IEEE P802.11
Wireless LANs

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| LB189 MU Comment Resolution |
| Date: 2012-11-13 |
| Author(s): |
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Abstract

This document proposes resolutions for the following MU CIDs: 7126, 7372, 7309, 7245, 7239, 7241, 7242, 7243, 7216, 7068, 7067, 7275, 7276, 7066, 7250, 7274, 7061, 7062, 7064, 7065, 7218, 7015, 7016.

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7126 | David Hunter | 8.4.1.52 | 74.26 | Where is "user position" defined, much less explained? | Define either here or in 10.40 what a user position is and how these user position values are used. | PROPOSED RESOLUTION: Revised. See changes under CID 7126 in document 12/1380r1. |

DISCUSSION: The commenter is correct that the use of User Position in Group ID is not indicated in this section nor is it explicitly stated in 10.40. It could be useful to the reader to provide a pointer to the section in clause 22 that explains how this information is used by a STA receiving an MU packet, and also to describe the intent of the group ID structure.

PROPOSED RESOLUTION to CID 7126: At the beginning of 10.40, 190.15, add the sentence:

 "An AP determines the possible combinations of STAs that can be addressed by an MU PPDU by assigning STAs to groups and to specific user positions within those groups."

At the end of the paragraph ending on 190.43 add the sentence:

 "The User Position in Group ID information is interpreted by a STA receiving an MU PPDU as explained in 22.3.11.4 (Group ID)."

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7372 | Mark RISON | 8.4.1.47 | 58.57 | When would a VHT Compressed Beamforming frame not contain any part of a BF report? | Add a "NOTE---This might be the case if the PPDU containing the VHT Compressed Beamforming report would otherwise violate a constraint such as aPPDUMaxTime." | Rejected. The commenters are referring to the sentence "In a VHT Compressed Beamforming frame not carrying all or part of a VHT Compressed Beamforming feedback(see 9.31.5 (VHT sounding protocol) for a description of such a case), …". This sentence refers to the following sentence in 9.31.5: "A VHT beamformee that transmits VHT Compressed Beamforming feedback shall not include the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information if the transmission duration of the PPDU carrying the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information would exceed the maximum PPDU duration." This pointer and the text 9.31.5 appear to give the reader sufficient information about such a case. |
| 7309 | Ahmadreza Hedayat | 8.4.1.47 | 58.56 | I have checked 9.31.5 and did not notice the exceptions cases that this paragraph refers to. Is the reference wrong? | Fix it. | Rejected. The sentence in 9.31.5 is: "A VHT beamformee that transmits VHT Compressed Beamforming feedback shall not include the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information if the transmission duration of the PPDU carrying the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information would exceed the maximum PPDU duration."  |

DISCUSSION: The commenters are referring to the sentence "In a VHT Compressed Beamforming frame not carrying all or part of a VHT Compressed Beamforming feedback
(see 9.31.5 (VHT sounding protocol) for a description of such a case), …". This sentence refers to the following sentence in 9.31.5: "A VHT beamformee that transmits VHT Compressed Beamforming feedback shall not include the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information if the transmission duration of the PPDU carrying the VHT Compressed Beamforming Report information and any MU Exclusive Beamforming Report information would exceed the maximum PPDU duration." This pointer and the text 9.31.5 appear to give the reader sufficient information about such a case.

PROPOSED RESOLUTION: Rejected.

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7245 | Sigurd Schelstraete | 8.4.1.49 | 70.15 | Add reference to define sscidx | sscidx is used in Table 8-53i without definition. Add a note similar to the note found at the bottom of Table 8-53f:"NOTE - sscidx(.) is defined in Table 8-53j" | PROPOSED RESOLUTION: Revised. Add the following note to the bottom of Table 8-53i. "NOTE—sscidx(.) is defined in Table 8-53j (Number of subcarriers and subcarrier mapping)". |
| 7239 | Sigurd Schelstraete | 8.4.1.48 | 61.24 | Inconsistent notation: both N\_STS and N\_STS,NDP are used | Replace "NDP with N\_STS space-time streams" with "NDP with N\_STS,NDP space-time streams" | PROPOSED RESOLUTION: Accepted |
| 7241 | Sigurd Schelstraete | 8.4.1.48 | 68.32 | Clarify requirement | Replace "includes subcarriers corresponding to the primary 20 MHz channel" with "includes only subcarriers corresponding to the primary 20 MHz channel" | PROPOSED RESOLUTION: Accepted |
| 7242 | Sigurd Schelstraete | 8.4.1.48 | 68.37 | Clarify requirement | Replace "includes subcarriers corresponding to the primary 40 MHz channel" with "includes only subcarriers corresponding to the primary 40 MHz channel" | PROPOSED RESOLUTION: Accepted |
| 7243 | Sigurd Schelstraete | 8.4.1.48 | 68.42 | Clarify requirement | Replace "includes subcarriers corresponding to the primary 80 MHz channel" with "includes only subcarriers corresponding to the primary 80 MHz channel" | PROPOSED RESOLUTION: Accepted |
| 7216 | Wei Shi | 8.4.1.48 | 62.01 | Table 8-53f shows the "structure" of a VHT Compressed Beamforming Report information. It is not clear (to me) that this is also the order in which information is sent. For example, Table 8-53d uses "Order". | Please specify for Table 8-53f that it is also the order in which information is sent. | PROPOSED RESOLUTION: Revised. On p. 61.61, change "structure" to "structure and order". |

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7068 | Brian Hart | 22.3.11.4 | 289.53 | A lot of overlap between para starting at L53 and para starting at L46 | reduce dup | PROPOSED RESOLUTION: Revised, see proposed text under CID 7068 in 12/1380r1. |
| 7067 | Brian Hart | 22.3.11.4 | 289.50 | "follow ... MU[0] NSTS ...MU[3] NSTS" is not correct | Change to "follow ... MU[0] NSTS ...MU[UserPositionInGroup[k]-1] NSTS" | PROPOSED RESOLUTION: Revised, see proposed text under CID 7068 in 12/1380r1. |
| 7275 | Sigurd Schelstraete | 22.3.11.4 | 289.49 | Unclear sentence: "The space time streams for the STA follow the space time streams indicated by the MU[0] NSTS, MU[1] NSTS, ..., MU[3] NSTS fields in VHT-SIG-A1."Does this simply repeat the requirement in the previous sentence or is there something new to this? | Clarify or delete sentence | Revised text under CID 7068 in 12/1380r1 has changed this to “MU[0] NSTS ...MU[UserPositionInGroup[k]-1] NSTS” so now it should be clear that this STA’s space-time streams will come after the streams assigned to smaller user position values.  |
| 7276 | Sigurd Schelstraete | 22.3.11.4 | 289.62 | "VHT-LTF symbols in the MU transmission are used to measure not only the channel for the space-time streams intended for the STA but also to measure the channel for the interfering space-time streams.".This looks like a statement of fact, while the actual operation is up to the implementer. | Replace "are used" with "may be used" | PROPOSED RESOLUTION: Revised, see proposed text under CID 7068 in 12/1380r1. |
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| 7066 | Brian Hart | 22.3.11.4 | 289.34 | ""group assignments shall have been establshed" belongs in a MAC clause. Ditto para's at P289L39 and P290L10 | Move | PROPOSED RESOLUTION: Revised, see proposed text under CID 7068 in 12/1380r1. |

Discussion. The text under discussion is the following:

A value in the Group ID field in VHT-SIG-A (see 22.3.8.2.3 (VHT-SIG-A definition)) in the range 1 to 62

indicates a VHT MU PPDU. Prior to transmitting a VHT MU PPDU, group assignments shall have been established

by the AP for DL-MU-MIMO capable STAs using the Group ID Management frame as defined in

8.5.23.3 (Group ID Management frame format).

When a STA receives a Group ID Management frame, the STA's MLME configures the following lookup

tables in the PHY using the PHYCONFIG\_VECTOR parameter GROUP\_ID\_MANAGEMENT:

a) group ID to Membership Status, denoted by MembershipStatusInGroupID[*g*] for

b) group ID to User Position, denoted by UserPositionInGroupID[*g*] for

When a STA that has these lookup tables configured receives a VHT MU PPDU where the Group ID field in

VHT-SIG-A1 has the value *k* and where MembershipStatusInGroupID[*k*] is equal to 1, then the number of

space time streams for that STA is indicated in the MU[UserPositionInGroupID[*k*]] NSTS field in VHT-SIGA1.

The space time streams for the STA follow the space time streams indicated by the MU[0] NSTS, MU[1]

NSTS, …, MU[3] NSTS fields in VHT-SIG-A1.

For group IDs whose corresponding Membership Status subfield is set to 1 in the Group ID Management

frame, the User Position subfield determines which of the four sets of 3 bits in the NSTS field in VHT-SIGA

corresponds to the user in an MU transmission. When a VHT MU PPDU is received, each STA identifies

whether it is a member of the group for this PPDU by detecting the Group ID field in VHT-SIG-A. If a STA

finds that it is a member of the group for the VHT MU PPDU, the STA determines the number of space-time

streams intended for it from its corresponding 3 bits in the NSTS field in VHT-SIG-A as determined by the

group definition of the corresponding group ID. At this point, a STA is also able to identify the space-time

streams it is intended to receive and the space-time streams intended for other STAs that act as interference.

VHT-LTF symbols in the MU transmission are used to measure not only the channel for the space-time

streams intended for the STA but also to measure the channel for the interfering space-time streams. To successfully

demodulate the space-time streams intended for the STA, it is recommended that the STA use the channel state information for all space-time streams to reduce the effect of interfering space-time streams.

If a STA finds that it is not a member of the group, or the STA is a member of the group but the corresponding

NSTS in VHT-SIG-A indicates that there are zero space-time streams for the STA in the PPDU, then the STA

may elect to not process the remainder of the PPDU.

The STA assigns or changes user positions corresponding to one or more group IDs through the PHY-CONFIG.

request primitive, specifying a PHYCONFIG\_VECTOR parameter GROUP\_ID\_MANAGEMENT that

indicates membership status and user position.

All of the above comments on this section of text are corrected and the text should be appropriately modified.

Proposed Resolution to CID 7086:

Modify text in 22.3.11.4 as follows:

A value in the Group ID field in VHT-SIG-A (see 22.3.8.2.3 (VHT-SIG-A definition)) in the range 1 to 62

indicates a VHT MU PPDU. Prior to transmitting a VHT MU PPDU, group assignments have been established

by the AP for DL-MU-MIMO capable STAs using the Group ID Management frame as defined in

8.5.23.3 (Group ID Management frame format).

After the STA's PLME is configured using the PHYCONFIG\_VECTOR parameter GROUP\_ID\_MANAGEMENT, the following lookup tables are populated:

a) group ID to Membership Status, denoted by MembershipStatusInGroupID[*g*] for

b) group ID to User Position, denoted by UserPositionInGroupID[*g*] for

When a STA receives a VHT MU PPDU where the Group ID field in

VHT-SIG-A1 has the value *k* and where MembershipStatusInGroupID[*k*] is equal to 1, then the number of

space time streams for that STA is indicated in the MU[UserPositionInGroupID[*k*]] NSTS field in VHT-SIGA1.

 The space-time streams of different users are ordered in accordance to user position values, i.e., the space-time streams for the user in user position 0 come first, followed by the space-time streams for the user in position 1, followed by the space-time streams for the user in position 2, and followed by the space-time streams for the user in position 3.

a STA is also able to identify the space-time

streams intended for other STAs that act as interference.

VHT-LTF symbols in the MU transmission are used to measure the channel for the space-time

streams intended for the STA, and can also be used to measure the channel for the interfering space-time streams. To successfully

demodulate the space-time streams intended for the STA, the STA may use the channel state information for all space-time streams to reduce the effect of interfering space-time streams.

If a STA finds that it is not a member of the group, or the STA is a member of the group but the corresponding

NSTS in VHT-SIG-A indicates that there are zero space-time streams for the STA in the PPDU, then the STA

may elect to not process the remainder of the PPDU.

Modify text in clause10.40 as follows:

A STA’s MLME that receives a Group ID Management frame with a RA matching its MAC address shall issue a

PHYCONFIG\_VECTOR primitive with the GROUP\_ID\_MANAGEMENT parameter based on the content

of the received Group ID Management framein order to configure the following lookup

tables in the PHY:

a) group ID to Membership Status, denoted by MembershipStatusInGroupID[*g*] for 1<= g <= 62.

b) group ID to User Position, denoted by UserPositionInGroupID[*g*] for 1 <= g <= 62.

Group ID values of 0 and 63 are used for SU PPDU and the

PHY filtering of such PPDUs is controlled by the PHYCONFIG\_VECTOR primitive LISTEN\_TO\_GID00

and LISTEN\_TO\_GID63 parameters.

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| 7250 | Sigurd Schelstraete | 8.5.23.3 | 114.56 | There is no statement on whether "Membership Status Array" and "User Position Array" should always be present or not. | Add appropriate requirement | Rejected |

DISCUSSION: The commenter is correct that there is no explicit statement regarding the inclusion of the two fields, but inclusion of all fields in other frame formats in 8.5 is assumed unless it is explicitly stated that a field is optional. Therefore, it does not seem that an explicit statement is necessary here.

PROPOSED RESOLUTION: Rejected

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7274 | Sigurd Schelstraete | 22.3.11.1 | 288.09 | Inconsistent use of "spatial streams" and "space-time streams".Text states: "With SU-MIMO beamforming, all spatial streams in the transmitted signal are intended for reception at a single STA. With DL-MU-MIMO beamforming, the space-time streams are divided between one or more STAs."Why "spatial streams" in one case (SU) and "space-time streams" in the other (MU)? | Use "space-time streams" or "spatial streams" for both cases (either works). | PROPOSED RESOLUTION. Revised. Change “spatial streams” on 290.9 to “space-time streams”. |

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7061 | Brian Hart | 22.3.11 | 288.01 | I'm really uncomfortable calling MU "beamforming" ... I'd say that MU requires both "beamforming (steering energy towards a desired user) and "null steering" (for a STS destined to one recipient, steering a null for that STS to all other recipients). | "MU precoding" / "MU beam+null steering" / "MU beamsteering+nullsteering", "MU steering", "MU Q-forming" seem to be more precise terms. Replace all instances of "MU BFer/BFing" by a more precise term |  Rejected. A general interpretation of the term “beamforming” encapsulates steering energy and creating spatial nulls, and thus can be applied to MU-MIMO. |

DISCUSSION: The commenter is correct that MU requires steering energy towards a desired user and steering a null towards unintended users, so this comment seems to reduce to one’s interpretation of the term

 “beamforming”: does “beamforming” only refer to the concept of steeing energy towards a user or direction, or does “beamforming” refer to the more general concept of antenna weighting and thus encapsulates steering energy and also creating nulls? I would argue the latter definition is more prevalent. For example, SU multi-stream SVD-based beamforming already corresponds to a more subtle and general concept of beamforming. The first sentence of the referenced clause also adheres to this more general interpretation: “SU-MIMO and DL-MU-MIMO beamforming are techniques used by a STA with multiple antennas (the beamformer) to **steer signals using knowledge of the channel to improve throughput**.” Second, implementing a change in terminology would require quite substantial throughout the spec because I believe using common terminology for SU/MU is preferable and thus a change along the lines suggested by the commenter would require changes throughout the spec. Based on these arguments I recommend to reject the comment.

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| 7062 | Brian Hart | 22.3.11.1 | 288.12 | "is determined by" is too strong. There are lots of other ways to determine Q | Replace by "can be determined from". Ditto P289L11, P289L12, |  PROPOSED RESOLUTION: Revise. On 288.12 change “is determined by” to “can be determined from”On 288.47 change “can be determined by” to “can be determined from”On 289.11 change “the beamformer uses this *Vk,*1 matrix to determine” to “the beamformer can use this *Vk,*1 matrix to determine” |

DISCUSSION: The sentence in question states: “For SU-MIMO beamforming, the steering matrix *Qk* is determined by the beamforming feedback matrix *Vk”.* The commenter is correct that this statement is too strong, for either SU or MU beamforming.

PROPOSED RESOLUTION:

On 288.12 change “is determined by” to “can be determined from”

On 288.47 change “can be determined by” to “can be determined from”

On 289.11 change “the beamformer uses this *Vk,*1 matrix to determine” to “the beamformer can use this *Vk,*1 matrix to determine”

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7064 | Brian Hart | 22.3.11.1 | 288.28 | u is usually used for user aka BFee | Change i to u in the equation and below |  PROPOSED RESOLUTION: Revised. See changes under CID 7064 in 12/1380r1. |

DISCUSSION: Commenter is correct that “u” is used for user indexing elsewhere in Clause 22, whereas in the 22.3.11.1 and 22.3.11.2 the indexes “i” and “j” are instead used. Furthermore, the indexing is “0,.., N\_{u} – 1” instead of the “1, ..,. N\_u” in this particular section.

PROPOSED RESOLUTION: In 22.3.11.1 and 22.3.11.2 , change all “i” indexes to “u”, change all “j” indexes to “u”, and change all indexing “1, ..,. N\_u” to “0,.., N\_{user} – 1”.

Note to Editor: please change all instances of “N\_u” in clause 22 with “N\_{user}”, consistent with the resolution to 12/812.

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| **CID** | **Commenter** | **Clause Number(C)** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7065 | Brian Hart | 22.3.11.2 | 289.21 | What is "MU BFer Capability"? | Rewrite as "If STA advertizes SU BFer Capable equal to 1, BFer shall support blah1. If STA advertizes MU BFer Capable equal to 1, BFer shall support blah2." |  PROPOSED RESOLUTION: Revise. See text under CID 7065 in 12/1380r1. |

DISCUSSION: The sentence under question is: “The beamformer shall support all tone grouping values and shall support all codebook information based on MU Beamformer Capability.” The commenter is correct that this sentence is unnecessarily vague.

PROPOSED RESOLUTION: Change last sentence in 22.3.11.2 to:

The beamformee decides the tone grouping value to be used in the beamforming feedback matrix *V*. A STA with dot11VHTSUBeamformerOptionImplemented equal to true shall support all tone grouping values and Codebook Information values.

NOTE: An MU beamformer is required to set dot11VHTSUBeamformerOptionImplemented to true (see 9.31.5).

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| 7218 | Wei Shi | 8.4.1.48 | 62.15 | Given that that the value k (Pg61, line 35) has been defined as transmited LSB first should we not also apply this to Average SNRs in Table 8.53f? | Please see comment. | Delete the sentence “The value of *k* for each angle is transmitted LSB to MSB.” on p. 61.35. |

DISCUSSION: In the description of the VHT Compressed Beamforming Report field it is stated: “The value of *k* for each angle is transmitted LSB to MSB.” Later in the same section the average SNR subfields are described as: “The Average SNR of Space-Time Stream *i* subfield in the Table 8-53f (VHT Compressed Beamforming Report information) is an 8-bit two's complement integer whose definition is shown in Table 8-53h (Average SNR of Space-Time Stream i subfield).”

Clause 8.2.2 (Conventions) establishes that LSB to MSB is the default bit ordering in frame formats, it does not seem that an explicit not is needed to describe the average SNR subfields or the quantized angle subfields.

PROPOSED RESOLUTION:

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| **CID** | **Commenter** | **Clause** | **Page** | **Comment** | **Proposed Change** | **Resolution** |
| 7015 | Yongho Seok | 10.40 | 190.38 | "A STA that receives a Group ID Management frame with a RA matching its MAC address shall issue aPHYCONFIG\_VECTOR primitive with the GROUP\_ID\_MANAGEMENT parameter based on the content of the received Group ID Management frame."If the message integrity check of protected Group ID management frame fails, the STA shall not issue aPHYCONFIG\_VECTOR primitive with the GROUP\_ID\_MANAGEMENT parameter. | Explain the procedure when the message integrity check of the Group ID management frame fail. |  |
| 7016 | Yongho Seok | 10.40 | 190.00 | STA sends an Acknowledgement frame after successfully receiving the Group ID management frame, regardless of the the message integrity check of the Group ID management frame.In that case, the Group ID membership status between AP and STA has not been synchronized.During this unsynchronized period, MU PPDU transmission will be failed and be dropped.At least, AP needs to recover this situation. | One simple solution is that AP requests STA Statistic Report about MU PPDU transmission.On this purpose, add the following counters in dot11CountersGroup3.- dot11TransmittedVHTMUPPDUCount (Counter32),- dot11TransmittedMPDUsInVHTMUPPDUCount (Counter32),- dot11TransmittedOctetsInVHTMUPPDUCount (Counter64),- dot11VHTMUPPDUReceivedCount (Counter32),- dot11MPDUInReceivedVHTMUPPDUCount (Counter32),- dot11ReceivedOctetsInVHTMUPPDUCount (Counter64),And, make a new group identity value in Table 8-88 for supporting STA Statistic Report of MU PPDU transmission. |   |

DISCUSSION: The commenter raises an interesting point about the scenario where the group ID management frame passes FCS but the message integrity check fails.

1. If the AP sends a legimate group ID management frame and it is decoded correctly, then both FCS and message integrity check will pass. The BFee will ACK the group ID management frame and the BFer (AP) and BFee will be synched as to the current group ID assignment.
2. If an illegimate group ID management frame is transmitted and it is decoded correctly, then the STA will immediately ACK the frame. However, the frame will not pass the message integrity check and therefore the STA will automatically not update the contents of its group ID assignment table – i.e., the group ID assignment table at the STA will remain unchaged. Furthermore, the true AP will not change its group ID assignment table since the true AP never transmitted a new group ID frame.

Based on the above two possibilities, it seems that the situation of a group ID management frame passing FCS but failing the message integrity check will not lead to group ID synchronization problems, and does not require further signalling along the lines of what is suggested by the commenter.