### **IEEE P802.11 Wireless LANs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PDT on MU-RTS | | | | |
| Date: 2021-06-28 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | Email |
| Yanjun Sun | Qualcomm |  |  |  |
| Steve Shellhammer |  |  |  |
| Alfred Asterjadhi |  |  |  |
| George Cherian |  |  |  |
| Bin Tian |  |  |  |
| Youhan Kim |  |  |  |
| Abhishek Patil |  |  |  |
| Duncan Ho |  |  |  |
| Gaurang Naik |  |  |  |
| Xiaogang Chen | Intel |  |  |  |
| Lei Huang | Oppo |  |  |  |
| Liwen Chu | Nxp |  |  |  |
| Ross Yu | Huawei |  |  |  |
| Ming Gan | Huawei |  |  |  |
| Po-kai Huang | Intel |  |  |  |

**Abstract**

This submission proposes spec text on MU-RTS/CTS based on SP #412 and #413.

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: added description on the PS160 subfield; added spec text to disallow MU-RTS in an EHT MU PPDU; revised text and illustration based on inputs.
* Rev 2: like in HE, prohibit MU-RTS in an “MU” PPDU and allow it in a “SU” PPDU; editorial updates to emphasize that the Rx has a unified procedure of identifying HE or EHT variant for MU-RTS and other Trigger types

**Discussion**

The following two SPs on MU-RTS have passed and we need to expand the subclauses related to Trigger frame based on them.

**Straw poll #412**

Do you agree:

* The special user info field (user info field with AID=2007) shall be present in all the EHT TF variants defined in 11be R1.
  + For the EHT variant of MU-RTS, all the bits in the special user info field are reserved except the “BW Extension” subfield. ***[#SP412]***

[21/0485r2 (Clarifications on the trigger frame design, Xiaogang Chen, Intel), SP#1, No objection]

**Straw poll #413**

Do you agree that

* The CTS response to MU-RTS supports all the modes in 11ax and 320MHz non-HT duplicate transmission;
* The CTS response to MU-RTS supports transmitting on non-contiguous 20MHz subchannels;
* The CTS response to MU-RTS is transmitted on the 20MHz subchannel(s) that are overlapped with the large size RU indicated by its own RU allocation subfield;
* The CTS response to MU-RTS shall be transmitted including the primary 20MHz channel.

Note: This SP is for R1. ***[#SP413]***

[21/0485r3 (EHT LTF clarification, Xiaoggang Chen, Intel), SP#2, No objection]

**Design direction based on SPs above:**

A User Info field in an MU-RTS Trigger frame indicates a large RU (i.e., no MRU) that includes the primary 20 MHz

* The Special User Info field shall be present when an EHT AP sends an EHT variant MU-RTS Trigger frame (needed for **320 MHz** and **punctured MU-RTS/CTS**)
  + Set B54 and B55 in Common Info field to 0 based on Table 9-29g1 in D1.0 (i.e., the last 2 rows in the snapshot below)
    - E.g. “B54=0, B55=0, B39=0” is for primary 160 within a 320 MHz MU-RTS
    - E.g. “B54=0, B55=0, B39=1” is for 320 MHz RU based on existing RU table
    - Table

      Description automatically generated
* If the PPDU carrying MU-RTS has a bandwidth of 160 MHz or less without puncturing, the EHT AP may send an HE or EHT variant MU-RTS Trigger frame (like the existing rules for basic Trigger frame)
  + For HE variant, set B54 and B55 in Common Info field to 1 and B39 in User Info field to 0 based on the above table
* AP shall not solicit punctured CTS from an HE STA.
  + Example: secondary 40 MHz punctured, indicated in beacons
    - An MU-RTS sent to an HE STA and an EHT STA
    - CTS from the HE STA can be sent on the primary 40 MHz
    - CTS from the EHT STA can be sent on the full bandwidth with secondary 40 MHz punctured

**To put the above design direction into context with a table:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MU-RTS/CTS for EHT STAs** | | | | | | | | | |
| **Input** | | | | | | | **Output at non-AP EHT STA** | | |
| **Common Info field** | | **User Info field** | | | **Presence of Special User Info** | **Bandwidth derived from UL BW (and BW Extension)** | **Variant of User Info** | **Non-AP EHT STA action** | **CTS BW** |
| **B54** | **B55** | **B39 (PS160)** | **RU Allocation** | |
| **B0** | **B7-B1** |
| 1 | 1 | 0 | 0 or 1 | 61-68 as in HE RU Allocation Table | No | <= 160 MHz | HE | Follow HE rules (puncturing disallowed) | |
| 0 | 0 | 0 | 0 or 1 | 61-68 as in EHT RU Allocation Table | Yes | <=160 MHz | EHT | Follow EHT rules (puncturing allowed) | |
| 0 | 0 | 0 | 0 | 61 | Yes | 320 MHz | EHT | respond | 20 MHz |
| 0 | 0 | 0 | 1 | discard |
| 0 | 0 | 1 | 0 | discard |
| 0 | 0 | 1 | 1 | discard |
| … … (i.e. entries for 62 to 67 not shown for brevity) | | | | | … … | |
| 0 | 0 | 0 | 0 | 68 | discard | 160 MHz |
| 0 | 0 | 0 | 1 | respond |
| 0 | 0 | 1 | 0 | discard |
| 0 | 0 | 1 | 1 | discard |
| 0 | 0 | 0 | 0 | 69 | discard | 320 MHz |
| 0 | 0 | 0 | 1 | discard |
| 0 | 0 | 1 | 0 | discard |
| 0 | 0 | 1 | 1 | respond |

***TGbe editor: Please note baselines are REVmd D5.0, 11ax D8.0 and 11be D1.0***

***TGbe editor: Please update subclause 9.3.1.22.5 as follows:***

* MU-RTS Trigger frame format(#24216) (#SP 412, #SP 413)

The Trigger Dependent Common Info subfield and Trigger Dependent User Info subfield are not present in the MU-RTS Trigger frame.

The UL BW subfield in the Common Info field along with the UL BW Extension subfield in the Special User Info field (if present) indicates the bandwidth of the PPDU carrying the MU-RTS Trigger frame and is defined in Table 9-31d (UL BW subfield encoding) and Table (9-29j3—UL Bandwidth Extension subfield encoding).

~~If any non-AP EHT STA is addressed in an MU-RTS Trigger frame from an EHT AP and any of the following conditions is met, the Special User Info field is present and B54 and B55 in the Common Info field of the MU-RTS Trigger frame are set to 0 to indicate that the User Info field addressed to an EHT STA in the MU-RTS Trigger frame is an EHT variant User Info field:~~

If any non-AP EHT STA is addressed in an MU-RTS Trigger frame from an EHT AP and any of the following conditions is met, the User Info field addressed to an EHT STA in the MU-RTS Trigger frame is an EHT variant User Info field:

* The bandwidth of the PPDU carrying the MU-RTS Trigger frame is 320 MHz;
* The PPDU carrying the MU-RTS Trigger frame is punctured.

~~Otherwise, the EHT AP decides whether to include the Special User Info field in the MU-RTS Trigger frame. If the Special User Info field is not present, B54 and B55 in the Common Info field are set to 1 and B39 in each User Info field is set to 0 in the MU-RTS Trigger frame to indicate that the MU-RTS Trigger frame contains one or more HE variant User Info fields and no EHT User Info field. In this case, the PPDU carrying the MU-RTS Trigger frame or any responding CTS frame is not punctured. If the Special User Info field is present, B54 and B55 in the Common Info field are set to 0 in the MU-RTS Trigger frame to indicate that the User Info field addressed to an EHT STA in the MU-RTS Trigger frame is an EHT variant User Info field.~~

Otherwise, the EHT AP decides whether the User Info field in the MU-RTS Trigger frame is an HE variant User Info field or an EHT variant User Info field.An EHT AP does not set B54 in the Common Info field to 1 and B55 in the Common Info field to 0 in an MU-RTS Trigger frame.

NOTE--refer to 9.3.1.22.1.2 (User Info List field) on valid combinations of B54 and B55 in the Common Info field, B39 in the User Info field, and User Info field variant.

The UL Length, MU-MIMO HE-LTF Mode, Number Of HE-LTF Symbols And Midamble Periodicity, UL STBC, LDPC Extra Symbol Segment, AP Tx Power(#24289), Pre-FEC Padding Factor, PE Disambiguity, UL Spatial Reuse, and Doppler subfields in the Common Info field are reserved. In the HE variant of the Common Info field, the HE-SIG-A2 Reserved subfield is reserved.

The TXOP Sharing Mode subfield in the Common Info field is set to a nonzero value if the MU-RTS Trigger frame is sent by an EHT AP that intends to allocate time within an obtained TXOP to a non-AP EHT STA for transmitting one or more non-TB PPDUs sequentially (see 35.2.1.3 (Triggered TXOP sharing procedure)); otherwise it is set to 0. The encoding of the TXOP Sharing Mode subfield is defined in Table 9-29j5 (TXOP Sharing Mode subfield encoding).

Table

Description automatically generated

An MU-RTS Trigger frame that has the TXOP Sharing Mode subfield set to a nonzero value is called an MU-RTS TXOP Sharing (TXS) Trigger frame for the remainder of this subclause and throughout Clause 35 (Extremely high throughput (EHT) MAC specification). An Allocation Duration subfield in the MU-RTS TXS Trigger frame indicates the time duration allocated to the non-AP STA within the TXOP obtained by the AP.

The UL HE-MCS, UL FEC Coding Type, UL DCM, SS Allocation/RA-RU Information and UL Target Receive Power fields(#24417) in the HE variant User Info field are reserved.

The UL EHT-MCS, UL FEC Coding Type, SS Allocation/RA-RU Information and UL Target Receive Power fields(#24417) in the EHT variant User Info field are reserved.

The RU Allocation subfield in the User Info field addressed to the STA indicates whether the CTS frame is transmitted on the primary 20 MHz channel, primary 40 MHz channel, primary 80 MHz channel, primary 160 MHz channel, 80+80 MHz channel (HE only) or 320 MHz channel.

B0 of the RU Allocation subfield is set to 0 to indicate primary 20 MHz channel, primary 40 MHz channel and primary 80 MHz channel. For primary 160 MHz, 80+80 MHz and 320 MHz indication, B0 of the RU Allocation subfield is set to 1. A non-AP HE STA ignores B0 for primary 160 MHz and 80+80 MHz (HE only) indication. A non-AP EHT STA checks B0 for primary 160 MHz and 320 MHz indication if the non-AP EHT STA is addressed by an EHT variant User Info field. In an EHT variant User Info filed, the PS160 subfield is set to 1 to indicate 320 MHz channel and set to 0 to indicate primary 20 MHz channel, primary 40 MHz channel, primary 80 MHz channel and primary 160 MHz channel.

B7–B1 of the RU Allocation subfield is set to indicate the primary 20 MHz channel as follows:

* 61 if the primary 20 MHz channel is the only 20 MHz channel or the lowest frequency 20 MHz channel in the primary 40 MHz channel or primary 80 MHz channel
* 62 if the primary 20 MHz channel is the second lowest frequency 20 MHz channel in the primary 40 MHz channel or primary 80 MHz channel
* 63 if the primary 20 MHz channel is the third lowest frequency 20 MHz channel in the primary 80 MHz channel
* 64 if the primary 20 MHz channel is the fourth lowest frequency 20 MHz channel in the primary 80 MHz channel

B7–B1 of the RU Allocation subfield is set to indicate the primary 40 MHz channel as follows:

* 65 if the primary 40 MHz channel is the only 40 MHz channel or the lowest frequency 40 MHz channel in the primary 80 MHz channel
* 66 if the primary 40 MHz channel is the second lowest frequency 40 MHz channel in the primary 80 MHz channel

B7–B1 of the RU Allocation subfield is set to 67 to indicate the primary 80 MHz channel.

B7–B1 of the RU Allocation subfield is set to 68 to indicate the primary and secondary 80 MHz channel if the bandwidth of the PPDU that carries the MU-RTS Trigger frame is less than 320 MHz, or to indicate the primary 160 MHz channel if the bandwidth of the PPDU that carries the MU-RTS Trigger frame is 320 MHz.

B7–B1 of the RU Allocation subfield is set to 69 to indicate the 320 MHz channel. (#SP 413)

The settings for B7–B1 of the RU Allocation subfield are illustrated in Figure 9-64j (B7–B1 of RU Allocation subfield in MU-RTS Trigger frame for various bandwidths).

***TGbe editor: Please update Figure 9-64j with the following figure:***

|  |
| --- |
|  |
| * B7–B1 of RU Allocation subfield in MU-RTS Trigger frame for various bandwidths (#SP 413) |

**35.2 Channel access**

***TGbe editor: Please add a new subclause 35.2.x as follows:***

**35.2.x MU-RTS Trigger/CTS frame exchange procedure for EHT STAs** (#SP 412, #SP 413)

**35.2.x.1 General**

**35.2.x.2 MU-RTS Trigger frame transmission**

An EHT AP shall follow the rules defined in 26.2.6.2 (MU-RTS Trigger frame transmission) and the following additional rules to transmit an MU-RTS Trigger frame.

If any non-AP EHT STA is addressed in an MU-RTS Trigger frame from an EHT AP and any of the following conditions is met, the User Info field addressed to an EHT STA in the MU-RTS Trigger frame shall be an EHT variant User Info field:

* The bandwidth of the PPDU carrying the MU-RTS Trigger frame is 320 MHz;
* The PPDU carrying the MU-RTS Trigger frame is punctured.

Otherwise, the EHT AP may decide whether the User Info field in the MU-RTS Trigger frame is an HE variant User Info field or an EHT variant User Info field.

An EHT AP shall not set B54 in the Common Info field to 1 and B55 in the Common Info field to 0 in an MU-RTS Trigger frame.

NOTE--refer to 9.3.1.22.1.2 (User Info List field) on valid combinations of B54 and B55 in the Common Info field, B39 in the User Info field, and User Info field variant.

An MU-RTS Trigger frame shall not solicit a CTS frame from an HE STA within a bandwidth that is indicated by UL BW field in the Common Info field of the MU-RTS Trigger frame and that contains any punctured 20 MHz subchannel. If all the User Info fields in the MU-RTS Trigger frame are HE variant, the PPDU carrying the MU-RTS Trigger frame or any responding CTS frame is not punctured.

An MU-RTS Trigger frame shall not be carried in an EHT MU PPDU with TXVECTOR parameter EHT\_PPDU\_TYPE not equal to 1.

**35.2.x.3 CTS frame response to an MU-RTS Trigger frame**

An non-AP EHT STA shall follow the rules defined in 35.4.2.2.1 (Allowed settings of the Trigger frame fields and TRS Control subfield) to determine whether the EHT STA is addressed by an HE variant User Info field or an EHT variant User Info filed in an MU-RTS Trigger frame.

If an EHT STA is addressed by an HE variant User Info field in a MU-RTS Trigger frame, the EHT STA shall follow the rules defined in 26.2.6 (MU-RTS Trigger/CTS frame exchange procedure) in sending a response.

If the EHT STA is addressed by an EHT variant User Info field in the MU-RTS Trigger frame, the EHT STA shall follow the rules defined in 26.2.6 (MU-RTS Trigger/CTS frame exchange procedure) in sending a response, except that UL MU CS condition shall be determined based on rules defined in 35.4.2.x (UL MU CS mechanism for EHT STAs). The CTS frame in response to the MU-RTS frame shall be sent in the RU indicated by the EHT variant User Info field, excluding any punctured 20 MHz subchannel indicated in the Disabled Subchannel Bitmap field in the EHT Operation element. (#SP 413)

35.4.2 UL MU operation

*TGbe editor: Please add a new subclause 35.4.2.x as follows:*

35.4.2.x UL MU CS mechanism for EHT STAs

An EHT STA shall follow the rules defined in 26.5.2.5 (UL MU CS mechanism), except that the EHT STA shall use the rules defined in 36.3.20.6.4 (Per 20 MHz CCA sensitivity) instead of those defined in 27.3.20.6.5 (Per 20 MHz CCA sensitivity) when CCA is performed on any nonpunctured 20 MHz subchannel in an EHT BSS.

Specifically, if the CS Required subfield in a Trigger frame is 1, then the non-AP STA shall consider the status of the CCA (using Energy Detect defined in 36.3.20.6.4 (Per 20 MHz CCA sensitivity) and the virtual carrier sense (NAV)) during the SIFS between the PPDU that contains the Trigger frame and the PPDU sent in response to the Trigger frame. In this case, the non-AP STA shall sense the medium using energy-detect (ED) after receiving the PPDU that contains the Trigger frame (i.e., during the SIFS), and it shall perform the energy-detect (ED) at least in the subchannel that contains the non-AP STA’s UL allocation, where the sensed subchannel consists of one or more occupied 20 MHz channels. The non-AP STA may transmit the solicited PPDU if all the occupied 20 MHz channels containing the RUs allocated in the Trigger frame are considered idle. If the non-AP STA detects that any of the occupied 20 MHz channels containing the allocated RUs are not all idle, then the non-AP STA shall not transmit.