IEEE P802.11
Wireless LANs

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| --- |
| TDD network entry |
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Proposed resolutions to CID 6235 (clarifying the TDD network entry process). Proposed text changes are based on 11md Draft 3.4 and 11ay Draft 5.0.

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| --- | --- | --- | --- |
| **CID** | **Comment** | **Proposed change** | **Resolution** |
| 6235 | Network entry (including association and initial TDD slot structure/schedue establishment) following initial beamforming is not clear, in particular, (1) there is a need for periodic transmit oppportunity to retry transmission, and (2) initial frame from the DN/initiator should be Probe Response (avoiding Class 0 Announce for mmWave use case) | Define the operation and applicable frames. | Revised  |

**Discussion:**

We find the comment generally valid and propose a few clarifications and changes to the the process that an AP and a non-AP STA follow for the non-AP to join the BSS.

First, we clarify that Initiator Transmit Offset and Responder Transmit Offset fields in the TDD SSW Ack frame define a periodic transmit opportunity to exchange management frames, in case retries are needed. This was originally descrined in Document 802.11-18/0381 (Slide 2), but not reflected in the implementation text.

Additionally, we align the management exchange after the last TDD SSW Ack frame with the standard Probe Request | Probe Response exchange. Client sending the first management frame,

* Aligns with the standard 802.11 model (including non-TDD in 802.11ad/ay)
* Enables the AP / infrastructure to further validate or better accommodate the client STA, e.g., based on the its capabilities and vendor-specific element contents (fundmantal need for clinet making attributes available to the infrastructure does not go away even when MAC address is known).
* Allows exchange of discovered beams (through TDD Route element) in the original order proposed in 802.11-17/1321 (Side14), where the non-AP (responder) transmits the best receive beams for the AP’s (initiator’s) different transmit beams.

|  |  |  |
| --- | --- | --- |
| **Draft 5.0** |  | **New sequence** |
| **Initiator -->** | **<-- Responder** |  | **Initiator -->** | **<-- Responder** |
| … |  |  | … |  |
| TDD SSW |  |  | TDD SSW |  |
|  | TDD SSW Feedback |  |  | TDD SSW Feedback |
| TDD SSW Ack |  |  | TDD SSW Ack |  |
|  |  |  |  |  |
|  |  |  |  | **Probe Request** |
| **Announce** |  |  | **Probe Response** |  |
|  | Announce |  |  |  |
|  | Association Request |  |  | Association Request |
| Association Response |  |  | Association Response |  |
| … |  |  | … |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Resolution:** Revised. Text implementation follows.

***Editor: Change Section 9.3.1.25.2 as follows***

**9.3.1.25.2 TDD SSW frame**

…

The Responder Feedback Offset subfield indicates the offset, in units of BTUs, beginning immediately after the end of the first TDD SSW frame, to where the first TDD SSW Feedback frame is to be transmitted by the responder. This subfield is reserved when the TDD SSW frame is transmitted exclusively for TDD beam measurement.

The Initiator Ack Offset subfield indicates the offset, in units of BTUs, beginning immediately after the end of the first TDD SSW frame, to where the first TDD SSW Ack frame is to be transmitted by the initiator. This subfield is reserved when TDD SSW frame is transmitted exclusively for TDD beam measurement.

***Editor: Change Section 9.3.1.25.4 as follows***

**9.3.1.25.4 TDD SSW Ack frame**

…

The Transmit Period subfield indicates the interval, in units of BTUs, between successive transmit opportunities for the initiator to transmit frames other than TDD Beamforming frames to the responder, and also between successive transmit opportunities for the responder to transmit frames other than TDD Beamforming frames to the initiator, after completion of the unscheduled beamforming procedure, as defined in 10.42.11 (TDD beamforming).

…

The Initiator Transmit Offset subfield indicates the offset, in units of BTUs, beginning immediately after the end of the first TDD SSW Ack frame with the End Of Training subfield set to 1, to the first point in time that the initiator has an opportunity to transmit a frame other than a TDD beamforming frame to the responder. When the Initiator Transmit Offset subfield is set to 0, no time offset indication is specified by the initiator.

The Responder Transmit Offset subfield indicates the offset, in units of BTUs, beginning immediately after the end of the first TDD SSW Ack frame with the End Of Training subfield set to 1, to the first point in time that the responder has an opportuity to transmit a frame other than a TDD beamforming frame to the initiator. When the Responder Transmit Offset subfield is set to 0, no time offset indication is specified by the initiator.

***Editor: Change Section 9.3.3.9 as follows***

**9.3.3.9 Probe Request frame format**

*Insert the following rows in Table 9-40 (Probe Request frame body)*

|  |  |  |
| --- | --- | --- |
| 38 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 39 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 40 | TDD Route | The TDD Route element is optionally present if dot11TDDOptionImplemented is true and is absent otherwise, |

***Editor: Change Section 9.3.3.10 as follows***

**9.3.3.10 Probe Response frame format**

*Insert the following rows in Table 9-41 (Probe Response frame body)*

|  |  |  |
| --- | --- | --- |
| 105 | EDMG Capabilities | The EDMG Capabilities element is present if dot11EDMGOptionImplemented is true. |
| 106 | EDMG Operation | The EDMG Operation element is present if dot11EDMGOptionImplemented is true. |
| 107 | Unsolicited Block Ack Extension | The Unsolicited Block Ack Extension element is optionally present if dot11UnsolicitedBAActivated is true and is absent otherwise. |
| 108 | TDD Slot Structure | The TDD Slot Structure element is optionally present if dot11TDDOptionImplemented is true and is absent otherwise, |
| 109 | TDD Route | The TDD Route element is optionally present if dot11TDDOptionImplemented is true and is absent otherwise, |

***Editor: Change Section 10.42.11.2 as follows***

**10.42.11.2 Initiator operation for TDD individual beamforming**

…

The TDD SSW Ack frame shall include the sector used by the initiator to transmit the TDD SSW Ack in the TX Sector ID subfield, the sector used by the responder to transmit the TDD SSW Feedback frame in the Decoded TX Sector ID subfield, the measured SNR of the decoded TDD SSW Feedback frame in the SNR Report subfield, and in when performing unscheduled TDD beamforming, the time offsets to exchange frames containing TDD Route, TDD Slot Structure, and TDD Slot Schedule elements.

…

After the initiator has sent the last TDD SSW Ack frame with the End Of Training subfield set to 1 to the responder, it may transmit a single PPDU other than a TDD Beamforming frame to the responder, setting its transmit antenna to the same sector it used to transmit the last TDD SSW Ack frame, at the following time offset relative to the end of the last transmitted TDD SSW Ack frame:

*InitiatorTransmitOffset* – [(*CountIndex* + 1) × TXTIME(TDD SSW) + (*CountIndex* × SBIFS)] (5)

where:

*InitiatorTransmitOffset* is the Initiator Transmit Offset subfield value, in microseconds, in the TDD SSW Ack frame with the End of Training subfield set to 1. This value is the summation of two terms: a) the first factor is the duration from the end of the first TDD SSW frame or TDD SSW Ack frame to the start of the first transmit opportunity for initiator; b) the second factor is TXTIME(TDD SSW), which is a fixed value.

*CountIndex* is the Count Index subfield value from the received TDD SSW or TDD SSW Ack frame

Subsequent opportunities for the initiator to transmit to the responder are separated by the value of the Transmit Period subfield in the last TDD SSW Ack frame.

Additionally, after the initiator has sent the last TDD SSW Ack frame with the End Of Training subfield set to 1 to the responder, it can receive a single PPDU other than a TDD Beamforming frame from the responder, setting its receive DMG antenna and sector to what was indicated in the TX Antenna ID and TX Sector ID subfield of the respective TDD SSW Ack frame, and at the following time offset relative to the end of the last transmitted TDD SSW Ack frame:

*ResponderTransmitOffset* – [(*CountIndex* + 1) × TXTIME(TDD SSW) + (*CountIndex* × SBIFS)] (6)

where:

*ResponderTransmitOffset* is the Responder Transmit Offset subfield value, in microseconds, in the TDD SSW Ack frame with the End of Training subfield equal to 1. This value is the summation of two terms: a) the first factor is the duration from the end of the first TDD SSW frame or TDD SSW Ack frame to the start of the first transmit opportunity for responder; b) the second factor is TXTIME(TDD SSW), which is a fixed value.

*CountIndex* is the Count Index subfield value from the respective TDD SSW or TDD SSW Ack frame

Subsequent opportunities for the responder to transmit to the initiator are separated by the value of the Transmit Period subfield in the last TDD SSW Ack frame.

For the unscheduled TDD beamforming procedure, equations (3) and (4) establish transmit opportunities to exchange TDD Beamforming frames, and equations (5) and (6) establish transmit opportunities to exchange frames other than TDD Beamforming frames after TDD beamforming training completion with the responder.

In the unscheduled TDD beamforming procedure, upon transmission of the last TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall be ready to receive a Probe Request frame from the responder at the time offset indicated by equation (6). The initiator shall then, at the time offset indicated by equation (5), shall transmit a Probe Response frame to the responder that includes a TDD Slot Structure element and a TDD Route element that lists the ordered pairs of TX sector IDs and decoded RX sector IDs obtained during the TDD beamforming training with the responder.

In the scheduled TDD beamforming procedure, the initiator shall send TDD SSW and TDD SSW Ack frames during BF TDD slots assigned to transmit from the initiator to the responder. The exchange of TDD Route elements takes place during non-beamforming TDD slots available to the initiator and to the responder after completion of the TDD beamforming training with the responder.

***Editor: Change Section 10.42.11.3 as follows***

**10.42.11.3 Responder operation for TDD individual beamforming**

…

In the unscheduled TDD beamforming procedure, upon reception of a TDD SSW Ack frame with End of Training subfield equal to 1, the responder, at the time offset indicated by equation (6), shall transmit a Probe Request frame to the initiator that includes a TDD Route element listing the ordered pairs of transmit sectors and decoded receive sectors obtained during the TDD beamforming training with the initiator. The responder shall then, at the time offset indicated by equation (5), be ready to receive a Probe Response frame from the initiator.

In the scheduled TDD beamforming procedure, the responder shall send TDD SSW Feedback frames during BF TDD slots assigned to transmit from the responder to the initiator. The exchange of TDD Route elements takes place during Basic or Data TDD slots available to the initiator and the responder after completion of the TDD bemforming training.

***Editor: Change Section 10.42.11.4 as follows***

**10.42.11.4 Initiator operation for TDD group beamforming**

…

The TDD SSW Ack frame shall include the DMG antenna and the sector used by the initiator to transmit the TDD SSW Ack frame in, respectively, the TX Antenna ID and TX Sector ID subfields, the DMG antenna and sector used by the responder to transmit the TDD SSW Feedback frame in, respectively, the Decoded TX Antenna ID and Decoded TX Sector ID subfields, the measured SNR of the decoded TDD SSW Feedback frame in the SNR Report subfield and, when performing unscheduled TDD beamforming, time offsets to exchange frames containing TDD Route, TDD Slot Structure, and TDD Slot Schedule elements.

…

Once the initiator sends a TDD SSW Ack frame with the End of Training subfield equal to 1 to a target responder, it may transmit a single PPDU other than a TDD Beamforming frame to the target responder, setting its transmit antenna to the same sector it used to transmit the last TDD SSW Ack frame, at the following time offset relative to the end of the last transmitted SSW Ack frame, or, alternatively, in an assigned BF TDD slot:

*InitiatorTransmitOffset* – [(*AckCountIndex* + 1) × TXTIME(TDD SSW Ack) + (*CountIndex* – *AckCountIndex*) × TXTIME(TDD SSW) + (*Count Index* × SBIFS)] (9)

where:

*InitiatorTransmitOffset* is the Initiator Transmit Offset subfield value, in microseconds, in the TDD SSW Ack frame with the End of Training subfield set to 1. This value is the summation of two terms: a) the first factor is the duration from the end of the first TDD SSW or TDD SSW Ack frame to the start of the first transmit opportunity for the initiator; b) the second factor is TXTIME(TDD SSW), which is variable.

*CountIndex* is the Count Index subfield value from the received TDD SSW or TDD SSW Ack frame

*AckCountIndex* is the Ack Count Index subfield value from the transmitted TDD SSW Ack frame

Subsequent opportunities for the initiator to transmit to the responder are separated by the value of the Transmit Period subfield in the last TDD SSW Ack frame.

Additionally, after the initiator has sent the last TDD SSW Ack frame with the End of Training subfield equal to 1 to a target responder, it can receive a single PPDU other than a TDD Beamforming frame from the responder, setting its receive DMG antenna and sector to what was indicated in the TX Antenna ID and TX Sector ID subfields of the respective TDD SSW Ack frame, and at the following offset relative to the end of the last transmitted TDD SSW Ack frame:

*ResponderTransmitOffset* – [(*AckCountIndex* + 1) × TXTIME(TDD SSW Ack) + (*CountIndex* – *AckCountIndex*) × TXTIME(TDD SSW) + (*Count Index* × SBIFS)] (10)

where:

*ResponderTransmitOffset* is the Responder Transmit Offset subfield value, in microseconds, in the TDD SSW Ack frame with the End of Training subfield set to 1. This value is the summation of two terms: a) the first factor is the duration from the end of the first TDD SSW or TDD SSW Ack frame to the start of the first transmit oportunity for responder; b) the second factor is TXTIME(TDD SSW), which is variable.

*CountIndex* is the Count Index subfield value from the respective TDD SSW or TDD SSW Ack

*AckCountIndex* is the Ack Count Index subfield value from the transmitted TDD SSW Ack frame

Subsequent opportunities for the responder to transmit to the initiator are separated by the value of the Transmit Period subfield in the last TDD SSW Ack frame.

 For the unscheduled TDD beamforming procedure, equations (7) and (8) establish transmit opportunities to exchange TDD Beamforming frames, and equations (9) and (10) establish transmit opportunities to exchange frames other than TDD Beamforming frames after TDD beamforming training completion with the target responder.

In the unscheduled TDD beamforming procedure, upon transmission of the last TDD SSW Ack frame with End of Training subfield equal to 1, the initiator shall be ready to receive a Probe Request frame from the responder at the time offset indicated by equation (10). The initiator shall then, at the time offset indicated by equation (9), shall transmit a Probe Response frame to the responder that includes a TDD Slot Structure element and a TDD Route element that lists the ordered pairs of TX sector IDs and decoded RX sector IDs obtained during the TDD beamforming training with the responder.

In the scheduled TDD beamforming procedure, the initiator shall send TDD SSW and TDD SSW Ack frames during BF TDD slots assigned to to transmit from the initiator to the responder. The exchange of TDD Route elements takes place during non-beamforming TDD slots available to the initiator and the target responder after completion of the TDD beamforming training with the target responder.

***Editor: Change Section 10.42.11.5 as follows***

**10.42.11.5 Responder operation for TDD group beamforming**

…

In the unscheduled TDD beamforming procedure, upon reception of a TDD SSW Ack frame with End of Training subfield equal to 1, the responder, at the time offset indicated by equation (10), shall transmit a Probe Request frame to the initiator that includes a TDD Route element listing the ordered pairs of transmit and decoded receive sectors obtained during the TDD beamforming training with the initiator. The responder shall then, at the time offset indicated by equation (9), be ready to receive a Probe Response frame from the initiator.

In the scheduled TDD beamforming procedure, the responder shall send TDD SSW Feedback frames during BF TDD slots assigned to transmit from the responder to the initiator. The exchange of TDD Route elements takes place during Basic or Data TDD slots available to the initiator and the responder after completion of the TDD bemforming training.