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. MIMO transmission format and singling is generalized to allow variety MIMO schemes to operate by using the same air-interface design, the basic transmission format are: (1) SM and (2) STTD, with vector or matrix weighted full MIMO or sub-MIMO transmission based on the 2 and 4 transmit antennas configurations.

Specific text changes

[Add the following text into section 8.4.8.3.3 and 8.4.8.3.4]

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---------Start text proposal-------
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For two transmit antenna the matrix weighted spatial multiplexing transmission, the following matrix is defined:

$$D=\begin{bmatrix} w_1 s_1 + w_2 s_2 \\ w_3 s_1 + w_4 s_2 \end{bmatrix}$$

For four transmit antenna the matrix weighted spatial multiplexing transmission, the following matrix is defined:

$$E=\begin{bmatrix} w_1 s_1 + w_2 s_2 + w_3 s_3 + w_4 s_4 \\ w_5 s_1 + w_6 s_2 + w_7 s_3 + w_8 s_4 \\ w_9 s_1 + w_{10} s_2 + w_{11} s_3 + w_{12} s_4 \\ w_{13} s_1 + w_{14} s_2 + w_{15} s_3 + w_{16} s_4 \end{bmatrix}$$

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---------Start text proposal-------
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The matrix weight MxN SM transmission can be applied to single user case reception case where N>=M or to the multi-user concurrent transmission cases, such as 2x2x1, 4x4x1, 4x2x2, 4x3x2x1, where we denote: *number_of-tranmsit_antenna* x *number_of_users* x *number_of_recieve_antennas.*

[Add the following text into section 8.4.9.4.3.2]

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---------Start text proposal-------
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8.4.5.4.12.1 CQICH Enhanced Allocation IE Format

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.
Feedback_type	4	0000 = Fast DL measurement 0001 = Layer specific channel strengths 0010 = Antenna weight associated with specific antenna 0011 = MIMO mode and permutation zone feedback 0100 = 2x1 channel matrix 0101 = 2x2 channel matrix 0110 = 4x1 channel matrix 0111 = 4x2 channel matrix 1000 = 4x4 channel matrix 1001 = 4x1x2 Sub-MIMO SM 1010 = 4x1x1 Sub-MIMO S-STTD 1011 = 4x1x2 Sub-MIMO D-STTD 1100 = 4x1x2 Sub-MIMO SM/TxAA 1101 ~ 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 !=0011) { 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 senton 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 is used to ensure the IE size is integer number of bytes.

CQICH_ID
The CQICH_ID uniquely identifies a fast feedback channel on which a MSS can transmit fast feedback information. With this allocation, a one-to-one relationship is established between the CQICH_ID and the SS.
Feedback type

This field specifies the types of the actual feedback information on CQICH.

CQICH_Num, Allocation index

if (Feedback_type == 0000) {
    CQICH_Num = number of BS antennas
Allocation_indices are assigned to each numbered BS antennas}
elseif ((Feedback_type == 0001)&(STC==01)&(No. SS antennas ==2)) { * STC = STC field in STC_Zone_IE()
    CQICH_Num = 4
Allocation_indeces are assigned in the following order in the matrix: (1,1),(1,2),(2,1),(2,2)}
elseif ((Feedback_type == 0010) & (STC == 01)) {
    CQICH_Num = 1
Allocation index is assigned to 2nd BS antenna}
elseif ((Feedback_type == 0010) & (STC == 10)) {
    CQICH_Num = 3
Allocation indices are assigned to 2nd, 3rd and 4th antennas}
elseif (Feedback_type == 0011) {
    CQICH_Num = number of BS antennas
Allocation indices are assigned to the top 2 or 4 modes selected by MSS}
elseif (Feedback_type == 0100) & (STC == 01)) {
    CQICH_Num = 1
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 0101) & (STC == 01)) {
    CQICH_Num = 3
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 0110) & (STC == 10)) {
    CQICH_Num = 3
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 0111) & (STC == 10)) {
    CQICH_Num = 7
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 1000) & (STC == 10)) {
    CQICH_Num = 15
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 1001) & (STC == 10)) {
    CQICH_Num = 2
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 1010) & (STC == 10)) {
    CQICH_Num = 2
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 1011) & (STC == 10)) {
    CQICH_Num = 3
Allocation indices are assigned to the channel elements}
elseif (Feedback_type == 1100) & (STC == 10)) {
    CQICH_Num = 4
Allocation indices are assigned to the channel elements}
end;

MIMO permutation feedback cycle

This field specifies the MIMO and permutation mode fast feedback cycle.

Table xxx Encoding of payload bits for Fast-feedback slot

Value	Description
0b0000	STTD and PUSC/FUSC permutation
0b0001	STTD and adjacent-subcarrier permutation
0b0010	SM and PUSC/FUSC permutation

0b0011	SM and adjacent-subcarrier permutation
0b0100	Closed-loop vector weighted STTD and PUSC/FUSC permutation
0b0101	Closed-loop vector weighted STTD adjacent-subcarrier permutation
0b0110	Closed-loop vector weighted SM and adjacent-subcarrier permutation
0b0111	Closed-loop matrix weighted SM and adjacent-subcarrier permutation
0b1010	Sub-MIMO SM
0b1011	Sub-MIMO SM/TxAA
0b1100	Sub-MIMO S-STTD
0b1101	Sub-MIMO D-STTD
0b1110-1111	Reserved

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