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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	
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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 $x=s_1$, and the output of the MIMO encoder is a scalar, $z=x$.~~

- ~~The output of the rank-1 precoder for $N_T=2, 4$, and 8 Tx antennas is a $N_T \times 1$ matrix $y=W \times z$, 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 $N_T \times 2$ 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

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

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

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

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

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

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

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

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

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

\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

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

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

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

\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.,

$$\mathbf{W}_2 = \begin{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \end{bmatrix}.$$

(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 2×1 vector (SM case), i.e.

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

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

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

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

$$\mathbf{y} = \mathbf{W} \times \mathbf{z}_1 \quad (\text{Equation 11.8.2.1.1.2-6})$$

where \mathbf{W} is a 4×4 unitary precoder (DSTTD case) or a 4×2 unitary precoder (SM case).

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

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

When using Antenna Hopping with SM, \mathbf{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 2×1 vector (SM case), i.e.

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

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

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

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 \mathbf{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 8×4 matrix which is implementation specific, \mathbf{W}_2 is a 4×4 unitary precoder (DSTTD case) or 4×2 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 \mathbf{W} is a 4×3 unitary precoder. Note that \mathbf{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 \mathbf{W} is a 8×3 precoder. Note that \mathbf{W} may be frequency and/ or time dependent as described in section 11.8.2.1.1.~~

where \mathbf{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 8×4 matrix which is implementation specific, \mathbf{W}_2 is a 4×3 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 \mathbf{W} is a 8×4 precoder which is implementation specific. Note that \mathbf{W} may be frequency and/or time dependent as described in section 11.8.2.1.1.

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