IEEE P802.11
Wireless LANs

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| Comment Resolutions on Clause 26.1.1 Part 2 |
| Date: 2016-04-29 |
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Abstract

This submission proposes resolutions for multiple comments related to TGax D0.1 as follows:

1864, 1849

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: Fixed an error as described below
* Single spatial stream HE-MCS~~s~~ 0 ~~- 2~~ in the right 106-tone RU of the primary 20 MHz channel for HE\_EXT\_SU PPDUs

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 Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGax 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** | **Clause Number** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 1864 | 26.1.1 | 69.58 | Add 1x LTF + 1.6 us CP as a mandatory mode | As in comment | Revised: Proposed resolution accounts for the suggested change.TGax Editor to make the changes shown in IEEE 802.11-16/1341r5 under all headings that include CID 1864. |
| 1849 | 26.3.1 | 73.38 | The introduction section needs to clearly define what features are mandatory and which are optional | Discuss technical controbutions on this topic and have corresponding spec text. | RevisedContribution was presented to TGax. Proposed resolution accounts for the suggested change.TGax Editor to make the changes shown in IEEE 802.11-16/1341r5 under all headings that include CID 1864. |

*Changes to D0.5 related to CID 1864:*

**26.1.1 Introduction to the HE PHY**

Clause 26 specifies the PHY entity for a high efficiency (HE) orthogonal frequency division multiplexing (OFDM) system. In addition to the requirements in Clause 26, an HE STA shall be capable of transmitting and receiving PPDUs that are compliant with the mandatory requirements of the following PHY specifications (#348):

* In Clause 19 (High Throughput (HT) PHY specification) and Clause 21 (Very High Throughput (VHT) PHY specification) when the HE STA is operating in the 5 GHz band
* In Clause 19 (High Throughput (HT) PHY specification) when the HE STA is operating in the 2.4 GHz band

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). The HE PHY extends the maximum number of users supported for downlink multi-user MIMO (MU-MIMO) transmissions to eigth and provides support for downlink and uplink orthogonal division multiple access (OFDMA) as well as for uplink MU-MIMO. Both downlink and uplink MU-MIMO transmissions are supported on portions of the PPDU bandwidth (on resource units greater than or equal to 106 tones) and in an MU-MIMO resource unit, there is support for up to eigth users with up to four space-time streams per user with the total number of space-time streams not exceeding eight.

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. For channel widths greater than or equal to 80 MHz, the HE PHY supports ~~channel bonding~~ preamble puncturing transmissions where one or more of the non-primary 20 MHz channels in an HE MU PPDU with more than one RU is zeroed out. (#879)

The HE PHY provides support for 0.8 μs, 1.6 μs and 3.2 μs (#1922) guard interval durations.

The HE PHY provides support for 3.2 $μ$*s* (1x LTF), 6.4 $μ$s (2x LTF), and 12.8 $μ$s (4x LTF) LTF symbol durations (symbol duration not including the guard interval). The HE PHY supports a single Data field OFDM symbol duration of 12.8 μs (excluding guard interval). (#269))

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 binary phase shift keying (BPSK), BPSK dual-carrier modulation (DCM), quadrature phase shift keting (QPSK), 16-quadrature amplitude modulation (16-QAM), 16-QAM DCM, 64-QAM, 256-QAM, and 1024-QAM. Forward error correction (FEC) coding (convolution or LDPC coding) is used with coding rates of ½, 2/3, ¾, and 5/6.

An HE STA refers to an AP STA and a non-AP STA.

A non-AP STA is inclusive of a 20 MHz-only non-AP STA.

An HE STA shall support the following Clause 26 features: (#351)

* Transmit and receive of HE\_SU PPDU consisting of a single RU spanning the entire PPDU bandwidth
* Transmit and receive of HE\_EXT\_SU PPDU consisting of a single RU spanning the entire primary 20 MHz PPDU bandwidth
* ~~Binary convolution coding for 26-, 52-, 106-, and 242-tone RUs (transmit and receive) when the number of spatial streams is less than or equal to 4~~
* ~~Binary convolution coding for a 20 MHz HE SU PPDU (transmit and receive) when the number of spatial streams is less than or equal to 4~~
* Binary convolutional coding (transmit and receive). Note that binary convolutional coding is not allowed in the following cases:
	+ HE\_SU PPDU with bandwidth greater than 20 MHz
	+ RUs with size greater than 242 tones
	+ HE\_SU PPDU or RUs allocated to a single user with number of spatial streams greater than 4
	+ HE PPDU using HE MCSs 10 and 11
* ~~LDPC as the only coding scheme for 484-,996-, and 2x996-tone RUs (transmit and receive)~~
* ~~LDPC coding for 40 MHz, 80 MHz, 160 MHz, and 80+80 MHz HE SU PPDUs~~
* ~~LDPC when declaring support for 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 supports transmitting and receiving HE SU PPDUs of bandwidths greater than 20 MHz
* LDPC coding (transmit) in all supported HE PPDU types, RU sizes, and number of spatial streams if the STA declares support for transmiting more than 4 spatial streams except when the STA is an 20 MHz only non-AP STA
* LDPC coding (receive) in all supported HE PPDU types, RU sizes, and number of spatial streams if the STA declares support for receiving more than 4 spatial streams except when the STA is an 20 MHz only non-AP STA
* ~~A combination of 2x LTF with 0.8 μs GI duration on both LTF and data~~
* ~~A combination of 2x LTF with 1.6 μs GI duration on both LTF and data~~
* ~~A combination of 4x LTF with 3.2 μs GI duration on both LTF and data~~
* Transmit and receive of HE-SIG-B field in HE MU PPDUs at HE-MCSs 0 to 5
* HE-MCSs 0 to 7 (transmit and receive) in all supported channel widths and RU sizes for HE SU PPDUs, HE MU PPDUs, and HE\_TRIG PPDUs
* 0.8 μs GI duration on both HE-LTF and data symbols when the HE-LTF is a 2x LTF (transmit and receive)
* 1.6 μs GI duration on both HE-LTF and data symbols when the HE-LTF is 1x (transmit and receive) for full bandwidth UL MU-MIMO if the STA supports UL MU-MIMO
* 1.6 μs GI duration on both HE-LTF and data symbols when the HE-LTF is a 2x LTF (transmit and receive)
* 3.2 μs GI duration on both HE-LTF and data symbols when the HE-LTF is a 4x LTF (transmit and receive)
* Single spatial stream HE-MCSs 0 – 2 in primary 20 MHz channel for HE\_EXT\_SU PPDUs
* 20 MHz channel width and all RU sizes and locations applicable to the 20 MHz channel width in 2.4 GHz and 5 GHz bands (transmit and receive)

An HE STA may support the following Clause 26 features: (#351)

* ~~Other combinations of LTF durations and GI durations~~
* Dual carrier modulation (transmit and receive)
* HE-MCSs 8 to 11 (transmit and receive)
* 0.8 μs GI duration on both HE-LTF and data symbols when the HE-LTF is a 1x LTF (transmit and receive) for HE\_SU PPDUs
* ~~LDPC coding for 26-, 52-, 106-, and 242-tone RUs (transmit and receive) when the number of spatial streams is less than or equal to 4~~
* ~~LDPC coding for a 20 MHz HE SU PPDU (transmit and receive) when the number of spatial streams is less than or equal to 4~~
* ~~LDPC (transmit and receive) when declaring support for less than or equal to 4 spatial streams~~
* LDPC coding (transmit) if
	+ the maximum number of spatial streams the STA is capable of transmitting in an HE\_SU PPDU is less than or equal to 4, and
	+ the STA is not capable of transmtting HE\_SU PPDUs with bandwidth greater than 20 MHz
* LDPC coding (receive) if
	+ the maximum number of spatial streams the STA is capable of receiving in an HE\_SU PPDU is less than or equal to 4, and
	+ the STA is not capable of transmtting HE\_SU PPDUs with bandwidth greater than 20 MHz
* Single spatial stream HE-MCS 0 in the right 106-tone RU of the primary 20 MHz channel for HE\_EXT\_SU PPDUs
* STBC (transmit and receive)

An HE AP STA shall support the following Clause 26 features:

* Transmit of HE\_MU PPDU when none of the RUs are utilizing MU-MIMO (downlink OFDMA)
* Receive of HE\_TRIG PPDU when none of the RUs are utilizing MU-MIMO (uplink OFDMA)
* Transmit of HE\_MU PPDU consisting of a single RU spanning the entire PPDU bandwidth and utilizing MU-MIMO (downlink MU-MIMO), whenever the AP STA is capable of transmitting greater than or equal to 4 spatial streams
* 40 MHz and 80 MHz channel width and all RU sizes and locations applicable to the 40 MHz and 80 MHz channel width in 5 GHz band (transmit and receive)

An HE AP may support the following Clause 26 features:

* MU-MIMO transmit on an RU in an HE\_MU PPDU where the RU does not span the entire PPDU bandwidth (Downlink MU-MIMO with OFDMA)
* MU-MIMO receive on an RU in an HE\_TRIG PPDU where the RU spans the entire PPDU bandwidth (uplink MU-MIMO)
* MU-MIMO receive on an RU in an HE\_TRIG PPDU where the RU does not span the entire PPDU bandwidth (uplink MU-MIMO with OFDMA)
* Receive of payload in an HE\_MU PPDU over a 106-tone RU within a 20 MHz PPDU bandwidth and full bandwidth PPDU
* 40 MHz channel width in 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 width and 2$×$996-tone RU size applicable to the 160/80+80 MHz channel width in 5 GHz band (transmit and receive)
* Transmit of HE\_MU PPDU with preamble puncturing

An HE non-AP STA shall support the following Clause 26 features:

* Receive of HE\_MU PPDU when the RU allocated to the non-AP STA is not utilizing MU-MIMO (downlink OFDMA)
* Transmit of HE\_TRIG PPDU when the RU allocated to the non-AP STA is not utilizing MU-MIMO (uplink OFDMA)
* Receive of HE\_MU PPDU consisting of a single RU spanning the entire PPDU bandwidth and utilizing MU-MIMO (downlink MU-MIMO). The maximum number of spatial streams per user the non-AP STA can receive in the downlink 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 total number of spatial streams the non-AP STA can handle in the downlink MU-MIMO reception shall be at least 4
* Responding with the requested beamforming feedback in an HE sounding procedure with the maximum number of space-time streams in the HE NDP that the non-AP STA can respond to being at least 4
* 40 MHz and 80 MHz channel width and all RU sizes and locations applicable to the 40 MHz and 80 MHz channel width in 5 GHz band (transmit and receive) except if the non-AP STA is 20 MHz-only capable in which case the 40 MHz and 80 MHz channel widths, 996-tone RU, and 484-tone RU sizes in 5 GHz band are not applicable
* A non-AP STA that is 20 MHz-only capable shall support 106/52/26-tone RU sizes and locations in 40 MHz and 80 MHz channel width in 5 GHz band (transmit and receive)

An HE non-AP STA may support

* Transmit of HE\_MU PPDU over partial PPDU bandwidth and full PPDU bandwidth
* 40 MHz channel width in 2.4 GHz band (transmit and receive). If 40 MHz channel width in 2.4 GHz band is supported then all RU sizes and locations applicable to 40 MHz channel width are supported in 2.4 GHz band (transmit and receive). If the non-AP STA is 20 MHz-only capable then 40 MHz channel width and 484-tone RU size in 2.4 GHz band are not supported
* 242/106/52/26-tone RU sizes and locations in a 40 MHz channel width in 2.4 GHz band if non-AP STA is 20 MHz-only capable
* 242-tone RU sizes and locations in a 40 MHz and 80 MHz channel widths in 5 GHz band if non-AP STA is 20 MHz-only capable
* 242-tone RU sizes and locations in a 160/80+80 MHz channel width in 5 GHz band if non-AP STA is 20 MHz-only capable
* 160 MHz and 80+80 MHz channel width and 2$×$996-tone RU size applicable to the 160/80+80 MHz channel width in 5 GHz band (transmit and receive). If the non-AP STA is 20 MHz-only capable then 160 MHz and 80+80 MHz channel width, 2$×$996/996/484-tone RU sizes in 5 GHz band are not applicable
* MU-MIMO receive on an RU in an HE\_MU PPDU where the RU does not span the entire PPDU bandwidth. (DL MU-MIMO with OFDMA). The maximum number of spatial streams per user the non-AP STA can receive in the downlink MU-MIMO with OFDMA transmission shall be equal to the minimum of 4 and the maximum number of spatial streams supported for reception of HE SU PPDUs. The total number of spatial streams the non-AP STA can handle in the downlink MU-MIMO with OFDMA reception shall be at least 4
* MU-MIMO transmit on an RU in an HE\_TRIG PPDU where the RU spans the entire PPDU bandwidth (UL MU-MIMO). If it is supported then a total of upto 8 space-time streams are supported
* MU-MIMO transmit on an RU in an HE\_TRIG PPDU where the RU does not span the entire PPDU bandwidth (UL MU-MIMO with OFDMA). If it is supported then a total of upto 8 space-time streams are supported

**References:**

1. **IEEE P802.11axTM/D0.5, September 2016.**