IEEE P802.11
Wireless LANs

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| Comment Resolution on MIMO BF Setup |
| Date: 2017-6-21 |
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Abstract

This submission proposes resolution of comment received from TGay comment collection (TGay Draft 0.3).

- CID: 198, 501, 46, 47, 185, 51, 52, 395

In more details, this submission proposes the format of the MIMO BF Setup frame as well as the modifications on the BRP frame and the texts related to SU/MU-MIMO BF setup.

1. **Introduction**

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 TGay Draft. The introduction and the explanation of the proposed changes are not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGay Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGay Editor: Editing instructions preceded by “TGay Editor” are instructions to the TGay editor to modify existing material in the TGay draft. As a result of adopting the changes, the TGay editor will execute the instructions rather than copy them to the TGay Draft.***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CID | Page Number | Line Number | Comment | Proposed Change | Resolution |
| 198 | 72 | 29 | The BF Setup frame has not been defined yet. | Define the BF Setup frame | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 198. |
| 501 | 66 | 26 | Please resolve editor's note | Please provide frame structure for MU-MIMO setup | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 501. |
| 46 | 69 | 12 | "In the SU-MIMO setup subphase, based on the SNRs of the transmit sectors collected from the responder in the SISO Feedback subphase of the SISO phase, the initiator may select a subset of candidate transmit sectors per DMG antenna to reduce the initiator SMT training time. " This whole paragraph describes non normative behavior that is irrelevant to the fileds | Repalce the text with normative behavior on what is sent by the inititor and what is replied by the respodner. It is not necessary for the initiator to inidcate the sectors it will use in advance, only their numbe, or the MID extension may be used. | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 46. |
| 47 | 69 | 28 | "the candidate transmit sectors" The list does not have to be know in advance, possilby it length may be required, the sector ID is transmitted inside each packet. | Remove the list of sectros, it is too long. | Accepted-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 47. |
| 185 | 70 | 30 | NI undefined, used further as N\_I | (N\_I) instead of NI | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 185. |
| 51 | 72 | 32 | "the order if which transmit sectors are trained" - why is this necessary, besides being long, this has no effect on reponders behavior | Remove this from the list | Accepted-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 51. |
| 52 | 72 | 34 | "the number of receive training fields based on the feedback from responders received at the SISO phase" - its receive training TRN-Units and the L-RX field in the responses shall be mentioned | Replace with "the number of receive TRN-Units based on the L-RX field in feedback from responders received at the SISO pahse" | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 52. |
| 395 | 72 | 34 | It is not clear how does initiator determine the number of rx training fields needed at responder, based on the feedback of MU-MIMO BF SISO phase.The MU-MIMO BF SISO phase does not conatin a RSS and initiator does not know which and how many sectors could be the candidates for RX training on rx MIMO antennas | change the sentence to'To reduce the MU-MIMO training time, the initiator may select a subset of TX sectors for each DMG antenna based on the feedback from responders received at the SISOphase, and the number of receive training fields .' | Revised-TGay editor to make the changes shown in 11-17/0921r0 under all headings that include CID 395. |

**Discussion:**

1. In terms of SU-MIMO BF training, if the initiator/responder has antenna pattern recipcocity, after TX sector down-selection, it need to inform the responder/initiator of the number of requested TRN subfields required for RX AWV training via the L-TX-RX field and the EDMG TRN-Unit M field.
2. In the SU/MU-MIMO BF training, a couple of BRP packets are transmitted from a transmitter to a receiver. The reason for having a BRP CDOWN field in the BRP frame is that even if the receiver missed a certain BRP packet, it is still able to know the number of remaining BRP packet transmission to the end of BF training. In addition, the BRP CDOWN information is also helpful for MIMO BF feedback.

Propose:

Revised for 8 CIDs 198, 501, 46, 47, 185, 51, 52, 395 as per discussion and editing instructions in 11-17/0921r0.

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**9.6.22.1 Unprotected DMG Action field**

***#1: Change Table 9-415 as follows (CID #198, #501):***

|  |
| --- |
| Table 9-415—Unprotected DMG Action field values(11ad) |
| Unprotected DMG Action field value | Meaning |
| 0 | Announce |
| 1 | BRP |
| x | MIMO BF Setup |

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***#2: Insert the following clause (CID #198, #501):***

9.6.22.x MIMO BF Setup frame format

The MIMO BF Setup frame is an Action No Ack frame. The format of a MIMO BF Setup frame Action field is shown in Table 9-xxx (MIMO BF Setup frame Action field format).

|  |
| --- |
| Table 9-xxx−MIMO BF Setup frame Action field format(11ad) |
| Order | Information |
| 1 | Category |
| 2 | Unprotected DMG Action |
| 3 | Dialog Token |
| 4 | MIMO Setup Control element |

The Category field is defined in 9.4.1.11 (Action field).(#3403)

The Unprotected DMG Action field is defined in 9.6.22.1 (Unprotected DMG Action field).(#3403)

The Dialog Token field is set to a value chosen by the STA sending the frame to uniquely identify the transaction.

The MIMO Setup Control element is defined in 9.4.2.x.

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***#3: Insert the following clause (CID #198, #501):***

9.4.2.x MIMO Setup Control element

The MIMO Setup Control element, as shown in Table 9-xxx (MIMO Setup Control element format), is used to carry setting information required for SU-MIMO BF training and feedback subphases or MU-MIMO BF training and feedback subphases.

|  |
| --- |
| Table 9-xxx MIMO Setup Control element format  (11ad) |
| Field | Size | Meaning |
| Element ID | 8 bits |  |
| Length | 8 bits |  |
| Element ID Extension | 8 bits |  |
| SU/MU | 1 bit | Sets to 1 to indicate SU-MIMO beamforming and sets to 0 to indicate MU-MIMO beamforming. |
| EDMG Group ID | 8 bits | Indicates the EDMG Group ID of target MU group. This field is reserved when the SU/MU field sets to 1. |
| Group User Mask | 32 bits |  |
| DL/UL MU-MIMO Phase | 1 bit | Sets to 1 to indicate downlink MIMO phase and sets to 0 to indicate uplink MIMO phase. This field is reserved when the SU/MU field sets to 1. |
| L-TX-RX | 8 bits | Indicates the requested number of consecutive TRN-Units in which the same AWV is used in the transmission of the last M TRN subfields of each TRN-Unit. This field is reserved when the SU/MU field is set to 0. |
| Requested EDMG TRN-Unit M | 4 bits | The value of this field plus one indicates the requested number of TRN subfields in a TRN-Unit transmitted with the same AWV following a possible AWV change. This field is reserved when the SU/MU field is set to 0. |
| Link Type | 1 bit | Sets to 1 to indicate initiator link and sets to 0 otherwise. This field shall be set to 1 when the SU/MU field is set to 0. |
| MIMO FBCK-REQ | 9 bits | Indicates channel measurement feedback requested for the link specified by the Link Type field. |

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

The Group User Mask field is a bitmap that indicates whether each of EDMG STAs in the target MU group is requested to engage the subsequent MU-MIMO BF training. The order of EDMG STAs in the Group User Mask field follows the order in which they appear in the corresponding EDMG Group field of EDMG Group ID Set element containing the target MU group. The first bit (i.e., the least significant bit) corresponds to the first EDMG STA, and the second bit corresponds to the second EDMG STA, and so on. A bit is set to 1 to indicate the associated EDMG STA is requested to engage the subsequent MU-MIMO BF training; otherwise the bit is set to 0. This field is reserved when the SU/MU field is set to 1. If the number of EDMG STAs in the target MU group is smaller than 32, the corresponding bits in the Group User Mask field shall be set to 0.

The MIMO FBCK-REQ field is defined in Figure 9-x and is described in Table 9-x.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Channel Measurement Requested | Number of Taps Requested | Number of TX Sector Combinations Requested |
| Bits: | 1 | 2 | 6 |

Figure 9-x-MIMO FBCK-REQ field format

Table 9-x-MIMO FBCK-REQ field description

|  |  |
| --- | --- |
| **Subfield** | **Meaning** |
| Channel Measurement Requested | If set to 1, the Channel Measurement subfield is requested as part of MIMO BF feedback. Otherwise, set to 0. |
| Number of Taps Requested | Number of taps requested in each channel measurement. |
| Number of TX Sector Combinations Requested | The value of this field plus one indicates the number of TX sector combinations requested for MIMO BF feedback  |

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* + - 1. EDMG BRP Request element

***#4: change Figure 44 as follows:***

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | B0 B7 | B8 B15 | B16 B23 | B24 B31 | B32 B39 | B40 B50 | B51 B52 | B53 B56 | B57 B58 |
|  | Element ID | Length | Element ID Extension | L-RX | L-TX-RX | TX Sector ID | EDMG TRN-Unit P | EDMG TRN-Unit M | EDMG TRN-Unit N |
| Bits: | 8 | 8 | 8 | 8 | 8 | 11 | 2 | 4 | 2 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | B59 | B60 | B61 B69 | B70 B75 | B76 B83  | B84 B87 |
|  | TXSS-REQ | TXSS-REQ-RECIPROCAL | TXSS-SECTORS | BRP CDOWN | TX Antenna Mask | Reserved |
| Bits: | 1 | 1 | 9 | 6 | 8 | 4 |

Figure 44—EDMG BRP Request element format

***#5: add the following at the end of this clause:***

The BRP CDOWN field is a down-counter indicating the number of remaining EDMG BRP packet transmissions to the end of the BF training.

The TX Antenna Mask field is a bitmap that indicates whether each of eight TX antennas is used in the transmission of the EDMG BRP packet. The first bit (i.e., the least significant bit) corresponds to the first TX antenna, and the second bit corresponds to the second TX antenna, and so on. A bit is set to 1 to indicate the associated TX antenna is used in the transmission of the EDMG BRP packet; otherwise the bit is set to 0.

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MIMO phase

***#6: Change the two paragraphes below Figure 54 as follows (CID #46, #47, #185):***

It is mandatory to perform the SU-MIMO BF setup subphase. In the SU-MIMO BF setup subphase, the initiator shall send a MIMO BF Setup frame with the SU/MU field set to 1 and the Link Type field set to 1 to the responder. The TA field and the RA field of the MIMO BF Setup frame shall be set to the MAC addresses of the initiator and the responder, respectively. The MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying SU-MIMO BF training and the number of transmit sector combinations requested for the initiator link () in the Number of TX Sector Combinations Requested field. The MIMO BF Setup frame shall also indicate whether time domain channel response is requested as part of SU-MIMO BF feedback in the Channel Measurement Requested field. If the time domain channel response is requested as part of SU-MIMO BF feedback, the Channel Measurement Requested field shall be set to 1 and the Number of Taps Requested field shall indicate the number of channel taps requested in time domain channel response. Additionally, based on the SNRs of the transmit sectors collected from the responder in the SISO phase, the initiator may select a subset of candidate transmit sectors per DMG antenna to reduce the initiator SMBT training time. Each DMG antenna should have the similar number of candidate transmit sectors in order to avoid biasing a DMG antenna. If the initiator has antenna pattern reciprocity, the initiator may also reduce the number of TRN subfields required for receive AWV training to reduce the responder SMBT training time. The L-TX-RX subfield and the Requested EDMG TRN-Unit M subfield of the MIMO BF Setup frame shall indicate the number of TRN subfields requested for receive AWV training in the following responder SMBT subphase.

The responder shall send a MIMO BF Setup frame with the SU/MU field set to 1 and the Link Type field set to 0 a SIFS following the reception of the MIMO BF Setup frame from the initiator. The TA field and the RA field of the MIMO BF Setup frame shall be set to the MAC address of the responder and the initiator, respectively. The MIMO BF Setup frame shall indicate a unique dialog token in the Dialog Token field for identifying SU-MIMO BF training and the number of transmit sector combinations requested for the responder link () in the Number of TX Sector Combinations Requested field. The MIMO BF Setup frame shall also indicate whether time domain channel response is requested as part of SU-MIMO BF feedback in the Channel Measurement Requested field. If the time domain channel response is requested as part of SU-MIMO BF feedback, the Channel Measurement Requested field shall be set to 1 and the Number of Taps Requested field shall indicate the number of channel taps requested in time domain channel response. Additionally, based on the SNRs of the transmit sectors collected from the initiator in the SISO phase, the responder may select a subset of candidate transmit sectors per DMG antenna to reduce the responder SMBT training time. Each DMG antenna should have the similar number of candidate transmit sectors in order to avoid biasing a DMG antenna. If the responder has antenna pattern reciprocity, the responder may also reduce the number of TRN subfields required for receive AWV training to reduce the initiator SMBT training time. The L-TX-RX subfield and the Requested EDMG TRN-Unit M subfield of the MIMO BF Setup frame shall indicate the number of TRN subfields requested for receive AWV training in the following initiator SMBT subphase.

All frames transmitted during the MIMO BF setup subphase should be sent using the DMG control mode.

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10.38.9.2.4.3.2 Downlink MIMO phase

***#7: Change the third paragraphes as follows (CID #51, #52, #395):***

In the MU-MIMO BF setup subphase, the initiator shall transmit one or more MIMO BF Setup frame with the SU/MU field set to 0 and the DL/UL MIMO Phase field set to 1 to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Setup frames to reach all responders in the MU group. The MIMO BF Setup frames should be sent using the DMG control mode. The TA field of the MIMO BF Setup frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. The MIMO BF Setup frame shall indicate the EDMG group ID of the MU group in the EDMG Group ID field, each remaining responder in the Group User Mask field, and a unique dialog token in the Dialog Token field for identifying MU-MIMO BF training. The MIMO BF Setup frame shall also indicate whether time domain channel response is requested as part of MU-MIMO BF feedback in the Channel Measurement Requested field. If the time domain channel response is requested as part of MU-MIMO BF feedback, the Channel Measurement Requested field shall be set to 1 and the Number of Taps Requested field shall indicate the number of channel taps requested in time domain channel response. To reduce the MU-MIMO BF training time, the initiator may select a subset of TX sectors for each DMG antenna and the number of TRN subfields required for receive AWV training based on the L-TX-RX subfields and the EDMG TRN-Unit M subfields in the feedback from responders received at the SISO phase. A responder whose corresponding bit in the Group User Mask field of the received MIMO BF Setup frame is set to 0 can ignore frames transmitted in the following MU-MIMO BF training subphase and MU-MIMO BF feedback subphase.

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10.38.9.2.4.3.3 Uplink MIMO phase

***#8: Change the second paragraph below Figure 57 as follows:***

In the MU-MIMO BF setup subphase, the initiator shall transmit one or more MIMO BF Setup frame with the SU/MU field set to 0 and the DL/UL MU-MIMO Phase field set to 0 to each responder in the MU group. The initiator should transmit the minimum number of MIMO BF Setup frames to reach all responders in the MU group. The MIMO BF Setup frames should be sent using the DMG control mode. The TA field of the MIMO BF Setup frame shall be set to the BSSID of the initiator and the RA field shall be set to the broadcast address. The MIMO BF Setup frame shall indicate the EDMG group ID of the MU group in the EDMG Group ID field, each remaining responder in the Group User Mask field, and a unique dialog token in the Dialog Token field for identifying MU-MIMO BF training. A responder whose correspond bit in the Group User Mask field of the received MIMO BF Setup frame is set to 0 can ignore the subsequent MU-MIMO BF training subphase.

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**Reference: IEEE 802.11ay D0.35**