Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Closed-loop MIMO enhancement**
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Re:	IEEE 802.16e D2 Draft
Abstract	To improve the closed loop MIMO
Purpose	To incorporate the changes here proposed into the 802.16e D4 draft.
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Closed-loop MIMO enhancement

1 Background

The closed-loop MIMO was introduced for optional AMC channels in IEEE802.16eD3. In this contribution, we present a unified closed-loop MIMO frame work to enable more flexible schemes.

Specific text changes

---------Start text proposal-------

[Replace the section 8.4.8.3.3 with the following]

8.4.8.3.3 Transmission schemes for 2-antenna BS in DL

The following matrices define the transmission format with the row index indicating antenna number and column index in dicating OFDMA symbol time. For both DL permutation zones with 2-antenna BS, one of the following two transmission matrices shall be used:

$$A = \begin{bmatrix} S_i & -S_{i+1}^* \\ S_{i+1} & S_i^* \end{bmatrix}$$

$$B = \begin{bmatrix} S_i \\ S_{i+1} \end{bmatrix}$$ where S_i and S_{i+1} may be encoded in different rates.

[Add a new section 8.4.8.4.3]

8.4.8.4.3 Transmission schemes for 2-antenna MSS in UL

The following matrices define the transmission format with the row index indicating antenna number and column index in dicating OFDMA symbol time. For both UL permutation zones with 2-antenna MSS, one of the following two transmission matrices shall be used:

$$A = \begin{bmatrix} S_i & -S_{i+1}^* \\ S_{i+1} & S_i^* \end{bmatrix}$$

$$B = \begin{bmatrix} S_i \\ S_{i+1} \end{bmatrix}$$ where S_i and S_{i+1} may be encoded in different rates.

The matrix B may also be used for two single antenna MSSs to share the same subchannel (collaborative spatial multiplex ing).

[Replace the section 8.4.8.3.5 with the following]

8.4.8.3.5 Transmission schemes for 4-antenna BS in DL

For both permutation zones with 4-antenna BS, one of the following three transmission matrices shall be used:

$$A = \begin{bmatrix} S_i & -(S_{i+1})^* & 0 & 0 \\ S_{i+1} & (S_i)^* & 0 & 0 \\ 0 & 0 & S_{i+2} & -(S_{i+3})^* \\ 0 & 0 & S_{i+3} & (S_{i+2})^* \end{bmatrix}$$

$$B = \begin{bmatrix} S_i & -(S_{i+1})^* & S_{i+4} & -(S_{i+6})^* \\ S_{i+1} & (S_i)^* & S_{i+5} & -(S_{i+7})^* \\ S_{i+2} & -(S_{i+3})^* & S_{i+6} & (S_{i+4})^* \\ S_{i+3} & (S_{i+2})^* & S_{i+7} & (S_{i+5})^* \end{bmatrix}$$

$$C = \begin{bmatrix} S_i \\ S_{i+1} \\ S_{i+2} \\ S_{i+3} \end{bmatrix}$$

,

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

---------Start text proposal-------

[Add the following text into section 8.4.8.3.7]

8.4.8.3.7 MIMO precoding

The space time coding output can be weighted by a matrix before mapping onto transmit antennas:

$$z = Wx,$$

where x is a $M_t \times 1$ vector with the output from the space-time coding (per-subcarrier), M_t is the number of antennas at the output of the space-time coding scheme. The matrix *W* is an $N_t \times M_t$ weighting matrix where the quantity N_t is the number of *actual transmit antennas*. The vector z contains the signals after weighting for the different actual antennas. The labeling of the elements in the weighting matrix W is performed in accordance with the example of W given below for the case of 4 actual antennas and 2 space-time coding output antennas:

$$W = \begin{bmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \\ w_{31} & w_{32} \\ w_{41} & w_{42} \end{bmatrix}$$

[Modify the following Table 298a in section 8.4.5.3.12.1]

Table 298a. CQICH Enhanced allocation IE format

Syntax	Size (bits)	Notes
CQICH_Enhanced_Alloc_IE() {		
Extended DIUC	4	0x09
Length	4	Length in bytes of following fields
CQICH_ID	variable	Index to uniquely identify the CQICH resource assigned to the MSS
Period (=p)	2	A CQI feedback is transmitted on the CQICH every 2^p frames
Frame offset	3	The MSS starts reporting at the frame of which the number has the same 3 LSB as the specified frame offset. If the current frame is specified, the MSS should start reporting in 8 frames
Duration (=d)	3	A CQI feedback is transmitted on the CQI channels indexed by the CQICH_ID for 10 x 2^d frames. If d== 0, the CQICH is de-allocated. If d == 111, the MSS should report until the BS command for the MSS to stop.
N_T actual BS antennas	3	001 = Reserved 010 = 2 actual antennas 011 = 3 actual antennas 100 = 4 actual antennas 101 = 5 actual antennas 110 = 6 actual antennas 111 = 7 actual antennas 000 = 8 actual antennas
Feedback_type	4	0000 = Open loop precoding. Pilots in burst to be precoded with *W*. SS to rely only on pilots in burst for channel estimation. 0001 = Complex weight of specific element of *W* 0010 = Fast DL measurement 0011 = Layer specific channel strengths 0100 = MIMO mode and permutation zone feedback 0101 = Feedback of subset of antennas to use.

		0110 ~ 1111 reserved
CQICH_Num	4	Number of CQICHs assigned to this CQICH_ID is (CQICH_Num +1)
for (i=0;i<CQICH_Num;i++) {		
Allocation index	6	Index to the fast feedback channel region marked by UIUC=0
}		
if (Feedback_type != 0100) { MIMO_permutation_feedback cycle }	2	00 = No MIMO and permutation mode feedback 01 = the MIMO and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 4 frames. The first indication is sent on the 8th CQICH frame. 10 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 8 frames. The first indication is sent on the 8th CQICH frame. 11 = the MIMO mode and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 16 frames. The first indication is sent on the 16th CQICH frame.
Padding	*variable*	The padding bits are used to ensure the IE size is integer number of bytes.

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