IEEE P802.11
Wireless LANs

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| Scheduled BF CIDs |
| Date: 2018-11-07 |
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Abstract

This document provides resolution to CIDs: 3630, 3582, 3637, 3645, 3648, 3649, 3655, 3585

The baseline is D2.1 and the changes proposed by 11-18-1837-02-00ay-tdd-bf-related-cids.

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| 3630 | 46.00 | 6 | 6.3.117 | There are at least two case of TDD beamforming: 1) initial, when an AP STA supports new coming non-AP STA to join the Distribution network and 2) ongoing, when two STA exchange beamforming sequences while continue transferring data. In case 1) beamforming schedule of the AP STA is used so the schedule shall be included in the primitive parameters. Case 2) is not covered in the existent definition. | Add schedule information to the list of parameters. Add reference to 11.36.2. Modify the existent primitive or define new to cover the case 2. Support of the case 2 shall be defined in the normative behavior |
| 3582 |   |   |   | Priority collision between TDD SSW and Ack/Block Ack control frames with in-band beamforing using TDD slots | For DMG devices operating in TDD SP mode, priority collision between TDD SSW frames and Ack/Block Ack frames can happen, resulting in loss of beamforming frame or Ack / Block Ack frames and poor performance. Consider a range of a solutions; a good one is probably- Define prioriy of TDD SSW frame as higher than Ack and Block Ack )TDD SSW transmissions need to be srictly periodic)- Add a NOTE to highlight the role of scheduling in ensuring size of TDD slots needs to accommodate beamformon and other control packets or poor performance such as data retransissionmay may result. |
| 3637 | 141.00 | 26 | 9.4.2.267 | Joined use of basic slot for TDD beamforming frames and other frames is problematic. Rx Antenna configuration for the TDD beamforming frames shall be configured differently than for data/management frames | Add additional Access Type of TDD Beamforming to the TDD Slot categories. |
| 3645 | 215.00 | 1 | 10.40.6.2.2 | "In a Basic TDD slot the transmission of all frame types defined in 9.2.4.1.3 shall be allowed. In a Basic TDD slot the transmission of a Control frame and a Management frame ..." The TDD Beamforming frame is a control frame but receive of the frame may require different antenna configuration than any other control, management and data frames. The frame shall be separated from the list. | Separate TDD Beamforming frames from the control frames allowed in the Basic TDD Slot. Specify indication of the TDD slot type for beamforming |
| 3648 | 291.00 | 6 | 10.43.10.1 | "During TDD individual beamforming training, a STA that has not established a DMG control mode connection with an intended peer ..." there is no definition of the beamforming in case the responder keeps the TDD Slots provided by TDD Slot Structure and TDD Slot Schedule elements. The mentioned issue is relevant for the beam link measurement as well. | Provide definition of beamforming under established scheduled TDD slots |
| 3649 | 295.00 | 27 | 10.43.10.3 | "A responder STA that ... or has not yet acquired the TDD Slot Structure element.." there is no definition of the beamforming in case the responder keeps the TDD Slots provided by TDD Slot Structure and TDD Slot Schedule elements. The mentioned issue is relevant for the beam link measurement as well | Provide definition of beamforming under established scheduled TDD slots |
| 3655 | 329.00 | 25 | 11.36.2 | Existent definition does not provide TDD beamforming in the established link when the STA's are exchanging data and beamforming is needed to keep or improve the existent link quality. | Define TDD beamforming in the established link conditions that both sides keep synchronization and schedule |

Proposed Resolution: **Revised** (for CIDs 3630, 3582, 3637, 3645, 3648, 3649, 3655 above)

**Discussion:**

Beamforming when a TDD SPs schedule is established between devices has some issues as described in the comments above. It is especially true when BF is performed while data transmission between the STAs involved in the BF training and with other STAs is on-going. We propose to define a TDD BF slot category that will be allocated to transmission of TDD-SSW, TDD-SSW-Ack frames. We propose that TDD-SSW-Feedback frames and frames will be transmitted in Basic Slots with higher priority than other control, management and data frames.

***TGay Editor: Modify the the text in P140L25-26 (in 9.4.2.267) as follows:***

and Access Type Schedule field. A value of 0 indicates Basic TDD slot and a value of 1 indicates Data-only TDD slot. A value of 2 indicates a BF TDD slot. The value 3 is reserved. The size of the Slot Category Schedule field is a function of

***TGay Editor: Modify the text in P216L1-4 (10.40.6.2.2) as follows:***

Each TDD slot has one slot category, namely, a Basic TDD slot,a Data-only TDD slot or a TDD BF slot. In a Basic TDD slot the transmission of all frame types defined in 9.2.4.1.3 shall be allowed. In a Basic TDD slot the transmission of a Control frame and a Management frame should be given priority over transmission of other frame types, and TDD-SSW Feedback frame shall have the highest priority. In a Data-only TDD slot, only Data frames and BlockAckReq frames shall be allowed. In a BF TDD slot only the transmission of TDD SSW and TDD SSW Ack frames is allowed.

**10.43.10.2 Initiator operation for TDD individual beamforming**

***TGay Editor: change text at p292 L23 as follow***

For TDD individual beamforming, the BFType parameter is set to TDD Individual BF in the MLME-TDD-

BF-TRAINING.request primitive.

To initiate TDD individual beamforming with a known responder, the initiator shall send multiple TDD SSW frames with the RA field set to the Responder STA’s MAC address as indicated by the PeerSTAAddress parameter of the
MLME-TDD-BF-TRAINING.request primitive.

To initiate TDD individual beamforming with an unknown responder, the initiator shall send multiple TDD SSW frames with the RA field set to the broadcast MAC address. The initiator should switch use the responder’s individual address in TDD SSW frame transmissions after receiving a TDD SSW Feedback frame from the designated responder.

TDD SSW frames that are sent from the same transmit DMG antenna shall have the same TX Antenna ID subfield value. TDD SSW frames that are sent from the same transmit antenna sector shall have the same TX Sector ID subfield value. These frames shall be transmitted with the same transmit power and the PPDUs carrying these frames shall not include TRN fields.

The initiator shall send TDD SSW frames through all the DMG antennas and through all the sectors indicated by the TX Antenna ID and TX Sector ID values as indicted in the TXSectorIDList parameter of the MLME-TDD-BF-TRAINING.request primitive. Moreover, for each DMG antenna and for each sector, the initiator shall send TDD SSW frames with the same TX Antenna ID and TX Sector ID subfield for the number of times indicated in the SectorRepetitions parameter of the MLME-TDD-BF-TRAINING.request primitive.

The Transmit Period subfield value within TDD SSW frames shall remain the same throughout a TDD beamforming training. If Transmit Period subfield is set to a nonzero value, the initiator STA shall transmit any two consecutive TDD SSW frames of the TDD beamforming training with the same Count Index value at the time offset equal to Transmit Period value.

When the link between the initiator and responder of the TDD individual beamforming is in the active state, with the initiator being a PCP/AP STA, and the initiator has sent the responder at least one frame with a TDD Slot Structure element and a TDD Slot Schedule element, the initiator shall use TDD BF Slots to send TDD SSW and TDD SSW Ack frames. In this case the Transmit Period subfield shall be set to zero.

TDD SSW and TDD SSW Ack frames transmitted in the same TDD slot shall be separated with SBIFS

interval and shall have a strictly increasing Count Index subfield value. The first TDD SSW frame or TDD

SSW Ack frame transmitted in a TDD slot shall have the Count Index subfield set to zero.

NOTE—It is recommended to transmit all TDD SSW frames, if any, before transmitting TDD SSW Ack frames in the same TDD slot.

To receive the TDD SSW Feedback frame from the responder, the initiator shall set its receive antenna to

the same DMG antenna and sector as was indicated in the TX Antenna ID and TX Sector ID subfields of the respective TDD SSW frame at the time offset indicated by the following equation:

**10.43.10.3 Responder operation for TDD individual beamforming**

***TGay Editor Change text in the first 3 paragraphs as follows:***

A responder STA that has received a TDD SSW frame shall sweep its receiver antenna configuration through its receive sectors between TDD beamforming frames received in a TDD slot and between TDD slots used for BF training. Responder antenna switching shall be done according to the period as indicated by the non-zero Transmit Period subfield of the received TDD SSW frame.

NOTE—To increase the likelihood of detecting the initiator’s TDD SSW frame, the responder SME can set

SectorDwellTime to at least [2 × TXTIME (TDD SSW) + SBIFS].

A responder STA that has received a TDD SSW frame with RA field set to the responder own MAC address or to broadcast address shall sweep its receiver antenna configuration through its receive sectors between TDD beamforming frames received in a TDD slot and between TDD slots used for BF training according to the period as indicated by the Transmit Period subfield of the received TDD SSW frame.

A responder STA that has received a frame with a TDD Slot Structure element and a TDD Slot Schedure element, shall sweep it receiver antenna configuration through its received sectors in TDD BF slots. It shall continue the sweep from the previous configuration (used in the preceding TDD BF slot) at the begining of each TDD BF slot regardless received of the values of received Transmit Period fields. In this case the SectorDwellTime should be set to TXTIME(TDD SSW)+SBIFS.

Such a responder STA may use any Basic TDD slot assigned for transmission from the responder to the initiator to trasnsmit the TDD SSW Feedback frame. The Responde may set the End of Training field in this TDD SSW Feedback frame to indicate that it has received enough repetitions from the current transmit sector and the initiator may proceed to the next transmit sector. In this case, the initiator does not set the End of Training field in the TDD SSW Ack frame to 1, unless it determined to terminate the beamforming training.

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| 3585 |  |  | Allow variants of beam measuremet operation where results are passed back to initiator over the air instead of local SME; this is to accommodate a class of non-AP STAs that may not have access to nework-level management softwae. | Define beam measurement opeartion with or without sending responses over the air |

Proposed Resolution: **Revised**

**Discussion**

We propose to add a bit to the TDD SSW BF frame that will indicate whether the initiator requests OTA feedback using a TDD route element. The TDD route element shall be sent after the end of the beamforming measurement.

***TGay Editor: Modify figure 13- TDD Beamformign Information field format (TDD beam measurement) in 9.3.1.24.2***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | TX SectorID | TX AntennaID | CountIndex | Beamforming TimeUnit | TransmitPeriod | TDD Slot CDOWN  | Feedback Requested | Reserved |
| Bits:  | 10 | 2 | 3 | 3 | 8 | 10 | 1 | 11 |

**Figure 13 —TDD Beamforming Information field format (TDD beam measurement)**

***TGay Editor: at the following text at the end 9.3.1.24.2***

The Feedback Requested field when sent as part of TDD beam measurement indicates that the initiator requests that the reponder(s) send a TDD route element as a feedback to the beam measurement.

***TGay Editor Modify 10.43.10.6 and 10.43.10.7 as follows***

**10.43.10.6 Initiator operation for TDD beam measurement**The initiator operation during a TDD beam measurement is the same as the initiator operation for TDD individual BF, with the following differences:

* TDD beam measurement is started upon receiving an MLME-TDD-BEAM-
MEASUREMENT.request primitive with BFRole parameter set to Initiator.
* During a TDD beam measurement, the TDD Slot CDOWN field in each transmitted frame shall contain the total number of TDD BF slots remaining until the end of the initiator TDD beam measurement, such that the last TDD SSW frame transmission by the initiator has the TDD Slot CDOWN field set to 0.
* The initiator may set the Feedback Requested field in the TDD Beaforming Information field to 1 to request that the responder(s) send a TDD Route element in an announce frame with the measurement results after the end
* No TDD SSW Ack frame shall be transmitted

**10.43.10.7 Responder operation for TDD beam measurement**

The responder operation during a TDD beam measurement procedure is the same as the responder operation for TDD individual BF, with the following differences:

* TDD beam measurement is started upon receiving an MLME-TDD-BEAM-MEASUREMENT.request primitive with BFRole parameter set to Responder, or by receiving a TDD SSW frame with the RA field equal to STA’s MAC address or the broadcast address with the TDD Beam Measurement field set to 1.
* If the Feedback Requested field in the TDD SSW frames received by the responder is set to 0, the responder shall not transmit any frames to the initiator and shall report the measurement results to the SME instead.
* TDD beam measurement ends at the end of the TDD slot during which the initiator transmits the last TDD SSW frames with the TDD Slot CDOWN field set to 0.
* If the Feedback Requested field in the TDD SSW frames received by the responder is set to 1, the responder shall sent an Announce frame with a TDD route element containing the results of the TDD beam measurement on all received transmit sectors in the first TDD slot allocated from the responder to the initiator.

**References:**

**[1] Draft P802.11ay\_D2.1**

**[2] 11-18-1837-02-00ay-tdd-bf-related-cids**