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Re:	Response to Sponsor Ballot call for comment
Abstract	To improve the CQICH Fast Feedback Channels. The update is in blue font.
Purpose	Comment on Sub-Channel Reuse for CQICH Fast Feedback Channels
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Comment on Sub-Channel Reuse for CQICH Fast Feedback Channels

1 Introduction

Contribution IEEEC802.16e-04/448 proposes to re-use the CQICH sub-channel to increase the feedback throughput and reduce the UL capacity penalty, such a reuse is based on the additional reception antenna at BS. However, we would like to comment that in addition to this approach, several other techniques are available to achieve the same objective. For example:

1. Improve the coding scheme of current CQICH
2. Use transmit diversity STC at MSS
3. Use collaborative spatial multiplexing at MSS

Solutions 2 and 3 are addressed in contribution IEEEC802.16e-04/518, in this comment as addressed the enhancement of Solution 1.

2 Proposed Solution

The code used in currently 4-bit, 5-bit, 5-bit CQICH channels has a minimum distance of 40 and diversity order 5. The code length is 96, we propose to use a first order Reed-Muller code, concatenated with a repetition code as enhanced CQICH channel. The minimum distance is increased to 48 with a guarantees diversity order a 6 (maximum possible). This results in about 1dB gain in performance as shown in the numerical results. In addition, the decoding complexity substantially reduced. See Table 1.

Table 1: Decoding Complexity and Hamming distance of the codes

Method		**Complexity of Decoding 1x1**	**Hamming Distance**
4-bit	Current	910	40
	Enhanced	110	48
5-bit	Current	1010	40
	Enhanced	140	48
6-bit	Current	1200	40
	Enhanced	240	48

3 Simulation Results

Figure 1 and Figure 2 present the simulation results, as we can see the enhanced CQICH has coding gain of 1dB and for 2x2 STC coded CQICH has 2dB gain. This benefit can be translated into performance improvement when the sub-channel reuse is employed or can be translated into battery life enhancement.

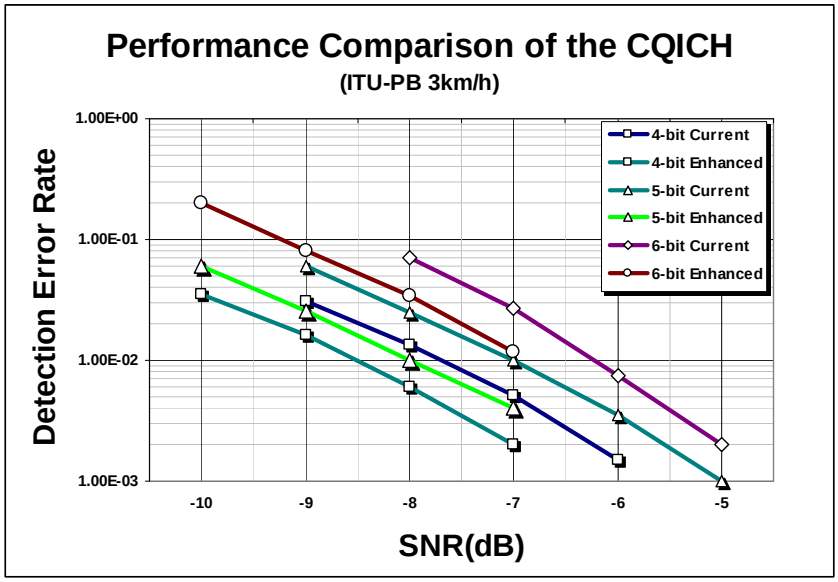

Figure 1 Performance enhancement of 4/5/6 bits CQICH channels

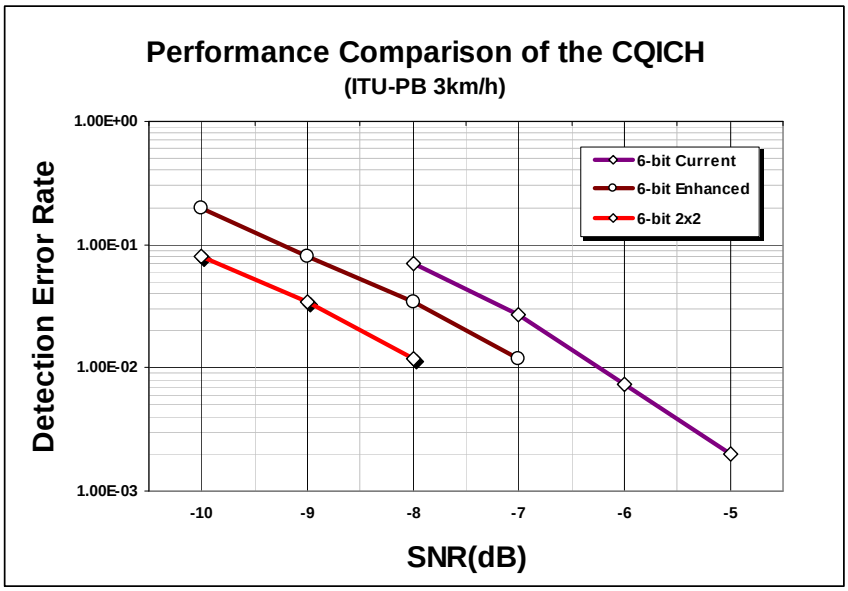

Figure 2 Performance enhancement of 6 bits CQICH channels

4 Text Proposal

[Add the following text into section 8.4.8.3.1]

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Table 3 FAST_FEEDBACK channel sub-carrier modulation with 6 bit

6 bit payload	Fast Feedback vector indices per Tile [Tile(0), Tile(1)]	[Tile(2), Tile(3)]	[Tile(4), Tile(5)]
0b000000	0	0	0
0b000001	1	1	1
0b000010	2	2	2
0b000011	3	3	3
0b000100	4	4	4
0b000101	5	5	5
0b000110	6	6	6
0b000111	7	7	7
0b001000	8	8	8
0b001001	9	9	9
0b001010	10	10	10
0b001011	11	11	11
0b001100	12	12	12
0b001101	13	13	13
0b001110	14	14	14
0b001111	15	15	15
0b010000	16	16	16
0b010001	17	17	17
0b010010	18	18	18
0b010011	19	19	19
0b010100	20	20	20
0b010101	21	21	21
0b010110	22	22	22
0b010111	23	23	23
0b011000	24	24	24
0b011001	25	25	25
0b011010	26	26	26
0b011011	27	27	27
0b011100	28	28	28
0b011101	29	29	29
0b011110	30	30	30
0b011111	31	31	31
0b100000	32	32	32
0b100001	33	33	33
0b100010	34	34	34
0b100011	35	35	35
0b100100	36	36	36
0b100101	37	37	37
0b100110	38	38	38
0b100111	39	39	39
0b101000	40	40	40
0b101001	41	41	41
0b101010	42	42	42
0b101011	43	43	43
0b101100	44	44	44
0b101101	45	45	45
0b101110	46	46	46
0b101111	47	47	47
0b110000	48	48	48
0b110001	49	49	49
0b110010	50	50	50
0b110011	51	51	51
0b110100	52	52	52
0b110101	53	53	53
0b110110	54	54	54
0b110111	55	55	55
0b111000	56	56	56

0b111001	57	57	57
0b111010	58	58	58
0b111011	59	59	59
0b111100	60	60	60
0b111101	61	61	61
0b111110	62	62	62
0b111111	63	63	63

In accordance with an embodiment of the invention, a FAST_FEEDBACK channel may be orthogonally modulated with QPSK symbols. For example, 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.
For 6 bits, we will have 64 symbols which are transmitted in two tiles.

Table 6 —Modulation Index in FAST_FEEDBACK Channel for 6 bits

Vector index	Antenna $M_{n,8m}$, $M_{n,8m+1}$ + , ⋯ $M_{n,8m+7}$
0	P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0 P0
1	P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3 P3
2	P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2 P2
3	P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1 P1
4	P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3
5	P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0 P3 P0
6	P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1
7	P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2 P1 P2
8	P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3
9	P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0
10	P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1
11	P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2
12	P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0
13	P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3 P3 P0 P0 P3
14	P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2
15	P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1 P1 P2 P2 P1
16	P0 P0 P0 P0 P3 P3 P3 P3 P0 P0 P0 P0 P3 P3 P3 P3
17	P3 P3 P3 P3 P0 P0 P0 P0 P3 P3 P3 P3 P0 P0 P0 P0
18	P2 P2 P2 P2 P1 P1 P1 P1 P2 P2 P2 P2 P1 P1 P1 P1
19	P1 P1 P1 P1 P2 P2 P2 P2 P1 P1 P1 P1 P2 P2 P2 P2
20	P0 P3 P0 P3 P3 P0 P3 P0 P0 P3 P0 P3 P3 P0 P3 P0
21	P3 P0 P3 P0 P0 P3 P0 P3 P3 P0 P3 P0 P0 P3 P0 P3
22	P2 P1 P2 P1 P1 P2 P1 P2 P2 P1 P2 P1 P1 P2 P1 P2
23	P1 P2 P1 P2 P2 P1 P2 P1 P1 P2 P1 P2 P2 P1 P2 P1
24	P0 P0 P3 P3 P3 P3 P0 P0 P0 P0 P3 P3 P3 P3 P0 P0
25	P3 P3 P0 P0 P0 P0 P3 P3 P3 P3 P0 P0 P0 P0 P3 P3
26	P2 P2 P1 P1 P1 P1 P2 P2 P2 P2 P1 P1 P1 P1 P2 P2
27	P1 P1 P2 P2 P2 P2 P1 P1 P1 P1 P2 P2 P2 P2 P1 P1
28	P0 P3 P3 P0 P3 P0 P0 P3 P0 P3 P3 P0 P3 P0 P0 P3
29	P3 P0 P0 P3 P0 P3 P3 P0 P3 P0 P0 P3 P0 P3 P3 P0
30	P2 P1 P1 P2 P1 P2 P2 P1 P2 P1 P1 P2 P1 P2 P2 P1
31	P1 P2 P2 P1 P2 P1 P1 P2 P1 P2 P2 P1 P2 P1 P1 P2
32	P0 P0 P0 P0 P0 P0 P0 P0 P3 P3 P3 P3 P3 P3 P3 P3
33	P3 P3 P3 P3 P3 P3 P3 P3 P0 P0 P0 P0 P0 P0 P0 P0
34	P2 P2 P2 P2 P2 P2 P2 P2 P1 P1 P1 P1 P1 P1 P1 P1
35	P1 P1 P1 P1 P1 P1 P1 P1 P2 P2 P2 P2 P2 P2 P2 P2
36	P0 P3 P0 P3 P0 P3 P0 P3 P3 P0 P3 P0 P3 P0 P3 P0
37	P3 P0 P3 P0 P3 P0 P3 P0 P0 P3 P0 P3 P0 P3 P0 P3
38	P2 P1 P2 P1 P2 P1 P2 P1 P1 P2 P1 P2 P1 P2 P1 P2
39	P1 P2 P1 P2 P1 P2 P1 P2 P2 P1 P2 P1 P2 P1 P2 P1

40	P0	P0	P3	P3	P0	P0	P3	P3	P3	P3	P0	P0	P3	P3	P0	P0
41	P3	P3	P0	P0	P3	P3	P0	P0	P0	P0	P3	P3	P0	P0	P3	P3
42	P2	P2	P1	P1	P2	P2	P1	P1	P1	P1	P2	P2	P1	P1	P2	P2
43	P1	P1	P2	P2	P1	P1	P2	P2	P2	P2	P1	P1	P2	P2	P1	P1
44	P0	P3	P3	P0	P0	P3	P3	P0	P3	P0	P0	P3	P3	P0	P0	P3
45	P3	P0	P0	P3	P3	P0	P0	P3	P0	P3	P3	P0	P0	P3	P3	P0
46	P2	P1	P1	P2	P2	P1	P1	P2	P1	P2	P2	P1	P1	P2	P2	P1
47	P1	P2	P2	P1	P1	P2	P2	P1	P2	P1	P1	P2	P2	P1	P1	P2
48	P0	P0	P0	P0	P3	P3	P3	P3	P3	P3	P3	P3	P0	P0	P0	P0
49	P3	P3	P3	P3	P0	P0	P0	P0	P0	P0	P0	P0	P3	P3	P3	P3
50	P2	P2	P2	P2	P1	P1	P1	P1	P1	P1	P1	P1	P2	P2	P2	P2
51	P1	P1	P1	P1	P2	P2	P2	P2	P2	P2	P2	P2	P1	P1	P1	P1
52	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0	P0
53	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3	P3
54	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2	P2
55	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1
56	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3
57	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0	P3	P0
58	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1
59	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
60	P0	P0	P3	P3	P0	P0	P3	P3	P0	P0	P3	P3	P0	P0	P3	P3
61	P3	P3	P0	P0	P3	P3	P0	P0	P3	P3	P0	P0	P3	P3	P0	P0
62	P2	P2	P1	P1	P2	P2	P1	P1	P2	P2	P1	P1	P2	P2	P1	P1
63	P1	P1	P2	P2	P1	P1	P2	P2	P1	P1	P2	P2	P1	P1	P2	P2

The mapping over constellation is as follows:

$$P0 = \exp(j \cdot \frac{\pi}{4}),\quad P1 = \exp(j \cdot \frac{3\pi}{4}),\quad P2 = \exp(-j \cdot \frac{\pi}{4}),\quad P3 = \exp(-j \cdot \frac{3\pi}{4})$$

----------End text ----------