Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	Clarification on UL CQICH SNR feedback for MIMO systems
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Source(s)	Jianzhong (Charlie) Zhang, Anthony Reid, Kiran Kuchi, Heikki Berg, Nico Van Waes Nokia Research Center 6000 Connection Drive Irving, TX 75039 Voice: 972-374-0958 Fax: 972-894-5937 charlie.zhang@nokia.com
Re:	IEEE 802.16e D5 Draft
Abstract	Proposes an improved channel quality indictor for vertically encoded MIMO systems
Purpose	To incorporate the changes proposed here into the 802.16e D6 Draft.
Notice	
Release	

UL CQICH SNR Feedback for MIMO Systems

Jianzhong (Charlie) Zhang

1. Introduction

In 8.4.5.4.10.5 of 802.16e D6 [1], the BS assigns burst profile based on CQI feedback from MSS for both the SISO case and the MIMO case. The feedback assignment is specified in sections 8.4.5.4.12 and 8.4.5.4.15. For MIMO case, two types of SNR feedbacks are specified according to the encoding practice. For a horizontally-encoded system, where different spatial layers carry different code packets, SNR for each layer is fed-back via CQICH in the UL. On the other hand, for a vertically-encoded system, where different spatial layers carry the same code packet, average SNR over spatial layers is feedback via UL CQICH.

It is well understood that for a vertically encoded system, the average SNR over the layers provides an overly pessimistic measure of the current channel quality. The reason is that the arithmetic mean in SNR does not properly account for the contributions from the weaker layers, especially when the SNR disparity among different spatial layers is large. To resolve this problem, in this contribution we propose to change the CQICH feedback for a vertically-encoded system. We propose to feedback an "Effective SNR (Eff_SNR) " that is calculated from the constrained mutual information of the channel that is constrained by the receiver used at the SS. This is a uniform treatment for a vertically-encoded system in the sense that the receiver-constrained mutual information can always be computed, for both LMMSE type of MIMO detectors and ML type of MIMO detectors. In contrast, the per-layer post-processing SNRs and the resulting average SNR across the layers are easy to find for LMMSE type of MIMO detectors, but difficult to obtain for ML type of MIMO detectors.

2. Proposed Text Change

Modify the text in section 8.4.5.4.10.5

After line 35 in page 273

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MIMO capable MS shall measure post processing S/N for each individual layers as shown in Figure 229b.When the FAST_FEEDBACK subheader Feedback Type field is "00", the MS shall report the post processing Effective SNR (Eff_SNR) as defined below. When BS requests MS feedback through CQICH_Alloc_IE() orCQICH_Enhanced_Alloc_IE() with '00' Feedback_type field, MS shall report Eff_SNR or individual layer S/N as described in 8.4.5.4.12 and 8.4.5.4.15

Note that the effective SNR (Eff_SNR) is defined as

(a)

where C(d,y|H) is the receiver-constrained mutual information conditioned on knowing the channel knowledge. Note that d is the transmitted signal, y is the post-processing receive signal and H is the channel matrix between transmit and receive antennas. For LMMSE-type of MIMO detectors where individual post-detector-processing signal to noise ratios are given as SNR_1, …,SNR_N, then the average receiver-constrained mutual information is given by

; (b)

on the other hand, for ML MIMO detectors the receiver-constrained mutual information is simply the MIMO channel mutual information:

(c)

where I_N is an N by N identity matrix and R is the correlation matrix of interference plus noise measured at SS. Once receiver-constrained mutual information is obtained from (b) or (c), equation (a) is used to calculate the Eff_SNR for a vertically encoded system.

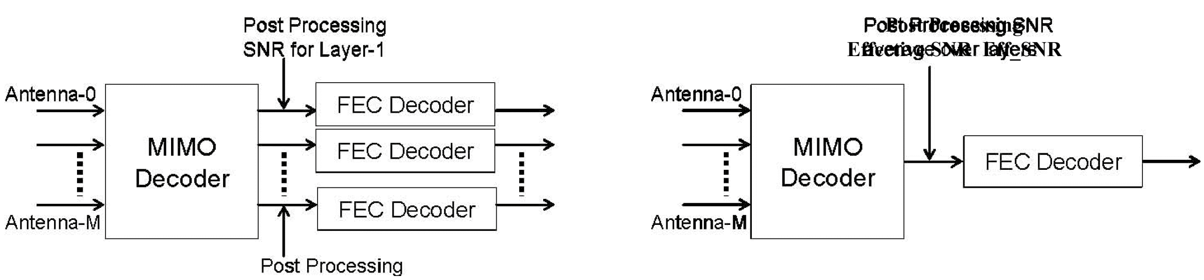

Figure 229b – Post Processed S/N for MIMO

For MS with more than one receive antennas, the following formula shall be used:

(107b)

where for the cases of single transmit antenna BS or 2 and 4 transmit antenna BS using matrix A transmission format and for case of 2 and 4 transmit antennas BS using matrix transmission format. Nr is the number of receive antennas.

When the FAST_FEEFBACK subheader Feedback Type field is '00' or at a specific frame indicated in the CQICH_Alloc_IE() (see 8.4.5.4.12), or the Feedback_type field in CQICH_Enhanced_Alloc_IE() is '00' see 8.4.5.4.15), the SS shall report the S/N it measures on the DL. For MS with more than one receive antennas, the following formula shall be used.

(107c)

where for the cases of single transmit antenna BS or 2 and 4 transmit antenna BS using matrix A transmission format and for case of 2 and 4 transmit antennas BS using matrix transmission format. Nr is the number of receive antennas. S/N is post processing effective SNR Eff_SNR as defined in (a).

For an MS which supports the feedback method by using Feedback header, if the value *M* is reserved as the indication flag in UCD, the MS shall set the payload bits nibble as *M*-1 instead of *M* if the outcome of payload bits nibble calculation based on the above equations is *M*.

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Modify the text in section 8.4.5.4.12.1

After line 57 in page 334

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8.4.5.4.12.1 CQICH Enhanced Allocation IE Format

For MIMO capable MSs, BS may allocate one or multiple CQICH channels to the MS in UL_MAP. IF CQICH_Num=0 and feedback type is '00', MS shall report the effective post processing S/R Eff_SNR as defined in 8.4.5.4.10.5 . For CQICH_Num>0 and feedbacy type is '00, MS shall report post processing SNR of individual layers, the order of CQICH channel allocation shall match the order of layer index.

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5. References

[1] IEEE P802.16-REVd/D6-2005 Draft standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems.