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Re:	Call for Comments on DL MIMO SDD text, C802.16m-08/657r2
Abstract	This contribution proposes modification to the open loop MIMO sections
Purpose	For discussion and approval by TGm for 802.16m SDD
Notice	
Release	
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Proposed Text Changes to Section 11.x.2.1.1 of DL MIMO SDD Text

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Introduction

This contribution proposes text change on the OL MIMO sections. In the current text in C802.16m-08/657r2, the precoding matrix is composed of two components, i.e. a unitary matrix and a diagonal matrix. However, the details on the elements in the matrices are TBD. Comparative studies were performed in C802.16m-08/824 for different OL schemes with different unitary matrices and with and without the diagonal matrix. The proposed text change reflects the conclusion drawn from the simulation results.

In addition, for the 8tx case for OL MIMO, the precoder used for mapping 8 physical antennas to ‘effective antenna’ as seen by the MS does not need to be specified as long as the demodulation pilots are precoded to the desired number of ‘effective antennas’. For example, to support up to 4 effective antennas regardless of the number of physical antennas, the demodulation pilots of up to 4 effective antennas can be defined from standards specification point of view. How the BS maps the physical antennas to the 4 effective antennas is implementation specific and does not need to be specified in the standards.

Proposed Text Change

11.x.2.1.1. Open-loop SU-MIMO

A number of antenna configurations and transmission rates are supported in open-loop SU-MIMO. Among them, 2Tx antennas with rate 1 transmission and 4Tx antennas with rate 1 transmission are defined as Transmit Diversity modes. The operation of these modes is specified in Section 11.x.2.1.1.1. The other modes, including 2Tx antennas with rate 2 transmission, 4Tx antennas with rate 2 transmission, 4Tx antennas with rate 3 transmission, and 4Tx antennas with rate 4 transmission, are defined as Spatial Multiplexing modes. The operation of these modes is specified in Section 11.x.2.1.1.2. The dimensions of the vectors and matrices for open-loop SU-MIMO are shown in the following table. The number of tx antennas are defined in terms of the number of effective antennas as seen by the MS. For OL SU-MIMO, up to 4 effective antennas are supported. When the number of physical antennas is greater than 4, how the BS map the physical antennas to the 4 effective antennas is implementation specific and does not need to be specified in the standards.~~:~~

Table 1. Matrix dimensions for open-loop SU-MIMO modes

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
8	2	2	1
4	3	3	1
8	3	3	1
4	4	4	1
8	4	4	1

On a given frequency resource k [size is FFS], the precoding matrix **P** can be defined using the following equation:

$$\mathbf{P}(k) = \mathbf{D}(k)\mathbf{W}(k).$$

The precoder is composed of two matrices. The first matrix **W**(k) is an $N_T \times M$ unitary matrix, where N_T is the number of transmit antennas and M areis the numbers of physical and effectivelayers antennas, respectively. The matrix **W**(k) is selected from a predefined unitary_ matrix codebook, and changes every u subcarriers. [The detailed unitary matrix codebook, and the parameter u are FFS.] The second matrix **D**(k) is an $N_T \times N_T$ diagonal matrix as follows,

$$\mathbf{D}(k) = \begin{bmatrix} e^{j\theta_0 k} & 0 & \cdots & 0 \\ 0 & e^{j\theta_1 k} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & e^{j\theta_{(N_T-1)} k} \end{bmatrix}$$

where k denotes frequency resource index and $\theta_i, i = 0,1,2,...,N_T-1$ denotes the phase anglesshift for the i-th each physicaltransmit antenna. [The value of the phase angleshift θ_i is FFS.]

11.x.2.1.1.1. Transmit Diversity

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

- 2Tx rate-1: STBC/SFBC
- 4Tx rate-1: STBC/SFBC with precoder
- 8Tx rate-1: STBC/SFBC with precoder

In Transmit Diversity mode, the MIMO encoder generates 2Tx STBC/SFBC, and then multiplied by $N_T \times 2$ unitary 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

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

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

$$\mathbf{z} = \begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix}.$$

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

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

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} \,,$$

where P is a set of 6 (combination of 2 out of 4) antenna circulation matrices with size 4x2, i.e.,W is a 4 × 2 unitary precoder and D is a 4 × 4 diagonal delay matrix. Note that W and D may be frequency dependaent as described in section 11.x.2.1.1.

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

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} \,,$$

where W is a 8 × 2 unitary precoder and D is a 8 × 8 diagonal delay matrix. Note that W and D may be frequency dependent as described in section 11.x.2.1.1.

11.x.2.1.1.2. Spatial Multiplexing

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 SM with precoding
- Rate-3 spatial multiplexing modes:
  - 4Tx rate-3: rate 3 SM with precoding
- Rate-4 spatial multiplexing modes:
  - 4Tx rate-4: rate 4 SM

For the rate-2 spatial multiplexing modes, the input to the MIMO encoder is represented as a 2 × 1 vector

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

The output of the MIMO encoder is a 2 × 1 vector

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

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

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

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} \,,$$

where P is a set of 6 (combination of 2 out of 4) antenna circulation matrices with size 4x2, i.e.

W is a 4 × 2 unitary precoder and D is a 4 × 4 diagonal delay matrix. Note that W and D may be frequency dependaent as described in section 11.x.2.1.1. $\mathbf{P} = \begin{bmatrix}1&0\\0&1\\0&0\\0&0\end{bmatrix},\begin{bmatrix}1&0\\0&0\\0&1\\0&0\end{bmatrix},\begin{bmatrix}1&0\\0&0\\0&0\\0&1\end{bmatrix},\begin{bmatrix}0&0\\1&0\\0&1\\0&0\end{bmatrix},\begin{bmatrix}0&0\\1&0\\0&0\\0&1\end{bmatrix},\begin{bmatrix}0&0\\0&0\\1&0\\0&1\end{bmatrix}$

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} ,$$

where **W** is a 8 × 2 unitary precoder and **D** is a 8 × 8 diagonal delay matrix. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

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

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

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

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

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} ,$$

where P is a set of 4 (combination of 3 out of 4) antenna circulation matrices with size 4x3, i.e., **W** is a 4 × 3 unitary precoder and **D** is a 4 × 4 diagonal delay matrix. Note that **W** and **D** may be frequency dependaent as described in section 11.x.2.1.1.

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

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

$$\mathbf{y} = \mathbf{P} \times \mathbf{z} ,$$

Where **W** is a 8 × 3 unitary precoder and **D** is a 8 × 8 diagonal delay matrix. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.

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

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

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

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

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

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

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

$\mathbf{y} = \mathbf{P} \times \mathbf{z}$,

where **W** is a 8 × 4 unitary precoder and **D** is a 8 × 8 diagonal delay matrix. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1.