IEEE P802.11  
Wireless LANs

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| Contributions to the BRP TXSS procedure | | | | |
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Abstract

This document suggests text that extends the BRP TXSS procedure to include transmit training by the responder, to the case when the used EDMG BRP-TX packets are transmitted using multiple transmit chains simultaneously, and that make the setup phase optional in certain scenarios.

**9.4.2.255 EDMG BRP Request element**

*Editor: Modify the 9th, 10th, and 11th paragraphs of 9.4.2.255 as follows*

The TXSS-REQUEST field is set to one to indicate the request to perform the BRP TXSS training defined in 10.38.9.5. Otherwise, this field is set to zero.

If the TXSS-REQUEST field is equal to one, the TXSS-RECIPROCAL field set to one indicates the request for reciprocal BRP TXSS training (see 10.38.9.5), otherwise it is set to zero. If the TXSS-REQUEST field is equal to zero, the TXSS- RECIPROCAL field is reserved.

If the TXSS-REQUEST field is equal to one, the TXSS-SECTORS field indicates the total number of AWV configurations the transmitter of this element uses in the BRP TXSS procedure combined over all of its DMG antennas or transmit chains. Otherwise if the TXSS-REQUEST field is equal to zero, the TXSS-SECTORS field is reserved.

*Editor: Add the following two paragraphs after the 11th paragraphs of 9.4.2.255*

If the TXSS-REQUEST field is equal to one, the TXSS-RESPONDER field set to one indicates that the requested BRP TXSS includes a Responder BRP TXSS (see 10.38.9.5). If the TXSS-REQUEST field is equal to one, the TXSS-RESPONDER field set to zero indicates that the requested BRP TXSS does not include a Responder BRP TXSS (see 10.38.9.5). If the TXSS-REQUEST field is equal to zero, the TXSS-RESPONDER field is reserved.

If the TXSS-REQUEST field is equal to one, the TXSS-MIMO field set to one indicates that the requested BRP TXSS is a MIMO BRP TXSS (see 10.38.9.5). If the TXSS-REQUEST field is equal to one, the TXSS-MIMO field set to zero indicates that the requested BRP TXSS is a SISO BRP TXSS (see 10.38.9.5). If the TXSS-REQUEST field is equal to zero, the TXSS-MIMO field is reserved.

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|  | 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 | B71 |
|  | TXSS-REQUEST | TXSS-RECIPROCAL | TXSS-SECTORS | TXSS-MIMO | TXSS-RESPONDER |
| Bits: | 1 | 1 | 9 | 1 | 1 |

1. —EDMG BRP Request element format

**10.38.9.5 BRP transmit sector sweep (BRP TXSS)**

**10.38.9.5.1 General**

Beam refinement protocol transmit sector sweep (BRP TXSS) is a procedure which makes use of BRP frames to perform transmit training and determine improved antenna configuration for transmission.

In this subclause, the STA that initiates a BRP TXSS through the transmission of a BRP frame with the TXSS-REQUEST field within the EDMG BRP Request element set to 1 is referred to as the initiator, and the recipient STA of the BRP frame that participates in a BRP TXSS with the initiator is referred to as the responder.

A BRP TXSS may be comprised of an optional setup phase, a mandatory transmit training phase by the initiator, referred to as an Initiator BRP TXSS, an optional transmit training phase by the responder, referred to as a Responder BRP TXSS, and a mandatory feedback phase. An example of BRP TXSS is shown in Figure 62 for the case when the procedure is comprised of a setup phase, an Initiator BRP TXSS, and a feedback phase, and the BRP frames used in the procedure are sent with a single transmit chain (SISO transmission). In Figure 62 and in the remainder of 10.38.9.5, is the number of transmit DMG antennas of the initiator, is the number of transmit DMG antennas of the responder, is the number of receive DMG antennas of the initiator, and is the number of receive DMG antennas of the responder.



**Figure 62—Example of BRP TXSS**

As defined in 10.38.9.5.3, a BRP TXSS may start with an optional setup phase, which consists of the transmission of a BRP frame that requests transmit training by the initiator followed by the transmission of a BRP frame that confirms the procedure by the responder. If a BRP TXSS includes a setup phase, after receiving confirmation of the BRP TXSS request from the responder, the initiator performs an Initiator BRP TXSS. In an Initiator BRP TXSS, the initiator transmits EDMG BRP-TX packets to perform transmit training using each of its DMG antennas, and the process is repeated for each DMG antenna of the responder. If the BRP TXSS does not include a Responder BRP TXSS, the feedback phase consists of the transmission of a BRP frame by the responder with feedback of the corresponding procedure based on measurements performed during the reception of EDMG BRP-TX packets. In some cases, as also defined in 10.38.9.5.3, a BRP TXSS may be initiated directly with the transmission of an EDMG BRP-TX packet by the initiator, and the setup phase is not performed.

If a BRP TXSS includes a Responder BRP TXSS, the Responder BRP TXSS is performed after the Initiator TXSS as shown in Figure 63. In a Responder BRP TXSS, the responder transmits EDMG BRP-TX packets to perform transmit training using each of its DMG antennas, and the process is repeated for each DMG antenna of the initiator. If a BRP TXSS includes a Responder BRP TXSS, the feedback phase consists of the transmission of a BRP frame by the initiator that contains feedback based on measurements it performed during the reception of EDMG BRP-TX packets sent by the responder, followed by the transmission of a BRP frame by the responder that contains feedback based on measurements it performed during the reception of EDMG BRP-TX packets sent by the initiator.

If both initiator and responder of a BRP TXSS are SU-MIMO capable (as defined in 10.38.9.2.3.1), EDMG BRP-TX packets used in a BRP TXSS may be sent using multiple transmit chains simultaneously (MIMO transmission). In this case, a single EDMG BRP-TX packet is transmitted in the training of a STA and, as defined in 30.9, the TRN field of the EDMG BRP-TX packet consists of *N* orthogonal waveforms, where *N* is the number of transmit chains used in the transmission of the packet. An example of a MIMO BRP TXSS is shown in Figure 64.

The configurations of the DMG antennas and of the TRN-Units used in BRP TXSS are defined in 10.38.9.5.2. In BRP TXSS, the receive antenna pattern utilized in the reception of the TRN field of EDMG BRP-TX packets may be quasi-omni or, in a specific case, directional. The receive antenna pattern to be utilized is determined in the BRP frame that starts the procedure.

As defined in 30.9.2.2.2, the TRN field of EDMG BRP-TX packets sent as part of BRP TXSS is transmitted over the entire channel bandwidth. Therefore, the BRP TXSS allows for transmit training over the entire channel bandwidth when the initiator and responder operate on a 4.32 GHz, 6.48 GHz, or 8.64 GHz channel.



**Figure 63—Example of BRP TXSS**



**Figure 64—Example of BRP TXSS**

**10.38.9.5.2 DMG antenna and TRN-Unit configuration during BRP TXSS**

A SISO BRP TXSS is a BRP TXSS in which EDMG BRP-TX packets used in the procedure are transmitted using a single transmit chain (SISO transmission). A MIMO BRP TXSS is a BRP TXSS in which EDMG BRP-TX packets used in the procedure are transmitted using multiple transmit chains (MIMO transmission).

**10.38.9.5.2.1 SISO BRP TXSS configuration**

All fields except for the TRN field of EDMG BRP-TX packets used in SISO BRP TXSS shall be transmitted with the same DMG antenna and antenna configuration used in the transmission of the BRP frame that started the procedure. The TRN field of EDMG BRP-TX packets used in SISO BRP TXSS may be transmitted with a different DMG antenna than the one used in the transmission of the remaining fields of the same EDMG BRP-TX packet.

All fields of EDMG BRP-TX packets used in SISO BRP TXSS except for the TRN field shall be received with the same DMG antenna and antenna configuration used in the reception of the BRP frame that started the procedure. The TRN field of EDMG BRP-TX packets used in SISO BRP TXSS may be received with a DMG antenna that is not the same one used in the reception of the remaining fields of the same EDMG BRP-TX packet.

If the TXSS-RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the SISO BRP TXSS is equal to 0, then:

* The total number of AWV combinations used in the transmit training shall be equal to the sum of all AWV configurations employed on all DMG antennas of the transmitter, and is equal to the value of the TXSS-SECTORS subfield within the EDMG BRP Request element that initiated the BRP TXSS. The process is repeated for each DMG antenna of the responder.
* The TRN-Unit RX Pattern field in the EDMG-Header-A of EDMG BRP-TX packets used in the procedure shall be set to 1.

The TXSS-RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the SISO BRP TXSS may be set to 1 only if:

* The Antenna Pattern Reciprocity subfield in the DMG STA Capability Information field of the responder and the Antenna Pattern Reciprocity subfield in the DMG STA Capability Information field of the initiator are both equal to 1.The TXSS-RESPONDER subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS is equal to 0.
* The last BRP TXSS performed between the BRP frame transmitter (that is, the initiator in the current BRP TXSS) and the BRP frame receiver (that is, the responder in the current BRP TXSS) was performed with the BRP frame transmitter in the role of responder and the BRP frame receiver in the role of initiator.

If the TXSS-RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the SISO BRP TXSS is equal to 1, then:

* The initiator shall transmit one EDMG BRP-TX packet using the DMG antenna corresponding to the best AWV configuration identified in the last BRP TXSS procedure between the two STAs and that was initiated by the responder of the current BRP TXSS procedure.The TRN-Unit RX Pattern field in the EDMG-Header-A of EDMG BRP-TX packets used in the procedure shall be set to 0.
* The AWV configuration used by the responder shall be the RX AWV configuration corresponding to the best AWV configuration identified in the last BRP TXSS procedure between the two STAs and that was initiated by the responder of the current BRP TXSS procedure.

The first TRN-Unit in an EDMG BRP packet used in a SISO BRP TXSS may be used for the initiator and responder to switch DMG antennas and shall not be processed by the receiver. Therefore, for EDMG BRP-TX packets transmitted during SISO BRP TXSS, the value of the TXVECTOR parameter EDMG\_TRN\_LEN shall be set to *k* + 1, where *k* is the number of TRN-Units used for transmit training.

When transmitting an EDMG BRP-TX packet as part of a SISO BRP TXSS, an EDMG STA may change the DMG antenna used in the transmission of its TRN field during the first TRN-Unit and shall not change DMG antenna during the remaining TRN-Units.

When receiving EDMG BRP-TX packets as part of SISO BRP TXSS, an EDMG STA may change the DMG antenna used in the reception of the TRN field during the first TRN-Unit and shall not change DMG antenna during the remaining TRN-Units.

**10.38.9.5.2.2 MIMO BRP TXSS configuration**

All fields of EDMG BRP-TX packets used in MIMO BRP TXSS shall be transmitted with all transmit chains of the transmitter and use an EDMG PPDU defined for MIMO transmission in Clause 30. The TRN field of EDMG BRP-TX packets used in MIMO BRP TXSS shall consist of *N* orthogonal waveforms, where *N* is the number of transmit chains used in the transmission of the packet, as defined in 30.9. In a MIMO BRP TXSS, channel measurements shall be obtained during the reception of a single EDMG BRP-TX packet.

A STA that is part of a MIMO BRP TXSS and receives EDMG BRP-TX packets shall perform channel measurements using all of its DMG antennas simultaneously and provide feedback for each of its DMG antennas, as defined in 10.38.9.5.4. The total number of AWV configurations used in the transmit training is equal to the total number of AWV configurations employed in the transmission of all *N* orthogonal waveforms that comprise the TRN field of the EDMG BRP-TX packet.

The TRN-Unit RX Pattern field in the EDMG-Header-A of EDMG BRP-TX packets used in MIMO BRP TXSS shall be set to 1.

The TXSS-RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start a MIMO BRP TXSS shall be equal to 0.

For EDMG BRP-TX packets transmitted in a MIMO BRP TXSS, the value of the TXVECTOR parameter EDMG\_TRN\_LEN shall be set to *k*, where *k* is the number of TRN-Units used in the transmit training.

**10.38.9.5.3 BRP TXSS execution**

A BRP TXSS shall complete within the CBAP or SP in which it was initiated.

The FBCK-REQ subfield in the DMG Beam Refinement element carried within the BRP frame that initiates a BRP TXSS shall be set to 10001 (binary).

A BRP TXSS shall be initiated with either a BRP frame exchange or with the transmission of an EDMG BRP-TX packet:

If a BRP TXSS includes a setup phase, the initiator sends a BRP frame with the TXSS-REQUEST subfield in the EDMG BRP Request element set to 1 and, for a SISO BRP TXSS procedure, the TXSS-SECTORS subfield set to indicate the total number of AWV configurations the initiator uses in the procedure combined over all of its DMG antennas. For a MIMO BRP TXSS procedure, the TXSS-SECTORS subfield shall be set to indicate the total number of AWV configurations employed in the transmission of all *N* orthogonal waveforms that comprise the TRN field of the EDMG BRP-TX packet. TXSS-OKBoth the BRP frame sent by the initiator to initiate the BRP TXSS and the BRP frame sent by the responder to confirm the BRP TXSS execution shall not include a TRN field. TXSS-OK

* If a BRP TXSS does not include a setup phase, the initiator shall initiate a BRP TXSS with the transmission of an EDMG BRP-TX packet. A BRP TXSS shall only be initiated with the transmission of an EDMG BRP-TX packet if the BRP TXSS is a SISO BRP TXSS and if it does not include a Responder BRP TXSS. The TXSS-REQUEST subfield in the EDMG BRP Request element of the EDMG BRP-TX packet that initiates the BRP TXSS shall be set to 1. The TXSS-SECTORS subfield in the packet shall be set to indicate the total number of AWV configurations the initiator uses in the procedure combined over all of its DMG antennas.

The TXSS-RESPONDER subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 1 when the procedure includes an Initiator BRP TXSS and a Responder BRP TXSS. If the BRP TXSS does not include a Responder BRP TXSS, the TXSS-RESPONDER subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 0.

In the setup phase of a BRP TXSS that includes a Responder BRP TXSS, the BRP frame sent by the responder to confirm the BRP TXSS execution shall include in the TXSS-SECTORS subfield the total number of AWV configurations that will use in the transmit training combined over all of its DMG antennas or transmit chains.

The TXSS-RESPONDER subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 1 only if the TXSS-RECIPROCAL subfield in the EDMG BRP Request element of the same frame is set to 0.

The TXSS-MIMO subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 1 when the procedure is a MIMO BRP TXSS. If the procedure is a SISO BRP TXSS, the TXSS-MIMO subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 0. Both initiator and responder of a BRP TXSS shall be SU-MIMO capable (as defined in 10.38.9.2.3.1) for the TXSS-MIMO subfield to be set to 1.

The TXSS-MIMO subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall be set to 1 only if the TXSS-RECIPROCAL subfield in the EDMG BRP Request element of the same frame is set to 0.

The TXSS-RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent by the initiator to start the BRP TXSS shall be set as decribed in 10.38.9.5.2

If a BRP TXSS does not include a setup phase, the TXSS-MIMO subfield and the TXSS- RESPONDER subfield in the EDMG BRP Request element of the BRP frame that initiates the BRP TXSS shall both be set to 0.

If a BRP TXSS includes a setup phase, the initiator shall transmit the first EDMG BRP-TX packet MBIFS interval after the reception of the BRP frame sent by the responder confirming the BRP TXSS execution.

In a SISO BRP TXSS, the EDMG BRP-TX packets sent by the initiator in a BRP TXSS procedure shall be separated by SIFS interval. If the procedure includes a Responder BRP TXSS, the responder shall send the first EDMG BRP-TX packet MBIFS after the last EDMG BRP-TX packet transmitted by the initiator. The EDMG BRP-TX packets sent by the responder in a BRP TXSS procedure shall be separated by SIFS interval.

In a MIMO BRP TXSS, if the procedure includes a Responder BRP TXSS, the responder shall transmit an EDMG BRP TXSS MBIFS after the EDMG BRP-TX packet transmitted by the initiator.

For a SISO BRP TXSS procedure,

* If the TXSS- RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent to start the procedure is 0, the initiator shall transmit EDMG BRP-TX packets per each DMG antenna of the responder. The total number of AWV configurations trained in the EDMG BRP-TX packets sent is *N*, where *N* is equal to the value of the TXSS-SECTORS subfield in the EDMG BRP Request element sent in the BRP frame that started the BRP TXSS procedure. If the responder has more than one receive DMG antenna, the initiator repeats the transmission of the EDMG BRP-TX packets for the number of DMG antennas indicated in the last negotiated Number of RX DMG Antennas field transmitted by the responder to the initiator. If the TXSS-RESPONDER subfield within the EDMG BRP Request element in the BRP frame sent to start the procedure was 1, the responder shall then transmit EDMG BRP-TX packets per each DMG antenna of the initiator. The total number of AWV configurations trained in the EDMG BRP-TX packets sent is *N*, where *N* is equal to the value of the TXSS-SECTORS subfield in the EDMG BRP Request element sent in the BRP frame that confirmed the BRP TXSS procedure. If the initiator has more than one receive DMG antenna, the responder repeats the transmission of the EDMG BRP-TX packets for the number of DMG antennas indicated in the last negotiated Number of RX DMG Antennas field transmitted by the initiator to the responder.
* If the TXSS- RECIPROCAL subfield within the EDMG BRP Request element in the BRP frame sent to start the procedure is 1, the initiator shall transmit one EDMG BRP-TX packet to the responder. The total number of AWV configurations trained in the packet is *N*, where *N* is equal to the value of the TXSS-SECTORS subfield in the EDMG BRP Request element sent in the BRP frame that started the procedure.

For a MIMO BRP TXSS procedure, the initiator shall transmit an EDMG BRP-TX packet and, as defined in 30.9, the TRN field of the EDMG BRP-TX packet shall consist of *N* orthogonal waveforms, where *N* is the number of transmit chains of the initiator. The receiver shall obtain channel measurements during the reception of the transmitted EDMG BRP-TX packet using all of its DMG antennas simultaneously, and provide feedback for each of its DMG antennas, as defined in 10.38.9.5.4. If the TXSS-RESPONDER subfield within the EDMG BRP Request element in the BRP frame sent to start the procedure was 1, the responder shall then transmit one EDMG BRP-TX packet and, as defined in 30.9, the TRN field of the EDMG BRP-TX packet shall consist of *N* orthogonal waveforms, where *N* is the number of transmit chains of the responder.

For each EDMG BRP-TX packet transmitted in a BRP TXSS procedure, the Packet Type field within the L-Header and the EDMG TRN Length, EDMG TRN-Unit P, EDMG TRN-Unit M, and EDMG TRN-Unit N fields in the EDMG-Header-A are set to indicate the configuration of the TRN field appended to the packets.

**10.38.9.5.4 BRP TXSS feedback**

BRP frames with feedback exchanged in a BRP TXSS shall not include a TRN field.

If the BRP TXSS does not include a Responder BRP TXSS, the responder shall send a BRP frame to the initiator containing feedback based on measurements it performed during the BRP TXSS. The BRP frame with feedback transmitted by the responder is separated from the last EDMG BRP-TX packet transmitted by the initiator by a BRPIFS interval.

If the BRP TXSS includes a Responder BRP TXSS, the initiator shall send a BRP frame to the responder containing feedback based on measurements it performed. The BRP frame with feedback transmitted by the initiator is separated from the last EDMG BRP-TX packet transmitted by the responder by a BRPIFS interval. The responder shall then send a BRP frame to the initiator containing feedback based on measurements it performed. The BRP frame with feedback sent by the responder is separated from the BRP frame with feedback sent by the initiator by a SIFS interval.

of the BRP frame with acknowledgement in the BRP frame exchange used to initiate the BRP TXSSof the BRP frame with acknowledgement sent by the responder in the BRP frame exchange used to initiate the BRP TXSS

If the BRP TXSS includes a Responder BRP TXSS, the BRP packet sent by the initiator with feedback shall be transmitted with the same DMG antenna and antenna configuration used in the transmission of the BRP frame that initiated the BRP TXSS. The BRP packet sent by the initiator with feedback shall be received by the responder with the same DMG antenna and antenna configuration used in the reception of the BRP frame sent by the initiator that initiated the BRP TXSS.

A BRP frame with feedback transmitted in a BRP TXSS shall have the SNR Present subfield within the FBCK-TYPE field set to 1, the Sector ID Order subfield set to 1, the EDMG Extension Flag set to 1 and the EDMG Channel Measurement Present set to 1. In the EDMG Sector ID Order subfield the SISO IDs indicate the AWV IDs, TX antennas and RX Antennas of Sectors that were received in the last BRP TXSS. The SNRs subfield in the Channel Measurement Feedback indicates the SNRs with which these sectors have been received. The BRP-CDOWNs associated with each SISO ID indicate the BRP-CDOWN of the packet in which the sector has been received.

The BRP TXSS procedure is completed when the responder transmits the BRP packet containing the feedback.

**SP**: Do you agree to include the text proposed in 17/1181r0 into the 802.11ay draft spec?

**References:**