IEEE P802.22  
Wireless RANs

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| Proposed Modification on Multidimentional TCM Text for the IEEE 802.22b | | | | |
| Date: 2013-09-18 | | | | |
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Abstract

This document presents the proposed draft text on the multidimentional trellis coded modulation (MD-TCM) based on the PHY proposal from Niigata University (doc. IEEE 802.22-12-0091/r1). This is a proposed resolution for Comment ID 195 in the LB commetns for IEEE Draft Std, 802.22b D1.0. The contents of this document is potentially included into the updated version of the IEEE 802.22b draft standard.

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# Introduction

This contribution contains the proposed modification on the Multidimentional trellis coded modulation (MD-TCM) text for the IEEE 802.22b draft standard. This is a propoded resolution for the following comment to the IEEE Draft Std. 802.22b D1.0.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Commenter Name | Type | Comment. | Suggested Remedy |
| 195 | Shigenobu Sasaki | TR | This subclause is incomplete. | Complete the subclause. |

# Proposed Text

*(Add new subclause after subclause 9.7.2.4)*

### 9.7.2.X Multidimensional Trellis Coded Modulation (MD-TCM) mode (optional)

**9.7.2.X.1 Overview of Multidimensional Trellis Coded Modulation (MD-TCM)**

Multidimensional trellis coded modulation (MD-TCM) is a combined coding and modulation for bandlimited channels by using multiple 2-dimentional (2D) symbols. In this subclause, 4-dimensional (4D)-TCM base on [2] is applied to achieve additional higher data rate option and peak-to-average power ratio (PAPR) reduction at data mapping. The functional block of the 4D-TCM encoder is illustrated in Figure xxx.1. 4D-TCM encoder contains the following functions:

1. Coset selection,
2. Region pair selection,
3. Symbol selection.

In the case of 4D-TCM 48QAM, a 4D-symbol (equal to two 2D symbols) contains 3 bits for coset selection, 3bits for region pair selection, and 2x2 bits for symbol selection. In total, it contains 10 bits per 4D-symbol, which is equal to 5 bits per 2D symbol (also equal to 5/6-coded 64QAM). In the case of 4D-TCM 48QAM, a 4D-symbol (equal to two 2D symbols) contains 3 bits for coset selection, 3bits for region pair selection, and 2x4 bits for symbol selection. In total, it contains 14 bits per 4D-symbol, which is equal to 7 bits per 2D symbol (also equal to 7/8-coded 256 QAM).

Detail structure of each component is described in the following subclauses.

*c*1(*t*)

*c*2(*t*)

*c*3(*t*)

*c*4(*t*)



Figure xxx.1: Structure of Multidimensional trellis encoder

**9.7.2.X.2 Coset selection**

Two bits enter the rate 2/3 convolutional encoder. This encoder generates three-bit output. With one additional bit, a total of four bits are used to choose a pair of signal points illustrated in Figure xxx.2 among the following pairs of signal points:

(A, A), (A, B), (A, C), (A, D), (B, A), (B, B), (B, C), (B, D), (C, A), (C, B), (C, C), (C, D),

(D, A), (D, B), (D, C), (D, D).

C

B

A

D

Fig. xxx.2 Signal constellation for Coset selection

Bit assignment for coset selection is listed in Table xxx.1.

Table xxx.1 Bit assignment for Coset selection

|  |  |
| --- | --- |
| Input of Coset selection  c1(t)c2(t) c3(t) c4(t) | Output of Coset at  *sa*(*t*) / *sb*(*t*) |
| 0000 | A / A |
| 0001 | A / C |
| 0010 | A / B |
| 0011 | A / D |
| 0100 | C / A |
| 0101 | C / C |
| 0110 | C / B |
| 0111 | C / D |
| 1000 | B / A |
| 1001 | B / C |
| 1010 | B / B |
| 1011 | B / D |
| 1100 | D / A |
| 1101 | D / C |
| 1110 | D / B |
| 1111 | D / D |

**9.7.2.X.3 Region pair selection**

Three bits enter a Region pair selector to select a pair of regions over two 2-D symbols. Fig. xxx.3 illustrates the sketch of regions. One 2-D symbol contains three regions, say I0, I1, and O illustrated in Fig. xxx.3. According to the contents of entered three bits, one region pair (R1, R2) shall be chosen among the following region pairs:

(I0, I0), (I0, I1), (I0, O), (I1, I0), (I1, I1), (I1, O), (O, I0), (O, I1),

Bit assignment of region pair selection is listed in Table xxx.2.

I

Q

I0

I1

O

I1

I1

I1

Figure xxx.3 Sketch of “Region” in MD-TCM

Table xxx.2 Region Pair Selection

|  |  |  |
| --- | --- | --- |
| d4(t)d5(t)d6(t) | Region at *sa*(*t*) | Region at *sb*(*t*) |
| 000 | I0 | I0 |
| 001 | I0 | I1 |
| 010 | I0 | O |
| 011 | I1 | I0 |
| 100 | I1 | I1 |
| 101 | I1 | O |
| 110 | O | I0 |
| 111 | O | I1 |

**9.7.2.X.4 Symbol selection**

In the case of MD-TCM 48 QAM, 2-dimensional (2-D) symbol selection contains QPSK mapper with constelletion mapping in Fig. 150. In the case of MD-TCM 192QAM, 2-D symbol selection contains 16QAM mapper with constellation mapping in Fig. 151. ,

**References:**

1. Shigenobu Sasaki, et al., PHY/MAC Proposal for the IEEE 802.22b, IEEE 802.22-12-0091/r1, Nov. 2012
2. L. F. Wei, “Trellis-coded modulation with multidimensional constellations,” IEEE Trans. Info. Theory, vol. 33, No. 4, pp. 483-531, 1987
3. Shigenobu Sasaki and Bingxuan Zhao, “Multidimentional TCM for the IEEE 802.22b,” Doc. IEEE 802.22-13-0153/r0, Sep. 2013
4. IEEE Std. 802.22-2011, July 2011.