Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**Proposed SDD Text for DL OL SU-MIMO**	
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Re:	SDD Session 56 Cleanup, Call for PHY Details ; in response to the Call for Contributions and Comments on Project 802.16m System Description Document (SDD) 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
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

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[*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.

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

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

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

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

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

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

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

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

where **W** is a 4×2 unitary precoder and **D** is a 4x4 identity matrix (D = I).

W is a set of 6 antenna circulation matrices, i.e.,

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

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

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

where **W** is a 8×2 unitary precoder and **D** is a 8×8 identity matrix (D = I).

W is defined as follows:

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

$\mathbf{W}_1$ 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.,

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

$\mathbf{W}_2$ 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 L41in 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 x 1 vector (SM case), i.e.

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

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 **W** is a 4 × 4 unitary precoder (DSTTD case) or a 4 × 2 unitary precoder (SM case) and **D** is a 4 × 4 identity matrix ($D = I$).

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

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

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

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$$\mathbf{W} = \left[\begin{matrix}1 & 0\\ 0 & 1\\ 0 & 0\\ 0 & 0\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 0 & 0\\ 1 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0\\ 0 & 0\\ 0 & 1\\ 0 & 0\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 1 & 0\\ 0 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 1 & 0\\ 0 & 1\\ 0 & 0\end{matrix}\right].$$

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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 x 1 vector (SM case), i.e.

$$\mathbf{x} = \left[\begin{matrix}s_1\\ s_2\\ s_3\\ s_4\end{matrix}\right] \text{ for DSTTD, } \mathbf{x} = \left[\begin{matrix}s_1\\ s_2\end{matrix}\right] \text{ for SM}$$

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

$$\mathbf{z} = \left[\begin{matrix}s_1 & -s_2^*\\ s_2 & s_1^*\\ s_3 & -s_4^*\\ s_4 & s_3^*\end{matrix}\right] \text{ for DSTTD, } \mathbf{z} = \mathbf{x} = \left[\begin{matrix}s_1\\ s_2\end{matrix}\right] \text{ for SM}$$

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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 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).

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

$$\mathbf{W}_2 = \left[\begin{matrix}1 & 0 & 0 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 1 & 0 & 0\\ 0 & 0 & 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\\ 0 & 0 & 0 & 1\\ 0 & 1 & 0 & 0\end{matrix}\right].$$

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

$$\mathbf{W}_2 = \left[\begin{matrix}1 & 0\\ 0 & 1\\ 0 & 0\\ 0 & 0\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 0 & 0\\ 1 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0\\ 0 & 0\\ 0 & 1\\ 0 & 0\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 1 & 0\\ 0 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}1 & 0\\ 0 & 0\\ 0 & 0\\ 0 & 1\end{matrix}\right], \left[\begin{matrix}0 & 0\\ 1 & 0\\ 0 & 1\\ 0 & 0\end{matrix}\right].$$

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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.

[*modify L1-L32 of P71of 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

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

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

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

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

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

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

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

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

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

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

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

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 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.

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

$\mathbf{W}_2$ 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

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$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}. \qquad \text{(Equation 11.x.2.1.1.2-10)}$$

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

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

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

$$\mathbf{y} = \mathbf{z}. \qquad \text{(Equation 11.x.2.1.1.2-12)}$$

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

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}, \qquad \text{(Equation 11.x.2.1.1.2-13)}$$

where **W** is a 8 × 4 precoder which is implementation specific, and **D** is a 8 × 8 identity matrix (D = I)

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