IEEE P802.11
Wireless LANs

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| LB258 - Resolution for CIDs 1073, 2327, 2328, 2329 |
| Date: June 3rd, 2022 |
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 Abstract

This submission proposes resolutions for following 4 CID received for LB258 (REVme D1.0): 1073, 2327, 2328, 2329

***TGm editor: The baseline for this document is REVme D1.0.***

**Revisions:**

* Rev 0: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGm Draft. This introduction is not part of the adopted material.

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| **CID** | **Commenter** | **Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Resolution** |
| 2327 | Thomas Handte | 9.4.2.265.1 | 1722 | 14 | It is not clear how the Maximum SC MCS field applies to non-uniform constellation (NUC) | Suggest to add "The highest supported EDMG SC mode MCS is also valid for reception of NUC if supported." | **Accepted**Agree with the commenter.**TGm editor, please implement changes as shown in doc 11-22/0838r0 tagged as 2327** |

**Discussion**

11ay defines different types of signal constellations for single carrier (SC) modulation listed in Table 28-48, 28-49, 28-50, 28-51 among which there are rectangular shaped constellations (QAM), circular shaped constellations (PSK), non-uniformly shaped constellations (NUC), and dual carrier modulation constellations (DCM), respectively.

Some configurations are mandatory, and some are optional for which reason the EDMG capabilities element carries a supported MCS field (Figure 9-910—Supported MCS field format) and a PHY Capabilities sub-element (Figure 9-916—Data field of the PHY Capabilities subelement format).

As can be seen from Table 28-50, non-uniform constellation (NUC) supports five MCS in total (MCS 17 to 21). The capability for non-uniform constellation (NUC) is currently not precise.

P1727L61 to L64 says: “The NUC RX Supported subfield is set to 1 if dot11EDMGNUCRXImplemented is true, and is set to 0 otherwise. If equal to 1, this subfield indicates that the STA supports reception of PPDUs using non-uniform constellation.”

However, it is not defined which of these MCS need to be supported. The closest interpretation is probably to have all MCS 17 to 21 supported. However, the supported MCS has a direct impact to device’s supported bandwidth and there is more than a factor of 2 between lowest (~4GBps) and highest (~8GBps) throughput provided by NUC. Therefore, it is not a good choice to mandate support of all NUC MCS.

The proposal is to reuse the existing mechanism for rectangular shaped constellation for NUC too. The existing mechanism defines a maximum MCS that is supported by a STA:

P1722L13 to L15 says: “The Maximum SC MCS subfield contains the index of the highest supported receive EDMG SC mode MCS. The mandatory EDMG SC mode MCSs are not impacted by the value of this subfield.”

**9.4.2.265.1 General
*TGm editor: Please update the following paragraph in this subclause as shown below:***The Supported MCS field is defined in Figure 9-910 (Supported MCS field format(11ay)).



The Maximum SC MCS subfield contains the index of the highest supported receive EDMG SC mode MCS. [2327]The highest supported receive EDMG SC mode MCS is also valid for reception of NUC if supported. The mandatory EDMG SC mode MCSs are not impacted by the value of this subfield.

The Maximum OFDM MCS subfield contains the index of the highest supported receive EDMG OFDM mode MCS. A value of zero indicates that the EDMG OFDM mode is not supported.

The Maximum PHY Rate subfield contains the maximum PHY data rate, in units of 100 Mb/s, that the STA supports in receive mode, over all supported channel bandwidths and number of spatial streams. This PHY data rate can be lower than the data rate provided by the maximum supported MCS when used with a combination of the largest supported channel bandwidth and the maximum number of supported spatial streams.

The SC MCS6 OFDM MCS5 Support subfield is set to 1 to indicate that MCS 6 of the EDMG SC mode and MCS 5 of the EDMG OFDM mode are supported in SISO. Otherwise, this subfield is set to 0.

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| 1073 | Dana Ciochina | 10.42.10.2.4.8 | 2522 | 38 | "...the feedback may be based on dynamic grouping of the subcarriers in which the distance between the subcarriers may vary based on the characteristics of the channel fed back." It is not"...the feedback may be based on dynamic grouping of the subcarriers in which the distance between the subcarriers may vary based on the characteristics of the channel fed back." It is not clear what is meant with channel characteristics here. | Suggest to add some wording clarifying that channel characteristics refers to how fast the channel varies. For example: "channel characteristics in this context refers to how much a difference measure between consecutive taps and/or subcarriers of the channel varies" or rephrase as " in which the distance between the subcarriers may vary based how much a difference measure between consecutive taps and/or subcarriers of the channel varies" | **Revised**Agree with the commenter in principle.A difference measure between consecutive taps and/or subcarriers targets a low reconstruction error.**TGm editor, please implement changes as shown in doc 11-22/0838r0 tagged as 1073** |
| 2328 | Thomas Handte | 10.42.10.2.4.8 | 2522 | 38 | "...the feedback may be based on dynamic grouping of the subcarriers in which the distance between the subcarriers may vary based on the characteristics of the channel fed back." It is not described how the characteristics of the channel that is fed back influence dynamic grouping. | Suggest to add "In dynamic grouping, the selection of subcarriers that are fed back targets minimization of the reconstruction error at the STA receiving the feedback." | **Accepted**Agree with the commenter.**TGm editor, please implement changes as shown in doc 11-22/0838r0 tagged as 2328** |

**Discussion**

11ay defines hybrid beamforming protocol i.e., combination of analog and digital beamforming for multiple transmitter chains. The digital beamforming requires a feedback of the channel characteristics in terms of at least the digital beamforming matrix carried in the Digital BF Feedback element on either tap (single carrier) or subcarrier (OFDM) basis. For subcarrier-based feedback, two variants exist:

* It may be based on fixed grouping with Ng=2, 4, or 8.
* It may be based on dynamic grouping in which the distance between two reported adjacent subcarriers can be 1, 2, 4, 8, 16, or 32 and varying (some restrictions apply such that edge subcarriers are always included).

How the subcarriers that are fed back are selected is not defined in REVme D1.0.

P2522L38 to L40 says “…in which the distance between the subcarriers may vary based on the characteristics of the channel fed back.”

However, an arbitrary selection of subcarriers that are fed back may result in poor performance of the digital beamformer. The statement “based on the characteristics of the channel” is very vague as it does not reveal which characteristics of the channel are relevant or how these are influencing the selection.

Therefore, the suggestion is to add a statement regarding how the subcarriers that are fed back should be selected in general. Thereby, the selection algorithm is still implementation dependent and beyond scope of the standard.

**10.42.10.2.4.8 Feedback phase**

***TGm editor: Please update the following paragraph in this subclause as shown below:***

The feedback phase is used by the hybrid beamforming protocol to feed back the hybrid beamforming information to the transmitter for use in a subsequent hybrid beamforming transmission.

The feedback is carried in the MIMO BF Feedback frame and its contents are as follows:

— For the EDMG SC mode, when the BRP frame used during the sounding phase has the DBF FBCK REQ field equal to 1 within the DMG Refinement element, the MIMO BF Feedback frame contains the Digital BF Feedback element carrying the digital beamforming matrix information. When DBF FBCK REQ field equal to 0, the MIMO BF Feedback frame contains the Channel Measurement Feedback element and the EDMG Channel Measurement Feedback element.

— For the EDMG OFDM mode, the MIMO BF Feedback frame contains the Digital BF Feedback element carrying the digital beamforming matrix information.

The feedback may be based on fixed grouping of the subcarriers with Ng = 2, 4 or 8 or the feedback may be based on dynamic grouping of the subcarriers in which the distance between the subcarriers may vary based on the characteristics of the channel fed back. [1073, 2328] In dynamic grouping, the selection of subcarriers that are fed back targets minimization of the reconstruction error at the STA receiving the feedback. These are illustrated in Figure 10-120 (Example of EDMG OFDM mode dynamic feedback(11ay)).

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| **CID** | **Commenter** | **Clause** | **Page** | **Line** | **Comment** | **Proposed Change** | **Resolution** |
| 2329 | Thomas Handte | 9.4.2.284 | 1766 | 32 | "The feedback information can be used by a transmit beamformer to determine digital beamforming steering matrices, Q. This process is described in 10.42.10.2.4 (Hybrid beamforming for SU-MIMO and MU-MIMO)." is not precise because of the "can be" since the feedback is essential to determine Q matrices. | Suggest to change to "In a hybrid beamforming transmission as described in 10.42.10.2.4 (Hybrid beamforming for SU-MIMO and MU-MIMO), the feedback information is used by a transmit beamformer to determine digital beamforming steering matrices, Q." | **Revised**Agree with the commenter in principle. Slightly different wording was applied to harmonize this subclause with 9.4.1.28 or 9.4.1.29 **TGm editor, please implement changes as shown in doc 11-22/0838r0 tagged as 2329** |

**Discussion**

In hybrid beamforming, a digital beamforming steering matrix Q (spatial mapping matrix) is applied on top of analog beamforming. The transmit beamformer uses the feedback information to determine the Q matrices.

In hybrid beamforming, the feedback plays an essential role in determining the Q matrix. Therefore, the “can be used … to determine” is too vague, whereas a “is used … to determine” statement is better. Also, when the digital beamforming feedback information was requested then it is for the purpose of applying digital beamforming. Nonetheless the “is used … to determine” allows still not to use digital beamforming in case the feedback reveals that digital beamforming is not needed or not possible.

The suggestion is to use similar statement as in “similar” subclauses such as “9.4.1.28 Noncompressed Beamforming Report field” or in “9.4.1.29 Compressed Beamforming Report field”

For example P1097L55 to L58 says “The Noncompressed Beamforming Report field is used by the Noncompressed Beamforming frame to carry explicit feedback in the form of noncompressed beamforming feedback matrices V **for use by** a transmit HT beamformer to determine steering matrices Q, as described in 10.34.3”

**9.4.2.284 Digital BF Feedback element(11ay)**

***TGm editor: Please update the following paragraph in this subclause as shown below:***

The Digital BF Feedback element is transmitted in the MIMO BF Feedback frame and carries feedback information in the form of beamforming feedback matrices and differential SNRs. The feedback information [2329] ~~can be used~~ is for use by a transmit beamformer to determine digital beamforming steering matrices, Q. This process is described in 10.42.10.2.4 (Hybrid beamforming for SU-MIMO and MU-MIMO). When the Digital BF Feedback element is transmitted in the MIMO BF Feedback frame, the SNR fields within the Channel Measurement Feedback element are interpreted as average SNR per stream, as defined in Table 9-264 (see 9.4.2.136 (Channel Measurement Feedback element)).