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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

$N_{\mathrm{T}}$	Rate	M	$N_{\mathrm{F}}$
2	1	1	1
2	1	2	2
4	4	1	1
4	1	2	2
8	4	1	1
8	1	2	2
2	2	2	1
4	2	2	1
<u>4</u>	<u>2</u>	<u>4</u>	<u>2</u>
8	2	2	1
<u>8</u>	<u>2</u>	<u>4</u>	<u>2</u>
4	3	3	1
8	3	3	1
NT       2       4       8       2       4       8       2       4       8       8       4       8       4       8       4       8       4       8       4       8	1 1 1 1 2 2 2 2 2 2 2 3 3 4 4	1 2 1 2 2 2 2 2 2 4 3 3 4 4	N <sub>F</sub> 1 2 1 2 1 1 2 1 1 1 1 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-08/003r4 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  $2 \times 1$  vector

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

The output of the MIMO encoder is a  $2 \times 2$  matrix

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

For the 2Tx rate-1 mode, the output of the precoder is a  $2 \times 2$  matrix

$$y = z$$
. (Equation 11.x.2.1.1.1-3)

For the 4Tx rate-1, the output of the precoder is a  $4 \times 2$  matrix

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

where **W** is a  $4 \times 2$  <u>unitary</u> precoder and **D** is a <u>4x4 identity matrix</u> (D = I).  $4 \times 4$  <u>diagonal phase matrix</u>. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

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

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

W can be changed every pair of tones or symbols.

For the 8Tx rate-1, the output of the precoder is a  $8 \times 2$  matrix

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

where **W** is a  $8 \times 2$  <u>unitary</u> precoder and **D** is a  $8 \times 8$  <u>identity matrix</u> (D = I)<u>diagonal phase matrix</u>. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

W is defined as follows:

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

 $\underline{\mathbf{W}_{1}}$  is a 8x4 matrix which is implementation specific,  $\underline{\mathbf{W}_{2}}$  is a 4 × 2 unitary precoder which consists of a set of 6 antenna circulation matrices, i.e.,

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

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

(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:
  - o 2Tx rate-2: rate 2 SM
  - o 4Tx rate-2: rate 2 D-STTD and rate 2 SM with precoding
  - o4Tx rate-2: rate 2 SM with precoding
  - o 8Tx rate-2: rate 2 SM with precoding 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  $4 \times 1$  vector (DSTTD case) or a  $2 \times 1$  vector (SM case), i.e.

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

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

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

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

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

where **W** is a  $4 \times 4$  unitary precoder (DSTTD case) or a  $4 \times 2$  unitary precoder (SM case) and **D** is a  $4 \times 4$  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 62 antenna circulation matrices, i.e.,

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

In DSTTD case, W can be changed every pair of tones or symbols. In SM case, W can be changed every tone or symbol.

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

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

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

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

the output of the precoder is a  $4 \times 2$  matrix

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

where **D** is a  $8 \times 8$  identity matrix (D = I) and **W** is defined as follows:

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

 $\underline{\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2}_{\underline{\phantom{0}}}.$   $\mathbf{W}_1 \underline{\phantom{0}} \underline{\phantom{0}$ unitary precoder (SM case).

When using Antenna Hopping with DSTTD,  $W_2$  is a set of 3 antenna circulation matrices, i.e.,

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

When using Antenna Hopping with SM, W<sub>2</sub> is a set of 6 antenna circulation matrices, i.e.,

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

In DSTTD case,  $\underline{\mathbf{W}_2}$  can be changed every upair of tones or symbols. In SM case,  $\underline{\mathbf{W}_2}$  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  $3 \times 1$  vector

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

The output of the MIMO encoder is a  $3 \times 1$  vector

$$z = x$$
. (Equation 11.x.2.1.1.2-7)

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

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

where **W** is a  $4 \times 3$  unitary precoder and **D** is a  $4 \times 4$  identity matrix (D = I)<del>diagonal phase matrix</del>. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

W is a set of 4 antenna circulation matrices, i.e.,

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

W can be changed every tone or symbol.

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

$$\mathbf{v} = \mathbf{D} \times \mathbf{W} \times \mathbf{z}$$
.

(Equation 11.x.2.1.1.2-9)

where **D** is a  $8 \times 8$  identity matrix (D = I) and **W** is defined as follows:

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

 $\underline{\mathbf{W} = \mathbf{W}_1 \times \mathbf{W}_2}_{\text{:}}.$  \textbf{W} is a 8 \times 3 precoder and \textbf{D} is a 8 \times 8 diagonal phase matrix. Note that \textbf{W} and \textbf{D} may be frequency dependentas described in section 11.x.2.1.1.

 $\mathbf{W}_1$  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.

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

W<sub>2</sub> 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  $4 \times 1$  vector

$$z = x$$
. (Equation 11.x.2.1.1.2-11)

For the 4Tx rate-4 mode, the output of the precoder is a  $4 \times 1$  vector

$$y = z$$
. (Equation 11.x.2.1.1.2-12)

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

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

where **W** is a  $8 \times 4$  precoder which is implementation specific, and **D** is a  $8 \times 8$  identity matrix (D = I) diagonal phase matrix. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

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