IEEE P802.11
Wireless LANs

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| 30.6.7.4 Modulation Mapping |
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Abstract

This document proposes specification text for subclause 30.6.7.4. (Modulation mapping) to define modulation mapping for OFDM PHY [1], [2].

**30.6.7.4 Modulation mapping**

*Editor: remove subclause 30.6.2 (Modulation) in D0.35, move subclause 30.6.2.1 (MIMO SQPSK) to new clause 30.6.7.4 (Modulation mapping), move subclause 30.6.7.1 (Space-time block coding) to new clause 30.6.7.4 (Modulation mapping)*

**30.6.7.4.1 General**

The coded and padded bit stream is converted into a stream of complex constellation points, following the rules defined for SQPSK, MIMO SQPSK, QPSK, 16-QAM, and 64-QAM modulations in 30.6.7.4.2 - 30.6.7.4.6 accordingly.

The SQPSK, MIMO SQPSK, and QPSK modulations use tone pairing mechanisms to extract channel frequency diversity as defined in 30.6.7.4.7. The 16-QAM and 64-QAM modulations use interleaver defined in 30.6.7.4.8.

**30.6.7.4.2 SQPSK modulation**

The input encoded bits of *iSS*-th spatial stream are broken into the groups of *NCBPS* bits, , where *q* denotes the group number. Each pair of bits , *k* = 0, 1, …, *NSD*/2 – 1, is converted into the pair of complex points . The modulation is performed in two steps:

* First, two BPSK points are modulated as , 
* Second, two BPSK points  are converted to two QPSK points  by multiplication on mapping matrix Q as follows:



where index *P*(*k*) is defined in the range *NSD*/2 to *NSD*/2 – 1. The *q*-th modulated data block of *iSS*-th spatial stream is mapped to *NSD* data subcarriers of *q*-th OFDM symbol of *iSS*-th spatial stream.

**30.6.7.4.3 MIMO SQPSK modulation**

*Editor: replace subclause 30.6.2.1 (MIMO SQPSK) in D0.35 with the following subclause*

A MIMO SQPSK modulation is applied if the number of spatial streams is equal to *NSS* = 2 and DCM SQPSK Applied bit in EDMG-Header-A is set to 1.

*Editor: Modify field DCM SQPSK Applied in Table 17 (D0.35) as shown below*

**Table 17 - EDMG-Header-A field structure and definition for a SU PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field** | **Number of bits** | **Start bit** | **Description** |
| DCM SQPSK Applied | 1 | 62 | ~~If set to 1, indicates that DCM SQPSK (30.5.7.4.2) was applied at the transmitter. Otherwise, set to 0.~~If set to 1, for SC mode indicates transmission using DCM SQPSK modulation defined in 30.5.7.4.2. For OFDM mode with two spatial streams indicates transmission using MIMO SQPSK modulation defined in 30.6.7.4.6.Otherwise, set to 0.  |

The input encoded bits of *iSS*-th spatial stream are broken into the groups of *NCBPS* bits, , where *q* denotes the group number. Each pair of bits , *k* = 0, 1, …, *NSD*/2 – 1, is converted into the complex point . The modulation is performed as follows:





where index *P*(*k*) is defined as *P*(*k*) = *k* + *NSD*/2. The *q*-th modulated data block of *iSS*-th spatial stream is mapped to *NSD* data subcarriers of *q*-th OFDM symbol of *iSS*-th spatial stream.

**30.6.7.4.4 QPSK modulation**

The input encoded bits of *iSS*-th spatial stream are broken into the groups of *NCBPS* bits, , where *q* denotes the group number. Each four bits , *k* = 0, 1, …, *NSD*/2 – 1, are converted into the pair of complex points . The modulation is performed in two steps:

* First, two QPSK points are modulated as , 
* Second, two QPSK points  are converted to two 16QAM points  by multiplication on mapping matrix Q as follows:



where index *P*(*k*) is defined in the range *NSD*/2 to *NSD*/2 – 1. The *q*-th modulated data block of *iSS*-th spatial stream is mapped to *NSD* data subcarriers of *q*-th OFDM symbol of *iSS*-th spatial stream.

**30.6.7.4.5 16-QAM modulation**

The input encoded bits of *iSS*-th spatial stream are broken into the groups of *NCBPS* bits, , where *q* denotes the group number. Each four bits , *k* = 0, 1, …, *NSD* – 1, are converted into the single constellation point . The modulation is performed as follows:



The *q*-th modulated data block of *iSS*-th spatial stream is mapped to *NSD* data subcarriers of *q*-th OFDM symbol of *iSS*-th spatial stream.

**30.6.7.4.6 64-QAM modulation**

The input encoded bits of *iSS*-th spatial stream are broken into the groups of *NCBPS* bits, , where *q* denotes the group number. Each six bits , *k* = 0, 1, …, *NSD* – 1, are converted into the single constellation point . The modulation is performed as follows:



The *q*-th modulated data block of *iSS*-th spatial stream is mapped to *NSD* data subcarriers of *q*-th OFDM symbol of *iSS*-th spatial stream.

**30.6.7.4.7 Tone pairing for SQPSK and QPSK**

**30.6.7.4.7.1 General**

The SQPSK and QPSK modulation performs mapping of pair of symbols  to OFDM subcarriers with indexes 0 ≤ *k* ≤ *NSD*/2 – 1 and *NSD*/2 ≤ *P*(*k*) ≤ *NSD* – 1 to exploit channel frequency diversity.

All EDMG modes shall support Static Tone Pairing (STP) where constant mapping between *k* and P(*k*) is employed. The EDMG-Header-B header is always mapped using STP mode.

A EDMG STA may employ Dynamic Tone Pairing (DTP) where the mapping between *k* and P(*k*) are determined by the receiving STA and fed back to the transmitting STA. A STA may use DTP when transmitting to a DTP-capable STA, from which it has received DTP feedback.

A DTP mapping can be applied for SU PPDU transmission with a single space-time stream only.

**30.6.7.4.7.2 Static tone pairing (STP)**

*Editor: in D0.35 add Tone Pairing Type bit to EDMG-Header-A for SU PPDU transmission (Table 17), shift the rest of the fields by 1 bit accordingly*

**Table 17 – EDMG-Header-A field structure and definition for a SU PPDU**

|  |  |  |  |
| --- | --- | --- | --- |
| **Field** | **Number of bits** | **Start bit** | **Description** |
| Tone Pairing Type | 1 | 92 | Set to 0 to indicate Static Tone Pairing (30.6.7.4.7.2).Set to 1 to indicate Dynamic Tone Pairing (30.6.7.4.7.3).Only valid for OFDM transmission mode, for SC transmission mode is reserved. |

An STP mapping is applied if Tone Pairing Type bit in EDMG-Header-A is set to 1. STP mapping is always applied for EDMG-Header-B.

The STP mapping defines *P*(*k*) index as follows:



**30.6.7.4.7.3 Dynamic tone pairing (DTP)**

A DTP mapping is applied if Tone Pairing Type bit in EDMG-Header-A is set to 0. A DTP mapping may be applied for data transmission with a single space-time stream only, *NSTS* = 1.

The DTP mapping defines *P*(*k*) index as follows:



where:

*  denotes the number of tones per group
*  denotes the starting index of *l*-th group of tones, *l* = 0, 1, …, *NG* – 1
*  denotes the total number of tone groups defined for *NSD*/2 OFDM subcarriers

The total number of groups  and the number of tones per group *NTPG* for given number of data subcarriers *NSD* is defined in Table 1.

Table 1: Number of tones per group - NG

|  |  |  |
| --- | --- | --- |
| **Number of data subcarriers - *NSD*** | **Total number of groups - *NG*** | **Number of tones in the group - *NTPG*** |
| 336 | 42 | 4 |
| 734 | 92 |
| 1134 | 142 |
| 1532 | 192 |

The tone index offset is defined as follows:



where:

*  is a value of GroupPairIndex subfield defined in a DTP report element (9.4.2.146) included in the last received DTP Report frame (9.6.20.9)

The array of group indexes GroupPairIndex can represent any permutation of indexes 0, 1, …, *NG* – 1. However, for *NG* = 92, 142, and 192, GroupPairIndex(*NG* - 1) shall be equal to *NG* – 1.

*Editor: modify the subclause 9.4.2.146 (Dynamic Tone Pairing (DTP) report element) as below*

The DTP Report element is included in the DTP Response frame. The format of the DTP Report element is shown in Table 9-245.

**Table 9-245 – DTP Report element format**

|  |  |  |
| --- | --- | --- |
| **Field** | **Length** | **Meaning** |
| Element ID | 8 bits |  |
| Length | 8 bits |  |
| GroupPairIndex(0) | 8 bits | Index of DTP group pair *n* in the range 0 to *NG* – 1, for *n* = 0, 1, …, *NG* – 1. |
| GroupPairIndex(1) | 8 bits |
| … | … |
| GroupPairIndex(*NG* - 1) | 8 bits |

The Element ID and Length fields are defined in 9.4.2.1.

GroupPairIndex(*n*) subfields for *n* = 0, 1,.., *NG* – 1 indicate DTP groups, which in turn determines how pairs of SQPSK and QPSK symbols are mapped to OFDM tones when DTP is enabled, as described in 30.6.7.4.7.3. Valid values of GroupPairIndex(*n*) are in the range 0 to *NG* – 1. The *NG* value is dependent on the total number of data subcarriers and for 2.16 GHz, 4.32 GHz, 6.48 GHz, and 8.64 GHz channel is equal to 42, 92, 142, and 192 accordingly. The valid values of GroupPairIndex(0), GroupPairIndex(1),…, GroupPairIndex(*NG* – 1) are distinct and therefore represent a permutation of integers 0 to *NG* – 1. For *NG* = 92, 142, and 192, GroupPairIndex(*NG* – 1) shall be equal to *NG* – 1.

All numeric fields are encoded as unsigned integers.

**30.6.7.4.8 Interleaver**

TBD

**SP:**

Do you agree to define the modulation description for OFDM mode as in (11-17-1170-00-00ay 30 6 7 4 Modulation mapping)?

**References:**

1. Draft P802.11ay\_D0.35
2. IEEE802.11-2016