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Re:	TGm SDD : Other In response to IEEE 802.16m-08/040 "Call for Contributions and Comments on Project 802.16m System Description Document (SDD)" for Session 58
Abstract	This contribution proposes SDD text for DL OL SU-MIMO schemes
Purpose	For discussion and approval into TGm SDD text
Notice	
Release	
Patent Policy	

Proposed SDD Text for DL OL SU-MIMO

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1. Introduction

This contribution is to propose DL OL SU-MIMO scheme. We propose a 4Tx antennas rate 2 scheme to be included in the MIMO SDD RG document.

2. Multiplexing scheme with 4 TX antennas and rate 2

Text Proposal modification to SDD

(L9, P79 of 003r5)

11.8.2.1.1. Open-loop SU-MIMO

N_T	Rate	M	N_F
~~2~~	~~1~~	~~1~~	~~1~~
2	1	2	2
~~4~~	~~1~~	~~1~~	~~1~~
4	1	2	2
~~8~~	~~1~~	~~1~~	~~1~~
8	1	2	2
2	2	2	1
4	2	2	1
4	2	4	2
8	2	2	1
8	2	4	2
4	3	3	1
8	3	3	1
4	4	4	1
8	4	4	1

Table 5 Matrix dimensions for open-loop SU-MIMO modes

[*modify section 11.8.2.1.1.1 of C802.16m-08/003r5 as follows*]

11.8.2.1.1.1 Transmit Diversity

The following transmit diversity modes are supported for open-loop single-user MIMO:

- 2Tx rate-1: ~~STBC/~~SFBC~~, and rank-1 precoder~~

- 4Tx rate-1: STBC/SFBC with precoder, and rank-1 precoder
- 8Tx rate-1: STBC/SFBC with precoder, and rank-1 precoder

For the transmit diversity modes with M=1, the input to MIMO encoder is x=s1, and the output of the MIMO encoder is a scalar, z=x.

- The output of the rank-1 precoder for NT = 2, 4, and 8 Tx antennas is a NT × 1 matrix y=W × z, where W may be frequency and/or time dependent as described in section 11.8.2.1.1.

For the transmit diversity modes with M=2, the input to the MIMO encoder is represented a 2 × 1 vector. The MIMO encoder generates 2Tx SFBC, and then multiplied by NT × 2 matrix as described in section 11.8.2.1.1.

For the transmit diversity modes, the input to the MIMO encoder is represented a 2 × 1 vector

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}. \qquad \text{(Equation 11.8.2.1.1.1-1)}$$

The output of the MIMO encoder is a 2 × 2 matrix

$$\mathbf{z} = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix} \qquad \text{(Equation 11.8.2.1.1.1-2)}$$

For the 2Tx rate-1 mode, the output of the precoder is a 2 × 2 matrix

$$\mathbf{y} = \mathbf{z}\,, \qquad \text{(Equation 11.8.2.1.1.1-3)}$$

For the 4Tx rate-1, the output of the precoder is a 4 × 2 matrix

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}\,, \qquad \text{(Equation 11.8.2.1.1.1-4)}$$

where **W** is a 4 × 2 unitary precoder. Note that **W** may be frequency and/ or time dependent as described in section 11.8.2.1.1. W is a set of 6 antenna circulation matrices, i.e.,

$$\mathbf{W} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}. \qquad \text{(Equation 11.8.2.1.1.1-5)}$$

$\mathbf{W}$ can be changed every pair of tones or symbols.

For the 8Tx rate-1, the output of the precoder is a 8 × 2 matrix

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}\,, \qquad \text{(Equation 11.8.2.1.1.1-6)}$$

where **W** is a 8 × 2 unitary precoder. Note that **W** may be frequency and/ or time dependent as described in section 11.8.2.1.1. **W** is defined as follows:

$$\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2\,. \qquad \text{(Equation 11.8.2.1.1.1-7)}$$

$\mathbf{W}_1$ is a 8x4 matrix which is implementation specific, $\mathbf{W}_2$ is a 4 × 2 unitary precoder which consists of a set of 6 antenna circulation matrices, i.e.,

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}. \qquad \text{(Equation 11.8.2.1.1.1-8)}$$

$\mathbf{W}_2$ can be changed every pair of tones or symbols.

(L5, P81)

11.8.2.1.1.2. Spatial Multiplexing

[*modify L7 to L11 of P81 of C802.16m-08/003r5 as follows*]

The following spatial multiplexing modes are supported for open-loop single-user MIMO:

- Rate-2 spatial multiplexing modes:
  - 2Tx rate-2: rate 2 SM
  - 4Tx rate-2: rate 2 DSTTD and rate 2 SM with precoding
  - 8Tx rate-2: rate 2 DSTTD and rate 2 SM with precoding

[*Delete the content from L28 to L37 in P81 and insert the following text in the section 11.8.2.1.1.2 of 80216m-08/003r5.*]

For 4Tx antennas rate2 mode, the input to the MIMO encoder is represented as a 4 × 1 vector (DSTTD case) or a 2 x 1 vector (SM case), i.e.

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} \text{ for DSTTD, } \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \text{ for SM} \qquad \text{(Equation 11.8.2.1.1.2-4)}$$

The output of the MIMO encoder is a 4 × 2 matrix (DSTTD case) or a 4 × 1 vector (SM case), i.e.,

$$\mathbf{z} = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \\ s_3 & -s_4^* \\ s_4 & s_3^* \end{bmatrix} \text{ for DSTTD, } \mathbf{z} = \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \text{ for SM} \qquad \text{(Equation 11.8.2.1.1.2-5)}$$

the output of the precoder is a 4 × 2 matrix (DSTTD case) or a 4 × 1 vector (SM case)

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}, \qquad \text{(Equation 11.8.2.1.1.2-6)}$$

where **W** is a 4 × 4 unitary precoder (DSTTD case) or a 4 × 2 unitary precoder (SM case).

When using Antenna Hopping with DSTTD, **W** is a set of 3 antenna circulation matrices, i.e.,

$$\mathbf{W} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}. \qquad \text{(Equation 11.8.2.1.1.2-7)}$$

When using Antenna Hopping with SM, **W** is a set of 6 antenna circulation matrices, i.e.,

$$\mathbf{W} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}. \quad \text{(Equation 11.8.2.1.1.2-8)}$$

In DSTTD case, $\mathbf{W}$ can be changed every pair of tones or symbols. In SM case, $\mathbf{W}$ can be changed every tone or symbol.

For 8Tx antennas rate2 mode, the input to the MIMO encoder is represented as a 4 × 1 vector (DSTTD case) or a 2 x 1 vector (SM case), i.e.

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} \text{ for DSTTD, } \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \text{ for SM} \quad \text{(Equation 11.8.2.1.1.2-9)}$$

The output of the MIMO encoder is a 4 × 2 matrix (DSTTD case) or a 4 × 1 vector (SM case)

$$\mathbf{z} = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \\ s_3 & -s_4^* \\ s_4 & s_3^* \end{bmatrix} \text{ for DSTTD, } \mathbf{z} = \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \text{ for SM} \quad \text{(Equation 11.8.2.1.1.2-10)}$$

the output of the precoder is a 4 × 2 matrix

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.8.2.1.1.2-11)}$$

where **W** is defined as follows:

$$\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2. \quad \text{(Equation 11.8.2.1.1.2-12)}$$

$\mathbf{W}_1$ is a 8x4 matrix which is implementation specific, $\mathbf{W}_2$ is a 4 × 4 unitary precoder (DSTTD case) or 4 x 2 unitary precoder (SM case).

When using Antenna Hopping with DSTTD, $\mathbf{W}_2$ is a set of 3 antenna circulation matrices, i.e.,

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix}. \quad \text{(Equation 11.8.2.1.1.2-13)}$$

When using Antenna Hopping with SM, $\mathbf{W}_2$ is a set of 6 antenna circulation matrices, i.e.,

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}. \quad \text{(Equation 11.8.2.1.1.2-14)}$$

In DSTTD case, $\mathbf{W}_2$ can be changed every pair of tones or symbols. In SM case, $\mathbf{W}_2$ can be changed every tone or symbol.

[*modify L39 P81 to L31 of P82 of C802.16m-08/003r5 as follows*]

For the rate-3 spatial multiplexing modes, the input to the MIMO encoder is represented as a 3 × 1 vector

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}, \quad \text{(Equation 11.8.2.1.1.2-15)}$$

The output of the MIMO encoder is a 3 × 1 vector

$$\mathbf{z} = \mathbf{x}, \quad \text{(Equation 11.8.2.1.1.2-16)}$$

For the 4Tx rate-3 mode, the output of the precoder is a 4 × 1 vector

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.8.2.1.1.2-17)}$$

where **W** is a 4 × 3 unitary precoder. Note that **W** may be frequency and/ or time dependent as described in section 11.8.2.1.1. $\mathbf{W}$ is a set of 4 antenna circulation matrices, i.e.,

$$\mathbf{W} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \text{(Equation 11.8.2.1.1.2-18)}$$

$\mathbf{W}$ can be changed every tone or symbol.

For the 8Tx rate-3 mode, the output of the precoder is a 8 × 1 vector

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.8.2.1.1.2-19)}$$

~~where **W** is a 8 × 3 precoder. Note that **W** may be frequency and/ or time dependent as described in section 11.8.2.1.1.~~

where **W** is defined as follows:

$$\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2. \quad \text{(Equation 11.8.2.1.1.2-20)}$$

$\mathbf{W}_1$ is a 8x4 matrix which is implementation specific, $\mathbf{W}_2$ is a 4x3 unitary precoder which consists of a set of antenna circulation matrices, i.e.,

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad \text{(Equation 11.8.2.1.1.2-21)}$$

$\mathbf{W}_2$ can be changed every tone or symbol.

For the rate-4 spatial multiplexing modes, the input to the MIMO encoder is represented as a 4×1 vector

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}, \quad \text{(Equation 11.8.2.1.1.2-22)}$$

The output of the MIMO encoder is a 4 × 1 vector

$$\mathbf{z} = \mathbf{x}, \quad \text{(Equation 11.8.2.1.1.2-23)}$$

For the 4Tx rate-4 mode, the output of the precoder is a 4 × 1 vector

$$\mathbf{y} = \mathbf{z}, \quad \text{(Equation 11.8.2.1.1.2-24)}$$

For the 8Tx rate-4 mode, the output of the precoder is a 8 × 1 vector

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.8.2.1.1.2-25)}$$

where **W** is a 8 × 4 precoder which is implementation specific. ~~Note that **W** may be frequency and/ or time dependent as described in section 11.8.2.1.1.~~

-----------------------------------End text proposal-----------------------------------