IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Doppler Comment Resolution | | | | |
| Date: 2017-09-12 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | Email |
| Hongyuan Zhang  Yan Zhang  Hua Mu  Rui Cao | Marvell | 5488 Marvell Ln,  Santa Clara, CA 95054 | 408-222-1837 | hongyuan@marvell.com |
| Bin Tian  Lochan Verma  Youhan Kim | Qualcomm |  |  |  |
| Jianhan Liu | Mediatek |  |  |  |
| Ron Porat | Broadcom |  |  |  |
| Xiaogang Chen  Qinghua Li | Intel |  |  |  |
| Ross Jian Yu  Ming Gan  David Xun yang  Shimi Shilo | Huawei |  |  |  |

*Abstract: This document contains the comment resolution for Doppler bit, including the proposed spec text for midamble based on 11ax D1.4*

*Related PHY CIDs:*

*3320, 3403, 5141, 5418, 5419, 7986, 8416, 8674, 9509, 10350,*

*4953, 8417, 8775, 10351, 10364, 5246, 5753*

*5301, 5303, 5413, 5414, 5415, 5416, 5787, 5792, 6123, 7236, 8079, 8418, 8419, 8567, 8912, 9552, 9553, 10210, 10408, 10410.*

*Related MAC CIDs:*

*3319, 3321, 3401, 3405, 3672, 5089, 5131, 5417, 6084, 8022, 8420, 8657, 9995, 10341, 5090*

**CIDs on Doppler PHY Capabilities**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3320 | 83.41 | 9.4.2.218.3 | Table 9-262aa defines HE-PHY Capabilities Information field. Doppler subfield makes reference to Doppler Procedure. There is no text on "Doppler procedure" procedure needs to be defined. | Add technical detail content or remove "Doppler subfield from Table 262aa | Revised.  Change as in doc IEEE802.11-17/0995r2 |
| 3403 | 83.41 | 9.4.2.218.3 | Table 9-262aa defines HE-PHY Capabilities Information field. Doppler subfield makes reference to Doppler Procedure. There is no text on "Doppler procedure" procedure needs to be defined. | Add technical detail content or remove "Doppler subfield from Table 262aa |
| 5141 | 83.46 | 9.4.2.218.3 | I couldn't find "Doppler procedure" defined anywhere. Either define the procedure or delete the field. | As in comment |
| 5418 | 83.41 | 9.4.2.218.3 | "Doppler procedure" not defined | Define "Doppler procedure" or remove it from the text |
| 5419 | 83.43 | 9.4.2.218.3 | "Doppler procedure" not defined | Define "Doppler procedure" or remove it from text |
| 7986 | 83.40 | 9.4.2.218.3 | The "Doppler procedure" is not defined in this draft. Either add its definition or referred to its definition if it is already defined in another amendment. | As in comment. |
| 8416 | 83.40 | 9.4.2.218.3 | No "Doppler procedure" has been defined so it is not possible to determine how this bit should be set. | Return bit to the pool of reserved bits |
| 8674 | 83.41 | 9.4.2.218.3 | What is "Doppler procedure"? | Clarify |
| 9509 | 83.40 | 9.4.2.218.3 | "Doppler" in Table 9-262aa--Subfields of the HE PHY Capabilities Information field:  "B20 indicates transmitting STA supports transmitting HE PPDUs with Doppler procedure B21 indicates transmitting STA supports receiving HE PPDUs with Doppler procedure"  Doppler procedure is not defined. | Define the Doppler procedure. |
| 10350 | 83.40 | 9.4.2.218.3 | "B20 indicates transmitting STA supports transmitting HE PPDUs with Doppler procedure" : Doppler not defined. | Define Doppler operation |

**CIDs on Doppler in Tx/RxVector**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 4953 | 223.51 | 28.2.2 | Missing detail | I've searched the spec for the impact of this parameter and nowhere can I find it defined. "B20 indicates transmitting STA supports transmitting HE PPDUs with Doppler procedure" and "The Doppler subfield indicates a high doppler mode of transmission." are uselessly vague. Add detail. Write exactly what does the TX PHY do differently when this parameter is true | Revised.  Change as in doc IEEE802.11-17/0995r2. |
| 8417 | 223.51 | 28.2.2 | What is "the doppler effect" and how should it be considered? The spec does not define such an effect and there is no text defining a) how this a prameter should be set and b) what the PHY does with this parameter | Remove the DOPPLER parameter from Table 28-1 |
| 8775 | 223.51 | 28.2.2 | "Indicates whether the doppler effect should be considered for the PPDU." There is no indication anywhere in the document what this means. This requirement is not actionable. | Clarify or remove parameter. |
| 10351 | 223.51 | 28.2.2 | Indicates whether the Doppler effect should be considered for the PPDU: Doppler not defined | Define Doppler operation |
| 10364 | 223.51 | 28.2.2 | DOPPLER: No Doppler Mode defined | Define Doppler operation |
| 5246 | 223.52 | 28.2.2 | Clarify whether 0 indicates that dopper should or should not considered | as in comment |
| 5753 | 223.53 | 28.2.2 | Though obvious, it is better to spell out what does 0 indicates and what does 1 indicates | Specify what does 0 and 1 indicates, respecetively. |

**CIDs on HE-SIG-A Doppler bit**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 5301 | 275.33 | 28.3.10.7.2 | In Table 28-16, HE-SIG-A field of an HE SU PPDU and HE extended range SU PPDU contains Doppler field but Doppler mode has not been defined yet. | Doppler mode needs to be defined or if it will not be determined, Doppler field sholuld be just removed and reserved in the HE-SIG-A field of an HE SU PPDU and HE extended range SU PPDU. | Revised.  Change as in doc IEEE802.11-17/0995r2. |
| 5303 | 275.35 | 28.3.10.7.2 | In Table 28-17, HE-SIG-A field of an HE MU PPDU contains Doppler field but Doppler mode has not been defined yet. | Doppler mode needs to be defined or if it will not be determined, Doppler field sholuld be just removed and reserved in the HE-SIG-A field of an HE MU PPDU. |
| 5413 | 275.34 | 28.3.10.7.2 | "Doppler mode" is not defined | Define Doppler mode or remove all references |
| 5414 | 275.35 | 28.3.10.7.2 | "Doppler mode" is not defined | Define "Doppler mode" or remove it from the text |
| 5415 | 277.36 | 28.3.10.7.2 | "Doppler mode" not defined | Define or remove the "Doppler mode" from the text |
| 5416 | 277.37 | 28.3.10.7.2 | "Doppler mode" not defined | Define or remove "Doppler mode" from the text |
| 5787 | 275.34 | 28.3.10.7.2 | Undefined mechanism when the "Doppler" bit in SIGA is set to 1, also applicable to HE-SIG-A of HE-MU PPDU format. | Either define the PHY mechanism when Doppler bit is set to 1, or change this bit to reserved, |
| 5792 | 275.34 | 28.3.10.7.2 | Mechanism undefined when "Doppler" bit in HE-SIG-A bit is set to 1. | Define the mechanism for the case when the Doppler bit is set to 1 and reference that in Table 28-16 for Doppler bit set to 1. |
| 6123 | 275.35 | 28.3.10.7.2 | In "Table 28-16--HE-SIG-A field of an HE SU PPDU and HE extended range SU PPDU", B15 is defined as Doppler bit to indicate if Dopploer mode is applied. However, Doppler mode is not clearly defined. | Define the "Doppler Mode" in detail |
| 7236 | 275.34 | 28.3.10.7.2 | Doppler bit exits in HE-SIG-A, while how to use this bit is not specified. | A resolution to this comment will be provided. |
| 8079 | 275.33 | 28.3.10.7.2 | In Table 28-16, the "Doppler mode" is not defined in the standard. Please add a definition and to what does it correspond? | As in comment. |
| 8418 | 275.33 | 28.3.10.7.2 | What is "Doppler mode"? Such a mode is not defined and thus it is not possible to determine how this bit is set | Return bit to the pool of reserved bits |
| 8419 | 277.35 | 28.3.10.7.2 | What is "Doppler mode"? Such a mode is not defined and thus it is not possible to determine how this bit is set | Return bit to the pool of reserved bits |
| 8567 | 275.34 | 28.3.10.7 | 1 bit in HE-SIG-A assigned to handle Doppler, but no mechanism provided (Table 28-16 and 28-17) | Propose to adopt traveling pilots (similar to 11ah) to handle Dopple |
| 8912 | 275.34 | 28.3.10.7.2 | " Doppler mode" is not explained anywhere. This requirement is not actionable. | Either clarify or remove bit. Similar comment for Table 28-17. |
| 9552 | 275.33 | 28.3.10.7.2 | Table 28-16 B15 of HE-SIG-A2 (HE SU PPDU) or HE-SIG-A3 (HE extended range SU PPDU):  "Set to 0 if Doppler mode is not used Set to 1 if Doppler mode is used"  Doppler mode is not defined in the draft. | Doppler mode should be defined, or make this bit reserved. |
| 9553 | 277.35 | 28.3.10.7.2 | Table 28-17, B25 of HE-SIG-A1 (Doppler):  "Set to 0 if Doppler mode is not used Set to 1 if Doppler mode is used"  Doppler mode is not defined in the draft. | Doppler mode should be defined, or make this bit reserved. |
| 10210 | 275.33 | 28.3.10.7.2 | "Doppler mode" is defined in an HE-SIG-A; however, there is no specific text for the definition of it and how a transmitter and a receiver should utilize this information. In addition, when this parameter should be enabled is not clear. | Clarify them add some normative text. |
| 10408 | 275.33 | 28.3.10.7.2 | Set to 0 if Doppler mode is not used | No Doppler Mode defined |
| 10410 | 277.35 | 28.3.10.7.2 | Doppler | No Doppler Mode defined |

**CIDs on Doppler field in Trigger Frame**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 3319 | 45.11 | 9.3.1.23 | "Doppler subfield indicates a high doppler mode of transmission." Definition, clarification and technical details are not in .11axD1.0 with respect to the range of doppler spread and operating conditions triggering "high doppler mode". In Table 9-262aa pg. 83 "doppler procedure" defines 2-bits and references for "doppler" and makes reference to STAs using a "Doppler Procedure" for HE PPDUs transmissions. Critical technical details on the doppler procedure are lacking in .11axD1.0. | Either remove all references to Doppler in .11axD1.0 (text and in Table 9-262aa) including STA doppler support or add detailed technical content on Doppler Procedure for HE PPDU transmissions in support of clause of 9.3.1.23 and Table 9-262aa. | Revised.  Change as in doc IEEE802.11-17/0995r2. |
| 3321 | 45.11 | 9.3.1.23 | Doppler is not defined in clause 3.4 of IEEE 802.11-2016 (802.11 REVmc D8.0) | Add "Doppler" definition in clause 3.4 Definitions, acronyms, and abbreviations |
| 3401 | 45.11 | 9.3.1.23 | "Doppler subfield indicates a high doppler mode of transmission." Definition, clarification and technical details are not in .11axD1.0 with respect to the range of doppler spread and operating conditions triggering "high doppler mode". In Table 9-262aa pg. 83 "doppler procedure" defines 2-bits and references for "doppler" and makes reference to STAs using a "Doppler Procedure" for HE PPDUs transmissions. Critical technical details on the doppler procedure are lacking in .11axD1.0. | Either remove all references to Doppler in .11axD1.0 (text and in Table 9-262aa) including STA doppler support or add detailed technical content on Doppler Procedure for HE PPDU transmissions in support of clause of 9.3.1.23 and Table 9-262aa. |
| 3405 | 45.11 | 9.3.1.23 | Doppler is not defined in clause 3.4 of IEEE 802.11-2016 (802.11 REVmc D8.0) | Add "Doppler" definition in clause 3.4 Definitions, acronyms, and abbreviations |
| 3672 | 45.11 | 9.3.1.23 | "Doppler subfield indicates a high doppler mode of transmission." Definition, clarification and technical details are not in .11axD1.0 with respect to the range of doppler spread and operating conditions triggering "high doppler mode". In Table 9-262aa pg. 83 "doppler procedure" defines 2-bits and references for "doppler" and makes reference to STAs using a "Doppler Procedure" for HE PPDUs transmissions. Critical technical details on the doppler procedure are lacking in .11axD1.0. | Either remove all references to Doppler in .11axD1.0 (text and in Table 9-262aa) including STA doppler support or add detailed technical content on Doppler Procedure for HE PPDU transmissions in support of clause of 9.3.1.23 and Table 9-262aa. |
| 5089 | 45.11 | 9.3.1.23 | Doppler mode is sufficiently defined | I can't propose a change, I can not figure out from the draft, what "Doppler mode" means. |
| 5131 | 45.11 | 9.3.1.23 | I don't see anywhere a definition for "high doppler mode of transmission". Please define or delete this field throughout the spec. | As in comment |
| 5417 | 45.11 | 9.3.1.23 | "doppler mode" not defined | Define or remove "doppler mode" from the text |
| 6084 | 45.11 | 9.3.1.23 | The doppler mode of transmission is not clear | Define doppler mode |
| 8022 | 45.11 | 9.1.3.23 | The "high doppler mode of transmission" is not clearly defined in the draft. What is the criteria to consider it "high" or not? What are the consequences for the STA? Also through all the document the "Doppler procedure" is also mentionned in relation with this Doppler bit, but no clear link is established between this procedure and this mode of transmission. Please clarify. | Please, add clarifications on what the "high doppler mode transmission" is and what are the consequences of it for a STA. |
| 8420 | 45.11 | 9.3.1.23 | What is a "high doppler mode of transmission" and why does this need to be indicated in the Trigger frame? There is no corresponding field in the HE trigger-based PPDU so nothing to set there. | Remove Doppler field from the Common Info field |
| 8657 | 45.11 | 9.3.1.23 | "The Doppler subfield indicates a high doppler mode of transmission" What does this mean? How would the AP know about the Doppler mode of the environment? Is the AP moving? | Clarify |
| 9995 | 45.11 | 9.3.1.23 | "The Doppler subfield..." Unclear how to set the field. | Replace with "The Doppler subfield is set to 1 if..." |
| 10341 | 45.11 | 9.3.1.23 | (MAC Motion #106)The Doppler subfield indicates(#Ed) a high Doppler mode of transmission. | No Doppler Mode defined |
| 5090 | 45.11 | 9.3.1.23 | Doppler refer to a last name of famous scientist and must be written with capital letter in the sentence:  "The Doppler subfield indicates a high doppler mode of transmission."  Also a mode can not be high. I think, the intention is to indicate a possible presence of high Doppler effect. | One possibility is:  The Doppler subfield indicates a mode of transmission accounting for a high Doppler effect.  As my another comment states, the Doppler mode is not sufficiently defined and here is the place where it could be elaborated. |

**Discussions**: propose the midamble mechanism to address high Doppler channels, refer to presentations 11-17-0734-01-00ax-doppler-discussions, 11-17-0773-02-00ax-thoughts-on-doppler-design-in-802-11ax, 11-17-0960-00-00ax-Follow-up-Doppler-Design-11ax, 11-17-0994-00-00ax-midamble-design; 11-17-1366-00-00ax-midamble-design-continued, 11-17-1376-00-00ax-usage-of-doppler-bit-in-11ax, and 11-17-1357-01-00ax-capablity-on-doppler-mode.

TGax editor: make the following changes in **9.3.1.23 Trigger frame format** **Figure 9-52d—Common Info field** starting from P78L13:

B23-B25

|  |
| --- |
| Number Of HE-LTF Symbols and Midamble Periodicity |

TGax editor: make the following changes in **9.3.1.23 Trigger frame format** starting from P80L19:

When Doppler subfield of the Common Info field is set to 0, ~~T~~the Number Of HE-LTF Symbols and Midamble Periodicity subfield of the Common Info field indicates the number of HE-LTF symbols present in the HE TB PPDU that is the response to the Trigger frame. When Doppler subfield of the Common Info field is set to 1, B23-B24 of the Number OF HE-LTF Symbols and Midamble Periodicity subfield indicates the number of HE-LTF symbols present in the HE TB PPDU that is the response to the Trigger frame, and B25 of the Number OF HE-LTF Symbols and Midamble Periodicity subfield indicates midamble periodicity in the same HE TB PPDU. The encoding of the Number Of HE-LTF Symbols and Midamble Periodicity subfield is the same as the Number of HE-LTF Symbols and Midamble Periodicty field in HE-SIG-A2, which is defined in Table 28-18(HE-SIG-A field of an HE MU PPDU).

TGax editor: make the following changes in **9.3.1.23 Trigger frame format** starting from P81L58:

The Doppler subfield of the Common Info field indicates ~~a high Doppler mode of transmission~~ whether midamble is present in the HE TB PPDU, setting to 1 indicates that midamble is present, setting to 0 otherwise.

TGax editor: make the following changes in **Figure 9-589cl— HE PHY Capabilities Information field format** starting from P125L44:

B15 B16 …. 67 68 ~~B68~~ B69 B71

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ~~Reserved~~  Midamble Rx Max NSTS | …… | 80 MHz In 160/ 80+80 MHz HE PPDU(#6 923) | Midamble Rx 2x and 1x HE-LTF | Reserved |

TGax editor: make the following changes in **Table 9-262aa—Subfields of the HE PHY Capabilities Information field** starting from P127L48:

**Table 9-262aa—Subfields of the HE PHY Capabilities Information field**

|  |  |  |
| --- | --- | --- |
| Midamble Rx Max NSTS | When Doppler Rx field is set to 1, indicates the maximum number of space-time streams supported for reception when midamble is used in the Data field. | Set to 0 for 1 space-time stream  Set to 1 for 2 space-time streams  Set to 2 for 3 space-time streams  Set to 3 for 4 space-time streams |
| …. | …. | ….. |
| Doppler Tx(#3484) | Indicates support for transmitting HE PPDUs with ~~the Doppler procedure~~ Midamble. | Set to 0 if not supported.  Set to 1 if supported. |
| Doppler Rx(#3484) | Indicates support for receiving HE PPDUs with ~~Doppler procedure~~ Midamble. | Set to 0 if not supported.  Set to 1 if supported. |
| …… | ……. | ……. |
| Midamble Rx 2x and 1x HE-LTF | When Doppler Rx field is set to 1, indicates support for receiving Midambles with 2x HE-LTF, 1x HE-LTF in HE SU PPDU if the “HE SU PPDU With 1x HE-LTF And 0.8 us GI” subfield is set to 1, and 1x HE-LTF in HE ER SU PPDU if the “HE ER SU PPDU With 1x HE-LTF And 0.8 us GI” subfield is set to 1. | Set to 0 if not supported.  Set to 1 if supported. |

TGax editor: make the following changes in **Table 28-1—TXVECTOR and RXVECTOR parameters** starting from P305L54:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| DOPPLER | FORMAT is HE\_SU, HE\_MU, HE\_EXT\_SU or HE\_TRIG | Indicates whether ~~the doppler effect should be considered~~ midamble is present for the PPDU, or whether the channel is with high Doppler. The value is 0 or 1 | Y | ~~N~~ Y |
| Otherwise | Not present | N | N |
| MIDAMBLE\_PERIODICITY | FORMAT is HE\_SU, HE\_MU, HE\_EXT\_SU or HE\_TRIG, and DOPPLER is 1 | Indicates the midamble periodicity in number of OFDM sybmols in HE Data field. The value is 10 or 20 | Y | N |
| Otherwise | Not present | N | N |

TGax editor: make the following changes in **28.3.10.7.2 Content** starting from P367L50

**Table 28-17—HE-SIG-A field of an HE SU PPDU and HE ER SU PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| …. | …. | …. | …. |
| B23-B25 | Nsts and Midamble Periodicity | 3 | When Doppler = 0:  Indicates the number of space time streams.  For an HE SU PPDU:  Set to the number of space time streams minus 1.  For an HE ER SU PPDU:  Set to 0 for one space time stream when STBC field is set to 0  Set to 1 for two space time streams when STBC field is set to 1  Values 2-7 are reserved  When Doppler = 1:  B23-B24 indicates the number of space time streams, up to 4:  For an HE SU PPDU:  Set to the number of space time streams minus 1.  For an HE ER SU PPDU:  Set to 0 for one space time stream when STBC field is set to 0  Set to 1 for two space time streams when STBC field is set to 1  Values 2-3 are reserved  B25 indicates the Midamble periodicity.  Set to 0 if TXVECTOR parameter MIDAMBLE\_PERIODICITY  is 10  Set to 1 if TXVECTOR parameter MIDAMBLE\_PERIODICITY  is 20 |
| …. | ….. | …. | …. |
| B15 | Doppler | 1 | ~~Set to 0 if Doppler mode is not used~~  ~~Set to 1 if Doppler mode is used~~  Set to 1 if one of the following two cases is valid:   1. The number of HE data symbols is larger than the signaled Midamble Periodicity and the midamble is present 2. The number of HE data symbols is less than or equal to the signaled Midamble Periodicity plus 1 (Refer to 28.3.11.16 Midamble) but the channel doppler is  high   Set to 0 otherwise |

…..

**Table 28-18—HE-SIG-A field of an HE MU PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| …. | …. | …. | …. |
| B25 | Doppler | 1 | ~~Set to 0 if Doppler mode is not used~~  ~~Set to 1 if Doppler mode is used~~  Set to 1 if one of the following two cases is valid:   1. The number of HE data symbols is larger than the signaled Midamble Periodicity and the midamble is present 2. The number of HE data symbols is less than or equal to the signaled Midamble Periodicity plus 1 (Refer to 28.3.11.16 Midamble) but the channel doppler is  high   Set to 0 otherwise |
| ….. | ….. | ….. | ….. |
| B8-B10 | Number of HE-LTF Symbols and Midamble Periodicity | 3 | When Doppler = 0:  Indicates the number of HE-LTF symbols:  Set to 0 for 1 HE-LTF symbol  Set to 1 for 2 HE-LTF symbols  Set to 2 for 4 HE-LTF symbols  Set to 3 for 6 HE-LTF symbols  Set to 4 for 8 HE-LTF symbols  Other values are reserved.  When Doppler = 1:  B8-B9 indicates the number of HE-LTF symbols, up to 4:  Set to 0 for 1 HE-LTF symbol  Set to 1 for 2 HE-LTF symbols  Set to 2 for 4 HE-LTF symbols  Value 3 is reserved.  B10 indicates the Midamble periodicity.  Set to 0 if TXVECTOR parameter MIDAMBLE\_PERIODICITY  is 10  Set to 1 if TXVECTOR parameter MIDAMBLE\_PERIODICITY  is 20 |

TGax editor: insert a **new clause** **28.3.11.16 Midamble** as below:

**28.3.11.16 Midamble**

Midamble is applied for HE PPDU transmissions in channels with high Doppler, and it is an optional feature. Midamble is defined only when . The recipient may use the Midamble to compensate the channel estimation when it is varying fast in channels with high Doppler.

When the Doppler field of HE-SIG-A field is set to 1 in an HE SU PPDU, HE ER SU PPDU, or HE MU PPDU, or when the Doppler field in the Common Info field is set to 1 in the Trigger frame preceding an HE TB PPDU, Midamble(s) are inserted to the HE Data field every data OFDM symbols, where is the midamble periodicity in number of OFDM symbols, whose value is either 10 or 20, as indicated by HE-SIG-A field, defined in 28.3.10.7 (HE-SIG-A), or indicated by the Common Info field in the Trigger frame, defined in 9.3.1.23 (Trigger frame format).

An HE SU PPDU or HE ER SU PPDU with the Doppler field of HE-SIG-A field setting to 1 shall only be sent to a STA that set the Doppler Rx field to 1 in its HE Capabilities field, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field).

An HE MU PPDU with the Doppler field of HE-SIG-A field is set to 1 is allowed only when all the recipient STAs of the HE MU PPDU set the Doppler Rx field to 1 in their HE Capabilities fields, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field).

A Trigger Frame with the Doppler subfield in Common Info field set to 1 is allowed only when all the recipient STAs of the Trigger Frame set the Doppler Tx field to 1 in their HE Capabilities fields, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field).

Each Midamble is the same as the HE-LTF field(s) in the preamble of the same PPDU as defined in 28.3.10.10 (HE-LTF), as shown in Figure 23.3.11.16.1 (HE PPDU with Midamble).

An HE PPDU with Midamble containing 2x HE-LTF or 1x HE-LTF shall only be sent to the STA(s) that set the Doppler Rx subfield to 1 and the Midamble Rx 2x and 1x HE-LTF subfield to 1 in the HE Capabilities fields, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field). An HE PPDU with Midamble containing 4x HE-LTF may be sent to any STA(s) that set the Doppler Rx field to 1 in the HE Capabilities fields, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field).

A non-AP HE STA that sets the Doppler Tx field to 1 in the HE Capabilities fields, as defined in 9.4.2.237.3 (HE PHY Capabilities Information field), shall be able to transmit midambles with 4x HE-LTF(s) or 2x HE-LTF(s) in an HE TB PPDU, and shall be able to transmit midambles with 1x HE-LTF(s) in a full bandwidth UL MU-MIMO PPDU if it sets the Full Bandwidth UL MU-MIMO field to 1 in the HE Capabilities field.

When midamble is used in an HE PPDU, the number of space-time streams in this PPDU shall not be more than that indicated by the Midamble Rx Max NSTS field in the HE Capabilities fields set by the recipient STA(s), as defined in 9.4.2.237.3 (HE PHY Capabilities Information field).

The scrambling and encoding process of the bits in the the Data field OFDM symbols before and after each Midamble are the same as the case where Midamble is not present.

When present, the number of midamble periods, , in a PPDU is calculated by Equation (28-x1).

, (28-x1)

where is as defined in 28.3.11.5 (Coding). As shown in Figure 23.3.11.16.1 (HE PPDU with Midamble), the first Midamble is inserted right after the *MMA*-th data OFDM symbol in HE Data field, and there is no Midamble inserted after the last data OFDM symbol if . At the end of a HE PPDU, if , there is also no Midamble inserted before the last OFDM symbol, as shown in Figure 23.3.11.16.2 (Midamble at the end of HE PPDU).



**Figure 23.3.11.16.1 HE PPDU with Midamble**



**Figure 23.3.11.16.2 Midamble at the end of HE PPDU**

In an HE SU PPDU, HE ER SU PPDU, or HE MU PPDU, if the Doppler field of HE-SIG-A field is set to 1 and +1, there is no Midamble present in the current PPDU. In this case, the Doppler field setting to 1 indicates that the current channel between the transmitter and the recipient is with high channel Doppler, and midamble is recommended for the PPDUs of the reverse link.

TGax editor: make the following changes in **28.3.12 Packet extension** starting from P437L31:

….

When transmitting an HE TB PPDU for which the TXVECTOR parameter TRIGGER\_METHOD is TRIGGER\_FRAME, each transmitter of an HE TB PPDU shall append a PE field with a duration *TPE* calculated using Equation (28-109).

 ~~(28-109)~~

 (28-109)

where

m=2 for an HE TB PPDU,





LENGTH is the value indicated by Length subfield of the Common Info field in the Trigger

frame.

…. are defined in Table 28-11 (Timing-related constants).

is the number of midamble periods in the current PPDU. There are multiple options for computing , one example is as below:

The duration of one midamble period is defined as

, (28-x2)

where is the Midamble Periodicity indicated by the Number of HE-LTF Symbols and Midamble Periodicity subfield of the Common Info field in the Trigger frame. in (28-109) is then given by:



(28-x3)

where Doppler is indicated by the Doppler subfield of the Common Info field in the Trigger frame.

TGax editor: make the following changes in **28.3.12 Packet extension** starting from P438L22:

The receiver computes , ~~and~~ , and using Equation (28-111) ~~and~~, Equation (28-112) and Equation (28-x4), respectively.

 (28-110)

 (28-111)

(28-111)

, (28-112)

where

may be computed by multiple methods, one example is as below:



(28-x4)

where

 is defined in Equation (28-x2) except that in (28-x2) is the Midamble Periodicity indicated by the Nsts and Midamble Periodicity field of HE-SIG-A field in HE SU and HE ER SU PPDUs, or by the Number of HE-LTF Symbols and Midamble Periodicity field of HE-SIG-A field in HE MU PPDUs;

Doppler is indicated by the Doppler field of HE-SIG-A field.

TGax editor: make the following changes in **28.3.21 HE Receive Procedure** starting from P472L16:

 (28-121)

 (28-121)

where , , ~~and~~ , and  are defined in Equation (28-111) ~~and~~, Equation (28-112) and Equation (28-x4).

TGax editor: make the following changes in **28.4.2 TXTIME and PSDU\_LENGTH calculation** starting from P473L1:



 (28-123)

where

 is defined as in Equation (28-111), ~~and~~ Equation (28-112) and Equation (28-x4), ….

……

*TPE* is given in 28.3.12 (Packet extension).(#9490)

is the number of midambles. Its values is given by (28-x1) if the TXVECTOR value DOPPLER is 1, and is 0 otherwise.

and are given in 28.3.8 (Timing-related parameters).