IEEE P802.11
Wireless LANs

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| Proposed Comment Resolution for CID 428: 30.7 EDMG Transmit Procedure |
| Date: 2017-08-01 |
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Abstract

This document proposes specification text for subclause 30.7 of the spec describing EDMG transmit procedure, [1], [2]. It is related to CID 428.

CID 428 comment:

Need definition of 30.7 EDMG transmit procedure. Currently blank.

Proposed change:

Define and update text.

**30.7 EDMG transmit procedure**

This clause defines the PHY transmit procedure for EDMG and non-EDMG duplicate format. The format selection is performed based on the FORMAT parameter of the PHY-TXSTART.request(TXVECTOR) primitive.

There are two paths for the transmit PHY procedure:

* The first path is selected if the FORMAT parameter is EDMG. In this case the modulation is defined by EDMG\_MODULATION parameter. If EDMG\_MODULATION parameter is set to EDMG\_C\_MODE, EDMG\_SC\_MODE, or EDMG\_OFDM\_MODE, then it indicates EDMG Control mode, EDMG SC mode, or EDMG OFDM mode defined in 30.4, 30.5, or 30.6 accordingly. An example of EDMG PHY transmit procedure provided in this subclause does not include optional features like A-PPDU, SU with multiple space-time streams, STBC, DCM SQPSK, MIMO SQPSK, and MU transmission.
* The second path is selected if the FORMAT parameter is non-EDMG. In this case the modulation is defined by NON\_EDMG\_MODULATION parameter. If NON\_EDMG\_MODULATION is set to C\_MODE or SC\_MODE, then it indicates Control mode or SC mode defined in Clause 20 accordingly. If NON\_EDMG\_MODULATION is set to NON\_EDMG\_DUP\_C\_MODE or NON\_EDMG\_DUP\_SC\_MODE, then it indicates non-EDMG duplicate Control mode or non-EDMG duplicate SC mode defined in subclauses 30.4 or 30.5 accordingly.

*Editor: add EDMG\_MODULATION parameter to TXVECTOR and RXVECTOR in Table 10*

**Table 10 – TXVECTOR and RXVECTOR parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Condition** | **Value** | **TXVECTOR** | **RXVECTOR** |
| EDMG\_MODULATION | FORMAT is EDMG | EDMG\_C\_MODE indicates Clause 30.4 EDMG Control modeEDMG\_SC\_MODE indicates Clause 30.5 EDMG SC modeEDMG\_OFDM\_MODE indicates Clause 30.6 EDMG OFDM mode | Y | Y |
| Otherwise | Not present | N | N |

In both paths, in order to transmit data, the MAC generates a PHY-TXSTART.request primitive, which causes PHY entity to enter the transmit state. Further, the PHY is set to operate at the appropriate frequency through station management via the PLME as specified in 30.12. Other transmit parameters, such as EDMG-MCS, PSDU Length, and others are set via the PHY SAP using the PHY-TXSTART.request(TXVECTOR) primitive, as described in 30.2.

The PHY indicates the state of the 2.16 GHz Primary channel and secondary channels (if any), including 2.16 GHz Secondary, 2.16 GHz Secondary1, and 2.16 GHz Secondary2 via a PHY-CCA.indication primitive as defined in 8.3.5.12. Transmission of the PPDU shall be initiated by the PHY after receiving the PHY-TXSTART.request(TXVECTOR) primitive. The TXVECTOR parameters for the PHY-TXSTART.request primitive are specified in 30.2.2, Table 10.

Figure 1 shows PHY transmit procedure for EDMG\_C\_MODE mode with schematic diagram of primitives exchange between the MAC and PHY layers through PHY SAP interface. Figure 2 shows PHY transmit procedure for SU PPDU format for EDMG\_SC\_MODE or EDMG\_OFDM\_MODE. The fields of the PPDU highlighted by dotted line may not be present for some particular parameters configuration.

The EDMG-STF and EDMG-CEF fields are not transmitted if EDMG\_MODULATION parameter is set to EDMG\_C\_MODE.

The EDMG-STF and EDMG-CEF fields are not transmitted if CH\_BANDWIDTH parameter indicating bandwidth configuration is set to CBW216, EDMG\_MODULATION parameter is set to EDMG\_SC\_MODE, the number of space-time streams NUM\_STS is set to 1, and STBC is set to 0 (see 30.2.2, Table 10).

*Editor: add STBC, NUM\_STS, NUM\_USERS, NUM\_TX fields in Table 10*

**Table 10 – TXVECTOR and RXVECTOR parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Condition** | **Value** | **TXVECTOR** | **RXVECTOR** |
| STBC | FORMAT is EDMG | Indicates whether STBC is used.0 indicates no STBC (*NSTS* = *NSS* in the Data field).1 indicates STBC is used (*NSTS* = 2, *NSS* = 1, in the Data field). | Y | Y |
| Otherwise | Not present | N | N |
| NUM\_STS | FORMAT is EDMG | Indicates the number of space-time streams.Integer: range 1 – 8 for SU, 1 – 2 per user for MU. | MU | Y |
| Otherwise | Not present | N | N |
| NUM\_USERS | FORMAT is EDMG | Indicates the number of users with nonzero space-time streams.Integer: range 1 to 8 in case of 1 space-time stream per user, range 1 to 4 in case of 2 space-time streams per user. | Y | N |
| Otherwise | Not present | N | N |
| NUM\_TX | FORMAT is EDMG | Indicates the number of transmit chains.Integer: range 1 to 8. | Y | N |
| Otherwise | Not present | N | N |

NOTE - MU indicates that the parameter is present once for an EDMG SU PPDU and present per user for an EDMG MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *iuser*, where *iuser* takes values 1 to NUM\_USERS.

The TRN field is not transmitted if EDMG\_TRN\_LEN parameter indicating the number of TRN-Units is set to 0 (see 30.2.2, Table 10).



Figure 1: PHY transmit procedure for Control mode



Figure 2: PHY transmit procedure for SU SC and OFDM mode

NOTE – This procedure does not describe the operation of optional features, such as A-PPDU, SU multiple space-time streams, STBC, DCM SQPSK, MIMO SQPSK, and MU transmission.

The PHY entity performs TXVECTOR parsing to extract the transmission parameters and build up the L-Header and EDMG-Header-A bit content. It computes CRC per each header separately.

If EDMG\_MODULATION parameter is set to EDMG\_C\_MODE, all fields are transmitted using SC modulation. The L-STF and L-CEF fields are transmitted using π/2-BPSK modulated Golay complementary sequences defined in time domain as specified in 20.4.3.1.2 and 20.4.3.1.3 accordingly. The L-Header, EDMG-Header-A composed of two parts EDMG-HeaderA1 and EDMG-Header-A2, and Data (PSDU) are transmitted applying scrambling, LDPC code with effective rate less or equal to 1/2, DBPSK modulation, x32 spreading applying Golay sequences, and π/2-rotation as defined in 30.4.4.2.3 and 30.4.4.2.4. The TRN field is transmitted using π/2-BPSK modulated Golay complementary sequences in time domain as defined in 30.9.2.2.5.

If EDMG\_MODULATION parameter is set to EDMG\_SC\_MODE or EDMG\_OFDM\_MODE, the L-STF, L-CEF, L-Header, and EDMG-Header-A are transmitted using SC modulation. The rest of the frame, including EDMG-STF, EDMG-CEF, Data (PSDU), and TRN field can be transmitted using SC or OFDM modulation.

The L-STF and L-CEF fields are transmitted using π/2-BPSK modulated Golay complementary sequences defined in time domain as specified in 30.3.3.2.3 and 30.3.3.2.4 accordingly. The L-Header is transmitted applying LDPC code with effective rate 2/7, π/2-BPSK modulation, and codeword repetition x4 times. The transmission of L-Header occupies two SC symbol blocks. The EDMG-Header-A is transmitted applying the LDPC code with effective rate 2/7, π/2-BPSK modulation, and codeword repetition x2 times. It is composed of two parts – EDMG-Header-A1 and EDMG-Header-A2. The transmission of EDMG-Header-A occupies two SC symbol blocks.

The SC symbol blocks used for the L-Header and EDMG-Header-A transmission are prepended with Guard Intervals (GIs). The extra GI is inserted at the end of EDMG-Header-A2 block. This creates the blocking structure when each SC symbol block is surrounded by two GIs. The GI is defined using π/2-BPSK modulated Golay sequence in time domain as specified in 30.5.7.1.

If EDMG\_MODULATION parameter is set to EDMG\_SC\_MODE, the EDMG-STF and EDMG-CEF are defined using π/2-BPSK modulated Golay complementary sequences in time domain as specified in 30.5.3 and 30.5.4 accordingly. The Data (PSDU) is scrambled and padded to get integer number of LDPC codewords and SC symbol blocks and then encoded as defined in 30.5.7.3. The encoded bits are modulated as defined in 30.5.7.4. The modulated symbols are grouped into the SC symbol blocks and prepended with GIs as defined in 30.5.7.2. The extra GI is inserted at the end of last SC symbol block. This creates the blocking structure when each SC symbol block is surrounded by two GIs. The GI is defined using π/2-BPSK modulated Golay sequence in time domain as specified in 30.5.7.1. The TRN field is defined using π/2-BPSK modulated Golay complementary sequences in time domain as specified in 30.9.2.2.5.

If EDMG\_MODULATION parameter is set to EDMG\_OFDM\_MODE, the EDMG-STF and EDMG-CEF are defined using 4-PSK modulated sequences in frequency domain as specified in 30.6.3 and 30.6.4 accordingly. The Data (PSDU) is scrambled and padded to get integer number of LDPC codewords and OFDM symbols and then encoded as defined in 30.6.7.3. The encoded bits are modulated as defined in 30.6.7.4. The modulated symbols are grouped into the OFDM data blocks, supplemented with pilots and converted to time domain applying IDFT. The OFDM symbol in time domain is prepended with GI, which is in fact a cyclic extension of OFDM symbol.

*Editor: add the reference to the definition of OFDM TRN units when available*

Transmission of the PHY preamble may start if TIME\_OF\_DEPARTURE\_REQUESTED is false, and shall start immediately if TIME\_OF\_DEPARTURE\_REQUESTED is true, based on the parameters passed in the PHY-TXSTART.request primitive.

*Editor: add TIME\_OF\_DEPARTURE\_REQUESTED parameter to TXVECTOR and RXVECTOR in Table 10 (similar to Table 19-1)*

**Table 10 – TXVECTOR and RXVECTOR parameters**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Condition** | **Value** | **TXVECTOR** | **RXVECTOR** |
| TIME\_OF\_DEPARTURE\_REQUESTED |  | Enumerated type:True indicates that the MAC entity requests that the PHY entity measures and reports time of departure parameters corresponding to the time when the first frame energy is sent by the transmitting port. False indicates that the MAC entity requests that the PHY entity neither measures nor reports time of departure parameters. | O | N |

NOTE – in the “TXVECTOR”, “RXVECTOR” columns the following apply:

Y = Present, N = Not present, O = Optional.

The PHY layer shall issue a PHY-TXSTART.confirm primitive to the MAC in response to the PHY-TXSTART.request(TXVECTOR) primitive when it is ready to receive an MPDU/A-MPDU from the MAC layer. The receipt of this primitive by the MAC entity causes the MAC to start the transfer of data octets.

The PHY-TXSTART.confirm(TXSTATUS) primitive shall contain TXSTATUS vector defined in Table 15-3, if the conditions below are met:

* If dot11TODImplemented and dot11TODActivated are both true or dot11TimingMsmtActivated is true; and the parameter TIME\_OF\_DEPARTURE\_REQUESTED in the TXVECTOR specified in the PHYTXSTART.request is true, then the PHY shall include the TIME\_OF\_DEPARTURE corresponding to the time when the first frame energy is sent by the transmitting port and TIME\_OF\_DEPARTURE\_ClockRate parameters in the TXSTATUS vector (See Table 15-3).
* If dot11TimingMsmtActivated is true, then the PHY shall include TX\_START\_OF\_FRAME\_OFFSET in the TXSTATUS vector (See Table 15-3).

Once a PHY-TXSTART.confirm primitive is issued, the MAC initiates data (MPDU bytes) exchange with the PHY entity. The data shall be exchanged between the MAC and the PHY through a series of PHY-DATA.request(DATA) primitives issued by the MAC, and PHY-DATA.confirm primitives issued by the PHY.

If TIME\_OF\_DEPARTURE\_REQUESTED is true, PHY entity shall generate the PHY-TXHEADEREND.indication primitive at the end of transmission of the last symbol containing the PHY EDMG-Header-A. The receipt of this primitive by the MAC entity causes the MAC to record the time when this primitive is received.

Transmission can be prematurely terminated by the MAC through the PHY-TXEND.request primitive. PSDU transmission is terminated by receiving a PHY-TXEND.request primitive. Each PHY-TXEND.request primitive is acknowledged with a PHY-TXEND.confirm primitive from the PHY. In an SU transmission, normal termination occurs after the transmission and confirmation of the last PSDU octet.

Once the PPDU transmission is completed the PHY entity issues PHY-TXEND.confirm primitive and enters to the receive state.

A typical transmit state machine for SU transmission with NUM\_STS = 1 and EDMG\_TRN\_LEN = 0 is shown in Figure 3 below.



Figure 3: PHY transmit state machine for SU transmission (NUM\_STS = 1, EDMG\_TRN\_LEN = 0)

NOTE – PSDU encoding and modulation can be started in parallel with preamble transmission and depends on the particular hardware pipeline implementation.

**SP:**

Do you agree to accept the proposed comment resolution for CID 428 as defined in (11-17-1180-00-00ay Proposed Comment Resolution for CID 428 30 7 EDMG Transmit Procedure)?

**References:**

1. Draft P802.11ay\_D0.35
2. IEEE802.11-2016