IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Resolution of MIMO-related CIDs | | | | |
| Date: 2018-07-06 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Claudio da Silva | Intel |  |  | claudio.da.silva@intel.com |
| Cheng Chen | Intel |  |  |  |
| Carlos Cordeiro | Intel |  |  |  |
| Sunwoong Yun | LG Electronics |  |  | sunwoong.yun@lge.com |
| SungJin Park | LG Electronics |  |  |  |
| Saehee Bang | LG Electronics |  |  |  |
| Jinmin Kim | LG Electronics |  |  |  |
| Jinsoo Choi | LG Electronics |  |  |  |
| Sanggook Kim | LG Electronics |  |  |  |

Abstract

This submission proposes resolutions to MIMO-related CIDs. The text used as reference is D1.3.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **CID** | **Clause** | **Page** | **Comment** | **Proposed change** |
| 1886 | 30 | 216.03 | No TPC protocol for EDMG | "Need to extend the TPC protocol (802.11-2016) section 10.29.2 to support multiple Tx chains (e.g. MIMO case). Will provide a detailed submission about the solution." |
| 1993 | 30 | 216.03 | No TPC protocol for EDMG | "Need to extend the TPC protocol (802.11-2016) section 10.29.2 to support multiple Tx chains (e.g. MIMO case). Will provide a detailed submission about the solution." |

**Proposed resolution**: Revised

**Discussion:**

* To support TPC, the Link Measurement Report frame includes MCS, link margin, SNR, and activity fields, which are sent within the DMG Link Margin element.
  + Two of the four parameters needed for TPC (SNR and MCS per space-time stream) can already be found in the “Parameters Across PPDUs” field
* Acknowledgement of TPC-related operations is performed with the DMG Link Adaptation Acknowledgement in the Link Measurement Report frame.
* Link Measurement Request frame: Indicate the transmit power used and the maximum transmit power of each transmit chain.

**Modifications:**

1. Changes to the DMG Link Margin element

*Modify the DMG Link Margin element defined in Figure 9-564, pages 97-98 as follows:*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | | Length | | Activity | | MCS | | Link Margin | | SNR | Reference Timestamp | |
| Octets | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | 4 | |
|  | | Rate Adaptation Control/EDMG TPC | | Parameters Across RX Chains | | Parameters Across PPDUs | | Parameters Across LDPC Codewords | | Parameters Across SC Blocks or OFDM Symbols | | | EDMG TPC |
| Octets | | 5 | | 0 or | | 0 or | | 0 or | | 0 or | | | 0 or |

*Modify the paragraph in lines 3-5 of page 98 as follows:*

The Rate Adaptation Control/EDMG TPC field contains the number of space-time streams reported () and indications of whether the element includes optional fields used for rate adaptation and/or TPC. The Rate Adaptation Control/EDMG TPC field is defined in 9.4.2.142.3.

*Add the following definition after the paragraph in lines 13-15 of page 98:*

The EDMG TPC field is optionally present. If present, as defined in defined in 9.4.2.141.8, it contains the activity and link margin of each transmit chain reported.

*Modify the Rate Adaptation Control (renamed as Rate Adaptation Control/EDMG TPC) field format defined in Figure 29, page 98 as follows:*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Number of Rx chains Reported (NRX) | Number of Transmit Chains Reported (NTX) | Number of Space-Time Streams Reported (NSTS) | | Indication for Parameters Across PPDUs | Indication for Parameters Across LDPC Codewords | Indication for Parameters Across SC Blocks or OFDM Symbols | IsEDMG | IsSC | Number of PPDUs | Indication of EDMG TPC | Reserved |
| Bits | 3 | 3 | 3 | 1 | | 1 | 1 | 1 | 1 | 16 | 1 | ~~13~~ 9 |

Rate Adaptation Control/EDMG TPC field format

*Add the following text after the paragraph in lines 14-15 of page 99:*

The Indication of EDMG TPC field is set to 1 if the DMG Link Margin element contains the EDMG TPC field. It is set to 0 otherwise.

*Create a new subclause (9.4.2.141.8 – EDMG TPC) after 9.4.2.141.7 and add the following:*

The EDMG TPC field is defined in Figure 9-XX.

|  |  |  |
| --- | --- | --- |
|  | Activity | Link Margin |
| Bits | 8 | 8 |

Figure 9.XX - EDMG TPC field format

The Activity subfield is set to a preferred action that the STA sending this element recommends that the peer STA indicated in the RA field of the Link Measurement Report frame execute for the transmit chain. The method by which the sending STA determines a suitable action for the peer STA is implementation specific. The Activity field is defined in 9.4.2.142.2.

The Link Margin field contains the measured link margin of the transmit chain received from the peer STA indicated in the RA field of the Link Measurement Report frame and is coded as a 2s complement signed integer in units of decibels. A value of –128 indicates that no link margin is provided. The method used to measure the link margin is beyond the scope of this standard.

2. Changes to the DMG Link Adaptation Acknowledgement element

*Modify Figure 9-535 of 802.11-2016 as follows:*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Element ID | Length | Activity | Reference Timestamp | Number of Transmit Chains Reported () | EDMG TPC Link Adaptation Acknowledgement |
| Bits | 8 | 8 | 8 | 8 | 3 |  |

Figure 9-535—DMG Link Adaptation Acknowledgment element format

*Add the following at the end of 9.4.2.143*

The Number of Transmit Chains Reported () subfield is optionally present. If present, it indicates the number of transmit chains being reported in the EDMG TPC Link Adaptation Acknowledgement subfield. If the value of this field is greater than 0, the Activity field in the DMG Link Adaptation Acknowledgment element is reserved.

The EDMG TPC Link Adaptation Acknowledgement subfield is only present if the value of the Number of Transmit Chains Reported () subfield is greater than 0, and its format is shown in Figure 9-536.

|  |  |
| --- | --- |
|  | Activity |
| Octets | 1 |

Figure 9-536 – MIMO TPC Link Adaptation Acknowledgement field format

The Activity field within the MIMO TPC Link Adaptation Acknowledgement field is set to the action that the STA sending this element has executed following the reception of the recommended activity in a Link Measurement Report frame for the transmit chain. The method by which the sending STA determines the action is described in 10.39 and the Activity field is defined in 9.4.2.142.2.

3. Changes to the Link Measurement Request

*Modify Figure 9-651 of 802.11-2016 as follows:*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Category | Radio Measurement Action | Dialog Token | Transmit Power Used | Max Transmit Power | EDMG TPC Configuration | EDMG Measurement Request |
| Octets | 1 | 1 | 1 | 1 | 1 | 1 | variable (2 |

Figure 9-651 – Link Measurement Request frame Action field format

*Add the following at the end of 9.6.7.4*

The TPC Configuration field is optionally present. It indicates if the frame containing the Link Measurement Request is transmitted over a 2.16+2.16 GHz or 4.32+4.32 GHz channel, and the number of transmit chains used. B0 is used to indicate the use of channel aggregation, B1-B3 are used to indicate the number of transmit chains, and B4-B7 are reserved. If B0 is set to 1, the number of transmit chains shall be an even number.

The EDMG Measurement Request field is optionally present, and indicates the transmit power and the upper limit on the transmit power of each transmit chain used to transmit the frame containing the Link Measurement Request. If present, the Transmit Power Used field and the Max Transmit Power field in the Link Measurement Request frame are reserved. The format of the EDMG Measurement Request field is shown in Figure 9-652.

|  |  |  |
| --- | --- | --- |
|  | Transmit Power Used | Max Transmit Power |
| Octets | 1 | 1 |

Figure 9-652 – EDMG Measurement Request element.

The Transmit Power Used field is set to the transmit power used by a transmit chain to transmit the frame containing the Link Measurement Request, as described in 9.4.1.20.

The Max Transmit Power field provides the upper limit on the transmit power of a transmit chain as measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. This field is described in 9.4.1.19. The Max Transmit Power field is a 2s complement signed integer and is 1 octet in length, providing an upper limit, in a dBm scale, on the transmit power as measured at the output of the antenna connector to be used by the transmitting STA on its operating channel. The maximum tolerance for the value reported in Max Transmit Power field is ±5 dB. The value of the Max Transmit Power field is equal to the minimum of the maximum powers at which the STA is permitted to transmit in the operating channel by device capability, policy, and regulatory authority.

4. Changes to 10.39 (DMG link adaptation) (802.11-2016)

*Modify the first paragraph of 10.39.1 (General) as follows*

A STA may transmit a Link Measurement Request frame to request a STA indicated in the RA field of the frame to respond with a Link Measurement Report frame (9.6.7.5). If the Link Measurement Request frame is sent within a PPDU defined in Clause 20 or in Clause 30, the Link Measurement Report frame shall contain the DMG Link Margin element. The requesting STA may use values of the MCS, of the SNR and of the Link Margin to transmit frames to the STA indicated in the RA field of the Link Measurement Request frame.

*Add the following paragraph after the first one of 10.39.1 (General)*

If the Link Measurement Request frame is sent within a PPDU defined in Clause 30, the Number of Transmit Chains Reported () field in the DMG Link Margin element within the Link Measurement Report frame shall be set to the same value indicated in the EDMG TPC Configuration element within the Link Measurement Request. In this case, the requesting STA may use the reported MCS, SNR, and link margin values when transmit frames to the STA indicated in the RA field of the Link Measurement Request frame using multiple transmit chains.

*Modify the eight paragraph of 10.39.1 (General) as follows*

The SNR field and Link Margin field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the same Link Measurement Report frame. If the Link Measurement Report frame contains measurements of more than one transmit chain, the SNR Per STS subfield in the Parameters Across PPDUs field and the Link Margin subfield in the EDMG TPC field in the Link Measurement Report frame shall indicate the corresponding measurements based on the reception of the PPDU that was used to generate the MCS feedback contained in the Parameters Across PPDUs field within the same Link Measurement Report frame.

*Modify the second paragraph of 10.39.2 (DMG TPC) as follows*

If the STA implements the recommendation indicated in the Activity field of ~~the~~ a Link Measurement

Report that does not include a Rate Adaptation Control/EDMG TPC field, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Activity field in the received DMG Link Margin Subelement.

*Modify the third paragraph of 10.39.2 (DMG TPC) as follows*

If the STA does not implement the recommendation indicated in the Activity field of ~~the~~ a Link Measurement Report that does not include a Rate Adaptation Control/EDMG TPC field, it may send a Link Measurement report containing a DMG Link Adaptation Acknowledgment element. The Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0~~, indicating that the STA did not change its transmit power~~.

*Add the following paragraph after the third paragraph of 10.39.2 (DMG TPC)*

If the STA implements the recommendation indicated in the Activity field of a Link Measurement

Report that includes a Rate Adaptation Control/EDMG TPC field for one or more transmit chains, it shall send a Link Measurement Report frame containing a DMG Link Adaptation Acknowledgment element. The value of the Number of Transmit Chains Reported field within the DMG Link Adaptation Acknowledgment element shall be set to the same value of the Number of Transmit Chains Reported field in the DMG Link Margin element within the Link Measurement Report frame. If the STA implements the recommendation for a transmit chain, the Activity field of the DMG Link Adaptation Acknowledgment element shall be set to the value of the Activity field in the received DMG Link Margin Subelement of the same transmit chains. If the STA does not implement the recommendation for a transmit chain, the Activity field of the DMG Link Adaptation Acknowledgment element shall be set to 0.