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Re:	Contribution supporting TGe WG ballot #14c	
Abstract	An Efficient CQICH Signaling for MIMO OFDMA	
Purpose	Adoption of proposed changes into P802.16e	
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An Efficient CQICH Signaling for MIMO OFDMA

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1. Introduction

In the current standard [1], [2], three options for CQICH, i.e., 4-bit, 5-bit and 6-bit payload are defined. For MIMO SS, the type of CQI payload can further be defined to indicate the usage of the CQICH allocated to a specific SS. In this contribution, an efficient operation of CQICH for MIMO SS is proposed as well as some clarification on the existing scheme.

The signaling scheme for CQICH differs in the regular MAP and H-ARQ MAP. In the regular MAP CQI channels are allocated for each SS through an extended DIUC of either CQICH_Alloc_IE (8.4.5.4.12) or CQICH_Enhanced_Alloc_IE (8.4.5.4.12.1), while they are allocated within the burst allocation through CQI_Control_IE (6.3.2.3.43.5). Whichever MAP is being used, for MIMO SS, BS indicates what type of content SS should report on the allocated CQICH. The indication of type is (or is proposed to be) made through FAST-FEEDBACK allocation subheader in Table 13 for 16d SS, through Feedback_type field in CQICH_Enhanced_Alloc_IE in Table 298a for 16e SS using the regular MAP, and through CQI_Feedback_type field in MIMO_Compact_DL-MAP_IE in Table 99a for 16e SS using H-ARQ MAP.

The type of contents can be the normal DL channel measurement, antenna weights, or MIMO mode and zone selection and so on. For the default 4-bit version and the optional 5-bit version, the entire 4 or 5 bits are used to report to BS the indicated type. This method, however, lacks adaptability in the mobile environment because SS can not suggest the best MIMO mode and zone and has to wait until BS asks him to do so. This BS initiating approach is addressed in this contribution and transformed to SS initiating approach with the help of 6-bit CQI.

2. Specific Text Changes

[Note to Reply Commentors: The following section numbers are based on the contribution C802.16e-04/126r3 which is an editorial contribution submitted for clarification purpose]

[Modify section 8.4.5.4.10.6 as follows]

8.4.5.4.10.6 Fast MIMO feedback for enhanced FAST_FEEDBACK channel

When the FAST_FEEDBACK subheader Feedback Type field is '01' or '10', or the CQI Feedback Type field in the MIMO Compact DL-MAP IE() (see 6.3.2.3.43.6.7) is 001, or the CQI Type field in CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.12.1) is 001, the SS shall report the MIMO coefficient the BS should use for best DL reception (see 8.4.8.1.6). The mapping for the complex weights is shown in Figure 230c. For this type of feedback, if *N* is the number of BS transmit antennas, then *(N-1)* CQICH shall be allocated to the SS and SS shall report the desired antenna weights of antenna 1 through *N-1* based on antenna 0.

[Modify section 8.4.5.4.10.7 as follows]

8.4.5.4.10.7 Mode Selection Feedback for enhanced FAST_FEEDBACK channel

For 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(), or when the Type field is '010' in CQICH_Enhanced_Alloc_IE() and MIMO Compact DL-MAP IE(), the SS shall send its selection in terms of MIMO mode (STTD versus SM) or permutation mode on the assigned FAST_FEEDBACK channel. Table 294c shows the encoding of payload bits for the enhanced FAST_FEEDBACK slot with 5 bit payload.

Table 294c —Encoding of payload bits for Fast-feedback slot with 5 bit payload

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
0b00111	Closed-loop SM and PUSC/FUSC permutation
0b01000	Closed-loop SM and adjacent-subcarrier permutation
~~0b00111~~ 0b01001–0b11111	Reserved

~~For 6 bit payload case, when the FAST_FEEDBACK subheader Feedback Type field is '00' or '01' or '10' the SS may send its selection in terms of MIMO mode (STTD versus SM) or permutation mode on the assigned FAST_FEEDBACK channel using the last 32 codewords. Table 294d shows the encoding of payload bits for the enhanced FAST_FEEDBACK slot with 6 bit payload.~~

~~Table 294d —Encoding of payload bits for Fast-feedback slot with 6 bit payload~~

~~Value~~	~~Description~~
~~0b100000~~	~~STTD and PUSC/FUSC permutation~~
~~0b100001~~	~~STTD and adjacent-subcarrier permutation~~

~~0b100010~~	~~SM and PUSC/FUSC permutation~~
~~0b100011~~	~~SM and adjacent-subcarrier permutation~~
~~0b100100~~	~~Hybrid and PUSC/FUSC permutation~~
~~0b100101~~	~~Hybrid and adjacent-subcarrier permutation~~
~~0b100110~~	~~Beamforming and adjacent-subcarrier permutation~~
~~0b100111 – 0b111111~~	~~Reserved~~

[Add a new section 8.4.5.4.10.8 as follows]

8.4.5.4.10.8 MIMO related Type Independent Feedback for enhanced FAST_FEEDBACK channel

For 6 bit payload case, MIMO related feedback shall be encoded as is shown in Table 294d regardless of feedback type.

Table 294d —Encoding of payload bits for MIMO related Type Independent Feedback with 6 bit payload

Value	Description
0b101000	STTD and PUSC/FUSC permutation
0b101001	STTD and adjacent-subcarrier permutation
0b101010	SM and PUSC/FUSC permutation
0b101011	SM and adjacent-subcarrier permutation
0b101100	Hybrid and PUSC/FUSC permutation
0b101101	Hybrid and adjacent-subcarrier permutation
0b101110	Beamforming and adjacent-subcarrier permutation
0b101111	Closed-loop SM and PUSC/FUSC permutation
0b110000	Closed-loop SM and adjacent-subcarrier permutation
0b110001 – 0b111111	Reserved

[Modify the following Table 298a in section 8.4.5.4.12.1]

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	3~~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 ~~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 != 011~~0100~~) & (! 6-bit CQICH)) { MIMO_permutation_feedback cycle }	2	This field exists only for 4-bit and 5-bit CQI payload. 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.
}		

Feedback Type
For 4-bit or 5-bit CQI payload, the type dependent feedback in 16 or 32 levels shall be feedback, respectively. For 6-bit CQI payload, however, the MSB of 6-bit payload from a SS is the indicator of the usage for the remaining 5 bits. When the MSB is set to '0' with 6-bit payload, the following 5-bit payload shall be used for the type dependent feedback, and '1' indicates the following 5-bit payload shall be used for type independent feedback in Table 294d.

[Add a new section 11.8.3.7.6 as follows]

11.8.3.7.6 OFDMA SS Demodulator for MIMO Support

This field indicates the MIMO capability of OFDMA SS demodulator. A bit value of 0 indicates "not supported" while 1 indicates "supported".

Type	Length	Value	Scope
155	1	Bit #0 Two receive antennas Bit #1 Three receive antennas Bit #2 Four receive antennas Bit #3 Capable of transmit diversity Bit #4 Capable of spatial multiplexing Bit #5-#7 Always set to zero	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

[Add a new section 11.8.3.7.7 as follows]

11.8.3.7.7 OFDMA SS Closed-Loop Feedback Demodulator for MIMO Support

This field indicates the closed-loop MIMO capability of OFDMA SS demodulator. A bit value of 0 indicates "not supported" while 1 indicates "supported".

Type	Length	Value	Scope
156	1	Bit #0 Capable of calculating precoding weight Bit #1 Capable of adaptive rate feedback Bit #2 Capable of calculating channel matrix Bit #3-#7 Always set to zero	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

[Add a new section 11.8.3.7.8 as follows]

11.8.3.7.8 OFDMA SS Modulator for MIMO Support

This field indicates the MIMO capability of OFDMA SS modulator. A bit value of 0 indicates “not supported” while 1 indicates “supported”.

Type	Length	Value	Scope
155	1	Bit #0 Two transmit antennas Bit #1 Capable of transmit diversity Bit #2 Capable of spatial multiplexing Bit #3 Capable of beamforming Bit #4 Capable of adaptive rate control Bit #5-#7 Always set to zero	SBC-REQ (See 6.3.2.3.23) SBC-RSP (See 6.3.2.3.24)

References:

[1] IEEE P802.16-REVd/D5-2004 Draft IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems

[2] IEEE P802.16e/D4 Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands