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Title	**FAST_FEEDBACK Channel Codeword Extension**
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Re:	IEEE P802.16e/D4-2004
Abstract	FAST_FEEDBACK Channel Codeword Extension
Purpose	Adopting of proposed method into P802.16e
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FAST_FEEDBACK Channel Codeword Extension

1. Introduction

The contribution C80216e-04_126r2 was proposed and accepted in the previous IEEE meeting, but the contents of the contribution is not reflected correctly in P802.16e/D4 standard.

In IEEE 802.16d/D5, FAST_FEEDBACK channel is defined to transfer the channel quality information from an MSS. However, FAST_FEEDBACK channel in D5 delivers only 4 payload bits, which is not enough to convey necessary information. 4 payload bits can classify MCS (Modulation and Coding Scheme) level up to 16 sorts, and their SNR resolution would be 2dB with the dynamic range of 30dB. However, some MCS level has SNR resolution finer than 2dB in certain channel conditions. If the SNR resolution can be made more elaborate, performance can be improved.

In the contribution C80216e-04_126r2, two codeword extension methods were proposed. One is to use the 32 codewords, and the other is to use the 64 codewords. In the first method, all the 32 codewords are used for channel quality information to give the finer resolution. In the second method, the first half of 64 codewords is also used for channel quality information, part of the second half is used for MIMO application, and remainings are reserved for the future usage.

Both methods were accepted in the previous meeting, but only the first method is reflected in P802.16e/D4 standard.

In this contribution, the non-reflected part of C80216e-04_126r2 is proposed again, and re-arrangement to the current standard is given for the purpose of clarification.

2. Suggested Text Changes

[Adopt the following changes in section 8.4.5.3.17, page 124, line 44]

~~8.4.5.3.17~~ 8.4.5.4.10.4 Optional Enhanced FAST_FEEDBACK channels

Enhanced Fast feedback slots may be individually allocated to SS for transmission of PHY related information that requires fast response from the SS. The allocations are done either in unicast manner through the FAST_FEEDBACK MAC subheader (see 6.3.2.2.6), or through the CQICH_Control IE() (see 6.3.2.3.43.5), or through the CQICH_Alloc_IE() (see 8.4.5.4.12), or through the CQICH_Enhanced_Alloc_IE() (see 8.4.5.4.12.1), and the transmission takes place in a specific UL region designated by UIUC = 0.
Each enhanced ~~F~~fast-feedback slot consists of 1 OFDMA slots mapped in a manner similar to the mapping of normal uplink data. An enhanced fast feedback slot uses QPSK modulation on the 48 data sub-carriers it contains, and can carry a data payload of 5 bits or 6 bits. Table ~~284g~~ 296a and 296b defines the mapping between the payload bit sequences and the subcarriers modulation for 5 bit payload and 6 bit payload, respectively.

Table ~~284g~~ 296a —FAST_FEEDBACK channel subcarrier modulation with 5 bit

5 bit payload	Fast Feedback vector indices per Tile Tile(0), Tile(1), … ,Tile(5)
0b00000	0,0,0,0,0,0
0b00001	1,1,1,1,1,1
0b00010	2,2,2,2,2,2
0b00011	3,3,3,3,3,3
0b00100	4,4,4,4,4,4
0b00101	5,5,5,5,5,5
0b00110	6,6,6,6,6,6
0b00111	7,7,7,7,7,7
0b01000	0,1,2,3,4,5
0b01001	1,2,3,4,5,6
0b01010	2,3,4,5,6,7
0b01011	3,4,5,6,7,0
0b01100	4,5,6,7,0,1
0b01101	5,6,7,0,1,2
0b01110	6,7,0,1,2,3
0b01111	7,0,1,2,3,4
0b10000	4,7,2,5,1,6
0b10001	5,0,3,6,2,7
0b10010	6,1,4,7,3,0
0b10011	7,2,5,0,4,1
0b10100	0,3,6,1,5,2
0b10101	1,4,7,2,6,3
0b10110	2,5,0,3,7,4
0b10111	3,6,1,4,0,5
0b11000	4,6,0,2,5,7
0b11001	5,7,1,3,6,0
0b11010	6,0,2,4,7,1
0b11011	7,1,3,5,0,2
0b11100	0,2,4,6,1,3
0b11101	1,3,5,7,2,4
0b11110	2,4,6,0,3,5
0b11111	3,5,7,1,4,6

Table 296b —FAST_FEEDBACK channel subcarrier modulation with 6 bit

6 bit payload	Fast Feedback vector indices per Tile Tile(0), Tile(1), … ,Tile(5)
0b000000	0,0,0,0,0,0
0b000001	1,1,1,1,1,1
0b000010	2,2,2,2,2,2
0b000011	3,3,3,3,3,3
0b000100	4,4,4,4,4,4
0b000101	5,5,5,5,5,5

0b000110	6,6,6,6,6,6
0b000111	7,7,7,7,7,7
0b001000	2,4,3,6,7,5
0b001001	3,5,2,7,6,4
0b001010	0,6,1,4,5,7
0b001011	1,7,0,5,4,6
0b001100	6,0,7,2,3,1
0b001101	7,1,6,3,2,0
0b001110	4,2,5,0,1,3
0b001111	5,3,4,1,0,2
0b010000	4,3,6,7,5,1
0b010001	5,2,7,6,4,0
0b010010	6,1,4,5,7,3
0b010011	7,0,5,4,6,2
0b010100	0,7,2,3,1,5
0b010101	1,6,3,2,0,4
0b010110	2,5,0,1,3,7
0b010111	3,4,1,0,2,6
0b011000	3,6,7,5,1,2
0b011001	2,7,6,4,0,3
0b011010	1,4,5,7,3,0
0b011011	0,5,4,6,2,1
0b011100	7,2,3,1,5,6
0b011101	6,3,2,0,4,7
0b011110	5,0,1,3,7,4
0b011111	4,1,0,2,6,5
0b100000	6,7,5,1,2,4
0b100001	7,6,4,0,3,5
0b100010	4,5,7,3,0,6
0b100011	5,4,6,2,1,7
0b100100	2,3,1,5,6,0
0b100101	3,2,0,4,7,1
0b100110	0,1,3,7,4,2
0b100111	1,0,2,6,5,3
0b101000	7,5,1,2,4,3
0b101001	6,4,0,3,5,2
0b101010	5,7,3,0,6,1
0b101011	4,6,2,1,7,0
0b101100	3,1,5,6,0,7
0b101101	2,0,4,7,1,6
0b101110	1,3,7,4,2,5
0b101111	0,2,6,5,3,4
0b110000	5,1,2,4,3,6
0b110001	4,0,3,5,2,7
0b110010	7,3,0,6,1,4
0b110011	6,2,1,7,0,5
0b110100	1,5,6,0,7,2

0b110101	0,4,7,1,6,3
0b110110	3,7,4,2,5,0
0b110111	2,6,5,3,4,1
0b111000	1,2,4,3,6,7
0b111001	0,3,5,2,7,6
0b111010	3,0,6,1,4,5
0b111011	2,1,7,0,5,4
0b111100	5,6,0,7,2,3
0b111101	4,7,1,6,3,2
0b111110	7,4,2,5,0,1
0b111111	6,5,3,4,1,0

The FAST_FEEDBACK channel is orthogonally modulated with QPSK symbols. Let $M_{n,8m+k}$ ($0 \le k \le 7$) be the modulation symbol index of the k-th modulation symbol in the m-th uplink tile of the n-th FAST_FEEDBACK channel. The possible modulation patterns composed of $M_{n,8m}$, $M_{n,8m+1}$, … , $M_{n,8m+7}$ in the m-th tile of the n-th FAST_FEEDBACK channel are defined in Table ~~284h~~ 296c.

Table ~~284h~~ 296c —Orthogonal Modulation Index in FAST_FEEDBACK Channel

Vector index	$M_{n,8m}$, $M_{n,8m+1}$, …, $M_{n,8m+7}$
0	P0, P1, P2, P3, P0, P1, P2, P3
1	P0, P3, P2, P1, P0, P3, P2, P1
2	P0, P0, P1, P1, P2, P2, P3, P3
3	P0, P0, P3, P3, P2, P2, P1, P1
4	P0, P0, P0, P0, P0, P0, P0, P0
5	P0, P2, P0, P2, P0, P2, P0, P2
6	P0, P2, P0, P2, P2, P0, P2, P0
7	P0, P2, P2, P0, P2, P0, P0, P2

Where

$$P0 = \exp(j \cdot \frac{\pi}{4}),$$

$$P1 = \exp(j \cdot \frac{3\pi}{4}),$$

~~$P2 = \exp(\angle j \cdot \frac{3\pi}{4})$~~ $P2 = \exp(-j \cdot \frac{3\pi}{4}),$

~~$P3 = \exp(\angle j \cdot \frac{\pi}{4})$~~ $P3 = \exp(-j \cdot \frac{\pi}{4})$.

$M_{n,8m+k}$ is mapped to FAST_FEEDBACK channel tile as shown in Figure ~~229a~~ 231a for PUSC uplink subchannel and in Figure ~~229b~~ 231b for optional PUSC uplink subchannel. A FAST_FEEDBACK channel is mapped to one subchannel composed of 6 tiles.

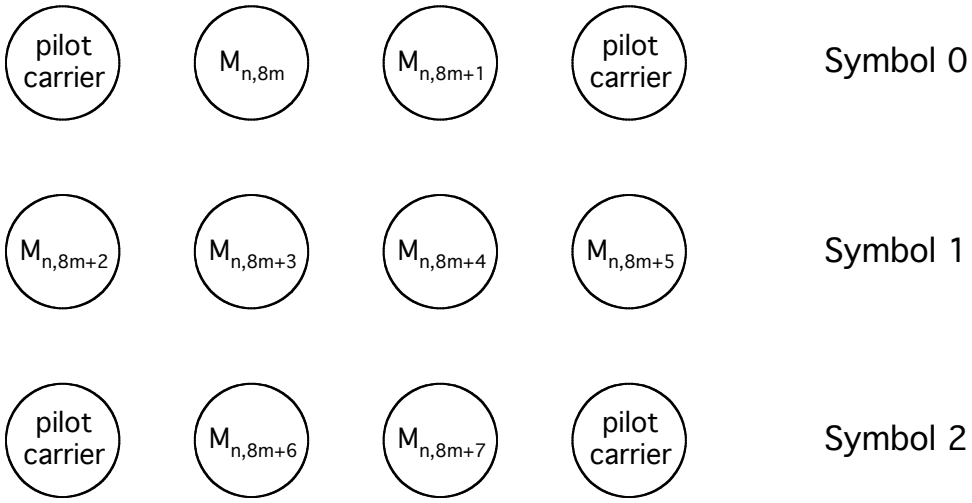

Figure ~~229a~~ 231a — Subcarrier Mapping of FAST_FEEDBACK Modulation Symbols for PUSC

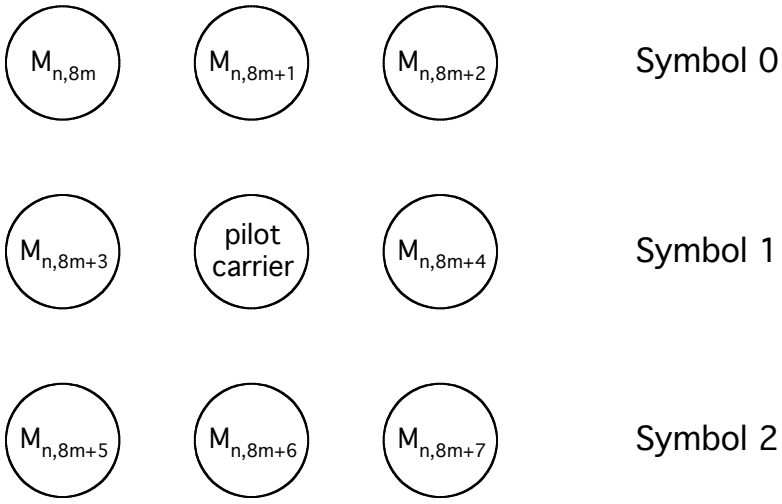

Figure ~~229b~~ 231b —Subcarrier Mapping of FAST_FEEDBACK Modulation Symbols for Optional PUSC

The enhanced fast feedback slot includes 5 bits or 6 bits of payload data, whose encoding depended on the instruction given in the FAST_FEEDBACK subheader, the CQICH_Control IE(), the CQICH_Alloc_IE(), or through the CQICH_Enhanced_Alloc_IE(). The following sections define these encoding.

~~8.4.5.3.17.1~~ 8.4.5.4.10.5 Fast DL measurement feedback for enhanced FAST_FEEDBACK channel

When the FAST_FEEDBACK subheader Feedback Type field is ‘00’, the SS shall report the S/N it measures on the DL. The following formula shall be used:

~~Payload bits = 0 S/N ≤ _3 dB~~
~~n n _4 < S/N ≤ n _30<n<31~~
~~31 S/N > 27 dB~~

$$Payload\ bits = \begin{cases} 0, & S/N \le -3dB \\ n, & n-4 < S/N \le n-3, \quad 0 < n < 31 \\ 31, & S/N > 27dB \end{cases}$$

~~8.4.5.3.17.2~~ 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' 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 i~~f~~n Figure ~~229c~~ 231c.

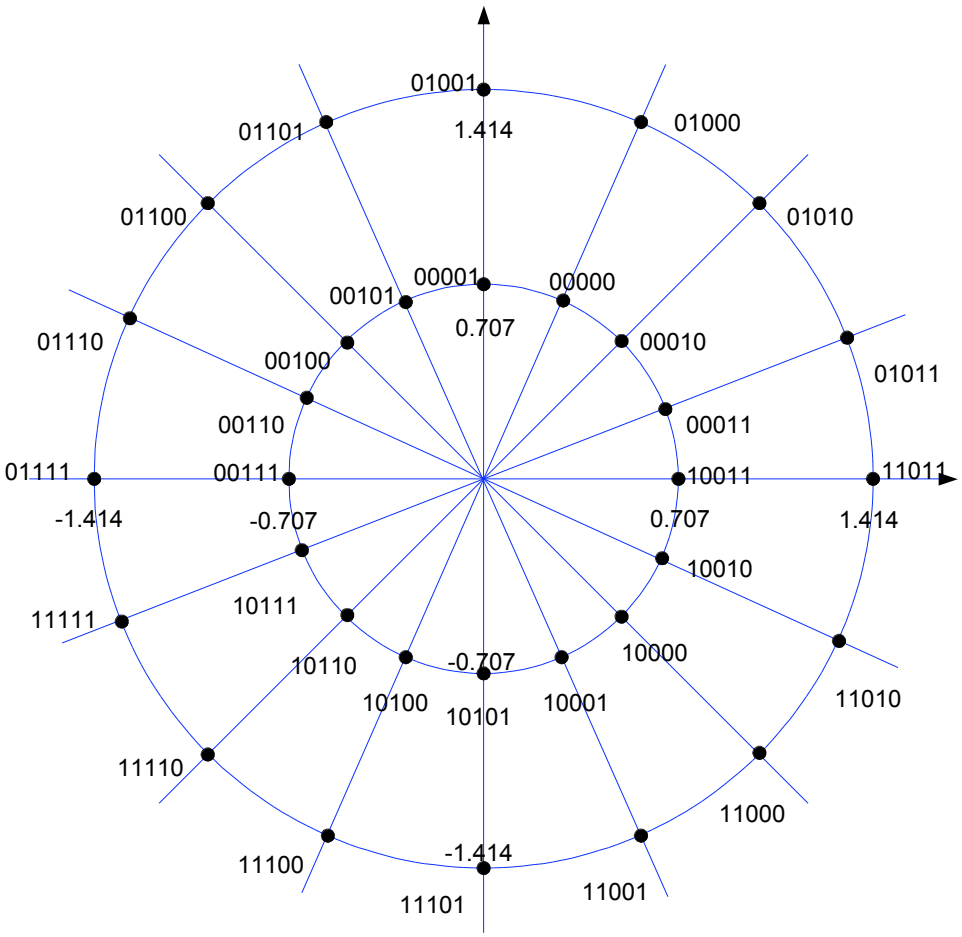

Figure ~~229c~~ 231c —Mapping of MIMO coefficients for enhanced fast MIMO feedback payload bits

~~8.4.5.3.17.3~~ 8.4.5.4.10.7 Mode Selection Feedback for enhanced FAST_FEEDBACK channel

For 5 bit payload case, ~~W~~when the FAST_FEEDBACK subheader Feedback Type field is '11' or at a specific

frame indicated in the CQICH_Alloc_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 ~~dd~~ 296d shows the encoding of payload bits for the enhanced FAST_FEEDBACK slot with 5 bit payload.

Table ~~284i~~ 296d —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 – 0b11111	Reserved

For 6 bit payload case, ~~W~~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 ~~dd~~ 296e shows the encoding of payload bits for the enhanced FAST_FEEDBACK slot with 6 bit payload.

Table 296e —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

[Delete the following Table in page 132, line 20]

~~**Table 294a—FAST_FEEDBACK channel subcarrier modulation (5 bit)**~~

~~n~~	~~5-bit payload~~	~~Fast Feedback vector indices per Tile~~
~~0~~	~~0b00000~~	~~0,0,0,0,0,0~~
~~1~~	~~0b00001~~	~~1,1,1,1,1,1~~
~~2~~	~~0b00010~~	~~2,2,2,2,2,2~~
~~3~~	~~0b00011~~	~~3,3,3,3,3,3~~
~~4~~	~~0b00100~~	~~4,4,4,4,4,4~~
~~5~~	~~0b00101~~	~~5,5,5,5,5,5~~
~~6~~	~~0b00110~~	~~6,6,6,6,6,6~~
~~7~~	~~0b00111~~	~~7,7,7,7,7,7~~
~~8~~	~~0b01000~~	~~0,1,2,3,4,5~~
~~9~~	~~0b01001~~	~~1,2,3,4,5,6~~
~~10~~	~~0b01010~~	~~2,3,4,5,6,7~~
~~11~~	~~0b01011~~	~~3,4,5,6,7,0~~
~~12~~	~~0b01100~~	~~4,5,6,7,0,1~~
~~13~~	~~0b01101~~	~~5,6,7,0,1,2~~
~~14~~	~~0b01110~~	~~6,7,0,1,2,3~~
~~15~~	~~0b01111~~	~~7,0,1,2,3,4~~
~~16~~	~~0b10000~~	~~4,7,2,5,1,6~~
~~17~~	~~0b10001~~	~~5,0,3,6,2,7~~
~~18~~	~~0b10010~~	~~6,1,4,7,3,0~~
~~19~~	~~0b10011~~	~~7,2,5,0,4,1~~
~~20~~	~~0b10100~~	~~0,3,6,1,5,2~~
~~21~~	~~0b10101~~	~~1,4,7,2,6,3~~
~~22~~	~~0b10110~~	~~2,5,0,3,7,4~~
~~23~~	~~0b10111~~	~~3,6,1,4,0,5~~
~~24~~	~~0b11000~~	~~4,6,0,2,5,7~~
~~25~~	~~0b11001~~	~~5,7,1,3,6,0~~
~~26~~	~~0b11010~~	~~6,0,2,4,7,1~~
~~27~~	~~0b11011~~	~~7,1,3,5,0,2~~
~~28~~	~~0b11100~~	~~0,2,4,6,1,3~~
~~29~~	~~0b11101~~	~~1,3,5,7,2,4~~
~~30~~	~~0b11110~~	~~2,4,6,0,3,5~~
~~31~~	~~0b11111~~	~~3,5,7,1,4,6~~

[Adopt the following changes in section 11.8.4.7.7, page 191, line 40]

11.8.4.7.7 Uplink control channel support

This field indicates the different uplink control channels supported by a WirelessMAN-OFDMA PHY SS for uplink transmission. A bit value of 0 indicates “not supported” while 1 indicates “supported.”

Type	Length	Value	Scope
xxx	1	Bit #0: FAST_FEEDBACK Bit #1: Enhanced FAST_FEEDBACK with 5 bit payload	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

		Bit #2: Enhanced FAST_FEEDBACK with 6 bit payload Bit #3: Optional FAST_FEEDBACK with unequal error protection for the 4-bit payload Bit #4: Optional FAST_FEEDBACK with unequal error protection for the 5-bit payload Bit #~~2~~5: UL ACK Bit #~~3~~6: Enhanced UL ACK Bit #~~4~~7: Reserved; shall be set to zero	

[Delete the following sections in page 191, line 58]

~~11.8.4.7.8 Uplink control channel support~~

~~This field indicates the different uplink control channels supported by a WirelessMAN-OFDMA PHY SS for uplink transmission. A bit value of 0 indicates "not supported" while 1 indicates "supported."~~

~~Type~~	~~Length~~	~~Value~~	~~Scope~~
~~xxx~~	~~1~~	~~Bit #0: FAST_FEEDBACK~~ ~~Bit #1: Enhanced FAST_FEEDBACK~~ ~~Bit #2: UL ACK~~ ~~Bit #3: Enhanced UL ACK~~ ~~Bit #4-7: Reserved; shall be set to zero~~	~~SBC-REQ (see 6.3.2.3.23)~~ ~~SBC-RSP (see 6.3.2.3.24)~~

~~11.8.4.7.9 Uplink control channel support~~

~~This field indicates the different uplink control channels supported by a WirelessMAN-OFDMA PHY SS for uplink transmission. A bit value of 0 indicates "not supported" while 1 indicates "supported."~~

~~Type~~	~~Length~~	~~Value~~	~~Scope~~
~~xxx~~	~~1~~	~~Bit #0: FAST_FEEDBACK~~ ~~Bit #1: Enhanced FAST_FEEDBACK~~ ~~Bit #2: UL ACK~~ ~~Bit #3: Enhanced UL ACK~~ ~~Bit #4: Optional FAST_FEEDBACK for the 4-bit payload~~ ~~Bit #5: Optional FAST_FEEDBACK for the 5-bit payload~~ ~~Bit #6,-7: reserved; shall be set~~	~~SBC-REQ (see 6.3.2.3.23)~~ ~~SBC-RSP (see 6.3.2.3.24)~~

		~~to zero~~	