IEEE P802.11
Wireless LANs

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| RD Protocol |
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Abstract

This submission provides resolutions to CIDs 52, 2459 and 2632.

The reverse direction (RD) protocol enables both UL and DL MPDUs transmissions in a single TXOP. The RD protocol has two main use cases in 802.11ax:

1. Power saving non-AP STA uses announced TWT. The STA may transmit UL Data and receive DL data frames in a single TXOP, which shortens the operation in Awake state and increases the transmission efficiency.
2. The HE AP may use RD protocol to allow a single STA to transmit at the whole bandwidth, using MCS and NSS that the STA desires. The non-AP STA transmission duration is limited to the remainder of the TXOP. This is similar operation to Triggering, except the HE AP does not need to precisely specify transmission parameters. This results to simple operation, precise use of transmission resources and low transmission overhead.

This submission describes:

* RD protocol signaling is proposed to be carried in a new A-Control field:
	+ This allows aggregation of Buffer Status Report(BSR) and RD protocol signaling to the same MPDU. BSR is needed for UL MU PPDUs triggering.
	+ No new control signaling for RD protocol.
* Use of Multi-TID transmissions with RD protocol:
	+ An HE AP RD intiator may allow the HE non-AP STA RD responder to aggregate MPDUs from any AC, similarly as in Triggering.
	+ HE AP RD responder transmits DL and receives UL MPDUs of RD initiator in primary AC and higher AC. The HE AP RD responder may transmit DL MPDUs and receive UL MPDUs of other STAs, if the transmission duration of the MPDUs to the RD initiator does not increase.

**CID 52**

* **Comment:**
	+ Clarify whether the TXOP that is used for cascading is owned by the AP or could be owned by a STA? If an AP can use the TXOP that is owned by a STA, how/where would the signaling between the AP and the STA for TXOP transefr or RD should take place?
* **Proposed change:**
	+ As in the comment.
* **Proposed resolution:**

REVISED.

The non-AP STA can obtain a TXOP and use reverse direction protocol to grant the HE AP to be RD responder. The main motivation of the RD protocol is to allow the RD responder opportunity to transmit reverse direction frames to the RD initiator. If the HE AP RD responder is allowed to transmit the HE UL and HE DL transmissions, the HE AP may transmit to multiple STAs and the RD intiator may not receive any data. This lowers RD initiator STA throughput and lowers the motivation to use the reverse direction protocol.

The HE AP RD responder is not allowed to transmit HE Triggered PPDUs or HE DL MU PPDU. This ensures that non-AP STA has motivation to use the RD protocol. To improve RD protocol efficiency, the RD responder is allowed to use Multi-TID A-MPDU aggregations and RD protocol may be signaled through A-Control HT Control field. These changes are described in the 11-16-xxxx-00-00ax-RD-protocol.docx submission.

HE AP is the TXOP holder of the MU cascade transmissions. This simplifies the data flow.

**CID 2459**

* **Comment:**
	+ "A HE AP can initiate a cascading sequence of MU PPDUs in a TXOP, allowing alternating HE MU PPDUs and HE trigger-based PPDUs starting with a DL MU PPDU in the same TXOP, as illustrated in Figure 25-2 (An example of cascading sequence of MU PPDUs)."
	+ In the HE MU cascading operation, can an HE non-AP STA initiate a cascading sequence? If it is allowed, please specify the detailed rule. Otherwise, change the sentence as the following:
	+ "Only HE AP can initiate a cascading sequence of MU PPDUs in a TXOP, allowing alternating HE MU PPDUs and HE trigger-based PPDUs starting with a DL MU PPDU in the same TXOP, as illustrated in Figure 25-2 (An example of cascading sequence of MU PPDUs).”
* **Proposed change:**
	+ As per comment
* **Proposed resolution:**

REVISED. The MU cascaded sequence requires MU DL, Trigger and HE Triggered PPDUs transmissions. All these PPDU types are not allowed to transmit by the RD responder. Thus, the HE non-AP STA is not allowed to initiate the cascading sequence.

**CID 2632**

* **Comment:**
	+ It is not clear if an AP can transmit a DL MU PPDU in a TXOP that is obtained from a non-AP STA. For example, when a STA obtains a TXOP by sending frames to the serving AP, it is not clear if the AP is allowed to send DL MU PPDU as a response to the UL frame.
* **Proposed change:**
	+ As mentioned in the comment, clarify if an AP is allowed to send a DL MU PPDU in a TXOP that is obtained from a non-AP STA.
* **Proposed resolution:**

REVISED.

The non-AP STA can obtain a TXOP and use reverse direction protocol to grant the HE AP to be RD responder. The main motivation of the RD protocol is to allow the RD responder opportunity to transmit reverse direction frames to the RD initiator. If the HE AP RD responder is allowed to transmit the HE UL and HE DL transmissions, the HE AP may transmit to multiple STAs and the RD intiator may not receive any data. This lowers RD initiator STA throughput and lowers the motivation to use the reverse direction protocol.

The HE AP RD responder is not allowed to transmit HE Triggered PPDUs or HE DL MU PPDU. This ensures that non-AP STA has motivation to use the RD protocol. To improve RD protocol efficiency, the RD responder is allowed to use Multi-TID A-MPDU aggregations and RD protocol may be signaled through A-Control HT Control field. These changes are described in the 11-16-xxxx-00-00ax-RD-protocol.docx submission.

The HE PA RD responder is not allowed to transmit DL MU PPDUs or Trigger frames. Thus, when DL MU PPDUs are transmitted, the TXOP is obtained by the AP.

**9.2.4.6 HT Control field**

**9.2.4.6.4.1 General**

***Instructions to Editor: Add The following control ID to Table 9-18a – Control ID subfield Values.***

|  |  |  |  |
| --- | --- | --- | --- |
| Control ID value | Meaning  | Length of the Control Information subfield (bits) | Content of the Control Information subfield |
| 5 | Reverse Direction Protocol | 8 | See 9.2.4.6.5.2 |
| ~~5~~6 - 15 | Reserved |

**9.2.4.6.5.2 Reverse direction protocol**

***Instructions to Editor: Add new clause as shown below***

|  |  |  |  |
| --- | --- | --- | --- |
|  | B0 | B1 | B2 B7 |
|  | AC Constraint  | RDG/More PPDU  | Reserved |
| Bits | 1 | 1 | 6 |

**Figure 9-15h—Control Information subfield format when the Control ID subfield is 5**

The AC Constraint subfield of the HT Control field indicates whether the mapped AC of an RD Data frame is constrained to a single AC. Value 1 indicates that the response from non-HE STA to an RDG contains Data frames only from the same AC as the last Data frame received from the RD initiator and the response from the HE STA contains Data frames from the same AC or higher AC; see 10.28.4 (Rules for RD responder). Value 0 indicates that the response to a reverse direction grant (RDG) contains Data frames from any TIDs; see 10.28.4 (Rules for RD responder).

NOTE 2—The AC of the last Data frame received from the RD initiator is determined directly from the TID of the received frame if the TID is between 0 and 7 inclusive or from the UP field of the TSPEC identified by the TID of the received frame if the TID is between 8 and 15 inclusive.

The RDG/More PPDU subfield of the HT Control field is interpreted differently depending on whether it is transmitted by an RD initiator or an RD responder, as defined in Table 9-15i (RDG/More PPDU subfield values).

**Table 9-15X— RDG/More PPDU subfield values**

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**10.28 Reverse direction protocol**

**10.28.2 Reverse direction (RD) exchange sequence**

***Instructions to Editor: Change the clause as shown.***

An RD exchange sequence comprises the following:

a) The transmission of a PPDU by a TXOP holder or SP source containing an RD grant (the RDG PPDU), which is indicated by the PPDU containing one or more A-Control, +HTC or DMG MPDUs in which the RDG/More PPDU subfield is equal to 1. The STA that transmits this PPDU is known as the RD initiator. The rules for an RD initiator apply only during a single RD exchange sequence, i.e., after the transmission of an RDG PPDU and up to the end of the last PPDU in the RD exchange sequence

**10.28.3 Rules for RD initiator**

***Instructions to Editor: Change the clause as shown.***

Transmission of a frame by an RD initiator with the RDG/More PPDU subfield equal to 1 (either transmitted as a non-A-MPDU frame, as a VHT single MPDU, or within an A-MPDU) indicates that the duration indicated by the Duration/ID field is available for the RD response burst and RD initiator final PPDU (if present).

An RD initiator other than HE AP that sets the RDG/More PPDU field to 1 in a +HTC or DMG frame transmitted during a TXOP shall set the AC Constraint subfield to 1 in that frame if the TXOP was gained through the EDCA channel access mechanism and shall otherwise set it to 0. An RD initiator that sets the RDG/More PPDU field to 1 in a DMG frame transmitted during an SP can set the AC Constraint subfield to 1 to limit the Data frames transmitted by the RD responder.

An HE AP RD initiator that sets the RDG/More PPDU field to 1 in a frame transmitted during a TXOP may set the AC Constraint subfield to 1.

An RD initiator shall not transmit a frame with the RDG/More PPDU subfield set to 1 that requires a response MPDU that is not one of the following frames:

—Ack

— Compressed BlockAck

—Multi-STA BlockAck

Subject to TXOP or SP constraints, after transmitting an RDG PPDU, an RD initiator may transmit its next PPDU as follows:

a) Normal continuation: The RD initiator may transmit its next PPDU a minimum of a SIFS after receiving a response PPDU that meets one of the following conditions:

1) Contains one or more received frames with the RDG/More PPDU subfield equal to 0

2) In an HT STA, contains one or more received frames that are capable of carrying the HT Control field but did not contain an HT Control field

3) Contains a received frame that requires an immediate response

4) In a DMG STA, none of the correctly received frames in the PPDU carry the QoS Control field

b) Error recovery: The RD initiator may transmit its next PPDU when the CS mechanism (see 10.3.2.1 (CS mechanism)) indicates that the medium is idle at the TxPIFS slot boundary (see Figure 10-26 (EDCA mechanism timing relationships)) (this transmission is a continuation of the current TXOP or SP).

**10.28.4 Rules for RD responder**

***Instructions to Editor: Change the clause as shown.***

An RD responder shall not transmit an MPDU (either individually or aggregated within an A-MPDU) that is not one of the following frames:

—Ack

— Compressed BlockAck

— Compressed BlockAckReq

— Extended Compressed BlockAck

— Extended Compressed BlockAckReq

—Multi-STA BlockAck

—QoS data

—Management

If the AC Constraint subfield is equal to 1, the non-HE RD responder shall transmit Data frames of only the same AC as the last frame received from the RD initiator. HE STA that is RD responder may transmit A-MPDU with MPDUs from multiple TIDs as described in 25.10.4 A-MPDU with multiple TID.

For a BlockAckReq or BlockAck frame, the AC is determined by examining the TID field. For a Management frame, the AC is AC\_VO. The RD initiator shall not transmit a MPDU with the RDG/More PPDU subfield set to 1 from which the AC cannot be determined. If the AC Constraint subfield is equal to 0, the RD responder may transmit Data frames of any TIDs.

**25.10.4 A-MPDU with multiple TIDs**

***Instructions to Editor: Change the clause as shown.***

A multi-TID A-MPDU shall not be transmitted in an HE SU PPDU or HE extended range SU PPDU except when TXOP limit is not zero for the AC that is used to gain access to the medium. This AC is defined as the primary AC. The TXOP limit of an RD responder is taken from the Duration/ID field of the final PPDU of the RD initiator. An RD responder with AC Constraint field set to 1 uses the AC of the last PPDU received from the RD initiator as the primary AC. An RD responder with AC Constraint field set to 0 may use any AC as the primary AC. When TXOP limit is not zero then the STA may aggregate QoS Data frames from one or more TIDs in the A-MPDU under the following conditions:

**References:**

802.11ax D0.5

802.11 revmc D8.0