IEEE P802.11
Wireless LANs

|  |
| --- |
| Draft Text for Analog and Baseband Beam Tracking in 802.11ay |
| Date: 2017-05-10 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Kome Oteri | InterDigital | 9710 Scranton Road, #250, San Diego, CA, 92121 | +1 858 210 4826 | Kome.oteri@interidigital.com |
| Li Hsiang Sun |  |  |
| Alphan Sahin |  |  |
| Hanqing Lou |  |  |
| Rui Yang |  |  |
|  |  |  |  |  |

Abstract

This document proposes specification text defining Analog and Digital Baseband Beam Tracking in 802.11ay [1].

***10.38.7 Beam tracking***

*Insert the following paragraph before the first paragraph*

Beam tracking enables an initiator or responder track the change in its analog or baseband beams without the need for the overhead of a BRP procedure. The signaling for beam tracking is sent in the DMG BRP packet header fields or EDMG header-A fields either in a standalone frame or piggy-backed on other transmitted frames. Analog beam tracking tracks changes in the analog beams. Baseband beam tracking tracks changes in the baseband beamformer only in a hybrid beamforming transmission.

Beam tracking may be one of the following:

• Initiator Receive Beam Tracking

• Initiator Transmit Beam Tracking

• Responder Receive Beam Tracking

**10.38.7.1 Initiator Receive Beam Tracking**

*Insert the following paragraph after the first paragraph*

An EDMG STA (beam tracking initiator) may request a peer EDMG STA (beam tracking responder) to perform receive beam tracking by setting, in a transmitted packet, the TXVECTOR parameter EDMG\_BEAM\_TRACKING\_REQUEST to Beam Tracking Requested, EDMG\_BEAM\_TRACKING\_TYPE to Analog Beam Tracking or Baseband Beam Tracking, BEAM\_TRACKING\_REQUEST to Beam Tracking Not Requested, EDMG\_TRN\_LEN, to the number of requested TRN ~~subfields~~ Units as described in 30.9.2.2, and packet type to TRN-R-PACKET. Otherwise, the EDMG\_BEAM\_TRACKING\_REQUEST parameter shall be set to Beam Tracking Not Requested.

*Change the second, third, and fourth paragraphs as follows*

A beam tracking responder that receives a packet requesting beam tracking (corresponding to the BEAM\_TRACKING\_REQUEST or EDMG\_BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR set to Beam Track Requested) and the Packet Type field in the PHY header equal to 0 (corresponding to PACKET-TYPE field in the RXVECTOR set to TRN-R-PACKET) shall:

* If BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR is Beam Tracking Requested, follow the rules described in 20.10.2.2 and shall include a beam refinement AGC field and TRN-R subfields appended to the following packet transmitted to the initiator in the same allocation, with an MCS index greater than 0. The value of TXVECTOR parameter TRN-LEN in the following packet from the responder to the initiator shall be equal to the value of the TRN-LEN parameter in the RXVECTOR of the packet from the initiator.
* If EDMG\_BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR is Beam Tracking Requested and the EDMG\_BEAM\_TRACKING\_TYPE parameter in the RXVECTOR is Analog Beam Tracking or Baseband Beam Tracking, follow the rules described in 30.9.2.2 and shall include TRN-R subfields to the following packet transmitted to the initiator in the same allocation, with an MCS index greater than 0. The value of TXVECTOR parameter EDMG\_TRN\_LEN in the following packet from the responder to the initiator shall be equal to the value of the EDMG\_TRN\_LEN parameter in the RXVECTOR of the packet from the initiator.
* NOTE:
* If EDMG\_BEAM\_TRACKING\_TYPE parameter in the RXVECTOR is Baseband Beam Tracking, the baseband beamformers at the initiator and responder should be set to a predetermined orthogonal matrix, e.g., the identity matrix, during the transmission of the appended TRN-R subfields only and the measurement at the initiator is based on the appended TRN-R packets.

If EDMG\_BEAM\_TRACKING\_TYPE parameter in the RXVECTOR is not equal to Baseband Beam Tracking a responder may ignore a request for beam tracking within an allocation if no packets with an MCS index greater than 0 are transmitted from the responder to the initiator within the allocation.

**10.38.7.2 Initiator Transmit Beam Tracking**

A beam tracking initiator requesting transmit beam tracking shall either:

* Set the BEAM\_TRACKING\_REQUEST parameter in the TXVECTOR to Beam Tracking Requested, Packet Type to TRN-T-PACKET, TRN-LEN to the number of TRN-Units as described in 20.10.2.2.3, and append an AGC field and TRN-T subfields to the packet.
* Set the EDMG\_BEAM\_TRACKING\_REQUEST parameter in the TXVECTOR to Beam Tracking Requested, EDMG\_BEAM\_TRACKING\_TYPE to Analog Beam Tracking or Baseband Beam Tracking, BEAM\_TRACKING\_REQUEST to Beam Tracking Not Requested, Packet Type to TRN-T-PACKET, and EDMG\_TRN\_LEN, EDMG\_TRN\_P, EDMG\_TRN\_M and EDMG\_TRN\_N as described in 30.9.2.2, and append TRN-T subfields to the packet.
* NOTE:

If the EDMG\_BEAM\_TRACKING\_TYPE parameter in the TXVECTOR is Baseband Beam Tracking, then EDMG\_TRN\_LEN TRN units are appended to the data packet (each with EDMG\_TRN\_P TRN subfields) and are transmitted using the same AWV as the preamble and data field of the packet. The baseband beamformer for the initiator and responder should be set to a predetermined orthogonal matrix, e.g., the identity matrix, during the transmission of the appended TRN-T subfields only and the measurement is based on the appended TRN-T subfields.

The beam tracking responder may append the feedback to any packet from the responder to the initiator. The initiator may allocate time for the feedback through a reverse direction grant, provided the reverse direction protocol is supported by both the initiator and responder. The feedback type shall be the same as the feedback type in the last BRP frame that was transmitted from the initiator to the responder with TX-TRN-REQ equal to 1.

If the responder has never received a BRP frame from the initiator with TX-TRN-REQ equal to 1, and

* If BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR is Beam Tracking Requested, or if EDMG\_BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR is Beam Tracking Requested and EDMG\_BEAM\_TRACKING\_TYPE is Analog Beam Tracking, the responder shall respond with all subfields of the FBCK-TYPE field equal to 0 and set the BS-FBCK field to the index of the TRN-T subfield that was received with the best quality.
* If EDMG\_BEAM\_TRACKING\_REQUEST parameter in the RXVECTOR is Beam Tracking Requested and EDMG\_BEAM\_TRACKING\_TYPE is Baseband Beam Tracking, the initiator shall include a FBCK-REQ in a DMG Beam Refinement element as in **9.4.2.130** and request for the feedback needed. The responder shall respond with the requested feedback.

**10.38.7.3 Responder Receive Beam Tracking**

A beam tracking initiator may request a beam tracking responder that the responder perform receive beam tracking by setting, in the PHY header of a transmitted packet, the Beam Tracking Request field to 0, the Training Length field to a nonzero value, the Packet Type field to 0, and append an AGC field and TRN-R subfields to the transmitted packet.

*Insert the following after the fifth/ sixth paragraph*

A beam tracking initiator may request a beam tracking responder that the responder perform receive beam tracking by setting the TXVECTOR parameter EDMG\_BEAM\_TRACKING\_REQUEST to Beam Tracking Not Requested, EDMG\_BEAM\_TRACKING\_TYPE to Analog Beam Tracking, BEAM\_TRACKING\_REQUEST to Beam Tracking Not Requested, TRN-LEN to zero, Packet Type to TRN-R-PACKET, EDMG\_TRN\_LEN to a nonzero value, and appending TRN-R subfields to the packet.

A beam tracking responder that receives a packet with RXVECTOR parameter EDMG\_BEAM\_TRACKING\_REQUEST equal to Beam Tracking Not Requested, EDMG\_BEAM\_TRACKING\_TYPE to Analog Beam Tracking, BEAM\_TRACKING\_REQUEST equal to Beam Tracking Not Requested, TRN-LEN equal to zero, Packet Type equal to TRN-R-PACKET, and EDMG\_TRN\_LEN to a nonzero value shall follow the rules described in 30.9.2.2 and may use the TRN-R subfields appended to the received packet to perform receive beam training.

**10.38.7.4 Initiator Transmit-Receive Beam Tracking**

A beam tracking initiator may use the procedures specified above to request a beam tracking responder to perform both transmit and receive beam tracking on the same packet. This is done by, on top of the corresponding TXVECTOR parameter configuration specified above, setting the TXVECTOR parameter RX\_TRN\_PER\_TX\_TRN to a value greater than zero and the Packet Type to TRN-T-PACKET. In this case, the beam tracking initiator and beam tracking shall use the rules described in 30.9.2.2 to perform both transmit and receive training over the TRN subfields appended to the transmitted packet.

*Change the 8th paragraph as follows*

A beam tracking initiator may transmit to the beam tracking responder a PPDU requesting transmit beam

tracking if at least one of the following conditions is met:

— The time duration since the last PPDU it transmitted to the beam tracking responder that requested

transmit beam tracking is greater than dot11BeamTrackingTimeLimit plus BRPIFS.

— A BRP frame with the channel measurement feedback from the beam tracking responder has been

received.

In addition, a beam tracking initiator or beam tracking responder may request baseband beam tracking if at least one of the following conditions is met:

* The performance of the system is degraded in a hybrid beamforming transmission and the requestor would like to re-estimate the baseband beams as part of the link adaptation procedure
* The requestor did not request for detailed baseband beam information as part of the MIMO setup procedure. In this case, the analog beams have been identified but the information to design the baseband beams is still needed.

**30.2.2 TXVECTOR and RXVECTOR parameters**

*Add variables to Table 7 as follows*

**Table 7 —1 TXVECTOR and RXVECTOR parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| parameter | Condition | Value | TXVECTOR | RXVECTOR |
| EDMG\_BEAM\_TRACKING\_TYPE | FORMAT is EDMG | This parameter indicates if analog beam tracking or baseband beam tracking is requestedEnumerated type:Analog beam Tracking or Baseband Beam Tracking | Y | Y |

**30.9.2.2.2 EDMG BRP packet structure**

*Change the 1st paragraph as follows:*

The EDMG\_TRN\_LEN parameter in the TVXVECTOR or RXVECTOR of an EDMG BRP packet shall be greater than zero. If the PACKET-TYPE parameter in the RXVECTOR or TXVECTOR is equal to TRN-R-PACKET, then both BEAM\_TRACKING\_REQUEST and EDMG\_BEAM\_TRACKING\_REQUEST parameters in the corresponding RXVECTOR or TXVECTOR shall be set to Beam Tracking Not Requested.

**30.3.3.3.2.3 Definition for EDMG SC mode and EDMG OFDM mode PPDUs**

*Modify and add variables to Table 16 as follows*

**Table 16 —EDMG-Header-A field 1 structure and definition for a SU PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field Name** | **Number of bits** | **Start bit** | **Description** |
| EDMG Beam Tracking Request | 1 | 91 | Corresponds to the TXVECTOR parameter EDMG\_BEAM\_TRACKING\_REQUEST. Used in combination with EDMG Beam Tracking Request Type with corresponding TXVECTOR parameter EDMG\_BEAM\_TRACKING\_TYPE.Set to 1 to indicate the need for beam tracking (10.38.7); otherwise, set to 0.The EDMG Beam Tracking Request field is reserved when the EDMG TRN Length field is 0 and EDMG Beam Tracking Request Type is 0 |
| EDMG TRN Unit M | 4 | 82 | For EDMG BRP-TX and EDMG BRP-RX/TX packets, the value of this field plus one indicates the number of TRN subfields in a TRN-Unit in which the transmitter may change AWV at the beginning of their transmission, as definedin 30.9.2.2.5. For EDMG BRP-RX packets, this field is reserved. For EDMG BRP-TX packets transmitted with EDMG Beam Tracking Request Type set to 1, this field is reserved. |
| EDMG TRN Unit N | 2 | 86 | For EDMG BRP-TX and EDMG BRP-RX/TX packets, the value of this field indicates the number of consecutive TRN subfields within EDMG TRN-Unit M which are transmitted using the same AWV, as defined in 30.9.2.2.5.Possible values for this field are:* 0: indicates one TRN subfield
* 1: indicates two TRN subfields
* 2: indicates three TRN subfields if EDMG TRN-Unit M is equal to 3, 6, 9 or 12; indicates eight TRN subfields if EDMG TRN-Unit M is equal to 8 or 16.
* 3: indicates four TRN subfields

For EDMG BRP-RX packets, this field is reserved.For EDMG BRP-TX packets transmitted with EDMG Beam Tracking Request Type set to 1, this field is reserved. |
| EDMG Beam Tracking Request Type | 1 | 95 | Corresponds to the TXVECTOR parameter EDMG\_BEAM\_TRACKING\_TYPE.Set to 0 to indicate Analog Beam Tracking (10.38.7) Set to 1 to indicate Baseband Beam Tracking (10.38.7) |
| Reserved | 16 | 96 | Set to 0 by the transmitter and ignored by the receiver. |

**References:**

1. Draft P802.11ay\_D0.3, P802.11ay™/D0.3
2. 802.11-2016, Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
3. IEEE 802.11-17/0189r0, Beam tracking request for EDMG SC mode, Intel
4. IEEE 802.11-17/1096r0, Definition of Analog and Baseband Beam Tracking in 802.11ay, InterDigital