Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Sub-channel Reuse for CQICH Fast Feed-back Channels in Multiple Antenna Base Stations**
Date Submitted	**2004-11-04**
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Re:	Recirculation of P802.16 REVe/D5
Abstract	Sub-channel reuse scheme is proposed to reduce bandwidth overhead of CQICH fast feed-back channels in multiple antenna base stations.
Purpose	Adoption of suggested changes into P802.16e/D6
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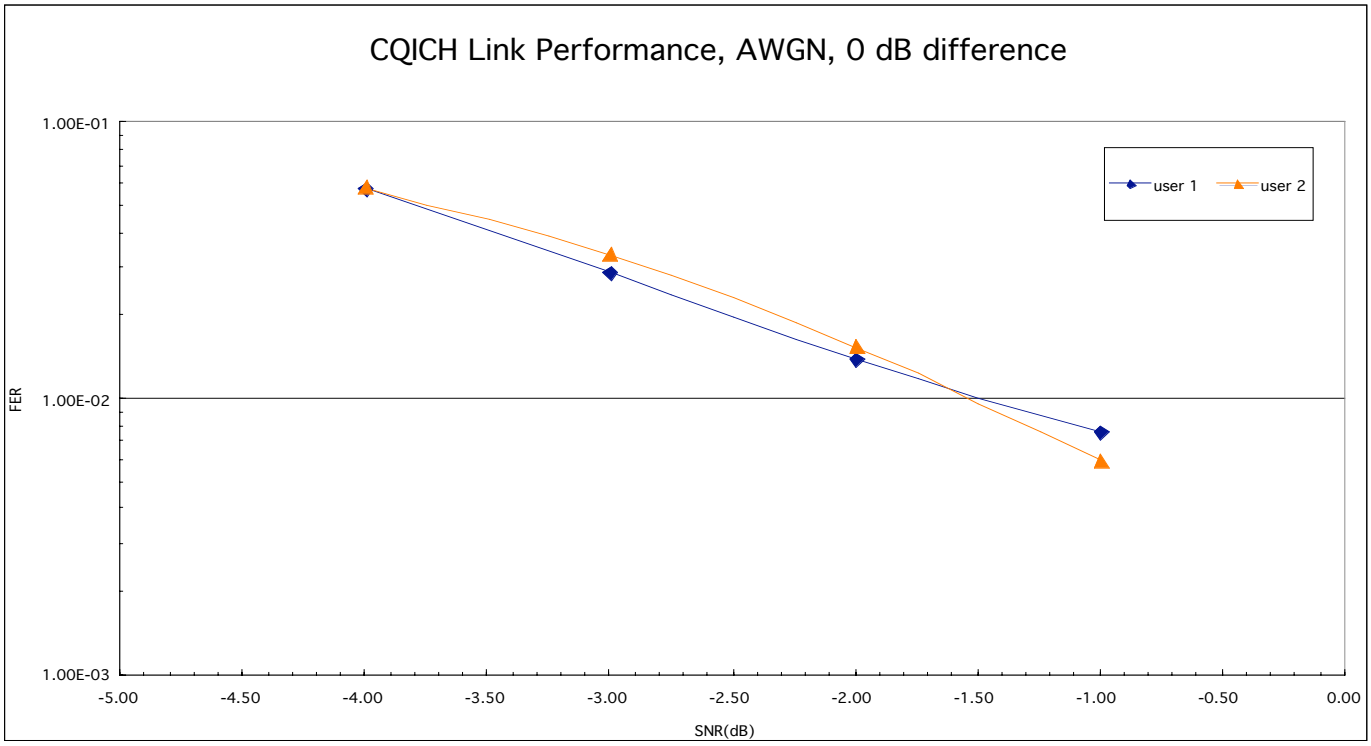
Problem Definition

The required number of fast feed-back channels increases as the number of data streams increases in multiple antenna mode. To reduce the uplink bandwidth overhead, there needs to utilize the SNR gain from multiple receiver antennas at BS.

Proposed Solution

The operating point of CQICH fast feedback channels, which can be specified as signal to noise ratio per antenna, decreases as the number of received antennas at BS increases and it can be well below 0 dB SNR. Under this situation, one sub-channel region for CQICH feedback can be allocated for multiple CQICH signaling when the BS provision multiple receive antennas, wherein each of multiple CQICH sub-channels has its own randomizing sequence offset for co-channel interference averaging.

The simulations results below are obtained using 5 bit codeword at BS with two receive antennas. We can observe that the operating point of 1 % error rate increases to -1.5 dB when CQICH codeword are reused by factor two in AWGN channels. The original point (not shown here) was -5.0 dB. The SNR degradation of 3.5 dB would be compensated when we employ more than two receive antennas at BS.



Simulation Results

Suggested text changes to 16.e standard

[Add the following text in Sec. 8.4.5.4.10.10]

8.4.5.4.10.10 Sub-channel Reuse for FAST_FEEDBACK channel

If BS supports multiple receive antenna for uplink reception, the number of Fast Feedback channels for a given uplink sub-channel with UIUC = 0 can be increased by tile randomization. The randomizing sequences are obtained by shifting the BS-specific randomization sequence in Sec 8.4.9.1.

Table xxx —Tile randomizing offset for Fast feedback channels

Reuse Index	Shifting offset	Description
00	0	Use BS-specific randomization sequences
01	10	Use BS-specific randomization sequences shifted by 10 offset
10	20	Use BS-specific randomization sequences shifted by 20 offset
11	30	Use BS-specific randomization sequences shifted by 30 offset

When the reuse indexes assigned by CQICH Enhanced allocation IE, each modulated sub-carrier in the assigned tile is multiplied by randomizing BPSK signals, which is obtained by shifting the BS-specific sequences in Sec 8.4.9.1.

[Modify the following Table 298a in 8.4.5.4.15 “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.
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	2	00 = Fast DL measurement 01 = MIMO Antenna Feedback 10 = MIMO mode and permutation mode feedback 11 = 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
Tile randomizer index	2	Index to tile randomizing sequences in Sec. 8.4.5.4.10.10 00 = No shift offset (Default) 01 = 10 shift offset 10 = 20 shift offset 11 = 30 shift offset
}		
if (Feedback_type != 10) { 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 CQICH frame.
Padding	*variable*	The padding bits are used to ensure the IE size is integer number of bytes.

[Add the text as follows in 11.8.3.7.7 “Uplink control channel support”]

11.8.3.7.5 OFDMA SS Permutation support

[Change the text as follows]

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 4 bit payload Bit# 5: Optional FAST_FEEDBACK for 5 bit payload Bit# 6: FAST_FEEDBACK with Subchannel Reuse Bit# 7: Reserved, shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)