IEEE P802.11
Wireless LANs

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| Resolution to CIDs related to asymmetric beamforming and directional allocation |
| Date: 2018-01-15 |
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Abstract

This submission proposes resolutions to several CIDs related to asymmetric beamforming and direcational allocation. These CIDs are:

1111, 1157, 1355, 1356, 1357, 1358, 1371, 1412, 1779, 1780, 1781, 1789, 1945, 2139, 2140, 2141, 2142, 2317, 2318.

The discussion is in reference to Draft IEEE P802.11ay/D1.0.

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| CID | Clause | Comment | Proposed change |
| 1111 | 10.38.9.3.3 | the text doesn't guide what should be the length of Beamforming Training Allocation in DTI in case N Space Time Slots are utilized | Suggest to provide guidance text for AP including the maximum size allowed for Sector SSW in case of N STS |

**Proposed resolution:** Accepted.

*Add the following bullet at the end of the first paragraph of 10.38.9.3.2*

*---*The duration of the allocated beamforming training allocation shall be at least:

NSTS\* aSTSTime +MBIFS+aAirPropagationTime+TXTIME(Sector Ack)

where

NSTS is the value of N STS subfield in the EDMG Extended Schedule elemnt describing this beamforming training allocation.

aSTSTime is the duration a space-time slot defined in 10.38.9.3.3.

TXTIME(Sector Ack) is the transmission time of a Sector Ack frame, assuming there are NSTS Sector Ack subfields in the Sector Ack frame (see 9.3.1.22).

*Change the second sentence in the first paragraph of 10.7.7.1 as follows:*

The DMG Beacon, SSW-Feedback, SSW-Ack, Sector Ack, RTS, DMG CTS, DMG CTS-to-self, DMG DTS, CF-End, Grant, SPR, Poll and first BRP packet in beam refinement shall be transmitted using the DMG Control modulation class

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| CID | Clause | Comment | Proposed change |
| 1157 | 10.38.9.3.3 | "The random backoff procedure begins at the start of the beamforming training allocation with the responder selecting a backoff count as a random integer drawn from a uniform distribution [0, NSTS), i.e., 0 to NSTS - 1". I am uneasy about hiding a channel access mechanism in a beamforming training subclause. | Move to the channel access mechanism subclause e.g. a new 10.36.11.x, and reference from here. |

**Discussion:**

In 11ad when describing the random backoff procedure in beamforming in A-BFT, the spec also puts the channel access behaviour within the corresponding section (see 10.38.5.2 Operation dring the A-BFT, 8th paragraph). Here 11ay is consistent with the spec behaviour of 11ad.

**Proposed resolution:** Rejected.

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| CID | Clause | Comment | Proposed change |
| 1355 | 10.38.9.3.1 | "An asymmetric link is present when a STA is able to receive frames from the peer STA, but its frame transmissions are not received by the peer STA due to a difference in link budget between the uplink and downlink between the STAs. The difference in the number of antenna elements between a pair of STAs may cause an asymmetric link if a quasi-omni antenna configuration is used by one of the STAs when attempting communication with the peer STA." - The terminology is poor and confusing. The problem of asymmetric links starts with the quasi-omni pattern, not with stations not being able to each other transmission | a submission will be provided |

**Proposed resolution:** Revised

*Change the first paragraph of 10.8.9.3.1 as follows:*

An asymmetric link is present when the difference in the number of antenna elements between a pair of STAs is large. In this case, a STA with smaller number of antenna elements may not be able to communicate with the peer STA with a large number of antenna elements but uses a quasi-omni antenna configuration. ~~a STA is able to receive frames from the peer STA, but its frame transmissions are not received by the peer STA due to a difference in link budget between the uplink and downlink between the STAs.~~ ~~The difference in the number of antenna elements between a pair of STAs may cause an asymmetric link if a quasi-omni antenna configuration is used by one of the STAs when attempting communication with the peer STA.~~

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| CID | Clause | Comment | Proposed change |
| 1356 | 10.38.9.3.2 | "perform beamforming using the procedure described in this subclause shall use the TRN-R fields to" - I don't think a "shall" is appropriate here. You cannot force a STA to perform receive training. | replace "shall" with "may" |

**Discussion:**

The sentence says “A non-PCP and non-AP STA…**that decides to perform beamforming** using the procedure described in this subclause shall use…”, so use of “shall” here is appropriate because it is already restricted to STAs that only decide to perforem receive training. As a result, there is no behaviour of forcing a STA to do so.

**Proposed resolution:** Rejected

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| CID | Clause | Comment | Proposed change |
| 1357 | 10.38.9.3.1 | Nowhere within the subclause is it mentioned that reciprocity is assumed for the procedure to work. It should be mentioned | Add text to limit the use of this procedure to devices which have AWV reciprocity |
| 1412 | 10.38.9.3 | The beamforming for asymmetric links require STAs to have DMG antenna reciprocity and antenna pattern reciprocity. Otherwise, using the same antenna configuration trained using the TRN-R subfields appended at the end of Beacon frame to transmit the SSW frame to AP will not work. | Add the requirement of DMG antenna reciprocity and antenna pattern reciprocity for STAs using asymmetric beamforming. |

**Discussion:**

The asymmetric beamforming protocol described in 10.38.9.3 requires both DMG antenna reciprocity and antenna pattern reciprocity at the AP/PCP and STAs.

**Proposed resolution:** Accepted.

*Add the following praragraph to 10.38.9.3.1:*

The procedure defined in this subclaues requires the following condition to be met:

* Both of the DMG Antenna Reciprocity and Antenna Pattern Reciprocity subfields within the DMG STA Capabilitiey Information field of the initiator and responder are set to 1.

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| CID | Clause | Comment | Proposed change |
| 1358 | 10.38.9.3.3 | "The responder's transmission is performed in directional mode using the sector trained by the TRN-R subfields received in the last BTI." - transmission cannot be done through a receive antenna sector | replace with "The responder's transmission is performed in directional mode using a transmit corresponding the receive sector trained by the TRN-R subfields received in the last BTI." |

**Proposed resolution:** Revised

*Change the second bullet of the first paragraph of 10.38.9.3.3 as follows:*

At the start of the allocation, the responder(s) shall invoke a random backoff procedure to transmit a SSW frame. The random backoff procedure begins at the start of the beamforming training allocation with the responder selecting a backoff count as a random integer drawn from a uniform distribution [0, NSTS), i.e., 0 to NSTS – 1. The responder shall decrement the backoff count by one at the end of each space-time slot, even if the CS function at the responder indicates the medium busy condition for that space-time slot. The responder may transmit the SSW frame only at the start of the space-time slot for which the backoff count is 0 at the beginning of the space-time slot. The responder’s transmission is performed in directional mode using a transmit DMG antenna and sector corresponding to the receive DMG antenna and sector trained by the TRN-R subfields received in the last BTI.

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| CID | Clause | Comment | Proposed change |
| 1371 | 10.36.11.3 | "performing the procedure specified in 10.38.9" - 10.38.9 has many procedures specified | replace "10.38.9" with "10.38.9.3" |

**Discussion:**

A directional allocation may be scheduled as long as a direcational link is established between the initiator and responder. As a result, this establishment of a direcational link does not necessarily only come from the procedures for asymmetric beamforming. It can come from any beamforming procedures introduced in 10.38.9.

**Proposed resolution:** Rejected

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| CID | Clause | Comment | Proposed change |
| 1779 | 10.36.11.3 | The sentence reads "A directional allocation has the IsDirectional subfield within..." What is directional allocation? There is no definition of directional allocation. | Please add definition of directional allocation in clause 3. Also, Clause 10.36.11.3 should start with a paragraph explaining what is directional allocation and its usage. |

**Discussion:**

A clear definition and usage description of directional allocation should be sufficient to resolve the comment. We do not need to add a specific definition in Clause 3.

**Proposed resolution:** Revised

*Add the following paragraph at the beginning of 10.36.11.3*

A directional allocation is an allocation during which an EDMG AP or PCP uses a directional, non quasi-omni DMG antenna pattern to receive frames. Directional allocation can facilitate the frame exchange between an EDMG AP or PCP and an EDMG STA through the use of a directional link, particularly for those STAs that have insufficient link budget if a quasi-omni antenna configuration is used at the AP or PCP.

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| CID | Clause | Comment | Proposed change |
| 1780 | 10.36.11.3 | The sentence reads "A directional allocation has the IsDirectional subfield within..." Likely, directional allocation is not a frame field and does not have IsDirectional subfield. | Replace "A directional allocation has the IsDirectional subfield within the EDMG Extended Schedule element equal to one" with "When EDMG STA schedules a directional allocation, it sets IsDirectional subfield in the Receive Direction subfield subfield within the corresponding Channel Allocation field of the EDMG Extended Schedule element to one." |

**Proposed resolution:** Revised

*Change the first paragraph in 10.36.11.3 as follows:*

When an EDMG AP or PCP schedules a directional allocation, it shall set the IsDirectional subfield in the Receive Direction subfield within the corresponding Channel Allocation field of the EDMG Extended Schedule element to one. ~~A directional allocation has the IsDirectional subfield within the EDMG Extended Schedule element equal to one.~~ The decision to schedule a directional allocation is implementation dependent, but may be as a result of perfoming the procedure specified in 10.38.9.

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| CID | Clause | Comment | Proposed change |
| 1781 | 10.36.11.3 | The sentence "The Sector ID and DMG Antenna ID subfields of a directional allocation shall be set to ..." should read "Within the Channel Allocation field in the EDMG Extended Schedule element that specifies a directional allocation, the Sector ID and DMG Antenna ID subfields in the Receive Direction subfield shall be set to...". | As in comment |

**Proposed resolution:** Accepted.

**Proposed resolution:**

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| CID | Clause | Comment | Proposed change |
| 1789 | 10.38.9.3.3 | There is too long space between "Figure 104" and "-". | Please remove space between "Figure 104" and "-". |

**Proposed resolution:** Accepted.

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| CID | Clause | Comment | Proposed change |
| 1945 | 9.3.1.22 | "The Duration field is set to the time until the end of the current allocation." Unclear when the time starts and how end of the current allocation is known. | Following 10.38.9.3.3 Beamforming training allocation in DTI the Sector Ack is last frame in sequence so the field shall be set to 0. |

**Discussion:**

The Sector Ack frame transmission occurs within a beamforming training allocation that is dedicated to performing the asymmetric beamforming procedures described in 10.38.9.3. The “current allocation” in this sentence refers to this beamforming training allocation.

**Proposed resolution:** Revised

*Change the paragraph following Figure 9 as follows:*

The Duration field is set to the time until the end of the current beamforming training allocation (see 10.38.9.3.3).

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| CID | Clause | Comment | Proposed change |
| 2139 | 10.38.9.3.3(Line 29) | Replace "2^{STS}" with "2^{Nmax STS}" | As in comment |

**Proposed resolution:** Accepted

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| CID | Clause | Comment | Proposed change |
| 2140 | 10.38.9.3.3(Line 33) | "it" is ambiguous. Replace with "initiator" | As in comment |

**Proposed resolution:** Accepted

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| CID | Clause | Comment | Proposed change |
| 2141 | 10.38.9.3.3(Line 45) | Remove first instance of unnecessary "the" | As in comment |

**Proposed resolution:** Accepted

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| CID | Clause | Comment | Proposed change |
| 2142 | 10.38.9.3.3 | According to Section 6.5.4.2 of the 802.11-2016 Draft, aAirPropagationTime is "twice the propagation time (in microseconds) for a signal to cross the maximum distance between the most distance allowable STAs that are slot synchronized", we should take that into account in our definitions. | Change aAirPropagationTime to aAirPropagationTime/2 |

**Discussion:**

The slot duration definition here basically adapts the definition of slot duration in A-BFT used in 11ad (see 10.38.5.2 in 802.11-2016).

**Proposed resolution:** Revised.

*Change the first bullet of 10.38.9.3.3 as follows:*

A space-time slot has a duration of

aSTSTime=aAirPropagationTime + TXTIME(SSW) + aSIFSTime.

where

aAirPropagationTime accounts for the propagation delay between the initiator and the responder

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| CID | Clause | Comment | Proposed change |
| 2317 | 10.38.9.3.3 | The allocation of asymmetric BF should not be restricted to BTI with TRN-R. The STA with collision can use the same tx awv to retry if the next BTI does not have TRN-T but has asymmetric BF allocation | change to 'trained by the TRN-R subfields received in the last BTI which has TRN-R included in DMG Beacon frame' |

**Discussion**:

If an AP or PCP wants to allocate a beamforming training allocation to enable asymmetric beamforming, it shall always append TRN-R subfields to the beacon frame. If a STA fails to complete asymmetric beamforming in a beamforming training allocation, it may retry to do asymmetric beamforming training only in the next beamforming training allocation.

**Proposed resolution:** Revised

*Add the following bullet after the second bullet in 10.38.9.3.2*

*---*A PCP or AP shall not include an EDMG Extended Schedule element including one or more allocations that have the Asymmetric Beamforming Training subfield for the allocation set to 1, in a DMG beacon frame without appended TRN-R subfields.

*Change the last bullet of the first paragraph in 10.38.9.3.3 as follows:*

---A responder that transmits an SSW frame during a beamforming training allocation, but that does not receive a Sector Ack frame in response, may repeat the attempt to perform asymmetric beamforming training during the next beamforming training allocation.

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| CID | Clause | Comment | Proposed change |
| 2318 | 10.38.9.3.3 | The reception of sector Ack could be quasi-omni | remove the reception antenna pattern for sector Ack |

**Discussion:**

The STA is already receiving data portion of beacon using quasi-omni without issues. It can receive sector ack with quasi-omni as well.

**Proposed resolution:** Accepted

TGay editor should modify Figure 104 accordingly.

**Straw Poll:**

* **Do you agree to accept comment resolutions as proposed in doc 11-18/0158r0?**

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