IEEE P802.11
Wireless LANs

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| Comment Resolution on SU-MIMO BF for TDD SP |
| Date: 2018-05-08 |
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Abstract

This document proposes resolution on the SU-MIMO BF during the TDD SP. The text used as reference is D1.0.

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| **CID** | **Page** | **Clause** | **Comment** | **Proposed Change** |
| 1636 | 135.02 | 10.36.6.2.2 | The SU-MIMO beamforming protocol defined in the current draft is not suitable to the TDD channel access | SU-MIMO beamforming protocol suited to TDD channel access is needed. |

**Proposed resolution:** revised

**Discussion:** The mmWave distribution network needs to support the SU-MIMO in order to achieve the requirement of this usage model. However, the SU-MIMO beamforming protocol defined in the current draft is not suitable to the TDD SP. According to the current draft, the SU-MIMO BF cannot be operated in the TDD SP. That’s because consecutive handshaking during the SU-MIMO BF keeps the specific IFS (MBIFS and SIFS) values. Therefore, the flow of subphases and the exchange of the MIMO BF frames need to be adapted in order to suite the TDD SP where bidirectional transmission is prohibited in a TDD Slot.

**Modification:** Modify and add in subclause 10.38.9.2.2 (SU-MIMO beamforming) as follows:

10.38.9.2.2 SU-MIMO beamforming

10.38.9.2.2.1 General

10.38.9.2.2.2 SISO phase

10.38.9.2.2.3 MIMO phase

The MIMO phase enables the training of transmit and receive sectors and DMG antennas to determine best combinations of transmit and receive sectors and DMG antennas for SU-MIMO operation. ~~The initiator shall start the MIMO phase an MBIFS following the end of the SISO phase~~. The MIMO phase is shown in Figure 99 and consists of four subphases: an SU-MIMO BF setup subphase, an initiator SU-MIMO BF training (SMBT) subphase, a responder SMBT subphase, and an SU-MIMO BF feedback subphase.

When the MIMO phase is performed outside of a TDD SP, the initiator shall start the MIMO phase an MBIFS following the end of the SISO phase. Each subphase shall be separated by an MBIFS.

When the MIMO phase is performed in a TDD SP, after the end of TDD beamforming, each subphase should start within the earliest occurring TDD slot the initiator is assigned to, with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268).

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. In case of channel aggregation, the Aggregation Requested field in the MIMO BF Setup frame should be set to 1. 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 ($N\_{tsc}^{(I)}$) 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.

In the MIMO phase outside of a TDD SP, t~~T~~he 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. In the MIMO phase in a TDD SP, upon reception of the MIMO BF Setup frame from the initiator, 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 within the earliest occurring TDD slot the responder is assigned to, with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268).

In case of channel aggregation, the Aggregation Requested field in the MIMO BF Setup frame should be set to 1. 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 ($N\_{tsc}^{(R)}$) 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 or using a non-EDMG duplicate PPDU transmitted with the DMG Control modulation class.

When the MIMO phase is performed outside of a TDD SP, t~~T~~he initiator shall initiate the initiator SMBT subphase a MBIFS following reception of the MIMO BF Setup frame from the responder. When the MIMO phase is performed in a TDD SP, upon reception of the MIMO BF Setup frame from the responder, the initiator shall initiate the initiator SMBT subphase within the earliest occurring TDD slot the initiator is assigned to with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268).

In the initiator SMBT subphase, the initiator shall transmit EDMG BRP-RX/TX packets to the responder. Each EDMG BRP-RX/TX packet shall be separated by SIFS. Each transmitted EDMG BRP-RX/TX packet is used to train one or more transmit sectors and, for each transmit sector, a number of receive AWVs. In each EDMG BRP-RX/TX packet, the initiator shall include, for each selected transmit sector, TRN subfields in the TRN field of the PPDU for the responder to perform receive AWV training. For each EDMG BRP-RX/TX packet, the TXVECTOR parameter EDMG\_TRN\_LEN shall be set to a value greater than zero, and the parameters RX\_TRN\_PER\_TX\_TRN and EDMG\_TRN\_M shall be set to the values of the L-TX-RX and EDMG TRN-Unit M subfields received in the feedback from the responder in the SISO phase, respectively. The initiator may transmit each EDMG BRP-RX/TX packet to train multiple TX DMG antennas simultaneously by using the TRN subfields defined in 30.9.2.2.6 and, therefore, reduce training time. The TX Antenna Mask field of each EDMG BRP-RX/TX packet shall indicate the TX DMG antenna(s) which is being used by the initiator to transmit the EDMG BRP-RX/TX packet. The BRP CDOWN field of each EDMG BRP-RX/TX packet shall indicate the number of remaining EDMG BRP RX/TX packets to be transmitted by the initiator in the initiator SMBT subphase.

In the MIMO phase outside of a TDD SP, t~~T~~he responder shall initiate the responder SMBT subphase a MBIFS following the reception of an EDMG BRP-RX/TX packet with the BRP CDOWN field set to 0 from the initiator. In the MIMO phase in a TDD SP, upon reception of an EDMG BRP-RX/TX packet with the BRP CDOWN field set to 0 from the initiator, the responder shall initiate the responder SMBT subphase within the earliest occurring TDD slot the responder is assigned to with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268). In the responder SMBT subphase, the responder shall transmit EDMG BRP-RX/TX packets to the initiator. Each EDMG BRP-RX/TX packet shall be separated by SIFS. For each EDMG BRP-RX/TX packet, the TXVECTOR parameter EDMG\_TRN\_LEN shall be set to a value greater than zero, and the parameters RX\_TRN\_PER\_TX\_TRN and EDMG\_TRN\_M shall be set to the values of the L-TX-RX and Requested EDMG TRN-Unit M subfields in the MIMO BF Setup frame received from the initiator in the SU-MIMO BF setup subphase, respectively. The responder may transmit each EDMG BRP-RX/TX packet to train multiple TX DMG antennas simultaneously by using the TRN subfields defined in 30.9.2.2.6 and, therefore, reduce training time. The TX Antenna Mask field of each EDMG BRP-RX/TX packet shall indicate the TX DMG antenna(s) which is being used by the responder to transmit the EDMG BRP-RX/TX packet. The BRP CDOWN field of each EDMG BRP-RX/TX packet shall indicate the number of remaining EDMG BRP RX/TX packets to be transmitted by the responder in the responder SMBT subphase.

When the MIMO phase is performed outside of a TDD SP, t~~T~~he initiator shall initiate the SU-MIMO BF feedback subphase a MBIFS following reception of an EDMG BRP-RX/TX packet with the BRP CDOWN field set to 0 from the responder. When the MIMO phase is performed in a TDD SP, upon reception of an EDMG BRP-RX/TX packet with the BRP CDOWN field set to 0 from the responder, the initiator shall initiate the SU-MIMO BF feedback subphase within the earliest occurring TDD slot the initiator is assigned to with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268).

All frames transmitted during the SU-MIMO BF feedback subphase should be sent using the DMG control mode. In the SU-MIMO BF feedback subphase, the initiator shall send to the responder a MIMO BF Feedback frame with the SU/MU field set to 1 and the Link Type field set to 0. In case of channel aggregation, the Aggregation Present field in the MIMO BF Feedback frame should be set to 1. The TA field of the MIMO BF Feedback frame shall be set to the MAC address of the initiator and the RA field shall be set to the MAC address of the responder. The MIMO BF Feedback frame shall carry the dialog token in the Dialog Token field that identifies the SU-MIMO BF training. The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N\_{tsc}^{(R)}$ best transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are determined based on channel measurement data captured from the responder SMBT subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain SNRs corresponding to the $N\_{tsc}^{(R)}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested field of the MIMO BF Setup frame received from the responder in the preceding SU-MIMO BF setup subphase is 1, the Channel Measurement Present field of the MIMO BF Feedback frame shall be set to 1 and the Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain channel measurements corresponding to the $N\_{tsc}^{(R)}$ transmit sector combinations in the Channel Measurement field.

In the MIMO phase outside of a TDD SP, t~~T~~he responder shall send a MIMO BF Feedback frame to the initiator with the SU/MU field set to 1 and the Link Type field set to 1 a SIFS following reception of a MIMO BF Feedback frame from the initiator. In the MIMO phase in a TDD SP, upon reception of a MIMO BF Feedback frame from the initiator, the responder shall send a MIMO BF Feedback frame to the initiator with the SU/MU field set to 1 and the Link Type field set to 1 within the earliest occurring TDD slot the responder is assigned to with access permission of the TDD slot, and with slot category of the TDD slot set to Basic TDD slot, as indicated in the TDD Slot Schedule element (see 9.4.2.268). In case of channel aggregation, the Aggregation Present field in the MIMO BF Feedback frame should be set to 1. The TA field of the MIMO BF Feedback shall be set to the MAC address of the responder and the RA field shall be set to the MAC address of the initiator. The MIMO BF Feedback frame shall carry the dialog token in the Dialog Token field that identifies the SU-MIMO BF training. The EDMG Channel Measurement Feedback element in the MIMO BF Feedback frame shall indicate $N\_{tsc}^{(I)}$ best transmit sector combinations in the EDMG Sector ID Order field and the BRP CDOWN field, which are determined based on channel measurement data captured from the initiator SMBT subphase. The Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain SNRs corresponding to the $N\_{tsc}^{(I)}$ transmit sector combinations in the SNR field. If the Channel Measurement Requested field of the MIMO BF Setup frame received from the initiator in the preceding SU-MIMO BF setup subphase is 1, the Channel Measurement Present field of the MIMO BF Feedback frame shall be set to 1 and the Channel Measurement Feedback element in the MIMO BF Feedback frame shall contain channel measurements corresponding to the $N\_{tsc}^{(I)}$ transmit sector combinations in the Channel Measurement field.

The $N\_{tsc}^{(I)}$ best transmit sector combinations (or equivalently $N\_{tsc}^{(I)}$ best TX-RX AWV configurations) for the initiator link and the $N\_{tsc}^{(R)}$ best transmit sector combinations (or equivalently $N\_{tsc}^{(R)}$ best TX-RX AWV configurations) for the responder link shall be determined in such a way that no transmit or receive AWV come from the same DMG antenna. The algorithms for determining the $N\_{tsc}^{(I)}$ best transmit sector combinations for the initiator link and for determining the $N\_{tsc}^{(R)}$ best transmit sector combinations for the responder link are implementation dependent.

**Straw Poll & Motion:**

**Do you agree the comment resolution to include the text changes proposed in (11-18-0841-00-00ay-** **Comment Resolution on SU-MIMO BF for TDD SP) to the spec draft?**