IEEE P802.11
Wireless LANs

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| Resolving TBD in section 36.1 |
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Abstract

This submission is to resolve some of TBDs in section 36.1 of TGbe D0.1.

**Discussion:**

1. Mandatory or optional support of preamble puncturing

Currently we have, “Single user transmission and reception of an EHT MU PPDU with single RU or MRU spanning the entire PPDU bandwidth.” as a mandatory feature for all EHT STA.

In case of a MRU spanning the entire PPDU bandwidth, preamble of unused tone should be punctured. Preamble puncturing for this case (at least) is mandatory.

We can add following text, “In case of MRU spanning the entire PPDU bandwidth, the preamble of unmodulated 20 MHz shall be punctured.” and delete “Mandatory or optional support of preamble puncturing”

1. LTF, GI combination

Currently LTF, GI combination capabilities are copied from 11ax.

But the benefit of 1x EHT-LTF in EHT MU-PPDU is not clear. We can delete 1x EHT-LTF in EHT MU-PPDU while maintain all other LTF, GI combo as in 11ax.

Also, 4x LTF with 3.2us GI and 2x LTF with 0.8us GI are mandatory. Once we support 4x LTF and 0.8us GI, then it will be easy to support 4x LTF with 0.8us GI as well. No reason to spend capability bit for this.

Whether EHT MU PPDU is sent to single user or multi user are captured in other requirement. It does not have to be combined with LTF and GI combo, requirement.

Transmission and reception of an EHT MU PPDU with 2x LTF and 0.8 us GI, 2x LTF and 1.6 us GI and 4x LTF and 3.2 us GI for "an AP EHT STA shall requirements" are already included in "a EHT STA shall requirements".

Transmission of an HE TB PPDU with 2x LTF with 1.6us GI is missing in a non-AP EHT STA’s requirement.

Split “Full bandwidth UL MU-MIMO with a 1 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.” to AP and non-AP requirements.

1. Duplicated requirement.

First requirements of an EHT STA and a non-AP EHT STA are same. Delete first requirement of a non-AP EHT STA.

1. Add MRU for entire PPDU bandwidth in DL/UL MU-MIMO.
2. 20 MHz only STA

242-tone RU size is missing in a 20 MHz-only non-AP EHT STA requirements.

In 36.3.2.2 (Support of wide bandwidth OFDM operation), a 20 MHz operating non-AP EHT STA shall be able to participate in 40 MHz, 80 MHz, 160 MHz, 80+80 MHz (TBD), 320 MHz, and 160+160 MHz (TBD) EHT DL and UL OFDMA transmissions. Need to make it consistency.

**Proposed changes:**

***TGbe Editor: Modify text in 36.1.1 (Introduction to the EHT PHY):***

* Extremely high throughput (EHT) PHY specification
* Introduction
* Introduction to the EHT PHY
* Per the authors of 20/1307r2, the followings are TBDs and need to be resolved in future discussion
* :
* ***DCM MCS value and its mandatory or optional support***
* ***Dup Mode MCS and its mandatory or optional support in 6 GHz band***
* ***Define ER-SU or not***
* ***Support of midamble***
* ***Noncontinuous channel 80+80 and 160+160 mandatory/optional support***
* ***EHT-SIG MCS support***

Clause 36 (Extremely high throughput (EHT) PHY specification) specifies the PHY entity for an extremely high throughput (EHT) orthogonal frequency division multiplexing (OFDM) system. In addition to the requirements in Clause 36 (Extremely high throughput (EHT) PHY specification), an EHT STA shall be capable of transmitting and receiving PPDUs that are compliant with the mandatory requirements of the following PHY specifications:

* Clause 19 (High Throughput (HT) PHY specification), Clause 21 (Very High Throughput (VHT) PHY specification), and Clause 27 (High Efficiency (HE) PHY specification) if the EHT STA supports an operating channel width greater than or equal to 80 MHz and is operating in the 5 GHz band.
* Clause 19 (High Throughput (HT) PHY specification), Clause 21 (Very High Throughput (VHT) PHY specification), and Clause 27 (High Efficiency (HE) PHY specification) transmission and reception on 20 MHz channel width (see 26.17.1 (Basic HE BSS operation)) if the EHT STA is a 20 MHz-only non-AP EHT STA and is operating in the 5 GHz band.
* Clause 19 (High Throughput (HT) PHY specification) and Clause 27 (High Efficiency (HE) PHY specification) if the EHT STA is operating in the 2.4 GHz band.
* Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) and Clause 27 (High Efficiency (HE) PHY specification) if the EHT STA is operating in the 6 GHz band.

For 2.4 GHz band operation, the EHT PHY is based on HE PHY defined in Clause 27 (High Efficiency (HE) PHY specification), which is based on the HT PHY defined in Clause 19 (High Throughput (HT) PHY specification), which is based on the OFDM PHY defined in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification).

For 5 GHz band operation, the EHT PHY is based on the HE PHY defined in Clause 27 (High Efficiency (HE) PHY specification), which is based on the VHT PHY defined in Clause 21 (Very High Throughput (VHT) PHY specification), which is based on the HT PHY defined in Clause 19 (High Throughput (HT) PHY specification), which is based on the OFDM PHY defined in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification).

For 6 GHz band operation, the EHT PHY is based on HE PHY defined in Clause 27 (High Efficiency (HE) PHY specification), which is based on the OFDM PHY defined in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification).

The EHT PHY provides support for DL OFDMA, UL OFDMA, DL MU-MIMO, and UL MU-MIMO. Both DL and UL MU-MIMO transmissions are supported on portions of the PPDU bandwidth (on resource units greater than or equal to 242 tones). In a MU-MIMO resource unit, there is support for up to 8 users with up to 4 spatial streams per user with the total across all users not exceeding 16 space-time streams.

The EHT PHY provides support of multiple Resource Unit (MRU) assigned to a single STA.

The EHT PHY provides support for 0.8 µs, 1.6 µs and 3.2 µs guard interval durations.

The EHT PHY provides support for 3.2 µs (1), 6.4 µs (2), and 12.8 µs (4) EHT-LTF symbol durations, excluding the GI duration.

The EHT PHY supports a DFT period of 3.2 µs for the pre-EHT modulated fields and 12.8 µs for the EHT modulated fields in an EHT PPDU.

The EHT PHY data subcarrier frequency spacing is the same as for the HE PHY and a quarter of the VHT PHY and HT PHY subcarrier frequency spacing.

The EHT PHY data subcarriers are modulated using BPSK, BPSK DCM, QPSK, 16-QAM, 64-QAM, 256-QAM, 1024-QAM, and 4096-QAM. Forward error correction (FEC) coding (convolutional or LDPC coding) is used with coding rates of 1/2, 2/3, 3/4 and 5/6.

An EHT STA shall support the following features:

* Single user transmission and reception of an EHT MU PPDU with single RU or MRU spanning the entire PPDU bandwidth. In case of MRU spanning the entire PPDU bandwidth, the preamble of unmodulated 20 MHz shall be punctured.
* BCC coding (transmit and receive). BCC coding is not used in the following cases:
* An RU or MRU of size greater than 242 subcarriers in an EHT MU PPDU or an EHT TB PPDU
* An RU or MRU with number of spatial streams greater than 4 in an EHT MU PPDU or an EHT TB PPDU
* An RU or MRU using EHT-MCSs 10, 11, 12, and 13 in an EHT MU PPDU or an EHT TB PPDU
* LDPC coding (transmit and receive) in all supported EHT PPDU types, RU and MRU sizes, and number of spatial streams if the STA supports transmitting and receiving in channel bandwidths greater than 20 MHz.
* LDPC coding (transmit and receive) in all supported EHT PPDU types, RU and MRU sizes, and number of spatial streams if the STA declares support for transmitting or receiving more than 4 spatial streams.
* LDPC coding (transmit and receive) in all supported EHT PPDU types, RU sizes, and number of spatial streams if the STA declares support for EHT-MCSs 10, 11, 12, and 13 (transmit and receive).
* Single spatial stream EHT-MCSs 0 to 7 (transmit and receive) in all supported channel widths of EHT PPDU.
* Reception of the EHT-SIG field in an EHT MU PPDU at TBD MCS.
* EHT MU PPDU with a 2 EHT-LTF and 0.8 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* EHT MU PPDU with a 2 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* EHT MU PPDU with a 4 EHT-LTF and 0.8 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* EHT MU PPDU with a 4 EHT-LTF and 3.2 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* 20 MHz channel width and all RU and MRU sizes and locations applicable to the 20 MHz channel width in 2.4 GHz, 5 GHz and 6 GHz bands (transmit and receive).

NOTE 1—TBD mandatory transmission of an EHT MU PPDU with preamble puncturing.

An EHT STA may support the following features:

* EHT-MCSs 10 to 13 and DCM MCS (TBD) (transmit and receive) if the STA is not a 20 MHz only non-AP STA. EHT-MCSs 8 to 13 and DCM MCS (TBD) (transmit and receive) if the STA is a 20 MHz only non-AP STA.
* Two or more spatial streams (transmit and receive).
* LDPC coding (transmit and receive) if the maximum number of spatial streams the STA is capable of transmitting or receiving in an EHT MU PPDU less than or equal to 4.

An EHT AP shall support the following features:

* Transmission of an EHT MU PPDU where none of the RUs or MRUs utilize MU-MIMO (DL OFDMA).
* Reception of an EHT TB PPDU where none of the RUs or MRUs utilize MU-MIMO (UL OFDMA).
* Transmission of an EHT MU PPDU consisting of a single RU or MRU (TBD) spanning the entire PPDU bandwidth and utilizing MU-MIMO (DL MU-MIMO) if the AP is capable of transmitting 4 or more spatial streams.
* MU-MIMO reception on an RU in an EHT TB PPDU where the RU or MRU (TBD) spans the entire PPDU bandwidth (UL MU-MIMO) if the AP is capable of receiving 4 or more spatial streams
* Single spatial stream EHT-MCSs 0 to 9 in all supported channel widths and RU sizes for EHT MU PPDUs (transmit) or EHT TB PPDUs (receive).
* 40 MHz and 80 MHz channel widths and all RU and MRU sizes and locations applicable to the 40 MHz and 80 MHz channel widths in 5 GHz (transmit and receive).
* 40 MHz, 80 MHz and 160 MHz channel widths and all RU and MRU sizes and locations applicable to the 40 MHz, 80 MHz and 160 MHz channel widths in 6 GHz bands (transmit and receive).
* Reception of an EHT TB PPDU utilizing UL MU-MIMO (TBD) with a 1 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* Reception of an EHT TB PPDU with a 2 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* Reception of an EHT TB PPDU with a 4 EHT-LTF and 3.2 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* All RU and MRU sizes and locations applicable to 40 MHz channel width in the 2.4 GHz band if 40 MHz channel width is supported in the 2.4 GHz band (transmit and receive).

An EHT AP may support the following features:

* MU-MIMO transmission on an RU/MRU in an EHT MU PPDU where the RU/MRU does not span the entire PPDU bandwidth (DL MU-MIMO within OFDMA).
* MU-MIMO reception on an RU/MRU in an EHT TB PPDU where the RU/MRU spans the entire PPDU bandwidth (UL MU-MIMO) when the AP is capable of receiving less than 4 spatial streams
* MU-MIMO reception on an RU/MRU in an EHT TB PPDU where the RU/MRU does not span the entire PPDU bandwidth (UL MU-MIMO within OFDMA).
* 40 MHz channel width in the 2.4 GHz band (transmit and receive).
* 160 MHz channel width in the 5 GHz band (transmit and receive).
* 320 MHz channel width in the 6 GHz band (transmit and receive).
* Punctured sounding operation.

A non-AP EHT STA shall support the following features:

* Reception of an EHT MU PPDU where the RU/MRU allocated to the non-AP STA is not utilizing MU-MIMO (DL OFDMA).
* Transmission of an EHT TB PPDU where the RU/MRU allocated to the non-AP STA is not utilizing MU-MIMO (UL OFDMA).
* Reception of an EHT MU PPDU consisting of a single RU or MRU (TBD) spanning the entire PPDU bandwidth and utilizing MU-MIMO (DL MU-MIMO). The maximum number of spatial streams per user the non-AP EHT STA can receive in the DL MU-MIMO transmission shall be equal to the minimum of 4 and the maximum number of spatial streams supported for reception of EHT MU PPDU sent to that EHT STA as an SU transmission. The non-AP EHT STA shall be able to receive its intended spatial streams in a DL MU-MIMO transmission with a total number of spatial streams across all users of at least 4.
* MU-MIMO transmission on a single RU or MRU (TBD) in an EHT TB PPDU where the RU spans the entire PPDU bandwidth (UL MU-MIMO). The non-AP EHT STA shall support transmitting UL MU-MIMO where the total spatial streams summed across all users is less than or equal to 8 (TBD).

NOTE 2—8 is used in IEEE 802.11ax.

* Responding with requested beamforming feedback in an EHT sounding procedure with the maximum number of space-time streams in the EHT sounding NDP that the non-AP EHT STA can respond to equal to at least 4.
* Single spatial stream EHT-MCSs 0 to 9 in all supported channel widths and RU and MRU sizes if the non-AP EHT STA is not a 20 MHz only non-AP EHT STA.
* Single spatial stream EHT-MCSs 0 to 7 in all supported channel widths and RU and MRU sizes if the non-AP EHT STA is a 20 MHz only non-AP EHT STA.
* 40 MHz and 80 MHz channel widths and all RU and MRU sizes and locations applicable to the 40 MHz and 80 MHz channel widths in the 5 GHz and 6 GHz band (transmit and receive) for non-AP EHT STA except for 20 MHz-only non-AP EHT STA.
* Reception of a 160 MHz EHT MU PPDU, or transmission of a 160 MHz EHT TB PPDU in 5 GHz and 6 GHz bands where the assigned RU/MRU is in the primary 80 MHz channel if the non-AP EHT STA is capable of up to 80 MHz channel width and operating with 80 MHz channel width.
* Reception of a 320 MHz EHT MU PPDU, or transmission of a 320 MHz EHT TB PPDU in 6 GHz band where the assigned RU/MRU is in the primary 80 MHz channel if the non-AP EHT STA is capable of up to 80 MHz channel width and operating with 80 MHz channel width
* Reception of a 320 MHz EHT MU PPDU, or transmission of a 320 MHz EHT TB PPDU in 6 GHz band where the assigned RU/MRU is in the primary 160 MHz channel if the non-AP EHT STA is capable of up to 160 MHz channel width and operating with 160 MHz channel width
* Transmission of an EHT TB PPDU utilizing UL MU-MIMO (TBD) with a 1 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* Transmission of an EHT TB PPDU with a 2 EHT-LTF and 1.6 µs GI duration on the EHT-LTF and Data field OFDM symbols.
* Transmission of an EHT TB PPDU with a 4 EHT-LTF and 3.2 µs GI duration on the EHT-LTF and Data field OFDM symbols.

A non-AP EHT STA may support the following:

* 40 MHz channel width in the 2.4 GHz band (transmit and receive). If 40 MHz channel width in the 2.4 GHz band is supported then all RU and MRU sizes and locations applicable to 40 MHz channel width are supported except for a 20 MHz-only non-AP EHT STA, in which case the 40 MHz channel width and all RU and MRU sizes and locations of 40 MHz channel width in 2.4 GHz band are not applicable.
* 160 MHz channel width and RU and MRU size larger than 996 tone in the 5 GHz and 6 GHz bands (transmit and receive) except for a 20 MHz-only non-AP EHT STA, in which case the 160 MHz channel width and RU and MRU size larger than 242 tone in the 5 GHz and 6 GHz bands are not applicable.
* 320 MHz channel width and RU and MRU size greater than 996 tone in the 6 GHz bands (transmit and receive).
* MU-MIMO reception on an RU and MRU in an EHT MU PPDU where the RU does not span the entire PPDU bandwidth (DL MU-MIMO within OFDMA). The maximum number of spatial streams per user in the DL MU-MIMO within OFDMA transmission that the non-AP STA can receive shall be a minimum of 4 and the maximum number of spatial streams supported for reception of EHT MU PPDU sent to that non-AP STA as an SU transmission. The total number of spatial streams (across all users) in the DL MU-MIMO within OFDMA transmission that the non-AP STA can receive shall be at least 4.
* MU-MIMO transmission on an RU in an EHT TB PPDU where the RU does not span the entire PPDU bandwidth (UL MU-MIMO within OFDMA). If supported, then the non-AP EHT STA shall support transmitting UL MU-MIMO where the total spatial streams summed across all users is less than or equal to 8 (TBD).

NOTE 3—8 is used in IEEE 802.11ax.

* Punctured sounding operation.

A 20 MHz-only non-AP EHT STA shall support the following:

* 26-, 52-, 106-tone, and 242-tone RU sizes and 26+52-, 26+106-tone MRU sizes on locations allowed in 36.3.2.5 (RU/MRU restrictions for 20 MHz operation) in the primary 20 MHz channel within 40 MHz, 80 MHz, and 160 MHz channel widths in the 5 GHz and 6 GHz bands and 320 MHz channel width in the 6 GHz band.

A 20 MHz-only non-AP EHT STA may support the following:

* 26-, 52-, 106-tone, and 242-tone RU sizes and 26+52-, 26+106-tone MRU sizes on locations allowed in 36.3.2.5 (RU/MRU restrictions for 20 MHz operation) in the primary 20 MHz channel within 40 MHz channel width in the 2.4 GHz band if the 20 MHz-only non-AP EHT STA does not support the EHT subchannel selective transmission operation described in 35.5.1 (EHT subchannel selective transmission).
* 26-, 52-, 106-tone, and 242-tone RU sizes and 26+52-, 26+106-tone MRU sizes on locations allowed in 36.3.2.5 (RU/MRU restrictions for 20 MHz operation) in any 20 MHz channel within 40 MHz channel width in the 2.4 GHz band if the 20 MHz-only non-AP EHT STA supports the EHT subchannel selective transmission operation described in 35.5.1 (EHT subchannel selective transmission).
* 26-, 52-, 106-tone, and 242-tone RU sizes and 26+52-, 26+106-tone MRU sizes on locations allowed in 36.3.2.5 (RU/MRU restrictions for 20 MHz operation) in any 20 MHz channel within 40 MHz, 80 MHz, and 160 MHz channel widths in the 5 GHz band and 6 GHz bands and 320 MHz channel width in the 6 GHz band if the 20 MHz-only non-AP EHT STA supports the EHT subchannel selective transmission operation described in 35.5.1 (EHT subchannel selective transmission).