IEEE P802.11  
Wireless LANs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Clause 20 SC MCS Extension | | | | |
| Date: 2015-10-08 | | | | |
| Author(s): | | | | |
| Name | Affiliation | Address | Phone | email |
| Assaf Kasher | Intel Corporation | Matam Industrial Park,  Haifa, Israel, 31015 | +97248651547 | assaf.kasher@intel.com |
| Alecsander Eitan | Qualcomm Inc. |  |  | eitana@qti.qualcomm.com |
| Payam Torab | Broadcom Ltd. |  |  | payam.torab@broadcom.com |
| Brad Lynch | Peraso |  |  | brad@perasotech.com |
| Christopher Hansen | Peraso |  |  | chris@covariantcorp.com |
| Dmitry Cherniavsky | Sibeam |  |  | dmitry.cherniavsky@sibeam.com |

Abstract

This document provides the details of the changes needed for adding 7 more rates: one QPSK, two 16-QAM and 4 64-QAM, to the SC PHY subclause. All references are to TGmc D5.0

**Discussion (1):**

In 11ad PHY (clause 20 in TGmc Draft 5.0) there is incompatibility between the OFDM mode and the mandatory SC mode. When a packet is sent in OFDM mode, SC only receiver cannot determine its length because it is coded inside an OFDM header. We therefore think that OFDM should not be implemented. To achieve the high rates allowed by the OFDM mode, we propose to add new MCSs to the SC mode. This is done in a way that is fully compatible with devices complying with the 11ad standard.

***Editor: replace the penultimate row of table 20-17 (SC header fields) with the following two lines:***

|  |  |  |  |
| --- | --- | --- | --- |
| Extended SC MCS Indication | 1 | 44 | Corresponds to the TXVECTOR parameter EXTENDED\_SC\_MCS.  Set to 0 to indicate regular interpretation of the MCS field.  Set to 1 to indicate that MCS 7-9 represent 64-QAM Modulations rather than QPSK Modulation with the same code rate, MCS 10 represents 16-QAM modulation with code rate 7/8, MCS12 represents 64-QAM Modulations with code rate of 7/8, MCS5 represents 16-QAM Modulations with code rate of 13/16, and MCS6 represents QPSK modulation with code rate of 7/8 rather than code rate of 1/2. |
| Reserved | 3 | 45 | set to 0, ignored by receiver |

***Editor: add the following text to the description of the length field in table 20-17 (SC header fields):***

If Extended SC MCS Indication field is 1, the length of the PSDU is computed according to Table 20-NEW. The number of data octets in the PSDU shall not exceed 262143.

**Table 20-NEW—Length value in SC header for Extended MCSs**

|  |  |  |
| --- | --- | --- |
| Extended MCS | Length | value in MCS field |
| 12.1 |  | 5 |
| 12.3, 12.4, 12.5 |  | 7,8,9 |
| 9.1,12.2, 12.6 |  | 6, 10, 12 |

***Editor: add the following line after line 10 of table 20-18 (Modulation and coding scheme for SC):***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 9.1 | π/2-QPSK | 2 | 1 | 7/8 | 2695 |

***Editor: add the following lines (at the end) to table 20-18 (Modulation and coding scheme for SC):***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 12.1 | π/2-16QAM | 4 | 1 | 13/16 | 5005 |
| 12.2 | π/2-16QAM | 4 | 1 | 7/8 | 5390 |
| 12.3 | π/2-64QAM | 6 | 1 | 5/8 | 5775 |
| 12.4 | π/2-64QAM | 6 | 1 | 3/4 | 6930 |
| 12.5 | π/2-64QAM | 6 | 1 | 13/16 | 7507.5 |
| 12.6 | π/2-64QAM | 6 | 1 | 7/8 | 8085 |

***Editor: add the following subclause after subclause 20.6.3.2.4.4:***

**20.6.3.2.4.5 π/2-64QAM Modulation**

In the π/2-64QAM modulation, the input bit stream is grouped in sets of 6 bits and mapped according to the following equation:

where *k* is the output symbol index, *k*=0,1, …. Each output symbol is then rotated according to the following equation The constellation bit encoding is depicted in Figure 1-64QAM constellation bit encoding.



Figure 1-64QAM constellation bit encoding

***Editor: Add the following lines to table 20-20 (Values of NCBPB)***

|  |  |
| --- | --- |
| π/2-64QAM | 2688 |

***Editor: Add the following line after the 6th line of table 20-21 (EVM requirements of DMG SC mode)***

|  |  |  |  |
| --- | --- | --- | --- |
| 9.1 | π/2-QPSK | 7/8 | -16 |

***Editor: Add the following lines to table 20-21 (EVM requirements of DMG SC mode)***

|  |  |  |  |
| --- | --- | --- | --- |
| 12.1 | π/2-16QAM | 13/16 | -22 |
| 12.2 | π/2-16QAM | 7/8 | -23 |
| 12.3 | π/2-64QAM | 5/8 | -26 |
| 12.4 | π/2-64QAM | 3/4 | -27 |
| 12.5 | π/2-64QAM | 13/16 | -29 |
| 12.6 | π/2-64QAM | 7/8 | -31 |

***Editor: Add the following line to table 20-3 (Receiver sensitivity) after the line of MCS Index 9:***

|  |  |
| --- | --- |
| 9.1 | -57 |

***Editor: Add the following lines to table 20-3 (Receiver sensitivity) after the line of MCS Index 12:***

|  |  |
| --- | --- |
| 12.1 | -51 |
| 12.2 | -50 |
| 12.3 | -48 |
| 12.4 | -46 |
| 12.5 | -44 |
| 12.6 | -42 |

***Editor: add the following line to table 20-1 after the MCS line:***

|  |  |  |  |
| --- | --- | --- | --- |
| EXTENDED\_SC\_MCS | Enumerated Type:   * NON\_EXTENDED\_MCS: indicates regular interpretation of the MCS field * EXTENDED\_MCS: indicates that MCS 7-9 represent 64-QAM Modulations rather than QPSK Modulation with the same code rate, MCS 10 represents 16-QAM with code rate 7/8, MCS12 represents 64-QAM Modulations with code rate of 7/8, MCS5 represents 16-QAM Modulations with code rate of 13/16, and MCS6 represents QPSK modulation with code rate of 7/8 rather than code rate of 1/2.   This parameter is reserved for all other MCSs. | **Y** | **Y** |

***Editor: add at the end of section 20.6.3.1.1 General the following lines:***

When the EXTENDED\_SC\_MCS field in the TXVECTOR (see table 20-1) is set to EXTENDED\_MCS, the rules for setting the bits X1–X7 of the initial scrambler state are as follows

* For MCS 12.1, bits (X6, X7) are set according to:

Bits (X1-X5) are set according to the transmitter implementation.

* For MCS 12.3, 12.4, 12.5 , bits (X6, X7) are set according to:

Bits (X1-X5) are set according to the transmitter implementation.

* For MCS 9.1, 12.2 and MCS 12.6, bit X7 is set according to:

Bits (X1-X6) are set according to the transmitter implementation.

X1-X7 are sent in the Scramber Initialization field, as defined in 20.6.3.1.4, and 20.6.3.2.2..

***Editor: Add the following text after P2465L29:***

When the code rate is 7/8, and for the purpose of computation.

***Editor: modify the text in P2465L36-44 as follows:***

* 1. If  = 1, and the code rate is not 7/8
     1. The output stream of the scrambler is broken into blocks of *LCWD* = *LCW ×R* bits such that the *m*th data word is .
     2. To each data word, *n-k*=*LCW-R×LCW* parity bits are added to create the code word  such that 

If ρ = 1 and the code rate is 7/8, 48 bits are punctured from the parity bits of the rate 13/16 parity bits:

1. The output stream of the scrambler is broken into blocks of 546 bits such that the *m*th data word is .
2. To each data word, *126* parity bits are added to create the code word **=** such that **.** The code word by removing the first 48 parity bits so that

***Editor Add the following line after the line of MCS 9 in Table 20-23—Zero filling for SC BRP packets:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 9.1 | π/2-QPSK | 2 | 1 | 7/8 | 2695 | 25 |

***Editor Add the following lines after the last line of Table 20-23—Zero filling for SC BRP packets:***

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 12.1 | π/2-16QAM | 4 | 1 | 13/16 | 5005 | 46 |
| 12.2 | π/2-16QAM | 4 | 1 | 7/8 | 5390 | 49 |
| 12.3 | π/2-64QAM | 6 | 1 | 5/8 | 5775 | 69 |
| 12.4 | π/2-64QAM | 6 | 1 | 3/4 | 6930 | 69 |
| 12.5 | π/2-64QAM | 6 | 1 | 13/16 | 7507.5 | 69 |
| 12.6 | π/2-64QAM | 6 | 1 | 7/8 | 8085 | 74 |

***Editor: Add a 1 octet field to figure 9-502 (DMG Capabilities element format) in page 1010: Extended SC MCS capabilities***



***Editor: Add the following subclause at P1016L21 (before 9.4.2.129)***

**9.4.2.128.5 Extended SC MCS Capabilities field**

The Extended SC MCS Capabilities field (see figure 9-50X) advertises the support of the STA to extended SC MCSs.



Figure 9-50X Extended SC MCS capabilities field

The Maximum Extended SC Tx MCS subfield indicates the maximum transmit extended SC MCS supported by the STA. The values in the subfield are ordered as shown in table 9-22X:

Table 9-22X – Mapping of Extended SC MCS to Maximum Supported Rx/Tx MCS subfields values

|  |  |
| --- | --- |
| Extended MCS name | Value in Maximum Extended SC Rx/Tx MCS field |
| None | 0 |
| MCS 9.1 | 1 |
| MCS 12.1 | 2 |
| MCS 12.2 | 3 |
| MCS 12.3 | 4 |
| MCS 12.4 | 5 |
| MCS 12.5 | 6 |
| MCS 12.6 | 7 |

A STA that indicates support for transmission of an Extended SC MCS by setting the value in the Maximum Extended SC Tx MCS subfield to *k,* supports all Extended SC MCSs with values lower than or equal to *k*.

A STA indicates support for transmission of code rate 7/8 by setting the value in this subfield to 1. If STA indicates that it does not support code rate 7/8, then the STA does not support MCS 9.1 or 12.2 even if the value in the Maximum Extended SC Tx MCS subfield is greater than 1 or 3 respectively.

A STA that indicates support for reception of an an Extended SC MCS by setting the value in the Maximum Extended SC Rx MCS subfield to *k,* supports all Extended SC MCSs with values lower than or equal to k.

A STA indicates support for reception of code rate 7/8 by setting the value in this subfield to 1. If STA indicates that it does not support code rate 7/8, the the STA does not support MCS 9.1 or 12.2 even if the value in the Maximum Extended SC Rx MCS field is greater than 1 or 3 respectively.

***Editor: modify the text in P1013L16-18 as follows:***

The Maximum SC Rx MCS subfield contains the value of the maximum MCS index the STA supports for reception of single-carrier frames. Values 0-3 of this (#3097) subfield are reserved. Possible values for this subfield are shown in Table 20-18 (Modulation and coding scheme for SC) (values for Extended SC MCSs are not valid for this field).

***Editor: modify the text in P1013L27-29 as follows:***

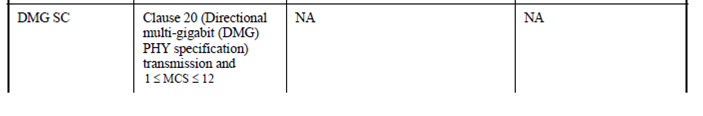
The Maximum SC Tx MCS subfield contains the value of the maximum MCS index the STA supports for transmission of single-carrierframes. Values 0-3 of this (#3097) subfield are reserved. Possible values for this subfield are shown in Table 20-18 (Modulation and coding scheme for SC) (values for Extended SC MCSs are not valid for this field).

***Editor: Modify the text in P1033L31-35 (in subclause 9.4.2.141.1)***

The MCS field is set to an MCS value that the STA sending this element recommends that the peer STA indicated in the RA field of the Link Measurement Report frame use to transmit frames to this STA. The reference PER for selection of the MCS is 10-2 for an MPDU length of 4096 octets. The method by which the sending STA determines a suitable MCS for the peer STA is implementation specific. If the most significant bit of the MCS field is set to 1, and the lower 7 bits indicate values of 5 to 10, or 12, the MCS should be interpreted as an Extended SC MCS, with MCSs 9.1, 12.1, 12.2 ,12.3, 12.4, 12.5 or 12 6 respectively, for lower bits values of 5,6,7,8,9,10,12 respectively. The most significant bit of the MCS field is set to 1 only if the receiving STA indicated support for the extended SC MCSs by adding the Extended SC MCS capabilities to the DMG capability element.

***Editor: Modify the text in P1325L61 (in subclause 10.7.9)***

Replace  1<=MCS<=12 by 1<=MCS<=12.6

**

**References:**

**All referenced sections and Tables are based on:** Draft P802.11REVmc\_D5.0.pdf