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Title	Proposed SDD Text for DL OL SU-MIMO	
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Re:	Re: PHY: MIMO; in response to the TGM Call for Contributions and Comments 802.16m-08/033 for Session 57	
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 in response to C802.16m MIMO-08/005r1. 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

(L19, P68 of 003r4)

11.8.2.1.1. Open-loop SU-MIMO

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

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

[modify section 11.8.2.1.1.1 of C802.16m-08/003r4 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~~

In Transmit Diversity mode, the MIMO encoder generates 2Tx STBC/SFBC, and then multiplied by $N_T \times 2$ matrix and $N_T \times N_T$ diagonal matrix as described in section 11.x.2.1.1.1.

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

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}. \quad \text{(Equation 11.x.2.1.1.1-1)}$$

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

$$\mathbf{z} = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}. \quad \text{(Equation 11.x.2.1.1.1-2)}$$

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

$$\mathbf{y} = \mathbf{z}. \quad \text{(Equation 11.x.2.1.1.1-3)}$$

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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.x.2.1.1.1-4)}$$

where \mathbf{W} is a 4×2 unitary precoder and \mathbf{D} is a 4x4 identity matrix ($\mathbf{D} = \mathbf{I}$).

\mathbf{W} is a set of 6 antenna circulation matrices, i.e.,

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

\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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}, \quad \text{(Equation 11.x.2.1.1.1-5)}$$

where \mathbf{W} is a 8×2 unitary precoder and \mathbf{D} is a 8×8 identity matrix ($\mathbf{D} = \mathbf{I}$).

\mathbf{W} is defined as follows:

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$$\underline{\mathbf{W}} = \underline{\mathbf{W}}_1 \times \underline{\mathbf{W}}_2$$

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

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

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

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(L8, P70)

11.8.2.1.1.2. Spatial Multiplexing

[modify L10 to L14 of P70 of C802.16m-08/003r4 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 D-STTD and rate 2 SM with precoding
 - 8Tx rate-2: rate 2 D-STTD and rate 2 SM with precoding

[Delete the content from L31 to L41 in P70 and Insert the following text in the section 11.8.2.1.1.2 of 80216m-08_003r4.]

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.

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} \text{ for DSTTD, } \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \text{ for SM}$$

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

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

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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}$$

where \mathbf{W} is a 4×4 unitary precoder (DSTTD case) or a 4×2 unitary precoder (SM case) and \mathbf{D} is a 4×4 identity matrix ($\mathbf{D} = \mathbf{I}$).

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

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

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

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$$\mathbf{W} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \quad \text{---}$$

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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.

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix} \quad \text{for DSTTD,} \quad \mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} \quad \text{for SM}$$

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

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

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the output of the precoder is a 4×2 matrix

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}$$

where \mathbf{D} is a 8×8 identity matrix ($D = I$) and \mathbf{W} is defined as follows:

$$\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2$$

\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).

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

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \quad \text{---}$$

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

$$\mathbf{W}_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \quad \text{---}$$

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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.

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[modify L1-L32 of P71 of C802.16m-08/003r4 as follows]

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

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}. \quad (\text{Equation 11.x.2.1.1.2-6})$$

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

$$\mathbf{z} = \mathbf{x}. \quad (\text{Equation 11.x.2.1.1.2-7})$$

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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}, \quad (\text{Equation 11.x.2.1.1.2-8})$$

where \mathbf{W} is a 4×3 unitary precoder and \mathbf{D} is a 4×4 identity matrix ($\mathbf{D} = \mathbf{I}$).

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\mathbf{W} is a set of 4 antenna circulation matrices, i.e.,

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

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\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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}, \quad (\text{Equation 11.x.2.1.1.2-9})$$

where \mathbf{D} is a 8×8 identity matrix ($\mathbf{D} = \mathbf{I}$) and \mathbf{W} is defined as follows:

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$$\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2$$

\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.

Deleted: \mathbf{W} is a 8×3 precoder and \mathbf{D} is a 8×8 diagonal phase matrix. Note that \mathbf{W} and \mathbf{D} may be frequency dependent as described in section 11.x.2.1.1.

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

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\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

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}.$$

(Equation 11.x.2.1.1.2-10)

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

$$\mathbf{z} = \mathbf{x}.$$

(Equation 11.x.2.1.1.2-11)

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

$$\mathbf{y} = \mathbf{z}.$$

(Equation 11.x.2.1.1.2-12)

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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z},$$

(Equation 11.x.2.1.1.2-13)

where \mathbf{W} is a 8×4 precoder which is implementation specific, and \mathbf{D} is a 8×8 identity matrix ($\mathbf{D} = \mathbf{I}$).

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