IEEE P802.11
Wireless LANs

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| Proposed Draft TextOverview of the PPDU Encoding Process |
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Abstract

This document contains proposed draft text update for subclause 36.3.6 (Overview of the PPDU encoding process).

**Revision History:**

R0: Initial version.

R1: Updated reference to stream parser.

 Added a NOTE indicating that EHT Duplicate mode is not included in the Data field description for simplicity.

R2: Fixed errorneous copy & paste for step b) in 36.3.6.4

R3: Some typo fixes

*Instruction to Editor: Update 36.3.6 at 11be D0.1 P160L37 as shown below.*

36.3.6 Overview of the PPDU encoding process

36.3.6.1 General

This subclause provides an overview of the EHT PPDU encoding process.

36.3.6.2 Construction of L-STF

Construct the L-STF field as defined in 36.3.11.3 (L-STF) with the following highlights:

1. Determine the channel bandwidth from the TXVECTOR parameter CH\_BANDWIDTH.
2. Sequence generation: Generate the L-STF sequence over the channel bandwidth as described in 36.3.11.3 (L-STF).
3. Phase rotation: Apply appropriate phase rotation for each 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
4. IDFT: Compute the inverse discrete Fourier transform.
5. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described in 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
6. Insert GI and apply windowing: Prepend a GI  and apply windowing as described in 36.3.10 (Mathematical description of signals).
7. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.3 Construction of L-LTF

Construct the L-LTF field as defined in 36.3.11.4 (L-LTF) with the following highlights:

1. Determine the channel bandwidth from the TXVECTOR parameter CH\_BANDWIDTH.
2. Sequence generation: Generate the L-LTF sequence over the channel bandwidth as described in 36.3.11.4 (L-LTF).
3. Phase rotation: Apply appropriate phase rotation for each 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
4. IDFT: Compute the inverse discrete Fourier transform.
5. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
6. Insert GI and apply windowing: Prepend a GI and apply windowing as described in 36.3.10 (Mathematical description of signals).
7. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the carrier frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.4 Construction of L-SIG

Construct the L-SIG field as the SIGNAL field defined in 36.3.11.5 (L-SIG) with the following highlights:

1. Set the RATE subfield in the SIGNAL field to 6 Mb/s. Set the LENGTH, Parity, and Tail fields in the SIGNAL field as described in 27.3.11.5 (L-SIG).
2. BCC encoder: Encode the SIGNAL field by a convolutional encoder at the rate of as described in 36.3.12.3.2 (BCC coding).
3. BCC interleaver: Interleave as described in 17.3.5.7 (Data interleavers).
4. Constellation Mapper: BPSK modulate as described in 36.3.12.7 (Constellation mapping).
5. Pilot insertion: Insert pilots as described in 36.3.11.5 (L-SIG).
6. Extra subcarrier insertion: Four extra subcarriers are inserted at  for channel estimation purpose and the values on these four extra subcarriers are respectively.
7. Duplication and phase rotation: Duplicate the L-SIG field over each occupied 20 MHz subchannel of the channel bandwidth. Apply appropriate phase rotation for each occupied 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
8. IDFT: Compute the inverse discrete Fourier transform.
9. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described in 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
10. Insert GI and apply windowing: Prepend a GI  and apply windowing as described in 36.3.10 (Mathematical description of signals).
11. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.5 Construction of RL-SIG

Construct the RL-SIG field as the repeat SIGNAL field defined in 36.3.11.6 (RL-SIG) with the following highlights:

1. Set the RATE subfield in the repeat SIGNAL field to 6 Mb/s. Set the LENGTH, Parity, and Tail fields in the repeat SIGNAL field as described in 36.3.11.6 (RL-SIG).
2. BCC encoder: Encode the repeat SIGNAL field by a convolutional encoder at the rate of  as described in 36.3.12.3.2 (BCC coding).
3. BCC interleaver: Interleave as described in 17.3.5.7 (Data interleavers).
4. Constellation Mapper: BPSK modulate as described in 36.3.12.7 (Constellation mapping).
5. Pilot insertion: Insert pilots as described in 36.3.11.6 (RL-SIG).
6. Extra subcarrier insertion: Four extra subcarriers are inserted at  for channel estimation purpose and the values on these four extra subcarriers are , respectively.
7. Duplication and phase rotation: Duplicate the RL-SIG field over each occupied 20 MHz subchannel of the channel bandwidth. Apply appropriate phase rotation for each occupied 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
8. IDFT: Compute the inverse discrete Fourier transform.
9. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described in 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
10. Insert GI and apply windowing: Prepend a GI  and apply windowing as described in 36.3.10 (Mathematical description of signals).
11. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.6 Construction of U-SIG

Construct the U-SIG field as defined in 36.3.11.7 (U-SIG) with the following highlights:

1. Obtain the U-SIG field values from the TXVECTOR. Add the disregard and validate bits, append the calculated CRC, and then append the *Ntail* tail bits as shown in 36.3.11.7 (U-SIG). This results in 52 uncoded bits.
2. BCC encoder: Encode the data by a convolutional encoder at the rate of *R* = 1/2 as described in 17.3.5.6 (Convolutional encoder).
3. BCC interleaver: Interleave as described in 27.3.12.8 (BCC interleavers) for HE-SIG-A/HE-SIG-B.
4. Constellation mapper: BPSK modulate the first 52 interleaved bits as described in 17.3.5.8 (Subcarrier modulation mapping) to form the first OFDM symbol of U-SIG. BPSK modulate the second 52 interleaved bits to form the second OFDM symbol of U-SIG.
5. Pilot insertion: Insert pilots as described in 17.3.5.9 (Pilot subcarriers).
6. Duplicate and phase rotation: Duplicate the U-SIG OFDM symbols over each occupied 20 MHz subchannel of the channel width. Apply the appropriate phase rotation for each occupied 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
7. IDFT: Compute the inverse discrete Fourier transform.
8. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described in 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
9. Insert GI and apply windowing: Prepend a GI (*TGI*,Pre-EHT) and apply windowing as described in 36.3.10 (Mathematical description of signals).
10. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.7 Construction of EHT-SIG

For an EHT MU PPDU, construct the EHT-SIG field as defined in 36.3.11.8 (EHT-SIG) with the following highlights:

1. Obtain the EHT-SIG field values from the TXVECTOR. Add the reserved bits, append the calculated CRC, and then append the *Ntail* tail bits as shown in 36.3.11.8 (EHT-SIG).
2. BCC encoder: Encode each code block by a convolutional encoder as described in 27.3.12.5.1 (BCC coding and puncturing).
3. BCC interleaver: Interleave as described in 27.3.12.8 (BCC interleavers) for HE-SIG-A/HE-SIG-B.
4. Constellation mapper: Obtain MCS\_EHT\_SIG from the TXVECTOR and use it to modulate the interleaved bits as described in 36.3.12.7 (Constellation mapping) to form the EHT-SIG OFDM symbols.
5. Pilot insertion: Insert pilots as described in 17.3.5.9 (Pilot subcarriers).
6. Duplicate and phase rotation: Duplicate EHT-SIG OFDM symbols as described in 36.3.11.8.6 (Encoding and modulation). Apply the appropriate phase rotation for each 20 MHz subchannel as described in 36.3.10 (Mathematical description of signals) and 36.3.10.4 (Transmitted signal).
7. IDFT: Compute the inverse Fourier transform.
8. CSD per chain: Apply CSD per chain for each transmit chain and frequency segment as described in 36.3.11.2.1 (Cyclic shift for pre-EHT modulated fields).
9. Insert GI and apply windowing: Prepend a GI (*TGI*,Pre-EHT) and apply windowing as described in 36.3.10 (Mathematical description of signals).
10. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.8 Construction of EHT-STF

Construct the EHT-STF field as defined in 36.3.11.9 (EHT-STF) with the following highlights:

1. Sequence generation: Generate the EHT-STF in the frequency domain over the bandwidth indicated by the TXVECTOR parameter CH\_BANDWIDTH as described in 36.3.11.9 (EHT-STF).
2. CSD: Apply CSD for each space-time stream and frequency segment as described in 36.3.11.2.2 (Cyclic shift for EHT modulated fields).
3. Spatial mapping: Apply the *Q* matrix as described in 36.3.11.9 (EHT-STF).
4. IDFT: Compute the inverse discrete Fourier transform.
5. Insert GI and apply windowing: Prepend a GI; 0.8 µs and 1.6 µs GI for EHT MU PPDU and EHT TB PPDU, respectively. Apply windowing as described in in 36.3.10 (Mathematical description of signals).
6. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.9 Construction of EHT-LTF

Construct the EHT-LTF field as defined in 36.3.11.10 (EHT-LTF) with the following highlights:

1. Sequence generation: Generate the EHT-LTF sequence in frequency domain over the bandwidth indicated by CH\_BANDWIDTH as described in 36.3.11.10 (EHT-LTF).
2. *A*EHT-LTF matrix mapping: Apply the *P*EHT-LTF matrix to the data tones of the EHT-LTF sequence and apply the *R*EHT-LTF matrix to pilot subcarriers of the EHT-LTF sequence except the UL MU-MIMO transmission not using EHT single stream pilot EHT-LTF mode as described in 36.3.11.10 (EHT-LTF).
3. CSD: Apply CSD for each space-time stream and frequency segment as described in 36.3.11.2.2 (Cyclic shift for EHT modulated fields).
4. Spatial mapping: Apply the *Q* matrix as described in 36.3.11.10 (EHT-LTF).
5. IDFT: Compute the inverse discrete Fourier transform.
6. Insert GI and apply windowing: Prepend a GI indicated by the TXVECTOR parameter GI\_TYPE and apply windowing as described in 36.3.10 (Mathematical description of signals).
7. Analog and RF: Upconvert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

36.3.6.10 Construction of Data field in an EHT PPDU

Construct the Data field as defined in 36.3.12 (Data field) with the following highlights:

NOTE – EHT Duplicate mode is not included in the description below for simplicity.

For each user,

1. Construct the SERVICE field as described in 36.3.12.1 (SERVICE field) and append the PSDU to the SERVICE field.
2. Pre-FEC padding: Append the pre-FEC pad bits as described in 36.3.12 (Data field). If the user is using BCC, then add tail bits.
3. Scrambler: Scramble the pre-FEC padded data.
4. Encoder: If the user is using BCC, then BCC encode as described in 36.3.12.3.2 (BCC coding). If the user is using LDPC, then LDPC encode as described in 36.3.12.3.3 (LDPC coding).
5. Post-FEC padding: Append the post-FEC pad bits and PE field as described in 36.3.12 (Data field).
6. Stream parser: Rearrange the output of encoder into blocks as described in 36.3.12.4 (Stream Parser).
7. Segment parser: In a 2×996-tone RU, 4x996-tone RU, 996+484-tone MRU, 996+484+242-tone MRU, 2x996+484-tone MRU, 3x996-tone MRU or 3x996+484-tone MRU, divide each spatial stream output by the stream parser into multiple frequency subblocks as described in 36.3.12.4 (Segment parser). This block is bypassed for RUs or MRUs of other sizes.
8. BCC interleaver: If the user is using BCC, interleave as described in 36.3.12.5 (BCC interleavers). This block is bypassed if the user is using LDPC.
9. Constellation mapper: Map to BPSK, BPSK DCM, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM or 4096-QAM constellation points as described in 36.3.12.7 (Constellation mapping).
10. LDPC tone mapper: If the user is using LDPC, the LDPC tone mapping is performed on all LDPC encoded streams as described in 36.3.12.6 (LDPC tone mapper). This block is bypassed if the user is using BCC.
11. Segment deparser: In a 2×996-tone RU, 4x996-tone RU, 996+484-tone MRU, 996+484+242-tone MRU, 2x996+484-tone MRU, 3x996-tone MRU or 3x996+484-tone MRU, merge the multiple frequency subblocks into one frequency segment as described in 36.3.12.4 (Segment deparser). This block is bypassed for RUs or MRUs of other sizes.
12. Pilot insertion: Insert pilots following the steps described in 36.3.12.8 (Pilot subcarriers).
13. CSD: Apply CSD for each space-time stream and frequency segment as described in 36.3.11.2.2 (Cyclic shift for EHT modulated fields).

After steps a)~m) have been performed for all users in the PPDU,

1. Spatial mapping: Apply the *Q* matrix as described in 36.3.12.9 (OFDM modulation). Signal from all users in each RU is combined in this block.
2. IDFT: Compute the inverse discrete Fourier transform.
3. Insert GI and apply windowing: Prepend a GI determined by the TXVECTOR parameter GI\_TYPE and apply windowing as described in 36.3.10 (Mathematical description of signals).
4. Analog and RF: Upconvert the resulting complex baseband waveform with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to 36.3.10 (Mathematical description of signals) and 36.3.11 (EHT preamble) for details.

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