IEEE P802.11

Wireless LANs

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**Comment**

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| 3747 | 8.2.4.6.3 | 23.36 | Since MU-MIMO is introduced in 11ac, why not consider MU-MIMO in RDG? If an STA grants its TXOP to the AP, AP should be able to do MU-MIMO transmission to a group of STAs including the RD initiator.  | Add the subclause 9.24.4 the following: "During an RDG, the RD responder may transmit frames with an Address 1 field matches the MAC address of the RD initiator or transmit to a group of STAs including the RD initiator using MU-MIMO." | **Agree in principle** |

**Discussion:**

It is not clear if MU-MIMO transmissions are allowed in the reverse direction, when RDG protocol is used. It is beneficial to allow MU MIMO operation in RD.

With the proposed amendments in this document

1. RD responder is allowed to send frames to STAs other that the RD initiator, hence also allowing MU-MIMO transmissions.
2. Moreover, a frame sent by the RD responder to a STA (let say STA A) that is not the RD initiator, shall not solicit a SIFS response;

The reason for the restriction of point 2) is to avoid hidden node conditions between the RD initiator and STA A; in fact, STA A may be hidden from the RD initiator and hence RD initiator may not detect the response sent by STA A; that would trigger the PIFS recovery operation by the initiator, resulting in a collision; by forbidding the SIFS response from STAs other than the initiator, the hidden condition is avoided.

No change in frame format is required.

**Instructions to the editor**

***(highlighted in yellow)***

**9.24 Reverse Direction Protocol**

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

An RD exchange sequence comprises the following:

1. The transmission of a PPDU by a TXOP holder containing an RD grant (the *RDG PPDU*), which is indicated by the PPDU containing one or more +HTC 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.
2. The transmission of one or more (MU) PPDUs (the RD response burst) by the STA addressed in the MPDUs of the RDG PPDU. The first (or only) PPDU of the RD response burst contains at most one immediate BlockAck or ACK response frame. The last (or only) PPDU of the RD response burst contains any MPDUs requiring an immediate BlockAck or ACK response. The STA that transmits the RD response burst is known as the RD responder. The rules for an RD responder apply only during a single RD exchange sequence, i.e., following the reception of an RDG PPDU and up to the transmission of a PPDU by the RD responder in which the RDG/More PPDU subfield is equal to 0.
3. The transmission of a PPDU by the RD initiator containing an immediate BlockAck or ACK MPDU (the RD initiator final PPDU), if so required by the last PPDU of the RD response burst.

NOTE—An RD initiator might include multiple RD exchange sequences within a single TXOP. Each RD exchange sequence within a single TXOP might be addressed to a different recipient, and any single recipient might be given more than one RDG within a single TXOP.

An example of an RD exchange sequence is given in S.3 (Example of an RD exchange sequence).

**9.24.2 Support for RD**

Support of the RD feature is an option for an HT STA. It is optional in the sense that a TXOP holder is never required to generate an RDG, and a STA receiving an RDG is never required to use the grant.

Support of the RD feature as an RD responder is indicated using the RD Responder subfield of the HT Extended Capabilities field of the HT Capabilities element. A STA shall set the RD Responder subfield to 1 in frames that it transmits containing the HT Capabilities element if dot11RDResponderOptionImplemented is true. Otherwise, the STA shall set the RD Responder subfield to 0.

**9.24.3 Rules for RD initiator**

An RDG shall not be present unless the MPDU carrying the grant, or every MPDU carrying the grant in an A-MPDU, matches one of the following conditions:

* A QoS data MPDU with the Ack Policy field equal to any value except PSMP Ack (i.e., including Implicit Block Ack Request), or
* A BlockAckReq related to an HT-immediate Block Ack agreement, or
* An MPDU not needing an immediate response (e.g., BlockAck under an HT-immediate Block Ack agreement, or Action No Ack).

An RDG shall not be present within a PSMP sequence.

NOTE 1—These rules together with the rules in 8.6.3 (A-MPDU contents) ensure that an RDG is delivered in a PPDU that either requires no immediate response or requires an immediate BlockAck or ACK response.

NOTE 2—An RD initiator is not required to examine the RD Responder field of a potential responder before deciding whether to send a PPDU to that STA in which the RDG/More PPDU subfield is set to 1.

NOTE 3—An RD initiator is required according to 9.9 (HT Control field operation) to examine the +HTC Support field of a potential responder before deciding whether to send a PPDU to that STA in which the RDG/More PPDU subfield is set to 1.

Transmission of a +HTC frame by an RD initiator with the RDG/More PPDU subfield equal to 1 (either transmitted as a non-A-MPDU frame 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 that sets the RDG/More PPDU field to 1 in a +HTC frame 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 shall not transmit a +HTC frame with the RDG/More PPDU subfield set to 1 that requires a response MPDU that is not one of the following:

* Ack
* Compressed BlockAck

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

1. *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 correctly received +HTC frames with the RDG/More PPDU subfield equal to 0, or
	2. Contains one or more correctly received frames that are capable of carrying the HT Control field but did not contain an HT Control field, or
	3. Contains a correctly received frame that requires an immediate response
2. *Error recovery:* The RD initiator may transmit its next PPDU when the CS mechanism (see 9.3.2.2 (CS mechanism)) indicates that the medium is idle at the TxPIFS slot boundary (defined in 9.3.7 (DCF timing relations)) (this transmission is a continuation of the current TXOP).

NOTE 1—Error recovery of the RDG mechanism is the responsibility of the RD initiator.

NOTE 2—After transmitting a PPDU containing an RDG, if the response is corrupted so that the state of the RDG/More PPDU subfield is unknown, the RD initiator of the RD exchange is not allowed to transmit after a SIFS interval. Transmission can occur a PIFS interval after deassertion of CS.

NOTE 3—After transmitting a PPDU requiring a response but not containing an RDG, the state of the RDG/More PPDU subfield in the response does not affect the behavior of the RD initiator.

A STA that transmits a QoS +CF-ACK data frame according to the rules in 9.19.3.5 (HCCA transfer rules) may also include an RDG in that frame provided that

* It is a non-A-MPDU frame, and
* The target of the +CF-ACK is equal to the Address 1 field of the frame.

NOTE—The RD initiator can transmit a CF-End frame according to the rules for TXOP truncation in 9.19.2.7 (Truncation of TXOP) following a RD transmit sequence. An RD responder never transmits a CF-End.

**9.24.4 Rules for RD responder**

An RD responder shall transmit the initial PPDU of the RD response burst a SIFS after the reception of the RDG PPDU. PPDUs in a response burst are separated by SIFS or RIFS. The RIFS rules in the RD are the same as in the forward direction; the use of RIFS is constrained as defined in 9.3.2.4.2 (RIFS) and 9.22.3.3 (RIFS protection).

NOTE—The transmission of a response by the RD responder does not constitute a new channel access but a continuation of the RD initiator’s TXOP. An RD responder ignores the NAV when responding to an RDG.

The recipient of an RDG may decline the RDG by

* Not transmitting any frames following the RDG PPDU when no response is otherwise required, or
* Transmitting a control response frame with the RDG/More PPDU subfield set to 0, or
* Transmitting a control response frame that contains no HT Control field

An RD responder may transmit a +CF-ACK non-A-MPDU frame in response to a non-A-MPDU QoS Data +HTC MPDU that has the Ack Policy field equal to Normal Ack and the RDG/More PPDU subfield equal to 1.

The RD responder shall ensure that its PPDU transmission(s) and any expected responses fit entirely within the remaining TXOP duration, as indicated in the Duration/ID field of MPDUs within the RDG PPDU.

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

* Ack
* Compressed BlockAck
* Compressed BlockAckReq
* QoS data
* Management

If the AC Constraint subfield is equal to 1, the RD responder shall transmit data frames of only the same AC as the last frame received from the RD initiator. 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 +HTC 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 TID.

During an RDG, the RD responder shall not transmit any frames causing a response after SIFS with an Address 1 field that does not match the MAC address of the RD initiator.

If an RDG PPDU also requires an immediate BlockAck response, the BlockAck response frame shall be included in the first PPDU of the response.

When a PPDU is not the final PPDU of a response burst, an HT Control field carrying the RDG/More PPDU subfield set to 1 shall be present in every MPDU within the PPDU capable of carrying the HT Control field. The last PPDU of a response burst shall have the RDG/More PPDU subfield set to 0 in all +HTC MPDUs contained in that PPDU.

The RD responder shall not set the RDG/More PPDU subfield to 1 in any MPDU in a PPDU that contains an MPDU that requires an immediate response.

NOTE— If the RD responder transmits a PPDU that expects a transmission by the RD initiator after SIFS and no such transmission is detected, the RD responder has to wait for either another RDG or its own TXOP before it can retry the exchange.

After transmitting a PPDU containing one or more +HTC MPDUs in which the RDG/More PPDU subfield is equal to 0, the RD responder shall not transmit any more PPDUs within the current response burst.

NOTE— If an RD-capable STA that is not the TXOP holder receives a PPDU that does not indicate an RDG, there is no difference in its response compared to a STA that is not RD-capable.