Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	Closed-loop MIMO Enhancement
Date Submitted	2004-11-13
Source(s)	Bin-Chul Ihm, Yongseok Jin, Jinyoung Chun, Kyuhyuk Chung LG Electronics,Inc. 533,Hogye-1dong,Dongan-gu, Anyang-shi,Kyongki-do,Korea Voice: 82-31-450-7187 Fax: 82-31-450-7912 [mailto: {bcihm, jayjay, jychun03, kyuhyuk}@lge.com]
Re:	This is a response to a Call for Comments on IEEE P802.16e-D5
Abstract	We propose a closed-loop MIMO method and feedback scheme
Purpose	This document is submitted for review by 802.16e Working Group members. underline green indicates new revised text change to the Standard
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Closed-loop MIMO enhancement

Bin-Chul Ihm, Yongseok Jin, Jin-young Chun, and Kyuhyuk Chung
LG Electronics

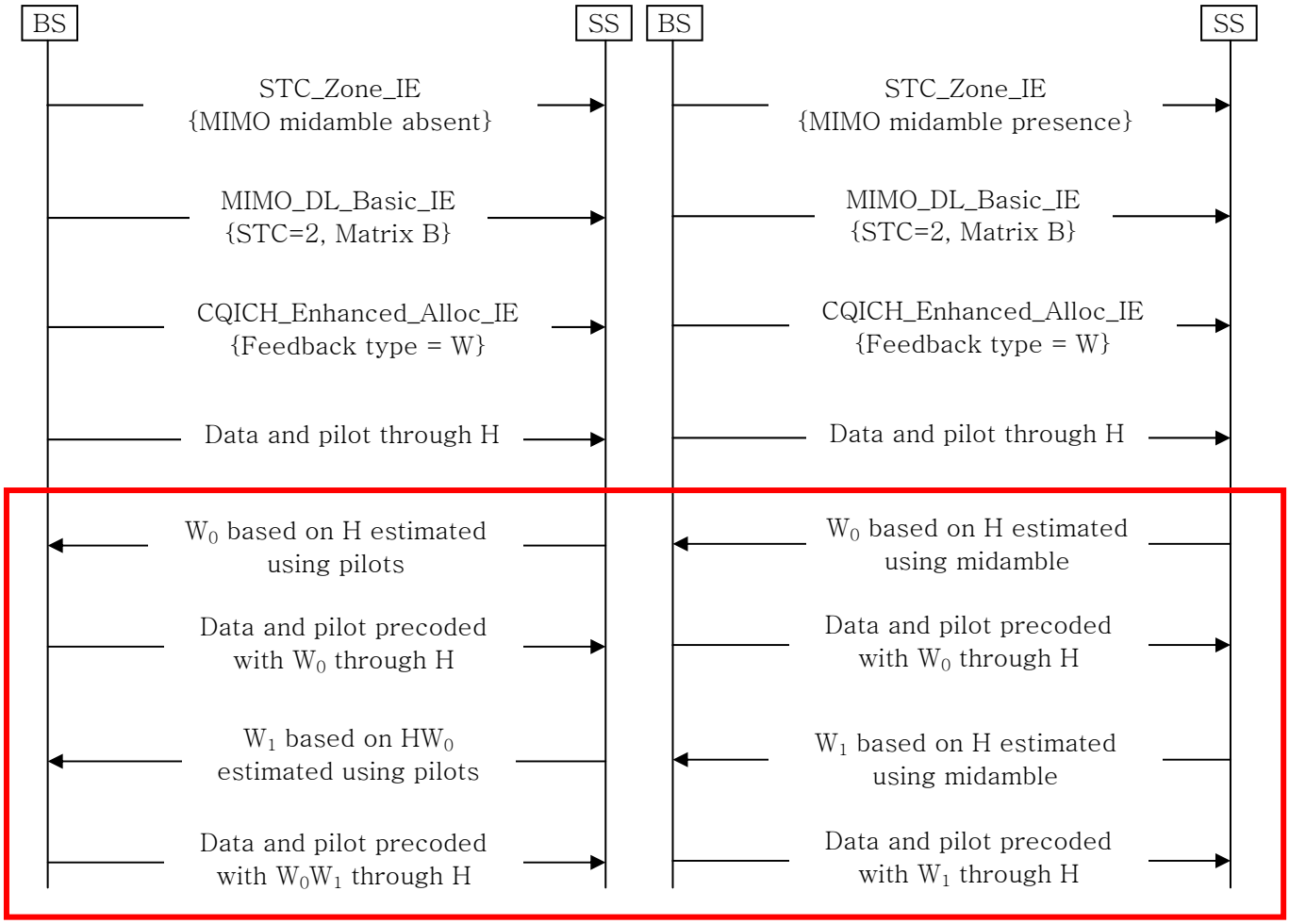
1. Introduction

We propose to clarify the closed-loop MIMO scheme using pilots and MIMO midamble and to report the number of streams.

2. MIMO channel estimation

Let us consider two exemplary cases.

Scenario 1: channel estimation using pilots in the burst



Scenario 2: channel estimation using MIMO-midamble

Figure 1. Two cases for channel estimation using pilots or midamble

As shown in Figure 1, BS sends the data precoded with W sent back by MSS where W is different according to which known signals (pilots or midamble) are used for channel estimation. Furthermore, when using pilots in the burst for channel estimation, BS has to save the previous W (W_0) because MSS computed the new W (W_1) based on H W_0. Therefore, there shall be a rule for use of pilots or midamble for channel estimation or BS should indicate MSS to use pilots or midamble for channel estimation.

Channel estimation can be done with the pilots in the DL burst or MIMO midamble. When DL burst to MSS exists and MIMO midamble is absent, MSS will perform channel estimation using pilots within the burst and sent back the feedback information such as channel matrix H, weight matrix W or mode selection. When DL burst and midamble co-exist, MSS

will estimate the channel using midamble or pilots according to indication of BS or certain rule where measurable subchannel in midamble is corresponding to the subchannnel of the burst.

3. Number of streams

According to the capability of MSS, characteristics of channel matrix H and so on, MSS can adapt the number of streams and send it back to BS through mode selection payload. For example, MSS with 4 rx antennas in the closed-loop SM mode can decide 2 streams and inform to BS. After reporting the number of streams, MSS can feed back the precoding weight matrix *W* when feedback type is 'precoding weight matrix'.

4. Specific text changes

[Apply the following changes to Section 8.4.8.3.6, line 32-43, page 242:]

The space time coding output can be weighted by a matrix before mapping onto transmit antennas:
$z = Wx$
where x is a vector with the output from the space-time coding (per-subcarrier), Mt is the number of antennas at the output of the space-time coding scheme. The matrix W is an Nt x Mt weighting matrix where the quantity Nt is the number of actual transmit antennas. Data and pilot are precoded with *W*. 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:

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

W is derived from pilots and/or midamble when Nt = Mt and BS indicates MS to use one of them in case of their coexistence. When Nt > Mt, *W* is obtained from only midamble.

[Apply the following changes to Table 298a in Section 8.4.5.4.15, page 188:]

CQICH Enhanced allocation IE() is introduced to dynamically allocate or de-allocate a CQICH to a MSS. Once allocated, the MSS transmits information of decided feedback type on assigned CQICH on every subsequent frames, until MSS receives a CQICH Enhanced allocation IE() to de-allocate the assigned CQICH.

Table 298 a. CQICH Enhanced allocation IE format

Syntax	Size(bits)	Notes
CQICH_Enhanced_Alloc_IE() {		
Extended ~~DIUC~~ UIUC	4	0x09
Length	4	Length (in bytes) of the 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 2p 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 2d frames. If d == 0, the CQI-CH is de-allocated. If d == 111, the MSS should report until the BS Commend for the MSS to stop.
NT actual BS antennas	~~3~~2	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	000 = Fast DL measurement/Default Feedback 001 = Precoding weight matrix information 010 = Channel matrix H 011 = MIMO mode and permutation zone ~~100 = Open loop precoding~~ 101 - 111 = Reserved
Base for feedback	1	0 = Use of pilots in the burst 1 = Use of midamble
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 != 11) {		
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 CQICHframe.
}		
Padding	variable	
}		

[Apply the changes into Table 296d in section 8.4.5.4.10.7, page 186]

8.4.5.3.17.3 Mode Selection Feedback

For the 5-bit payload case, when the FAST_FEEDBACK subheader Feedback Type field is '11' or at a specific frame indicated in the CQICH_Alloc_IE(), and CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.~~12.1~~15), the MSS shall send its selection in terms of MIMO mode (STTD versus SM), ~~or~~ permutation mode or number of streams on the assigned FAST_FEEDBACK channel. Table 296d shows the encoding of payload bits for the enhanced FAST_FEEDBACK slot with 5 bit payload.

Table 296d—Encoding of payload bits for Fast-feedback slot

Value	Description
0b00000	STTD and PUSC/FUSC permutation
0b00001	STTD and adjacent-subcarrier permutation
0b00010	SM and PUSC/FUSC permutation
0b00011	SM and adjacent-subcarrier permutation
0b00100	Hybrid and PUSC/FUSC permutation
0b00101	Hybrid and adjacent-subcarrier permutation
0b00110	Beamforming and adjacent-subcarrier permutation

0b01111	Closed-loop SM and PUSC/FUSC permutation
0b10000	Closed-loop SM and adjacent-subcarrier permuation
~~0b10001~0b11111~~	~~Reserved~~
~~0b10001~~	~~1 Stream~~
~~0b10010~~	~~2 Streams~~
~~0b10011~~	~~3 Streams~~
~~0b10100~~	~~4 Streams~~
0b1x000	+1 STC outputs
0b1x001	-1 STC outputs
~~0b10101~0b11111~~	~~Reserved~~

[Apply the changes into Table 297 in section 8.4.5.4.10.8, page 186]

Table 297—Encoding of payload bits for MIMO feedback with 6 bit payload

Value	Description
0b101000	STC and PUSC/FUSC permutation
0b101001	STC and adjacent-subcarrier permutation
0b101010	SM and PUSC/FUSC permutation
0b101011	SM and adjacent-subcarrier permutation
0b101100	Closed-loop SM and PUSC/FUSC permutation
0b101101	Closed-loop SM and adjacent-subcarrier permuation
0b101110	Hybrid and PUSC/FUSC permutation
0b101111	Hybrid and adjacent-subcarrier permutation
0b110000	Beamforming and adjacent-subcarrier permutation
~~0b110001~~	~~Antenna Group A For 3-antenna BS, 00 = Antenna group 0,1 & 0,2 For 4-antenna BS, 00 = Antenna group 0,1 & 2,3~~
~~0b110010~~	~~Antenna Group B For 3-antenna BS, 00 = Antenna group 0,1 & 1,2 For 4-antenna BS, 00 = Antenna group 0,2 & 1,3~~
~~0b110011~~	~~Antenna Group C For 3-antenna BS, 00 = Antenna group 0,2 & 1,2 For 4-antenna BS, 00 = Antenna group 0,3 & 1,2~~
~~0b110100~0b111111~~	~~Reserved~~
~~0b110001~~	~~1 Stream~~
~~0b110010~~	~~2 Streams~~
~~0b110011~~	~~3 Streams~~
~~0b110100~~	~~4 Streams~~
0b1x0000	+1 STC outputs
0b1x0001	-1 STC outputs
~~0b110101~0b111111~~	~~Reserved~~