IEEE P802.11
Wireless LANs

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| Comment Resolutions on PHY INTRODUCTION Part 1 |
| Date: 2018-01-10 |
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Abstract

This submission proposes resolutions for the following comments on section 28.1.1 of TGax D2.0:

11166, 11420, 11421, 11720,

12785, 13068, 13107, 13108,

13110, 13345, 13346, 13347, 13348,

14003, 13567, 13568, 13569, 13570,

13989, 13990, 13991, 13994, 13995,

13996, 13997, 13998, 13999, 14000,

14003

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 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** |
| 11166 | 28.1.1 | 329.64 | The text reads: the maximum number of spatial stream per user a non-AP-STA can receive in the DL-MU-MIMO transmission is a minimum of 4. The maximum number of spatial streams supported for reception of HE SU PPDUs is unclear as stated. | Clarify the number of streams for supported for HE SU PPDUs. If they are equal, change " 4 and the maximum" to "4 and is the maximum" | Reject—The statement is correct and does not need further clarification.The maximum number of spatial streams supported for reception of HE SU PPDU is indicated for various bandwidths in Supported HE-MCS and NSS set field in HE Capabilities element |
| 11420 | 28.1.1 | 330.28 | The description for "20 MHz operating STA" in "may" part is not in consistence with what's described in "shall" part nor in consistence with the definition of "20 MHz operating STA" in 28.3.3.5. | Modify the description with correct conception of "20 MHz operating STA". | Revised—Agree to discrepancy b/w Pg/ln 330/13 and 330/25. Please see discussion under CID11420 in 11-18/0036r0 for more details.TGax Editor to make the changes for CID11420 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 11421 | 28.1.1 | 330.25 | In line 13, it states the 20 MHz-only STA shall suppport 26-, 52-, 106-tone RU and 242-tone RU sizes and locations in 40MHz channel width in the 2.4 GHz band; while in line 25, it states above feature is optional which is contradict. | change"For a 20 MHz-only non-AP HE STA, 26-, 52-, 106-, and 242-tone RU sizes and locations in 40 MHz channel width in the 2.4 GHz band" to "For a 20 MHz-only non-AP HE STA 242-tone RU sizes and locations in 40 MHz channel width in the 2.4 GHz band" | Revised—Comment 11421 is similar in nature to CID11420 and the resolution of CID11420 applies here as well. |
| 11720 | 28.1.1 | 378.21 | why a "20MHz-only non-AP HESTA" shall support clause is included in HE STA shall support list | Remove this item from "Shall support" list | Reject—The page and line numbers are incorrect for CID11720. |
| 12785 | 28.1.1 |  | 28.1.1 Introduction to the HE PHY seems to be not just an intro but also a list of requirements, some of which don't appear to be specified elsewhere in the clause (e.g. "An HE AP shall support [...] 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"?) | Move the normative requirements into a new Subclause 28.1.1b, and keep only general introductory material in 28.1.1 | Reject—The 28.1.1 serves as an introduction to 11ax PHY specification. It is typical in .11 specification to mention mandatory and optional features in PHY introduction.The e.g., quoted in the comment is incorrect. The pg/ln 368/33, describes the normative behaviour: “for an HE AP that is capable of transmitting 4 or more space-time streams shall support DL MU-MIMO transmissions on full bandwidth” |
| 13068 | 28.3.3.5 | 366.27 | A statement on P.366 says "A 20 MHz operatingnon-AP STA shall operate in the primary 20 MHz". On P.367 there are some restriction on RU assignment for 20 MHz operating channels. It is not clear to me that these rules don't contradict the statement on P.366. For example RU 5 and RU 14 are not assigned. Aren't these RU's in the primary channel? I think a general discussion on the use of the primary channels and its RUs is needed. For example Figure 28-6, where is the primary channel? And where is the secondary channel? | as in comment | Reject—A 20 MHz operating non-AP HE STA has poor PER performance on certain RUs due to its limitation of RX filters and tone-mapping descripency such as guard tone misalignment, pilot tone misallignement, etc. (see 11-16/906r0).A 20 MHz operating non-AP HE STA shall operate in the primary 20 MHz. The location of P20 is floating (not fixed) in 40/80/160 MHz. For e.g., in an 80 MHz, the location of P20 may correspond to one of the four 20 MHz frequency segments. Therefore, RU restrictions for 20 MHz operation (section 28.3.3.6) exists. |
| 13107 | 28.1.1 | 328.24 | The statement on lines 24-27 "LDPC coding (transmit and receive) in all supported HE PPDU...." seems to indicate that if the STA supports transmitting and receiving HE SU PPDUs of bandwidth greater than 20 MHz, then LDPC coding will be used for all HE PPDU types, including 20 MHz PPDU. This contradicts the previous statement that BCC may be used for 20 MHz HE SU PPDU | Change this feature statement to: "LDPC coding (transmit and receive) in all supported HE PPDU types with a bandwidth larger than 20 MHz , RU sizes, and number of spatial streams if the STA supports transmitting and receiving HE SU PPDUs of bandwidths greater than 20 MHz" | Reject—A STA that supports transmit and receive of HE SU PPDU of bandwidths greater than 20 MHz, can use either BCC or LDPC to transmit a 20 MHz HE SU PPDU.There is no contradiction in sentences quoted in the comments, i.e., pg/ln 328/13 and 328/24. The former is described as “BCC is not used for the following” |
| 13108 | 28.1.1 | 328.28 | This statement implies that if the STA declares support for transmitting more than 4 spatial streams then LDPC coding (transmit) will be used in all supported HE PPDU types, RU sizes, and number of spatial streams. This contradicts to the statement on lines 10-23. | Change this feature statement to: "LDPC coding (transmit) in all supported HE PPDU types that occupy more than 4 spatial streams, RU sizes, and number of spatial streams if the STA declares support for transmitting more than 4 spatial streams" | Reject—A STA that supports transmit of more than 4 spatial streams, can use either BCC or LDPC for transmit of less than or equal to 4 spatial.There is no contradiction in sentences quoted in the comments, i.e., pg/ln 328/16 and 328/28. The former is described as “BCC is not used for the following” |
| 13110 | 28.3.3.5 | 366.19 | It appears that there are 2 interchangeable references to a non-AP HE STA that supports 20 MHz bandwidth. One is a 20 MHz operating non-AP HE STA, the other is a 20 MHz-only non-AP HE STA. Suggest to use 20 MHz operating non AP HE STA throughout the draft. | Replace 20 MHz-only non-AP HE STA by 20 MHz operating non-AP HE STA throughout the draft. | Reject—20 MHz-only non-AP HE STA and 20 MHz operating non-AP HE STA are not interchangeable as described in the Definition section 3. A 20 MHz-only non-AP HE STA supports only 20 MHz channel width. A 20 MHz operating non-AP HE STA is an HE STA that is operating in 20 MHz channel width mode (e.g., by reducing operating bandwidth using OMI) |
| 13345 | 28.1 | 328.23 | Formulation too broad. In MU or TB PPDU, when some users deploy MCS 10/11, it doesn't mean other users cannot use BCC. | For HE MU PPDU or HE TB PPDU, the text should mention that BCC is not used for the users that are allocated MCS 10/11. | Revised—Agree in principle with the comment. Please see discussion under CID13345 in 11-18/0036r0 for more details.TGax Editor to make the changes for CID13345 as suggested in proposed resolution in IEEE 802.11-17/0000r0 |
| 13346 | 28.1.1 | 328.36 | Since a non-AP STA is not required to transmit HE-MU-PPDU (optional), it cannot be required to transmit HE-SIG-B for all STALikewise, since an AP STA is not required to receive HE-MU-PPDU (optional), it cannot be required to receive HE-SIG-B for all STA | Move the transmit HE-SIG-B requirement to "AP-STA shall" and "Non-AP-STA may" sections.andMove the receive HE-SIG-B requirement to "non-AP STA shall" and "AP-STA may" sections.or add "when transmit and receive of HE MU PPDU is supported, respectively" to the existing text. | Revised—Agree in principle with the comment. Please see discussion under CID13346 in 11-18/0036r0 for more details.TGax Editor to make the changes for CID13346 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13347 | 28.1.1 | 329.63 | The text requires the non-AP STA to receive > 4 streams per user in DL-MUMIMO if that STA supports > 4 streams in HE SU PPDU. The maximum number of streams per user is 4 in DL MUMIMO, so inconsistent. | Change "The maximum number of spatial streams per user .. reception of HE SU PPDU." to a sentence specifying the total number of spatial streams in the PPDU | Reject—Max # of spatial streams per user in DL MU MIMO = MIN(4, max # of spatial streams supported for HE SU PPDU RX). Hence, in no case, the non-AP STA is required to receive > 4 streams per user in DL-MU MIMO |
| 13348 | 28.1.1 | 330.36 | The text requires the non-AP STA to receive > 4 streams per user in DL-MUMIMO (+OFDMA) if that STA supports > 4 streams in HE SU PPDU. The maximum number of streams per user is 4 in DL MUMIMO, so inconsistent. | Change "The maximum number of spatial streams per user .. reception of HE SU PPDU." to a sentence specifying the total number of spatial streams in the PPDU | Reject—Max # of spatial streams per user in DL MU MIMO (+OFDMA) = MIN(4, max # of spatial streams supported for HE SU PPDU RX). Hence, in no case, the non-AP STA is required to receive > 4 streams per user in DL-MU MIMO (+OFDMA) |
| 13567 | 28.1.1 | 328.14 | For consistency either change HE MU or HE TB PPDU description to the other way | Change HE MU PPDU description as 'An HE MU PPDU on an RU of size greater than 242 subcarriers' | Revised—TGax Editor to make the changes for CID13567 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13568 | 28.1.1 | 328.18 | For consistency either change HE MU or HE TB PPDU description to the other way | Change HE MU PPDU description 'An RU allocated to a single user in an HE MU PPDU' to 'An HE MU PPDU on an RU allocated to a single user' | Revised—TGax Editor to make the changes for CID13568 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13569 | 28.1.1 | 329.42 | For consistency either change MU-MIMO description to the other way | Change MU-MIMO description 'Reception of the payload on an RU in an HE MU PPDU' to 'MU-MIMO reception on an RU in an HE MU PPDU' | Reject—The sentence under question is not limited to MU-MIMO behaviour. As is, the statement is correct |
| 13570 | 28.1.2 | 331.01 | Change 20MHz-only capability to the common terminolgy | Change 'A non-AP STA with 20 MHz-only capability' to 'A 20 MHz-only HE non-AP STA' | Accept— |
| 13989 | 28.1.1 | 328.14 | An RU with less than or equal to 242-tones in an HE TB PPDU can use BCC even if there are other RUs in the same HE TB PPDU with more than 242-tones. | Change "\* An RU of size greater than 242 subcarriers in an HE MU PPDU. \* An HE TB PPDU on an RU of size greater than 242 subcarriers" to "\* An RU of size greater than 242 subcarriers in an HE MU or HE TB PPDU" | Revised—TGax Editor to make the changes for CID13989 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13990 | 28.1.1 | 328.18 | An RU with less than or equal to 242-tones in an HE TB PPDU can use BCC even if there are other RUs in the same HE TB PPDU with more than 242-tones. | Change "\* An RU allocated to a single user in an HE MU PPDU with number of spatial streams greater than 4. \* An HE TB PPDU on an RU allocated to a single user with number of spatial streams greater than 4" to "\* An RU allocated to a single user in an HE MU or HE TB PPDU with number of spatial streams greater than 4." | Revised—TGax Editor to make the changes for CID13990 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13991 | 28.1.1 | 328.23 | An RU using MCS 9 or lower can use BCC even if there are other RUs in the same PPDU using MCS 10 or 11. | Change "\* An HE PPDU using HE-MCSs 10 or 11" to "\* An HE SU PPDU using HE-MCSs 10 or 11 \* An RU in an HE MU or HE TB PPDU using HE-MCSs 10 or 11" | Revised—CID13345 is similar in nature to CID13991. Please refer to resolution of CID13345 for resolution of CID 13991 |
| 13994 | 28.1.1 | 328.36 | It is optional for an HE AP STA to receive HE MU PPDUs, and for an non-AP HE STA to transmit HE MU PPDUs. | Delete "Transmit and receive of HE-SIG-B field in HE MU PPDUs at HE-MCSs 0 to 5" from P328L36. Add at P329L8 "- HE MU PPDUs with a single RU either spanning the entire PPDU BW (transmit) - HE MU PPDUs of 20 MHz PPDU bandwidth with a single RU of size 106 tones within the Primary 20 MHz channel (transmit)". Note that HE AP optionally receiving the HE MU PPDU is already specified at P329L42. | Revised—CID 13346 and CID 13994 are similar in nature. Please refer to discussion and resolution of CID 13346 for resolution of CID 13994. |
| 13995 | 28.1.1 | 328.38 | It is optional for an HE AP STA to receive HE MU PPDUs, and for an non-AP HE STA to transmit HE MU PPDUs. HE AP STA does not transmit HE TB PPDUs, and non-AP HE STA does not receive HE TB PPDUs. | Change "Single spatial stream 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 TB PPDUs" to "Single spatial stream HE-MCSs 0 to 7 (transmit and receive) in all supported channel widths for HE SU PPDUs". | Revised—Agree with the comment. However, simply deleting reference to HE MU PPDU and HE TB PPDU is insufficient.TGax Editor to make the changes for CID13995 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13996 | 28.1.1 | 328.40 | HE TB PPDU does not support 0.8 us GI | Change "0.8 ++s and 1.6 ++s GI duration on both HE-LTF and data symbols when the 2x HE-LTF is used (transmit and receive)" to "0.8 ++s and 1.6 ++s GI duration on both HE-LTF and data symbols when the 2x HE-LTF is used in HE SU PPDUs (transmit and receive)" | Revised—Agree with the comment. 0.8 and 1.6 us GI and 2x HE-LTF is used for both HE SU PPDU and HE MU PPDU.TGax Editor to make the changes for CID13996 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13397 | 28.1.1 | 328.43 | AP does not transmit HE TB PPDU. Non-AP STA does not receive HE TB PPDU. | Delete "(transmit and receive)" | Revised—TGax Editor to make the changes for CID13997 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13398 | 28.1.1 | 328.46 | It is optional for an HE AP STA to receive HE MU PPDUs, and for an non-AP HE STA to transmit HE MU PPDUs. HE AP STA does not transmit HE TB PPDUs, and non-AP HE STA does not receive HE TB PPDUs. | Change "3.2 ++s GI duration on both HE-LTF and data symbols when the 4x HE-LTF is used (transmit and receive)" to "3.2 ++s GI duration on both HE-LTF and data symbols when the 4x HE-LTF is used in HE SU PPDUs (transmit and receive)" | Revised—TGax Editor to make the changes for CID13998 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 13399 | 28.1.1 | 328.49 | It is optional for an HE AP STA to receive HE MU PPDUs, and for an non-AP HE STA to transmit HE MU PPDUs. | Change "HE SU PPDUs and HE MU PPDUs" to "HE SU PPDUs" at P328L49. Add at P329L28 "HE MU PPDUs with 0.8 ++s GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF if the STA supports HE ER SU PPDUs with 0.8 ++s GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF (transmit)". Add at P330L16 "Reception of HE MU PPDUs with 0.8 ++s GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF if the STA supports HE ER SU PPDUs with 0.8 ++s GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF" | Revised—TGax Editor to make the changes for CID13999 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 14000 | 28.1.1 | 329.01 | It is optional for an HE AP STA to receive HE MU PPDUs, and for an non-AP HE STA to transmit HE MU PPDUs. | Change "HE SU PPDUs and HE MU PPDUs" | Revised—TGax Editor to make the changes for CID14000 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |
| 14003  | 28.1.1 | 330.13 | 20 MHz-only non-AP HE STA supporting RUs in 40 MHz is optional. | Move P330L13-16 to P330L52. | Revised—CID 11420 and CID 14003 are similar in nature. Agree with the comment that there is an error in the statement.TGax Editor to make the changes for CID14003 as suggested in proposed resolution in IEEE 802.11-18/0036r0 |

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**Discussion for CID 11420, 14003**

The following are the definitions of 20 MHz-only non-AP HE STA and 20 MHz operating non-AP HE STA:

**20 MHz-only non-AP high efficiency STA (HE STA):** A non-AP HE STA that indicates in the Channel Width Set subfield in the HE PHY Capabilities Information field of the HE Capabilities element that it transmits, support for only 20 MHz channel width for the frequency band in which it is operating.

**20 MHz operating non-AP high efficiency STA (HE STA):** A non-AP HE STA that is operating in 20 MHz channel width mode, such as a 20 MHz-only non-AP HE STA or an HE STA that reduced its operating channel width to 20 MHz using operating mode indication (OMI).

There may exist a non-AP HE STA that supports 40 MHz channel width in 2.4 GHz band but for some reason has reduced its operating bandwidth to 20 MHz in 2.4 GHz. For such a non-AP HE STA, support of 26/52/106 tone mapping in 40 MHz is mandatory (please see ’20 MHz In 40 MHz HE PPDU In 2.4 GHz Band’ capability). A 20 MHz-only non-AP HE STA shall never support 40 MHz channel width and support of 26/52/106 tone mapping in 40 MHz is optional for it.

Support of 242-tone mapping in 40 MHz is optional for 20 MHz operating non-AP HE STA

Hence, the following sentence in spec. used ‘20 MHz-only non-AP HE STA’ in lieu of ‘20 MHz operating non-AP HE STA’

* For a 20 MHz-only non-AP HE STA, 26-, 52-, 106-, and 242-tone RU sizes and locations in 40 MHz channel width in the 2.4 GHz band

**Resolution for CID 11420, 14003**

**TGax Editor: Please make the following changes to section 28.1.1 (pg 330, ln 13) (CIDs: 11420, 14003)**

* A 20 MHz~~-only~~operating (#11420) non-AP HE STA shall support 26-, 52-, and 106-tone RU sizes and locations in ~~40 MHz channel width in the 2.4 GHz band and~~ (#11420, #14003) 40 MHz and 80 MHz channel width in 5 GHz band (transmit and receive)

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**Discussion for 13345, 13991**

LDPC coding (transmit and receive) is mandatory in HE SU PPDU with HE MCSs 10 or 11.

In case of 20 MHz OFDMA transmission, LDPC use is mandatory in only RUs with HE MCSs 10 or 11.

**Resolution for CID13345, 13567, 13568, 13989, 13990**

**TGax Editor: Please make the following changes to section 28.1.1 (pg 328, ln 23) (CIDs: 13345, 13567, 13568, 13989, 13990)**

Binary convolutional coding (transmit and receive). Binary convolutional coding is not used for the following:

• 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 (#13567, #13989)

~~• An HE TB PPDU on an RU of size greater than 242 subcarriers (~~#13989)

• 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 an HE TB PPDU with number of spatial streams greater than 4 (#13568, #13990)

~~• An HE TB PPDU on an RU allocated to a single user with number of spatial streams greater than 4 (~~#13990)

• An HE SU (#13345) PPDU using HE-MCSs 10 or 11

* **An HE MU PPDU or an HE TB PPDU on an RU with HE-MCSs 10 or 11 (#13345)**

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**Discussion on CID 13346, 13395, 13396, 13397, 13398, 13899**

DL OFDMA is mandatory in 11ax. Therefore, transmission of HE MU PPDU format by the AP is mandatory while reception of HE MU PPDU format by the non-AP STA is mandatory. On the other hand, transmission of HE MU PPDU format by the non-AP STA is optional and reception of HE MU PPDU format by the AP is optional.

HE-SIG-B transmission and reception with HE-MCSs 0 to 5 needs to be described accordingly to reflect the above statements. Transmission of HE MU PPDU by a non-AP HE STA is optional. This is stated on Pg/ln 330/20. HE-SIG-B MCSs, payload HE-MCSs 0 – 7, etc. are optional by feature being optional. Hence their mention can be omitted.

Similarly, HE AP does not transmit HE TB PPDUs.

**Resolution of CID 13346, 13395, 13396, 13397, 13398, 13899, 14000**

**TGax Editor: Please make the following changes to section 28.1.1 (CIDs: 13346, 13395, 13396, 13397,13398, 13899, 14000)**

An HE STA shall support the following features:

* **…**
* **~~Transmit and receive of HE-SIG-B field in HE MU PPDUs at HE-MCSs 0 to 5~~(#13346)**
* Single spatial stream 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 TB PPDUs~~(#13995)
* **0.8 us and 1.6 us GI duration on both HE-LTF and data symbols when 2x HE-LTF is used in HE SU PPDUs (transmit and receive) (#13396)**
* **~~1.6 μs GI duration on both HE-LTF and data symbols when the 1x HE-LTF is used (transmit and receive) for full bandwidth UL MU-MIMO if the STA supports UL MU-MIMO~~ (#13397)**
* **3.2 μs GI duration on both HE-LTF and data symbols when the 4x HE-LTF is used in HE SU PPDUs (transmit and receive)** (#13998)
* **HE SU PPDUs ~~and HE MU PPDUs~~** (#13999) **with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF if the STA supports HE ER SU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF (transmit and receive)**
* **..**

**An HE STA may support the following features:**

* **…**
* **HE SU PPDUs ~~and HE MU PPDUs~~** (#14000) **with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x 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 symbols when the HE-LTF is a 4x LTF (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 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**
* **Transmit of HE-SIG-B field in HE MU PPDUs at HE MCSs 0 to 5 (#13346)**
* **Single spatial stream HE-MCSs 0 to 7 (transmit) in all supported channel widths and RU sizes for HE MU PPDUs (transmit) or HE TB PPDUs (receive)** (#13995)
* **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 band (transmit and receive)**
* **0.8 us and 1.6 us GI duration on both HE-LTF and data symbols when 2x HE-LTF is used in HE MU PPDU (transmit) (#13396)**
* **1.6 us GI duration on both HE-LTF and data symbols when 2x HE-LTF is used in HE TB PPDU (receive) (#13396)**
* **1.6 us GI duration on both HE-LTF and data symbols when the 1x HE-LTF is used (receive) for full bandwidth UL MU-MIMO if the HE AP supports UL MU-MIMO (#13397)**
* **3.2 μs GI duration on both HE-LTF and data symbols when the 4x HE-LTF is used in HE MU PPDUs (transmit) or HE TB PPDU (receive)** (#13998)
* **HE MU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF if the HE AP supports HE ER SU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF (transmit)** (#13999)
* **…**

**An HE AP may support the following features:**

* **…**
* **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 symbols when the HE-LTF is a 4x 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 symbols when the HE-LTF is a 4x LTF (transmit)** (#14000)

**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 of 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**
* **Receive of HE-SIG-B field in HE MU PPDUs at HE MCSs 0 to 5 (#13346)**
* **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)** (#13995)
* **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 band are not applicable**
* **A 20 MHz-only non-AP HE STA shall support 26-, 52-, and 106-tone RU sizes and locations in 40 MHz channel width in the 2.4 GHz band and 40 MHz and 80 MHz channel width in 5 GHz band (transmit and receive)**
* **0.8 us and 1.6 us GI duration on both HE-LTF and data symbols when 2x HE-LTF is used in HE MU PPDU (receive) (#13396)**
* **1.6 us GI duration on both HE-LTF and data symbols when 2x HE-LTF is used in HE TB PPDU (transmit) (#13396)**
* **1.6 us GI duration on both HE-LTF and data symbols when the 1x HE-LTF is used (transmit) for full bandwidth UL MU-MIMO if the non-AP HE STA supports UL MU-MIMO (#13397)**
* **3.2 μs GI duration on both HE-LTF and data symbols when the 4x HE-LTF is used in HE MU PPDUs (receive) or HE TB PPDU (transmit)** (#13998)
* **HE MU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF if the non-AP HE STA supports HE ER SU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF (receive)** (#13999)
* **…**

**A non-AP HE STA may support the following features:**

* **…**
* **For a non-AP HE STA capable of up to 80 MHz channel width, when operating with 80 MHz channel width, the reception of 160 MHz or 80+80 MHz HE MU PPDU, or the transmission of 160 MHz or 80+80 MHz HE TB PPDU**
* **HE MU PPDUs with 0.8 μs GI duration on both the HE-LTF and Data field symbols when the HE-LTF is a 4x LTF 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 symbols when the HE-LTF is a 4x LTF (receive)** (#14000)

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**References:**

1. **IEEE P802.11axTM/D2.0, Oct 2017.**