Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**MIMO Channel Feedback with Feedback Header**
Date Submitted	**2005-01-23**

	Sean Cai Jason Hou Mary Chion Jing Wang Dazi Feng Jun Han Irving Wang	scai@ztesandiego.com jhou@ztesandiego.com
	ZTE San Diego Inc. 10105 Pacific Heights Blvd. San Diego, CA 92121 USA	Voice: 858-554-0387 Fax: 858-554-0894

Re:	Response to Sponsor Ballot on IEEE802.16e/D5a document
Abstract	The proposed MIMO Channel Feedback header enables MSS initiated fast channel feedback to assist base station scheduler to properly assign the best-effort channel for each MSS in STC/MIMO mode
Purpose	To incorporate the text changes proposed in this contribution into the 802.16e/D6 draft.
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 (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing 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:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

MIMO Channel Feedback with Feedback Header

Sean Cai , Jason Hou, Mary Chion
Jing Wang, Dazi Feng, Jun Han, Irving Wang

ZTE San Diego Inc. USA

1. Problem Statement

In order to maximize downlink capacity, the base station must have the knowledge of channel conditions for each MSS. In current standard, there is no MSS initiated fast channel feedback in place to assist base station scheduler to properly assign the best-effort channel for each MSS in STC/MIMO mode.

2. Proposed Solutions

Due to multiple scattering, propagation channel experiences frequency selective fading. Figure 1 shows a typical snapshot of the channel SNR distribution across used channel bandwidth. As seen in the figure, the received SNR for each antenna (0 or 1) is different for the same subchannels due to multipath fading. The composite SNR shows the best regions of both.

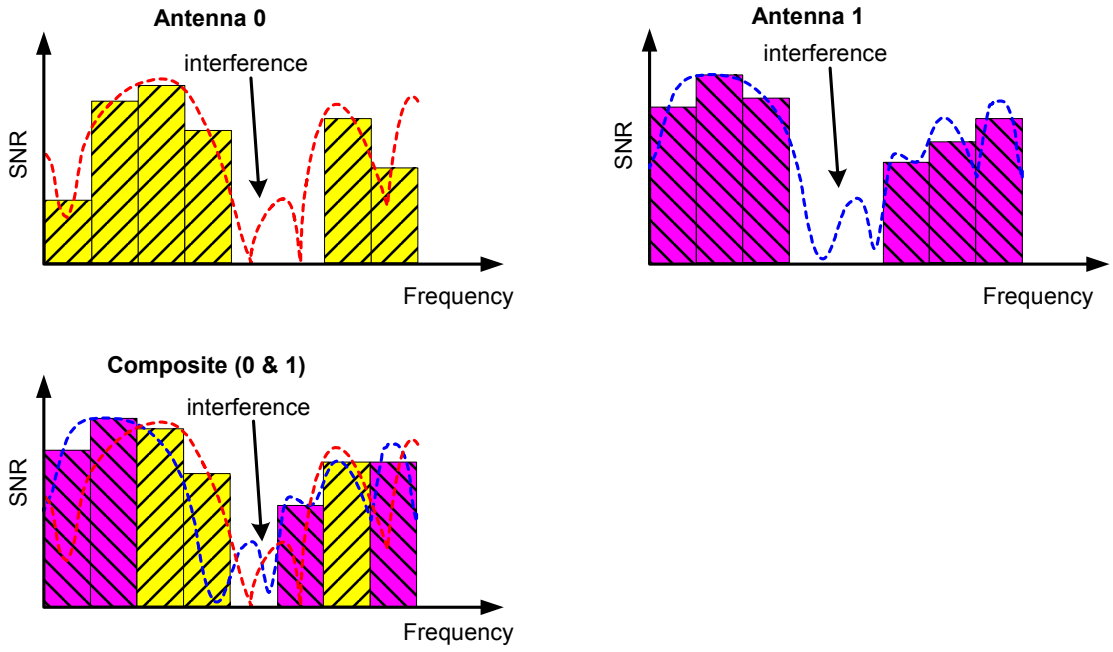

Figure 1. STC/MIMO channel conditions

The channel information for each antenna can be obtained from CQI measurement. For example, it can be determined by comparing the measured average SNR over a group of subchannels to determine the preferred DIUC.

Similarly, for multiple antennas, the composite averaged SNR (over multiple antennas) is measured, and composite CQI channel can be reported in MIMO mode. The result is fed back to BS via a MIMO Channel Feedback header.

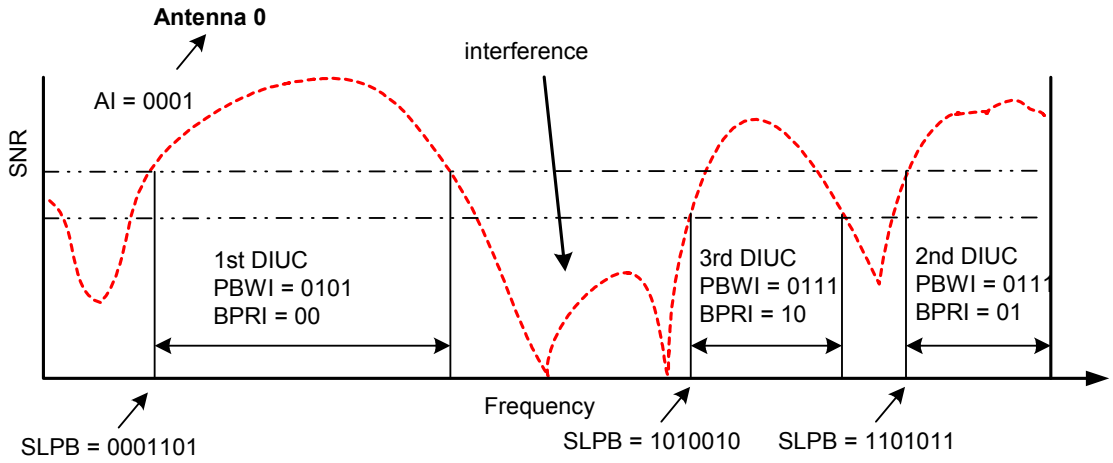

Figure 2. Example of MIMO Feedback header settings (see Table 7c)

3. Specific Text Changes

[Modify the following section:]

6.3.2.1.4.1 Feedback header

Table 7b—Feedback type and feedback content

Feedback Type	Feedback contents	Description
0b0000	Set as described in Table 296d	MIMO mode and permutation feedback
0b0001	DL average CQI (5 bits)	5 bits CQI feedback
0b0010	Number of index, *L* (2 bits) + *L* occurances of Antenna index (2 bits) +MIMO coefficients (5 bits, 8.4.5.4.10.6)	MIMO coefficients feedback
0b0011	Preferred-DIUC (4 bits)	Preferred DL channel DIUC feedback
0b0100	UL-TX-Power (7 bits) (see Table 7a)	UL transmission power
0b0101	Preferred DIUC(4 bits) + UL-TXPower(7 bits) + UL-headroom (6 bits) (see Table 7a)	PHY channel feedback
0b0110	Number of bands, *N* (2 bits) + *N* occurances of 'band index (6 bits) + CQI (5bits)'	CQIs of multiple AMC bands
0b0111	Number of feedback types, *0* (2 bits) +*0* occurances of 'feedback type (4 bits)+ feedback content (variable)'	Multiple types of feedback
0b1000	MIMO channel feedback (see Table 7c)	MIMO mode channel condition feedback
0b1001-0b1111	Reserved for future use	

[Insert the following section:]

6.3.2.1.4.3 MIMO Channel Feedback header

The MIMO Channel Feedback header is used for MSS to provide DL MIMO channel quality feedback to the BS. The MIMO Channel Feedback header can be used to provide a single or composite channel feedback. The MIMO Channel Feedback header with or without basic CID field is illustrated in Figure 20d and Figure 20e respectively.

HT=1(1)	EC=1(1)	N/M=0 (1)	CII=1(1)	Feedback Type =1000 (4)	PREFERRED-DIUC (4)	PBWI (4)
SLPB (7)				BPLI (1)	Basic CID MSB (8)	
Basic CID LSB (8)					HCS (8)	

Figure 20d—MIMO Channel Feedback header with CID field

HT=1(1)	EC=1(1)	N/M=0 (1)	CII=0(1)	Feedback Type =1000 (4)	PREFERRED-DIUC (4)	PBWI (4)
SLPB (7)				BPLI (2)	CTI (3)	AI (4)
MI (2)		CT (1)		CQI (5)	HCS (8)	

Figure 20e—MIMO Channel Feedback header without CID field

The MIMO Channel Feedback header shall have the following properties:

a) The length of the header shall always be 6 bytes.
b) The TYPE field shall be "1000"
c) PREERRED-DIUC indicates the preferred DIUC suggested by the MSS
d) PBWI provides the size of the preferred bandwidth which can be used for DIUC transmission
e) SLPB points to the starting preferred bandwidth location. Combining with PBWI field, BS knows the exact size and location of the preferred bandwidth in the channel
f) BPRI can be used to rank up to 4 preferred burst profiles within the DL channel
g) CTI provides coherent time information
h) AI can support up to 4 antennas
i) MI suggests the preferred STC/MIMO Matrix for the MSS
j) CT/CQI can support two types of CQI report

The fields of MIMO Channel Feedback header are defined in Table 7c.

Table 7c—Description of MIMO Channel Feedback header fields

Name	Length (bits)	Description
HT	1	Header Type = 1
EC	1	Always set to 1
N/M	1	Always set to zero
CII	1	The CII field (Full CID Inclusion Indication) shall be set to 1 for the header with full CID field and set to 0 for the header with truncated CID field.
Feedback Type	4	Type = 1000
PREFERRED-DIUC	4	Index of the DIUC preferred by the MSS
PBWI	4	Preferred Bandwidth Index indicates the ratio of the preferred bandwidth over used channel bandwidth: 0000: 1 0001: 3/4 0010: 2/3 0011: 1/2 0100: 1/3 0101: 1/4 0110: 1/5 0111: 1/6 1000: 1/8 1001: 1/10 1010: 1/12 1011: 1/16 1100: 1/24 1101: 1/32 1110: 1/48 1111: 1/64 Where Ratio = $BW_{preferred}/BW_{used}$ $BW_{preferred}$: Preferred bandwidth for DIUC transmission BW_{used}: Actual used channel bandwidth (excluding guard bands)
SLPB	7	Starting Location of Preferred Bandwidth: 0-127

		The effective bandwidth (used bandwidth) is divided into 1/128 interval, from 0 to 127 representing from lower to higher band. SLPB indicates the starting location of preferred bandwidth for the DIUC burst profile
BPRI	1/2	Burst Profile Ranking Indicator (without basic CID): ~~(Or, Channel Condition Ranking Indicator)~~ BPRI indicates the ranking for DL channel condition of the preferred bandwidth as reported in the current header where 0 is the most preferred bandwidth) 00: 1st preferred burst profile 10: 2nd preferred burst profile 01: 3rd preferred burst profile 11: 4th preferred burst profile Burst Profile Ranking Indicator (including basic CID): 0: 1st preferred burst profile 1: 2nd preferred burst profile
CTI	3	Coherent Time Index: CTI indicates the proximate duration of the valid MIMO channel conditions 000: Infinite 001: 1 frame 010: 2 frames 011: 3 frames 100: 4 frames 101: 8 frames 110: 14 frames 111: 24 frames
AI	4	This report can be a composite channel condition report, each bit represents for each antenna; "1" is applicable, "0" is not applicable Antenna Index: Bit 0 (MSB)- Antenna 0 Bit 1 – Antenna 1 Bit 2 – Antenna 2 Bit 3 (LSB) – Antenna 3
MI	2	Matrix Indicator: 00: No STC 01: Matrix A 10: Matrix B 11: Matrix C
CT	1	CQI Type: The type of CQI feedback in the CQI field 0: DL average CQI feedback 1: CQI feedback for the preferred bandwidth indicated in the current header
CQI	5	CQI feedback
CID	16	MSS basic CID
HCS	8	Header Check Sequence (same usage as HCS entry in Table 5).

4. References

[1] IEEE 802.16- 2004 IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems

[2] IEEE P802.16e-D5a-2004