IEEE P802.11
Wireless LANs

|  |
| --- |
| LB273 CR for CID 4407, 4408, 4409 - HE MU PPDU |
| Date: 2023-06-DD |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Yoshio Urabe | Panasonic |  |  | urabe.yoshio@jp.panasonic.com |
|  |  |  |  |  |

Abstract

This submission proposes the resolutions for CIDs 4407, 4408 and 4409 from LB273.

The proposed changes are based on REVme/D3.0.

Revision history:

R0 – initial version

**Discussion:**

An HE MU PPDU is typically used for DL MU transmission, but it is also allowed for non-DL transmission intended for a single user (if the peer STA supports the PPDU type), such as

* Uplink (a non-AP STA to an AP)
* From a TDLS STA to a peer TDLS STA
* From an IBSS STA to another IBSS STA

Such non-DL usages are not covered or not clear in some definitions and behavior descriptions.

An HE MU PPDU for single user transmission may be either of

* An HE MU PPDU with an RU spanning the entire PPDU bandwidth
	+ Full bandwidth HE MU PPDU for SU transmission may be either a compressed or a non-compressed HE-SIG-B format unlike an HE MU PPDU for MU-MIMO.
* A 20 MHz HE MU PPDU with just a 106-tone RU

It is difficult to understand the specifications because the relevant descriptions are scattered in various subclauses as follows.

* HE PHY Capabilities Information field



*The capability shows a 20 MHz HE MU PPDU with just a 106 tone RU may be used for TDLS and IBSS, in addition to Uplink (for an AP).*



*The capability shows a full bandwidth HE MU PPDU with noncompressed HE-SIG-B is allowed for SU tramsmission.*

* PPDU format selection

A non-AP STA, TDLS STA, or IBSS STA shall not transmit a 20 MHz HE MU PPDU with only a 106-tone RU to a peer STA, unless it has received from the peer STA an HE Capabilities element with the Rx Partial BW SU In 20 MHz HE MU PPDU subfield in the HE PHY Capabilities Information field equal to 1.

NOTE 1—A non-AP STA transmitting an HE MU PPDU sets the TXVECTOR parameter UPLINK\_FLAG to 1 if the PPDU is sent to the AP and to 0 if the PPDU is sent to a TDLS STA (see 26.11.2 (UPLINK\_FLAG)). The HE MU PPDU format enables the non-AP STA to include its AID (i.e., transmitter’s AID if the UPLINK\_FLAG is 1 and the receiver’s AID if the UPLINK\_FLAG is 0) in the PHY header of the PPDU, and its use is beyond the scope of this standard.

An HE STA shall not transmit an HE MU PPDU with a single user being allocated an RU occupying the entire PPDU bandwidth and a compressed HE-SIG-B field to a peer STA, unless the HE STA has received from the peer STA an HE Capabilities element with the Rx Full BW SU Using HE MU PPDU With Compressed HE-SIG-B subfield in the HE PHY Capabilities Information field equal to 1.

An HE STA shall not transmit an HE MU PPDU with a single user being allocated an RU occupying the entire PPDU bandwidth and a noncompressed HE-SIG-B field to a peer STA, unless the PPDU bandwidth is less than or equal to 80 MHz and the HE STA has received from the peer STA an HE Capabilities element with the Rx Full BW SU Using HE MU PPDU With Non-Compressed HE-SIG-B subfield in the HE PHY Capabilities Information field equal to 1.

*The behaviors for a 20 MHz HE MU PPDU with just a 106 tone RU and a full bandwidth HE MU PPDU with noncompressed HE-SIG-B are described in 26.15.2 PPDU format selection but it is difficult to understand the details and relationship with other type of HE MU PPDU. I propose adding some NOTES for clarification to 26.15.2 PPDU format selection subclause.*

* Resource indication and User identification in an HE MU PPDU

A full-bandwidth MU-MIMO transmission using the HE MU PPDU format shall have a value of 1 for the HE-SIG-B Compression field in the HE-SIG-A field, where the Common field in the HE-SIG-B field is not present, the HE modulated fields of the PPDU consist of one RU that spans the entire PPDU bandwidth, and the preamble is not punctured.

*A full bandwidth MU-MIMO using an HE MU PPDU with noncompressed HE-SIG-B is prohibited but it is not explicitly described in 26.15.2 PPDU format selection. I propose adding a sentence for full bandwidth MU-MIMO to 26.15.2 PPDU format selection to make easy to contrast with the HE MU PPDU for full bandwidth SU transmission case which allows noncompressed HE-SIG-B field format.*

* Definitions specific to IEEE Std 802.11

[P219L5]

**multi-user (MU) physical layer (PHY) protocol data unit (PPDU):** [MU PPDU] A PPDU that carries one or more PHY service data units (PSDUs) for one or more stations (STAs) using the downlink multi-user multiple input, multiple output (DL MU-MIMO)(#3367) technique, orthogonal frequency division multiple access (DL OFDMA) technique, or a combination of the two techniques, or that carries a PSDU for an AP is in high-efficiency (HE) MU PPDU format.(11ax)

*The definition covers an MU transmission and an UL SU transmission but doesn’t cover a non-UL SU transmission intended for a TDLS STA or an IBSS STA.*

[P237L45]

**uplink (UL) high-efficiency (HE) multi-user (MU) physical layer (PHY) protocol data unit (PPDU):** [UL HE MU PPDU] An HE MU PPDU transmitted by a (#1295)non–access point (non-AP) station (STA). This PPDU carries a single PHY service data unit (PSDU).

NOTE—The UL HE MU PPDU has an HE-SIG-B field that contains additional information (e.g., the identifier of the transmitter) that can be used by the recipient of the UL HE MU PPDU to determine the transmitter of the PPDU even in cases where the Data field of the PPDU is not received. For example, this allows the originator of persistently failing PPDUs to be identified.(11ax)

*“An HE MU PPDU transmitted by a non-AP STA” is not limited to UL HE MU PPDU. It is also applicable to an HE MU PPDU intended for a TDLS STA or an IBSS STA. The definition should exclude the cases intended for TDLS or IBSS.*

* **STA\_ID**

Each parameter STA\_ID in the TXVECTOR identifies the STA or group of STAs that is the recipient of an RU in the HE MU PPDU transmitted with the TXVECTOR parameter UPLINK\_FLAG set to 0. For an individually addressed RU the parameter STA\_ID is set to the 11 LSBs of the AID of the STA receiving the PSDU contained in that RU. If an RU is intended for one or more unassociated non-AP STAs, then the parameter STA\_ID for that RU is set to 2045. If an RU is intended for no user, then the parameter STA\_ID for that RU is set to 2046.

If an RU is intended for an AP (i.e., the TXVECTOR parameter UPLINK\_FLAG is 1), then the parameter STA\_ID contains only one element that is set to the 11 LSBs of the AID of the non-AP STA transmitting the PPDU.

*I believe the second sentence doesn’t care about a 20 MHz HE MU PPDU with just a 106-tone RU and “only one element” is not correct for the 106-tone RU format. In my understanding, an HE MU PPDU* *with just a 106-tone RU requires at least two RU allocations indicated in the RU Allocation subfield and corresponding two or more User fields are required in the HE-SIG-B field.*



*Since there is no entry for an RU Allocation subfield for just a single 106-tone RU, at least two RUs are indicated in the RU Allocation subfield (e.g. the value of the RU Allocation subfield is set to 96).*



Unallocated (AID12 is set to 2046)

Allocated

*or*



Unallocated (AID12 is set to 2046)

Allocated

*There are some other allocation patterns that include 106-tone RU(s), but the value 96 is the most efficient choise because it is the only pattern which requires least (two) User Info fields while other patterns require more three or more User fields. The resolution for clarification may be:*

*Option 1: The value of RU Allocation subfield is implementation dependent for a 20 MHz HE MU PPDU with just a 106-tone RU for an SU transmission.*

*Option 2: The value 96 is specified for a 20 MHz HE MU PPDU with just a 106-tone RU for an SU transmission.*

*I propose option 2 because the patterns other than 96 don’t have any benefit and the processing in the receiver may be a little bit simpler if it is limited to 96. It is also clearer for implementers.*

* Definitions

**non–access point (non-AP)(#1295) station (STA):** [non-AP STA] A STA that is not contained within an access point (AP).

* Introduction to the HE PHY

[P3992L29]

A non-AP HE STA shall support the following features:

* Reception of an HE MU PPDU where the RU allocated to the non-AP STA is not utilizing MU‑MIMO (DL OFDMA).

*By definition of a non-AP STA, A non-AP STA may be a TDLS STA or an IBSS STA, in these cases it should not be mandatory to receive an HE MU PPDU. In addition, if the HE MU PPDU is intended only for one user (SU transmission), it is not a DL OFDMA.*

* RU allocation in an HE MU PPDU

An HE MU PPDU shall have a sufficient number of RUs allocated to users such that all of the following conditions are satisfied:

* At least *N* × 4 × 26 subcarriers are modulated by the allocated RUs within the entire PPDU, where *N* is the number of 20 MHz subchannels that are not preamble punctured in the PPDU.

*I believe the reason why only a 106-tone RU is allowed for a partial bandwidth 20 MHz HE MU PPDU comes from the rule in* **“26.5.1.3 RU allocation in an HE MU PPDU”***, but it is also difficult to understand without a reference to the subclause. I propose adding a NOTE on it to* **“26.15.2 PPDU format selection”***.*

**Proposed resolutions:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 4407 | 219.00 | 3.1 | HE MU PPDU for SU transmission from/to TDLS STA or IBSS STA, which is neither downlink nor "for AP", is not covered by this definition. Such usage should be allowed according to "9.4.2.247.3 HE PHY Capabilities Information field" (P194L15) and "26.15.2 PPDU format selection; NOTE 1" (P3963L43). | Change the definition to cover the case of SU transmission from/to TDLS STA or IBSS STA. | RevisedAgree with the comment in principle.Please apply the changes tagged with (#4407) in this document. |
| 4408 |  | General | Details are missing for a partial BW SU transmission in 20 MHz HE MU PPDU.Since the Table 27-26 (RU Allocation field) in P4093 doesn't have an entry for a single 106-tone RU, the User Specific field shall include two or more User Info (one for AP, others should be 2046 (unallocated)). However, it is difficult to understand such a specific signaling. The specific examples/descriptions are desired for RU Allocation field and STA-ID field in the HE-SIG-B and corresponding TXVECTOR parameters (RU\_ALLOCATION and STA\_ID).Preferably, the RU Allocation field value may be fixed to 96 for partial BW (106-tone RU) SU transmission in HE MU PPDU because RU Allocation 96 is the natural choise (most efficient allocation pattern) which includes 106-tone RU + 106-tone RU (needs two User Info fields in which one is an unallocated RU (2096)). Some other RU Allocation field values may be used for partial BW SU but need more than three User fields and there is no benefit to use such allocations. | Add specific descriptions/examples for partial bandwidth (just 106-tone RU) SU transmission in HE MU PPDU in appropriate clauses, e.g., "26.11 Rules for setting some TXVECTOR parameters for PPDUs transmitted by an HE STA", "27.2.2 TXVECTOR and RXVECTOR parameters" and "27.3.11 HE preamble".Preferably, define that the RU Allocation subfield value is set to 96 for partial BW SU transmission in HE MU PPDU. | RevisedAgree with the comment in principle.It is partially resolved by the changes for CID4409 in this document (tagged with (#4409)).The details are not easy to understand but essential descriptions are included in “9.4.2.247.3 HE PHY Capabilities Information field” and “26.15.2 PPDU format selection”. For these essential features, it is better to add some NOTES to “26.15.2 PPDU format selection” for clarification.Some other relevant corrections and changes are also included in this document.Please apply the changes tagged with (#4408) in this document. |
| 4409 | 3948.00 | 26.11.1 | "... then the parameter STA\_ID contains only one element" is not correct (or at least not clear) for partial bandwidth (106-tone RU) UL HE MU PPDU. Since the Table 27-26 (RU Allocation field) in P4093 doesn't have an entry for a single 106-tone RU, the User Specific field shall include two or more User Info (one for AP, others should be 2046 (unallocated)). | Change the sentence "... then the parameter STA\_ID contains only one element that is set to the 11 LSBs of the AID of the non-AP STA transmitting the PPDU." to "... then the parameter STA\_ID for the RU intended to the AP is set to the 11 LSBs of the AID of the non-AP STA transmitting the PPDU and other RUs (if exist) are set to 4096." | RevisedAgree with the comment in principle.Please apply the changes tagged with (#4407) in this document. |

**Proposed changes:**

(Proposed hanges are indicated in green)

* Definitions specific to IEEE Std 802.11

[P219L5]

**multi-user (MU) physical layer (PHY) protocol data unit (PPDU):** [MU PPDU] A PPDU that carries one or more PHY service data units (PSDUs) for one or more stations (STAs) using the downlink multi-user multiple input, multiple output (DL MU-MIMO)(#3367) technique, orthogonal frequency division multiple access (DL OFDMA) technique, or a combination of the two techniques, or that carries a PSDU for either an AP, a TDLS STA or an IBSS STA(#4407) and is in high-efficiency (HE) MU PPDU format.(11ax)

[P237L45]

**uplink (UL) high-efficiency (HE) multi-user (MU) physical layer (PHY) protocol data unit (PPDU):** [UL HE MU PPDU] An HE MU PPDU transmitted by a (#1295)non–access point (non-AP) station (STA) intended for an AP (#4407). This PPDU carries a single PHY service data unit (PSDU).

* **STA\_ID**

[P3948L27]

If an RU is intended for an AP (i.e., the TXVECTOR parameter UPLINK\_FLAG is 1), then the parameter STA\_ID ~~contains only one element that~~ for the RU allocated to the AP is set to the 11 LSBs of the AID of the non-AP STA transmitting the PPDU and the STA\_ID for other RU (if exist) is set to 2046(#4409).

NOTE 1 —When the UL HE MU PPDU is a 20 MHz HE MU PPDU with just a 106-tone RU, the parameter STA\_ID contains two elements, one is for the RU allocated to the AP and another is for an unallocated RU, each RU corresponds to one of RUs indicated by the RU Allocation subfield which is set to 96 (Table 27-26—RU Allocation subfield)(#4409).

NOTE 2—A non-AP STA can transmit (#2318)a UL HE MU PPDU to help the AP identify the transmitter of a failed PPDU so that the AP can allocate resources for that non-AP STA in a later TXOP. All unassociated STAs share the same parameter STA\_ID value (i.e., 2045), which does not uniquely identify the transmitter. Therefore an unassociated STA is not allowed to transmit (#2318)a UL HE MU PPDU.

* PPDU format selection

[P3963L38]

A non-AP STA, TDLS STA, or IBSS STA shall not transmit a 20 MHz HE MU PPDU with only a 106-tone RU to a peer STA, unless it has received from the peer STA an HE Capabilities element with the Rx Partial BW SU In 20 MHz HE MU PPDU subfield in the HE PHY Capabilities Information field equal to 1.

NOTE 1—A non-AP STA transmitting an HE MU PPDU sets the TXVECTOR parameter UPLINK\_FLAG to 1 if the PPDU is sent to the AP and to 0 if the PPDU is sent to a TDLS STA (see 26.11.2 (UPLINK\_FLAG)). The HE MU PPDU format enables the non-AP STA to include its AID (i.e., transmitter’s AID if the UPLINK\_FLAG is 1 and the receiver’s AID if the UPLINK\_FLAG is 0) in the PHY header of the PPDU, and its use is beyond the scope of this standard.

An HE STA may transmit a 20 MHz HE MU PPDU with a single user being allocated a 106-tone RU. The RU Allocaton subfield in the Common field of the HE-SIG-B field shall be set to 96(#4408).

NOTE 2—Only a 106-tone RU is allowed for a 20 MHz HE MU PPDU which doesn’t span the entire 20 MHz bandwidth and intended for a single user according to the rule for the RU allocation **(26.5.1.3 RU allocation in an HE MU PPDU)** (#4408).

NOTE 3—Since there is no entry for an RU Allocation subfield in a HE-SIG-B field(Table 27-26—RU Allocation subfield) defined for just a single 106-tone RU, at least two RUs are indicated in the RU Allocation subfield and corresponding two or more User fields are required in the HE-SIG-B field. The value 96 of the RU Allocation subfield is designated for a 20 MHz HE MU PPDU with only a 106-tone RU because it indicates the only pattern which requires only two User fields(#4408).

An HE AP shall not transmit an HE MU PPDU for full-bandwidth MU-MIMO transmission with noncompressed HE-SIG-B field format(#4408).

An HE STA shall not transmit an HE MU PPDU with a single user being allocated an RU occupying the entire PPDU bandwidth and a compressed HE-SIG-B field to a peer STA, unless the HE STA has received from the peer STA an HE Capabilities element with the Rx Full BW SU Using HE MU PPDU With Compressed HE-SIG-B subfield in the HE PHY Capabilities Information field equal to 1.

An HE STA shall not transmit an HE MU PPDU with a single user being allocated an RU occupying the entire PPDU bandwidth and a noncompressed HE-SIG-B field to a peer STA, unless the PPDU bandwidth is less than or equal to 80 MHz and the HE STA has received from the peer STA an HE Capabilities element with the Rx Full BW SU Using HE MU PPDU With Non-Compressed HE-SIG-B subfield in the HE PHY Capabilities Information field equal to 1.

NOTE 4—An HE MU PPDU with a single RU occupying the entire PPDU bandwidth fields(#4408).

NOTE ~~2~~5—A change in the format of the PPDU containing the control response frame (between non-HT and HE ER SU PPDU) occurs in subsequent TXOPs. A STA that solicits a control response frame from a responding STA accounts for the PPDU format of the control response frame to calculate the expected duration of the TXOP. The responding STA determines that the most recent PPDU sent to the soliciting STA is received if it receives an immediate acknowledgment by the soliciting STA in response to the PPDU.

NOTE ~~3~~6—A STA does not transmit a Control frame in an HE ER SU PPDU to a receiving STA, unless the receiving STA indicates that HE ER SU PPDU reception is enabled.

* Introduction to the HE PHY

[P3992L29]

A non-AP HE STA shall support the following features:

* Reception of an HE MU PPDU from an AP with which the non-AP HE STA is associated and where the RU allocated to the non-AP STA is not utilizing MU‑MIMO ~~(DL OFDMA)~~(#4408).