### IEEE P802.11Wireless LANs

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| 11ax D4.2 MAC Comment Resolution for PHY Introduction |
| Date: 2019-07-08 |
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Abstract

This submission proposes resolutions for comments of TGax Draft D4.3 with the following CIDs:

20087, 20088, 20166, 21001

Revisions:

* Rev 0: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGax D4.0 Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGax D4.0 Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGax Editor: Editing instructions preceded by “TGax Editor” are instructions to the TGax editor to modify existing material in the TGax draft. As a result of adopting the changes, the TGax editor will execute the instructions rather than copy them to the TGax Draft.***

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| **CID** | **Commenter** | **P.L** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 20087 | Albert Petrick | 445.18 | 27.1.1 | grammar sentence structure | Change text to read "supported and not applicable..." | Revised – We revise according to the suggestion based on the latest text in D4.3 and align the description with other subbullet.TGax editor to make the changes shown in 11-19/1377r0 under all headings that include CID 20087 |
| 20088 | Albert Petrick | 445.43 | 27.1.1 | grammar sentence structure | Change text to read "and received) and not applicable..." | Revised – We revise according to the suggestion based on the latest text in D4.3 and align the description with other subbullet.TGax editor to make the changes shown in 11-19/1377r0 under all headings that include CID 20088 |
| 20166 | Bo Sun | 441.33 | 27.1.1 | The appearance of 6 GHz operation description in this paragraph is pretty strange and unappropriate. | Move the sentence into paragraph on line 43 | Revised – TGax editor to make the changes shown in 11-19/1377r0 under all headings that include CID 20166 |
| 21001 | Mark RISON | 441.07 | 27.1.1 | Re CID 16314: the wording is still broken, e.g. "A non-AP HE STA shall support the following features: [...] A 20 MHz operating non-AP HE STA shall support 26-, 52-, and 106-tone RU sizes" | Change "A non-AP HE STA shall support the following features:" to "A non-AP HE STA that is not a 20 MHz-only non-AP HE STA shall support the following features:", remove the 20MOSTA stuff from the bullets, then add a new starter "A 20 MHz-only non-AP HE STA shall support the features that a non-AP HE STA that is not a 20 MHz-only non-AP HE STA shall support, except that:" and then introduce the diffs. Ditto for the "may support"s | Revised – We think the problem is that you cannot have a subject (non-AP HE STA) that shall support a bulleted list of requirements and then half way through change the subject ("20 MHz operatating non-AP HE STA"). The bulleted list should apply directly to the subject. If there are additional conditions for a different subject then move this to a separate paragraph.TGax editor to make the changes shown in 11-19/1377r0 under all headings that include CID 21001 |

**Discussion:** *None.*

**Propose:** Revised for CID 21211 per discussion and editing instructions in 11-19/1167r0.

* Introduction to the HE PHY

Clause 27 (High Efficiency (HE) PHY specification) specifies the PHY entity for a high efficiency (HE) orthogonal frequency division multiplexing (OFDM) system. In addition to the requirements in Clause 27 (High Efficiency (HE) PHY specification), an HE 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) and Clause 21 (Very High Throughput (VHT) PHY specification) if the HE 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) and Clause 21 (Very High Throughput (VHT) PHY specification) transmission and reception on 20 MHz channel width (see 26.17.1 (Basic HE BSS operation)) if the HE STA is a 20 MHz-only non-AP HE STA and is operating in the 5 GHz band(#20695).
* Clause 19 (High Throughput (HT) PHY specification) if the HE STA is operating in the 2.4 GHz band.
* Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification) if the HE STA is operating in the 6 GHz band.

For 2.4 GHz band operation, the HE PHY is based on HT PHY defined in Clause 19 (High Throughput (HT) PHY specification), which in turn is based on the OFDM PHY defined in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification). (#20166)

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

For 6 GHz band operation, the HE PHY is based on the OFDM PHY defined in Clause 17 (Orthogonal frequency division multiplexing (OFDM) PHY specification). (#20166)

The HE PHY extends the maximum number of users supported for DL MU-MIMO transmissions to(#21373) 8 users per resource unit (RU) and provides support for DL and UL orthogonal frequency division multiple access (OFDMA) as well as for 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 106 tones). In an MU-MIMO resource unit, there is support for up to 8 users with up to 4 space-time streams per user with the total across all users not exceeding 8 space-time streams(#21374).

The HE PHY provides support for 20 MHz, 40 MHz, 80 MHz and 160 MHz contiguous channel widths and support for 80+80 MHz non-contiguous channel width, depending on the frequency band and capability. For PPDU bandwidths greater than or equal to 80 MHz, the HE PHY supports preamble punctured HE MU PPDU transmissions where pre-HE modulated fields (see Figure 27-23 (Timing boundaries for HE PPDU fields if midamble is not present)) are not transmitted in one or more of the non-primary 20 MHz channels, and RUs associated with those punctured 20 MHz channels as defined in 27.3.10.8.3 (Common field(#21226)) are not allocated.

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

The HE PHY provides support for 3.2 µs (1x), 6.4 µs (2x), and 12.8 µs (4x) HE-LTF symbol durations, excluding the GI duration. The HE PHY supports a DFT period of 3.2 µs and 12.8 µs for the pre-HE modulated fields and the HE modulated fields in an HE PPDU, respectively. The HE PHY data subcarrier frequency spacing is a quarter of VHT PHY and HT PHY subcarrier frequency spacing defined in Clause 21 (Very High Throughput (VHT) PHY specification) and Clause 19 (High Throughput (HT) PHY specification), respectively.

The HE PHY data subcarriers are modulated using BPSK, BPSK DCM, QPSK, QPSK DCM, 16-QAM, 16-QAM DCM, 64-QAM, 256-QAM and 1024-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.

The HE PHY provides support for midambles. Midambles facilitate updating of the channel estimate during HE PPDU reception and might be of use in high mobility scenarios that often result in significant variations of the wireless channel over the duration of a PPDU.(#20095)

An HE STA shall support the following features:

* Transmission and reception of an HE SU PPDU that consists of a single RU spanning the entire PPDU bandwidth.
* Transmission and reception of an HE ER SU PPDU that consists of a 242-tone RU spanning the entire primary 20 MHz PPDU bandwidth.
* BCC(#20693) coding (transmit and receive). BCC(#20693) coding is not used in the following cases:
* An HE SU PPDU with a bandwidth greater than 20 MHz
* An RU of size greater than 242 subcarriers in an HE MU PPDU or an HE TB PPDU
* An HE SU PPDU with number of spatial streams greater than 4
* An RU allocated to a single user in an HE MU PPDU or for an HE TB PPDU with a number of spatial streams greater than 4
* An HE SU PPDU using HE-MCSs 10 or 11
* An RU in an HE MU PPDU or an HE TB PPDU using HE-MCSs 10 or 11
* LDPC coding (transmit and receive) in all supported HE PPDU types, RU 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 HE PPDU types, RU 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 HE PPDU types, RU sizes, and number of spatial streams if the STA declares support for HE-MCSs 10 and 11 (transmit and receive).
* Single spatial stream HE-MCSs 0 to 7 (transmit and receive) in all supported channel widths for HE SU PPDUs.(#21377)
* 2x HE-LTF with 0.8 µs GI duration on both HE-LTF and Data field OFDM symbols for HE SU PPDUs and HE ER SU PPDUs (transmit and receive)(#21379)
* 2x HE-LTF with 1.6 µs GI duration on both HE-LTF and Data field OFDM symbols for HE SU PPDUs and HE ER SU PPDUs (transmit and receive)(#21379)
* 4x HE-LTF with 3.2 µs GI duration on both HE-LTF and Data field OFDM symbols of an HE SU PPDU and HE ER SU PPDU (transmit and receive).(#21379)
* 1x HE-LTF with 1.6 µs GI duration on both HE-LTF and Data field OFDM symbols for full bandwidth UL MU-MIMO if the HE STA supports UL MU-MIMO.(#21379, #21359)
* HE SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols when the HE-LTF is a 4x HE-LTF if the STA supports HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols when the HE-LTF is a 4x HE-LTF (transmit and receive).
* Single spatial stream HE-MCSs 0 to 2 in primary 20 MHz channel for HE ER SU PPDUs.
* HE ER SU PPDU is not used in the following cases:
* Number of spatial streams greater than 1
* HE-MCS greater than 2 when 242 subcarriers are used in the Data field OFDM symbols
* HE-MCS greater than 0 when 106 subcarriers are used in the Data field OFDM symbols
* Bandwidth greater than 20 MHz
* 20 MHz channel width and all RU sizes and locations applicable to the 20 MHz channel width in 2.4 GHz, 5 GHz and 6 GHz bands (transmit and receive).

An HE STA may support the following features:

* HE-MCSs 8 to 11 (transmit and receive).
* Two or more spatial streams (transmit and receive).
* DCM (transmit and receive).
* HE SU PPDUs and HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols(#20692) if the HE-LTF is a 1x HE-LTF (transmit and receive).
* HE SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols(#20692) if(#20985) the HE-LTF is a 4x HE-LTF if the STA does not support HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols(#20692) if(#20985) the HE-LTF is a 4x HE-LTF (transmit and receive).
* HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols(#20692) if(#20985) the HE-LTF is a 4x HE-LTF (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 HE SU PPDU is less than or equal to 4.
* Single spatial stream HE-MCS 0 in the higher frequency 106-tone RU of the primary 20 MHz channel for an HE ER SU PPDU.
* STBC (transmit and receive).

An HE AP shall support the following features:

* Transmission of an HE MU PPDU where none of the RUs utilize MU-MIMO (DL OFDMA).
* Reception of an HE TB PPDU where none of the RUs utilize MU-MIMO (UL OFDMA).
* Transmission of an HE MU PPDU consisting of a single RU spanning the entire PPDU bandwidth and utilizing MU-MIMO (DL MU-MIMO), provided the AP is capable of transmitting 4 or more spatial streams.
* Transmission of the HE-SIG-B field in an HE MU PPDU at HE-MCSs 0 to 5.
* Single spatial stream HE-MCSs 0 to 7 in all supported channel widths and RU sizes for HE MU PPDUs (transmit) or HE TB PPDUs (receive).
* 40 MHz and 80 MHz channel widths and all RU sizes and locations applicable to the 40 MHz and 80 MHz channel width in 5 GHz and 6 GHz bands (transmit and receive).
* 0.8 µs and 1.6 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692) of an HE MU PPDU if a 2x HE-LTF is used (transmit).
* Reception of an HE TB PPDU with a 2x HE-LTF and with 1.6 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692).
* Reception of an HE TB PPDU with a 4x HE-LTF and with 3.2 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692).
* Transmission of an HE MU PPDU with a 4x HE-LTF and with 3.2 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692).
* Transmission of an HE MU PPDU with a 4x HE-LTF and with 0.8 µs GI duration on both the HE-LTF and the Data field OFDM symbols(#20692) if the HE AP supports HE ER SU PPDUs with the same LTF and GI combination(#21380).

An HE AP may support the following features:

* MU-MIMO transmission on an RU in an HE MU PPDU where the RU does not span the entire PPDU bandwidth (DL MU-MIMO within OFDMA).
* MU-MIMO reception on an RU in an HE TB PPDU where the RU spans the entire PPDU bandwidth (UL MU-MIMO).
* MU-MIMO reception on an RU in an HE TB PPDU where the RU does not span the entire PPDU bandwidth (UL MU-MIMO within OFDMA).
* Reception of the payload on an RU in an HE MU PPDU where RU spans the entire PPDU bandwidth or a 106-tone RU within 20 MHz PPDU bandwidth.
* 40 MHz channel width in the 2.4 GHz band (transmit and receive). If it is supported then all RU sizes and locations applicable to 40 MHz channel width are supported in 2.4 GHz band (transmit and receive).
* 160 MHz and 80+80 MHz channel widths and 2×996-tone RU size applicable to the 160/80+80 MHz channel width in the 5 GHz and 6 GHz bands (transmit and receive).
* Transmission of an HE MU PPDU with preamble puncturing.
* HE MU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols(#20692) when the 4x HE-LTF is used if the STA does not support HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols if the HE-LTF is a 4x HE-LTF (transmit).
* Punctured sounding operation

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

* Reception of an HE MU PPDU where the RU allocated to the non-AP STA is not utilizing MU-MIMO (DL OFDMA).
* Transmission of an HE TB PPDU where the RU allocated to the non-AP STA is not utilizing MU-MIMO (UL OFDMA).
* Reception of an HE MU PPDU consisting of a single RU spanning the entire PPDU bandwidth and utilizing MU-MIMO (DL MU-MIMO). The maximum number of spatial streams per user the non-AP 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 HE SU PPDUs. The non-AP 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(#21375).
* Responding with the requested beamforming feedback in an HE sounding procedure with the maximum number of space-time streams in the HE sounding NDP that the non-AP STA can respond to being at least 4.
* Reception of the HE-SIG-B field in an HE MU PPDU at HE-MCSs 0 to 5.
* Single spatial stream HE-MCSs 0 to 7 in all supported channel widths and RU sizes for HE MU PPDUs (receive) or HE TB PPDUs (transmit).
* 40 MHz and 80 MHz channel widths and all RU sizes and locations applicable to the 40 MHz and 80 MHz channel widths in the 5 GHz band (transmit and receive) except for a 20 MHz-only non-AP HE STA in which case the 40 MHz and 80 MHz channel widths, 996-tone RU, and 484-tone RU sizes in 5 GHz and 6 GHz bands are not applicable.
* (#21001)Reception of an HE MU PPDU with a 2x HE-LTF and with 0.8 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692).
* Reception of an HE MU PPDU with a 2x HE-LTF and with 1.6 µs GI duration on the HE-LTF and Data field OFDM symbols(#20692).
* Transmission of an HE TB PPDU with a 2x HE-LTF and with 1.6 µs GI duration on the HE-LTF and Data field OFDM symbols.
* Reception of an HE MU PPDU with a 4x HE-LTF and with 3.2 µs GI duration on the HE-LTF and Data field OFDM symbols.
* Transmission of an HE TB PPDU with a 4x HE-LTF and with 3.2 µs GI duration on the HE-LTF and Data field OFDM symbols.
* Reception of an HE MU PPDU with 4x HE-LTF and with 0.8 µs GI duration on both the HE-LTF and the Data field OFDM symbols if the non-AP HE STA supports HE ER SU PPDUs for the same LTF and GI combinations(#21380).

A 20 MHz operating non-AP HE STA shall support 26-, 52-, and 106-tone RU sizes on locations allowed in 27.3.2.8 (RU restrictions for 20 MHz operation) in the primary 20 MHz channel within 40 MHz and the primary 20 MHz channel within 80 MHz channel widths in the 5 GHz and 6 GHz bands (transmit and receive).(#21001)

A non-AP HE STA may support the following:

* Transmission of an HE MU PPDU with a single RU spanning the entire PPDU bandwidth or a 20 MHz HE MU PPDU with a single 106-tone RU in the primary 20 MHz channel.
* 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 sizes and locations applicable to 40 MHz channel width are supported except for a 20 MHz-only non-AP HE STA in which case the 40 MHz channel width and all RU sizes and locations of 40 MHz channel width in 2.4 GHz band are not applicable.(#20087)
* (#21001)
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* (#21001)
* 160 MHz and 80+80 MHz channel width and 2×996-tone RU size applicable to the 160 MHz and 80+80 MHz channel width in the 5 GHz and 6 GHz bands (transmit and receive) except for a 20 MHz-only non-AP HE STA in which case the 160 MHz and 80+80 MHz channel width and 2×996-tone RU size in 5 GHz and 6 GHz bands are not applicable.(#20088)
* MU-MIMO reception on an RU in an HE 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 HE SU PPDUs. The total number of spatial streams (across all users)(#21376) 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 HE TB PPDU where the RU spans the entire PPDU bandwidth (UL MU-MIMO). If supported, then the non-AP HE STA shall support transmitting UL MU-MIMO where the total space-time streams summed across all users is less than or equal to 8.
* MU-MIMO transmission on an RU in an HE TB PPDU where the RU does not span the entire PPDU bandwidth (UL MU-MIMO within OFDMA). If supported, then the non-AP HE STA shall support transmitting UL MU-MIMO where the total space-time streams summed across all users is less than or equal to 8.
* the reception of a 160 MHz or 80+80 MHz HE MU PPDU, or the transmission of a 160 MHz or 80+80 MHz HE TB PPDU where the assigned RU is in the primary 80 MHz channel if the non-AP HE STA is capable of up to 80 MHz channel width and operating with 80 MHz channel width,. (#21001)
* HE MU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols when the 4x HE-LTF is used if the non-AP HE STA does not support HE ER SU PPDUs with 0.8 µs GI duration on both the HE-LTF and Data field OFDM symbols if the HE-LTF is a 4x HE-LTF (receive).
* Punctured sounding operation

A 20 MHz-only non-AP HE STA may support the following: (#21001)

A may support (#21001)