operates in a DMG BSS and supports transmission and reception of frames that are compliant with PHY specifications as defined in Clause 20. A DMG STA is also a QoS STA. The basic channel access of a DMG STA (see 10.39) allows it to operate in an Infrastructure BSS, in an IBSS, and in a PBSS. Certain DMG features such as service period allocation are available only to DMG STAs that are associated with an AP or with a PCP, while other DMG features such as EDCA operation in a PBSS and DMG STAs operating OCB do not require association. A DMG

STA supports beamforming (BF) as described in 10.42 and 20.9 and GCM encryption as described in 12.5.5.

Change the third paragraph of 4.3.22 (as amended by IEEE Std 802.11ay-2021) as follows:

A DMG STA supports MAC features that provide channel access in an environment in which transmissions use a directional antenna pattern. The MAC entity of a DMG STA provides frame aggregation, block ~~acknowledgment~~ acknowledgment, service periods, contention based access periods, DMG protected period, AP or PCP clustering, dynamic channel time management (see 10.39.7, 10.39.8, and 10.39.9), reverse direction, spatial sharing, beamforming, discovery assistance, TDD channel access, ~~and fast session transfer in a multi-band device~~, transmission of Data frames OCB (see 11.18), and DMG discovery OCB (see 11.1.4.7). A DMG STA is not a mesh STA. A DMG STA does not use any of the following: HCCA, power save multi-poll (PSMP), TDLS, GCR.

5. MAC service definition

5.2 MAC data service specification

Insert 5.2.2a after 5.2.2 as follows:

5.2.2a NGV MAC data service specification

An NGV STA coordinates with higher layer ITS entities (e.g., IEEE 1609 [B22] family of standards) to provide wireless communications services via the LLC sublayer. The MA-UNITDATA primitives contain the radio environment request vector to facilitate the coordination.

5.2.3 MA-UNITDATA.request

5.2.3.2 Semantics of the service primitive

Change the first paragraph of 5.2.3.2 as follows:

The parameters of the primitive are as follows:

```
MA-UNITDATA.request(  
    source address,  
    destination address,  
    routing information,  
    data,  
    priority,  
    drop eligible,  
    service class,  
    station vector,  
    MSDU format,  
    radio environment request vector  
)
```

Insert the following at the end of 5.2.3.2:

The radio environment request vector parameter contains information that allows higher layer entities to configure the PPDU format, encoding, and MPDU handling for NGV transmission. This parameter is present when dot11NGVOptionImplemented is true or dot11NONNGVRadioEnvironmentImplemented is true, and absent otherwise.

The radio environment request vector parameter contains the following members pertaining to the transmission of the MPDU that contains the MSDU associated with the request containing the vector:

- PPDU format (non-NGV/NGV)
- data rate/NGV-MCS
- number of spatial streams
- permitted aggregation
- number of repetitions
- expiry time
- channel
- primary channel
- channel width

- fallback enabled
- transmit power spectral density

The PPDU format member indicates the format of the PPDU as defined in Table 5-1 that is used to transmit the MSDU.

Table 5-1—PPDU format values

PPDU format value	Description
0	Non-NGV PPDU
1	NGV PPDU
2	The PPDU format decided by the MAC layer

The data rate/NGV-MCS member indicates the data rate of the PPDU carrying the MSDU if the PPDU format has value 0. The data rate can be either 0 (decided by MAC layer), 3 Mb/s, 4.5 Mb/s, 6 Mb/s, 9 Mb/s, 12 Mb/s, 18 Mb/s, 24 Mb/s, or 27 Mb/s as defined in Table 17-4. If the PPDU format has value 1, the data rate/NGV-MCS member indicates the NGV-MCS index as defined in 32.5 with an exception that the value 14 means that the actual MCS is decided by the MAC layer. If the PPDU format has value 2, the data rate/NGV-MCS member is set to value 14 indicating that the actual data-rate/MCS is decided by the MAC layer.

The number of spatial streams member with value 1 or 2 indicates the number of spatial streams being used to transmit the PPDU carrying the MSDU. The number of spatial streams member with value 0 means that the number of spatial streams is decided by the MAC layer. The permitted aggregation member indicates whether A-MPDU aggregation can be applied to the MSDU. The value 0 means that aggregation is not applied, the value 1 means that aggregation can be applied, while the value 2 means that it is up to the MAC layer to decide whether the aggregation can be applied.

The number of repetitions member indicates the maximal number of repetitions that can be used to transmit the MSDU in a broadcast MPDU of a non-NGV PPDU in a 10 MHz channel width where the values can be in the range 0 to 3 or 15. The value 15 means that it is up to the MAC layer to decide whether the repetition is applied to the MSDU. This parameter is reserved when the MSDU is not in a broadcast MPDU in 10 MHz channel width.

The expiry time member indicates the time in milliseconds until the MSDU is discarded if still not transmitted, where the value 0 means that it is up to the MAC layer to decide the expiry time of the MSDU.

NOTE 1—When an MSDU reaches its expiry time and is discarded, the CW state variable of the EDCAF associated with that MSDU is unchanged.

The channel member indicates the channel where the MSDU is transmitted in the 5.9 GHz band as defined in E.2.3 and E.2.4 with the exception for value 0, which means that the MAC layer selects the channel.

The primary channel indicates the primary 10 MHz channel where the MSDU is transmitted, where the value 0 means that the MAC layer selects the primary channel. This member is present when dot11NGVOptionImplemented is true and when the channel width member is 20 MHz and is absent otherwise.

The channel width member indicates either 10 MHz or 20 MHz channel width used to transmit the MSDU as defined in Table 5-2. When the channel width indicates 20 MHz, the primary channel member indicates the OCB primary channel.

NOTE 2—An NGV STA transmitting in a 20 MHz channel maintains a single primary channel at any given time.

Table 5-2—Channel width values

Channel width value	Description
0	10 MHz
1	20 MHz
2	The channel width is decided by the MAC layer

The fallback enabled member indicates whether the transmission of a 10 MHz PPDU in the OCB primary channel is allowed by an NGV STA while the NGV STA performs channel access to transmit a 20 MHz NGV PPDU. The value 0 means that the fallback to 10 MHz can be applied to the MSDU, the value 1 means that the fallback to 10 MHz cannot be applied to the MSDU, while the value 3 means that it is up to the MAC layer to decide whether the fallback is applied to the MSDU. This member is present when dot11NGVOptionImplemented is true and when the channel width member is 20 MHz and is absent otherwise.

The transmit power spectral density member indicates the combined transmit power at the transmit antenna connector of all the antennas used to transmit the MSDU in units of dBm/10 MHz. The transmit power is described with a resolution of 1 dB, with values in the range 0 to 60 representing –20 dBm/10 MHz to 40 dBm/10 MHz, respectively. Values from 61 to 126 are reserved. The value 127 means that it is up to the MAC layer to decide the transmit power of the MSDU.

5.2.4 MA-UNITDATA.indication

5.2.4.2 Semantics of the service primitive

Change the first paragraph of 5.2.4.2 as follows:

The parameters of the primitive are as follows:

```
MA-UNITDATA.indication(
    source address,
    destination address,
    routing information,
    data,
    reception status,
    priority,
    drop eligible,
    service class,
    station vector,
    MSDU format,
    radio environment status vector
)
```

Insert the following at the end of 5.2.4.2:

The radio environment status vector parameter provides information to higher layer entities about the current radio environment and the most recent reception. This parameter is present when dot11NGVOptionImplemented is true or dot11NONNGVRadioEnvironmentImplemented is true, and absent otherwise.

The radio environment status vector parameter contains the following members pertaining to the reception of the MPDU that contained the MSDU associated with the indication containing the vector:

- PPDU format (non-NGV/NGV)
- data rate/NGV-MCS
- aggregation
- channel
- primary channel
- channel width
- RSSI

The PPDU format member indicates the format of the received PPDU that carries the MSDU as defined in Table 5-1.

The data rate/NGV-MCS member indicates the data rate of the PPDU carrying the MSDU if the PPDU format has value 0. The data rate can be one of 3 Mb/s, 4.5 Mb/s, 6 Mb/s, 9 Mb/s, 12 Mb/s, 18 Mb/s, 24 Mb/s, or 27 Mb/s as defined in Table 17-4. If the PPDU format has value 1, the data rate/NGV-MCS member indicates the NGV-MCS index as defined in 32.5.

The aggregation member indicates whether A-MPDU aggregation is applied to the received MSDU. The value 0 means that aggregation is not applied, while the value 1 means that aggregation is applied.

The channel member indicates the channel where the MSDU is transmitted in the 5.9 GHz band as defined in E.2.3 and E.2.4 with the exception for value 0, which means that the MAC layer selects the channel.

The primary channel member indicates the primary 10 MHz channel where the MSDU is received.

The channel width member indicates either 10 MHz or 20 MHz channel width of the PPDU carrying the received MSDU as defined in Table 5-2. When the channel width indicates 20 MHz, the primary channel parameter indicates the OCB primary channel.

The RSSI parameter indicates the receive signal power, measured at the STA's antenna connector and averaged over the antennas, for the NGV portion of the received NGV PPDU and is defined in Table 5-3.

Table 5-3—RSSI values

RSSI	Description
0 to 90	The RSSI, in units of dBm, is $-113 + F_{val}$, where F_{val} is the subfield value
91 to 127	Reserved

5.2.5 MA-UNITDATA-STATUS.indication

5.2.5.2 Semantics of the service primitive

Change the first paragraph of 5.2.5.2 as follows:

The parameters of the primitive are as follows:

```
MA-UNITDATA-STATUS.indication(  
    source address,  
    destination address,  
    transmission status,  
    provided priority,  
    provided service class,  
    radio environment request vector  
)
```

Insert the following at the end of 5.2.5.2:

The radio environment request vector parameter (see 5.2.3.2) contains information that is used by the MAC entity to report the used format, encoding, and MPDU handling for NGV transmission. This parameter is present when dot11NGVOptionImplemented is true or dot11NONNGVRadioEnvironmentImplemented is true, and absent otherwise.

6. Layer management

6.3 MLME SAP interface

Insert 6.3.126, 6.3.127, and 6.3.128 after 6.3.125 (inserted by IEEE Std 802.11ba-2021) as follows:

6.3.126 Cancel transmissions of MSDUs

6.3.126.1 Introduction

This primitive allows higher layer entities (e.g., entities based on the IEEE 1609 [B22] family of standards) to cancel transmission of MSDUs that were previously sent to the STA and are still in the MAC entity's transmit queue.

6.3.126.2 MLME-CANCELTX.request

6.3.126.2.1 Function

Requests cancellation of transmission of all queued MSDUs belonging to the specified access category.

6.3.126.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-CANCELTX.request(  
    AccessCategoryIndex  
)
```

Name	Type	Valid range	Description
AccessCategoryIndex	Integer	0–4	Specifies the access category index of the MSDUs that are to be removed from the transmit queue. Index 0–3 is the value of the access category in Table 9-283 and index 4 indicates all access categories.

6.3.126.2.3 When generated

This primitive is generated by the SME when the SME receives a request (from a higher layer entity) to remove MSDUs from the transmit queue.

6.3.126.2.4 Effect of receipt

The receipt of this primitive by the MAC entity causes the MAC entity to remove MSDUs of the specified access category index from the transmit queue.

6.3.126.3 MLME-CANCELTX.confirm

6.3.126.3.1 Function

This primitive reports completion of the removal of MSDUs from the transmit queue.

6.3.126.3.2 Semantics of the service primitive

This primitive has no parameters.

6.3.126.3.3 When generated

The primitive is generated by the MLME to inform the SME that an MLME-CANCELTX.request primitive has been completed, so that the SME can inform the requesting entity (a higher layer entity).

6.3.126.3.4 Effect of receipt

The SME is notified that the MAC entity has removed MSDUs of the specified access category from the transmit queue.

6.3.127 NGV radio environment measurement

6.3.127.1 General

This primitive provides a report on the STA's radio environment.

6.3.127.2 MLME-RADIOENVIRONMENT.request

6.3.127.2.1 Function

This primitive is used to request the status information on the state of the STA's radio environment.

6.3.127.2.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-RADIOENVIRONMENT.request (
 RadioEnvironmentMeasurementPeriod,
 StationMeasurementPeriod
)

Name	Type	Valid range	Description
RadioEnvironmentMeasurementPeriod	Integer	0 or 100–1000	Specifies the amount of time in milliseconds during which the NGV STA measures the channel busy percentage measurement. When equal to 0, measurements are not made.
StationMeasurementPeriod	Integer	0 or 100–1000	Specifies the amount of time in milliseconds during which the NGV STA measures the number of neighboring STAs and the number of neighboring NGV STAs. When equal to 0, measurements are not made.

6.3.127.2.3 When generated

The primitive is generated when a higher layer entity wants to acquire the status information on the state of the STA's radio environment.

6.3.127.3 MLME-RADIOENVIRONMENT.indication

6.3.127.3.1 Function

This primitive provides status information on the state of the STA's radio environment.

6.3.127.3.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-RADIOENVIRONMENT.indication(
StationCount,
NGVCapabilityPercentage,
ChannelBusyPercentage
)

Name	Type	Valid range	Description
StationCount	Integer	0–65 535	Indicates the number of unique individual station MAC addresses detected during the most recent measurement period of duration dot11RadioEnvironmentMeasurementPeriod.
NGVCapabilityPercentage	Integer	0–100	Indicates the percentage of the stations indicated in StationCount whose transmissions contain indication of NGV capability. When StationCount is equal to 0, the NGVCapabilityPercentage shall be set to 0.
ChannelBusyPercentage	Integer	0–100	The percentage of time the channel was busy during the most recent measurement of duration dot11RadioEnvironmentMeasurementPeriod. The channel is busy when the NGV STA is either transmitting or its clear channel assessment function indicates the channel is busy. It is calculated as follows: $\frac{100 \times \text{duration as indicated channel busy}}{\text{dot11RadioEnvironmentMeasurementPeriod}}$

6.3.127.3.3 When generated

The primitive is generated by the MAC entity every dot11RadioEnvironmentMeasurementPeriod if dot11NGVOptionImplemented is true.

6.3.128 DMG operation outside the context of a BSS

6.3.128.1 General

The following primitives support DMG operation outside the context of a BSS.

6.3.128.2 MLME-DMG-OCB-START.request

6.3.128.2.1 Function

This primitive requests the MAC entity to initiate DMG operation outside the context of a BSS.

6.3.128.2.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-DMG-OCB-START.request(  

    Channel number,  

    Discovery beacon,  

    DMG parameters,  

    DMG capabilities,  

    EDMG capabilities,  

    Unsolicited Block Ack Extension,  

    VendorSpecificInfo  

)
```

Name	Type	Valid range	Description
Channel number	Integer	Selected from the valid channel range for the appropriate PHY and carrier set.	Specifies a channel number to perform discovery for peer STAs outside the context of a BSS.
Discovery beacon	Boolean	true, false	Indicates whether the STA is required to transmit DMG Beacon frames to discover peer STAs.
DMG parameters	As defined in frame format	As defined in 9.3.4.2	Specifies the parameters to be advertised to peer STAs.
DMG capabilities	As defined in frame format	As defined in 9.4.2.127	Specifies the parameters to be advertised to peer STAs.
EDMG capabilities	As defined in frame format	As defined in 9.4.2.265	Specifies the parameters to be advertised to peer STAs. Optionally present if dot11EDMGOptionImplemented is true and is absent otherwise.
Unsolicited Block Ack Extension	Unsolicited Block Ack Extension element	As defined in 9.4.2.279	Specifies the parameters within the Unsolicited Block Ack Extension element that are supported by the MAC entity. Optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise.
VendorSpecificInfo	A set of elements	As defined in 9.4.2.25	Zero or more elements.

6.3.128.2.3 When generated

The primitive is generated by the SME for a STA to initiate DMG operation outside the context of a BSS.

6.3.128.2.4 Effect of receipt

The primitive initiates a discovery procedure and data transmission outside the context of a BSS.

6.3.128.3 MLME-DMG-OCB-START.confirm

6.3.128.3.1 Function

This primitive reports the result of the initiation of a DMG operation outside the context of a BSS.

6.3.128.3.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-DMG-OCB-START.confirm(  
    ResultCode,  
    VendorSpecificInfo  
)
```

Name	Type	Valid range	Description
ResultCode	Enumeration	SUCCESS, NOT_SUPPORTED	Indicates the result of the MLME-DMG-OCB-START.request primitive.
VendorSpecificInfo	A set of elements	As defined in 9.4.2.25	Zero or more elements.

6.3.128.3.3 When generated

The primitive is generated by the MLME as a result of an MLME-DMG-OCB-START.request primitive to initiate a discovery procedure and data transmission outside the context of a BSS.

6.3.128.3.4 Effect of receipt

The SME is notified of the result of the initiation of a DMG operation outside the context of a BSS.

6.3.128.4 MLME-DMG-OCB-STOP.request

6.3.128.4.1 Function

This primitive requests the MAC entity to stop the DMG operation outside the context of a BSS previously started by using an MLME-DMG-OCB-START.request.

6.3.128.4.2 Semantics of the service primitive

The primitive parameters are as follows:

```
MLME-DMG-OCB-STOP.request()
```

6.3.128.4.3 When generated

This primitive is generated by the SME to terminate discovery procedure and data transmission operating outside the context of a BSS by the MAC entity. The MLME-DMG-OCB-STOP.request primitive shall be generated only after the SME receives an MLME-DMG-OCB-START.confirm primitive with result code equal to SUCCESS.

6.3.128.4.4 Effect of receipt

This request terminates the DMG operation outside the context of a BSS when the current frame exchange sequence is completed.

6.3.128.5 MLME-OCB-DMGDISCOVERY.indication

6.3.128.5.1 Function

This primitive indicates discovery of peer DMG STAs outside the context of a BSS.

6.3.128.5.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-OCB-DMGDISCOVERY.indication(
 PeerInfoSet,
 VendorSpecificInfo
)

Name	Type	Valid range	Description
PeerInfoSet	Set of PeerInfo vectors as defined below	N/A	The PeerInfoSet is returned to indicate the results of the discovery request outside the context of a BSS as described in 11.1.4.7. It is a set containing zero or more instances of a PeerInfo vector.
VendorSpecificInfo	A set of elements	As defined in 9.4.2.25	Zero or more elements.

Each PeerInfo vector consists of the parameters shown in the following table, in which the term peer STA refers to the STA that transmitted the received DMG Beacon frame, SSW frame, SSW Feedback frame, or SSW Ack frame.

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	Specifies the MAC address of the discovered peer STA.
Sector sweep	As defined in frame format	As defined in 9.3.4.2	The values from the Sector Sweep field from the DMG Beacon frame, else null.
Sector sweep feedback	As defined in frame format	As defined in 9.5.3	The values from the Sector Sweep field from the SSW, SSW Feedback, or SSW Ack frame, else null.
DMG parameters	As defined in frame format	As defined in 9.3.4.2	The values from the DMG Parameters field from the DMG Beacon frame, else null.
DMG capabilities	As defined in frame format	As defined in 9.4.2.127	The values from the DMG Capabilities element if such an element was present in the DMG Beacon frame, else null.
EDMG capabilities	As defined in frame format	As defined in 9.4.2.265	Specifies the parameters within the EDMG Capabilities element that are supported by the MAC entity.

6.3.128.5.3 When generated

This primitive is generated by the MLME when the MAC entity successfully completes the beamforming training with the discovered peer MAC entities.

6.3.128.5.4 Effect of receipt

The SME is notified of the discovered peer MAC entities.

6.3.128.6 MLME-OCB-LINKSTATUS.indication

6.3.128.6.1 Function

This primitive indicates the status change of beamformed link with a peer STA.

6.3.128.6.2 Semantics of the service primitive

The primitive parameters are as follows:

MLME-OCB-LINKSTATUS.indication(
 PeerSTAAddress,
 BeamLinkStatus,
 VendorSpecificInfo
)

Name	Type	Valid range	Description
PeerSTAAddress	MAC address	Any valid individual MAC address	The MAC address of the STA that is the peer STA in the beamformed link being reported on.
BeamLinkStatus	Enumeration	ESTABLISHED, TIMER_EXPIRED, NOT_ESTABLISHED	Indicates the status of beamformed link as described in 11.27.1.1.
VendorSpecificInfo	A set of elements	As defined in 9.4.2.25	Zero or more elements.

6.3.128.6.3 When generated

This primitive is generated by the MLME when the MAC entity detects the expiration of a beam link maintenance timer or any status change on a beamformed link with peer MAC entity.

6.3.128.6.4 Effect of receipt

The SME is notified of the status of the beamformed link and beam link maintenance timer with the peer MAC entity.

9. Frame formats

9.2 MAC frame formats

9.2.4 Frame fields

9.2.4.7 Frame Body field

9.2.4.7.1 General

Change Table 9-25 (as amended by IEEE Std 802.11ay-2021) as shown on the following three pages:

Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds)

	Non-HT non-VHT non-HE non-SIG non-DMG PPDU and non-HT duplicate PPDU	HT PPDU	VHT PPDU	HE PPDU	SIG PPDU	DMG PPDU	EDMG PPDU	NGV PPDU
MMPDU size	2304	2304	See NOTE 1	See NOTE 1	See NOTE 1	2304	2304	2304
MSDU size	2304	2304	2304	2304	2304	Without SAR agreement: for the basic A-MSDU format, it is equal to the value of A-MSDU size minus 14, or minus 2 for the short A-MSDU format, if the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element is valid; otherwise, it is equal to 7920. With SAR agreement: see NOTE 8.	Without SAR agreement: for the basic A-MSDU format, it is equal to the value of A-MSDU size minus 14, or minus 2 for the short A-MSDU format, if the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element is valid; otherwise, it is equal to 7920. With SAR agreement: see NOTE 8.	2304
A-MSDU size	3839 or 4065 (see NOTE 2) (HT STA, see also Table 9-184), or N/A (non-HT STA, see also 10.11)	3839 or 7935 (see also Table 9-184)	See NOTE 3	2.4 GHz band: 3839 or 7935 (see also Table 9-184) Otherwise: see NOTE 3	See NOTE 3	Without SAR agreement: indirectly limited by the value of the MPDU Limit subfield in the Extended MPDU Capability field of the DMG Capabilities element, if the subfield is valid; otherwise, it is equal to 7935. With SAR agreement: see NOTE 8.	Without SAR agreement: indirectly limited by the value of the MPDU Limit subfield in the Extended MPDU Capability field of the DMG Capabilities element, if the subfield is valid; otherwise, it is equal to 7935. With SAR agreement: see NOTE 8.	7935

Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds) (continued)

	Non-HT non-VHT non-HE non-SIG non-DMG PPDU and non-HT duplicate PPDU	HT PPDU	VHT PPDU	HE PPDU	SIG PPDU	DMG PPDU	EDMG PPDU	<u>NGV PPDU</u>
MPDU size	See NOTE 4	See NOTE 5	3895 or 7991 or 11 454 (see also Table 9-271)	2.4 GHz band; see NOTE 5 Otherwise: 3895 or 7991 or 11 454 (see also Table 9-271) See NOTE 7	3895 or 7991 (see also Table 9-300)	The value indicated in the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element if the subfield is valid; otherwise, as in NOTE 5.	The value indicated in the MPDU Limit subfield of the Extended MPDU Capability field of the DMG Capabilities element if the subfield is valid; otherwise, as in NOTE 5.	<u>7991</u>
PSDU size	2^{12-1} (see Table 15-5, Table 16-4, Table 17-21, Table 18-5)	2^{16-1} (see Table 19-25)	4 692 480 ($\sim 2^{22.16}$) (see Table 21-28)	6 500 631 ($\sim 2^{22.63}$) (see Table 27-54)	797 160 ($\sim 2^{19.60}$) (see Table 23-40)	2^{18-1} (see Table 20-30)	2^{22-1} (see Table 28-12 and Table 28-19)	<u>244 800</u>
PPDU duration	See NOTE 6	5484 (HT_MF, see 10.27.4) or 10 000 (HT_GF, see Table 19-25)	5484 (see Table 21-28)	5484 (see Table 27-54)	27 840 (see Table 23-40)	2000 (see Table 20-30)	2000 (see Table 20-30)	<u>10 968</u>

Table 9-25—Maximum data unit sizes (in octets) and durations (in microseconds) (continued)

Non-HT non-VHT non-HE non-SIG non-DMG PPDU and non-HT duplicate PPDU	HT PPDU	VHT PPDU	HE PPDU	SIG PPDU	DMG PPDU	EDMG PPDU	<u>NGV</u> <u>PPDU</u>
NOTE 1—No direct constraint on the maximum MMPDU size; indirectly constrained by the maximum MPDU size (see 9.3.3.1).							
NOTE 2—Indirect constraint from the maximum PSDU size: 212–1 octets minus the minimum QoS Data frame overhead (26 octets for the MAC header and 4 octets for the FCS).							
NOTE 3—No direct constraint on the maximum A-MSDU size; indirectly constrained by the maximum MPDU size.							
NOTE 4—No direct constraint on the maximum MPDU size; indirectly constrained by the maximum MSDU/MMPDU or (for HT STAs only) A-MSDU size.							
NOTE 5—No direct constraint on the maximum MPDU size; indirectly constrained by the maximum A-MSDU size.							
NOTE 6—No direct constraint on the maximum duration, but an L_LENGTH value above 2332 might not be supported by some receivers (see NOTE 2 in 10.27.4).							
NOTE 7—The maximum MPDU size might be greater than the size declared as supported by the recipient if the MPDU is an HE Compressed Beamforming/CQI frame.							
NOTE 8—No direct constraint on the maximum MSDU or A-MSDU size; indirectly constrained by the maximum PSDU size. Each MPDU in an A-MPDU of the PSDU that contains the MSDU or A-MSDU generates an overhead of MPDU Header (26 bytes), FCS (4 bytes), GCMP Header (8 bytes), MIC (16 bytes), and MPDU delimiter (4 bytes).							

9.2.5 Duration/ID field (QoS STA)

9.2.5.1 General

Insert the following paragraph at the end of 9.2.5.1:

The value in the Duration/ID field in a frame transmitted by an NGV STA is further defined in 31.2.1.

9.3 Format of individual frame types

9.3.4 Extension frames

9.3.4.2 DMG Beacon

Insert a new row above the last row of Table 9-45 as follows (unchanged rows not shown):

Table 9-45—DMG Beacon frame body

Order	Information	Notes
...		
64	DMG OCB	This element is present if dot11DMGOCBActivated is true; otherwise not present.
...		

Replace Figure 9-79 with the following figure (with a new column for B48):

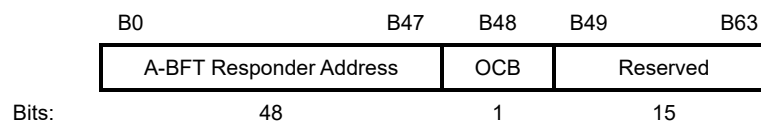


Figure 9-79—Clustering Control field format if the Discovery Mode is 1

Change the last paragraph of 9.3.4.2 as follows:

The A-BFT Responder Address subfield contains the MAC address of the STA that is allowed to transmit during the A-BFT, if present, that follows the BTI. If all bits of the A-BFT Responder Address subfield are equal to 1 and the OCB subfield is equal to 1, any STA is allowed to transmit during the A-BFT, if present.

Insert the following paragraph at the end of 9.3.4.2:

The OCB subfield is set to 1 to indicate the support of communication outside the context of a BSS by the STA transmitting the DMG Beacon frame.

9.4 Management and Extension frame body components

9.4.1 Fields that are not elements

9.4.1.46 DMG Parameters field

Change Table 9-69 as follows:

Table 9-69—The BSS Type subfield when the Discovery mode field is 1

Subfield value	Responding STA role	Applicable BSS types
3	AP	Infrastructure BSS
2	PCP	PBSS
1	Non-AP STA	PBSS, IBSS, <u>OCB</u>
0	Any	Infrastructure BSS, PBSS, IBSS, <u>OCB</u>
<u>NOTE—OCB is not a BSS Type, but rather an indication of communication outside the context of a BSS.</u>		

9.4.2 Elements

9.4.2.1 General

Insert two rows above the last reserved row and change the last reserved row in Table 9-92 (as amended by IEEE Std 802.11az-2022) as follows (unchanged rows not shown):

Table 9-92—Element IDs

Element	Element ID	Element ID Extension	Extensible	Fragmentable
...				
Reserved	255	106–114		
DMG OCB (see 9.4.2.308)	255	115	Yes	No
Reserved	255	~~106–255~~ <u>116–255</u>		
...				

9.4.2.298 Ranging Parameters element

Insert two new rows above the last row, change the last row, and insert a table note at the end of Table 9-322a (as inserted by IEEE Std 802.11az-2022) as follows (unchanged rows not shown):

Table 9-322a—Format and Bandwidth subfield

Field value	Format	Bandwidth
...		
6	NGV	10
7	NGV	20
~~6–63~~ 8–63	Reserved	Reserved
NOTE—Values 6 and 7 are supported only when dot11NGVOptionImplemented is true.		

Insert 9.4.2.308 after 9.4.2.307 (as inserted by IEEE Std 802.11az-2022) as follows:

9.4.2.308 DMG OCB element

The format of the DMG OCB element is shown in Figure 9-788fm.

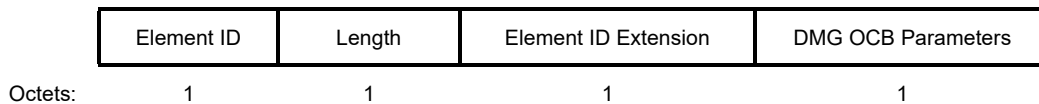


Figure 9-788fm—DMG OCB element format

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

The DMG OCB Parameters field is defined in Figure 9-788fn.

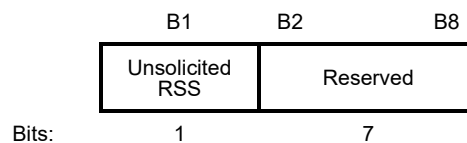


Figure 9-788fn—DMG OCB Parameters field format

The Unsolicited RSS subfield is defined in 9.5.5.