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Source(s)	**Hosein Nikopourdeilami, Mo-Han Fong, Jun Yuan, Sophie Vrzic, Robert Novak, Dongsheng Yu, Kathiravetpillai Sivanesan** — Email: hosein@nortel.com, mhfong@nortel.com **Nortel Networks** **Serdar Sezginer, Bertrand Muquet, Fabien Buda, Jeremy Gosteau** — jgosteau@sequans.com **Sequans Communications** **Markus Muck** — MarkusDominik.Mueck@infineon.com **Infineon**
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
Notice	
Release	
Patent Policy	

Proposed SDD Text for DL OL SU-MIMO

Hosein Nikopourdeilami, Mo-Han Fong, Jun Yuan, Sophie Vrzic, Robert Novak, Dongsheng Yu, Kathiravetpillai Sivanesan

Nortel Networks

Serdar Sezginer, Bertrand Muquet, Fabien Buda, Jeremy Gosteau

Sequans Communications

Markus Muck

Infineon

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~~	~~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-08/003r4 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

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

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 **W** is a 4×2 unitary precoder and **D** is a 4x4 identity matrix (D = I). ~~4×4 diagonal phase matrix. 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.,

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

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

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

where **W** is a 8×2 unitary precoder and **D** is a 8×8 identity matrix (D = I)~~diagonal phase matrix. Note that **W** and **D** may be frequency dependent as described in section 11.x.2.1.1~~.

W is defined as follows:

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

$\mathbf{W}_1$ 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.

(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
  - ~~o4Tx rate-2: rate 2 SM with precoding~~
  - 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 × 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.

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

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~~2~~ antenna circulation matrices, i.e.,

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

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.

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

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

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

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).

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

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

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

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

In DSTTD case, $\mathbf{W}_2$ can be changed every upair 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

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

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 **W** is a 4 × 3 unitary precoder and **D** is a 4 × 4 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.~~

$\mathbf{W}$ 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

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

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

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

~~**W** is a 8 × 3 precoder and **D** is a 8 × 8 diagonal phase matrix. Note that **W** and **D** may be frequency dependent as 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.

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

$\mathbf{W}_2$ 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

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

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

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

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

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

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

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

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

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