
Project	IEEE 802.16 Broadband Wireless Access Working Group < http://ieee802.org/16 >
Title	CSI Feedback scheme for downlink MIMO in TDD mode
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Re:	IEEE 802.16m-08/016r1: Call for Contributions on Project 802.16m System Description Document (SDD). Target topic: “Downlink MIMO Schemes” and “Uplink control Structures”.
Abstract	This contribution proposes channel status information feedback scheme for downlink MIMO, especially for TDD mode
Purpose	For discussion and approval by TGm
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Objectives

- In this contribution, we propose a channel status information feedback scheme for the TDD mode.
- The proposed scheme focuses on the cases where the number of receive antennas is greater than that of transmit antennas at the mobile station side.

Background

- In TDD mode, the downlink channel and uplink channel are highly correlated, and thus by estimating the uplink channel the BS can easily acquire channel status information (CSI) of downlink channel.
- However, usually mobile stations have more number of receive antennas than transmit antennas. In this case, the BS cannot have full CSI by utilizing channel reciprocity property.
- Thus, we need another way of feedback while fully utilizing channel reciprocity property and minimizing feedback overhead.

Proposed Scheme

- Notation

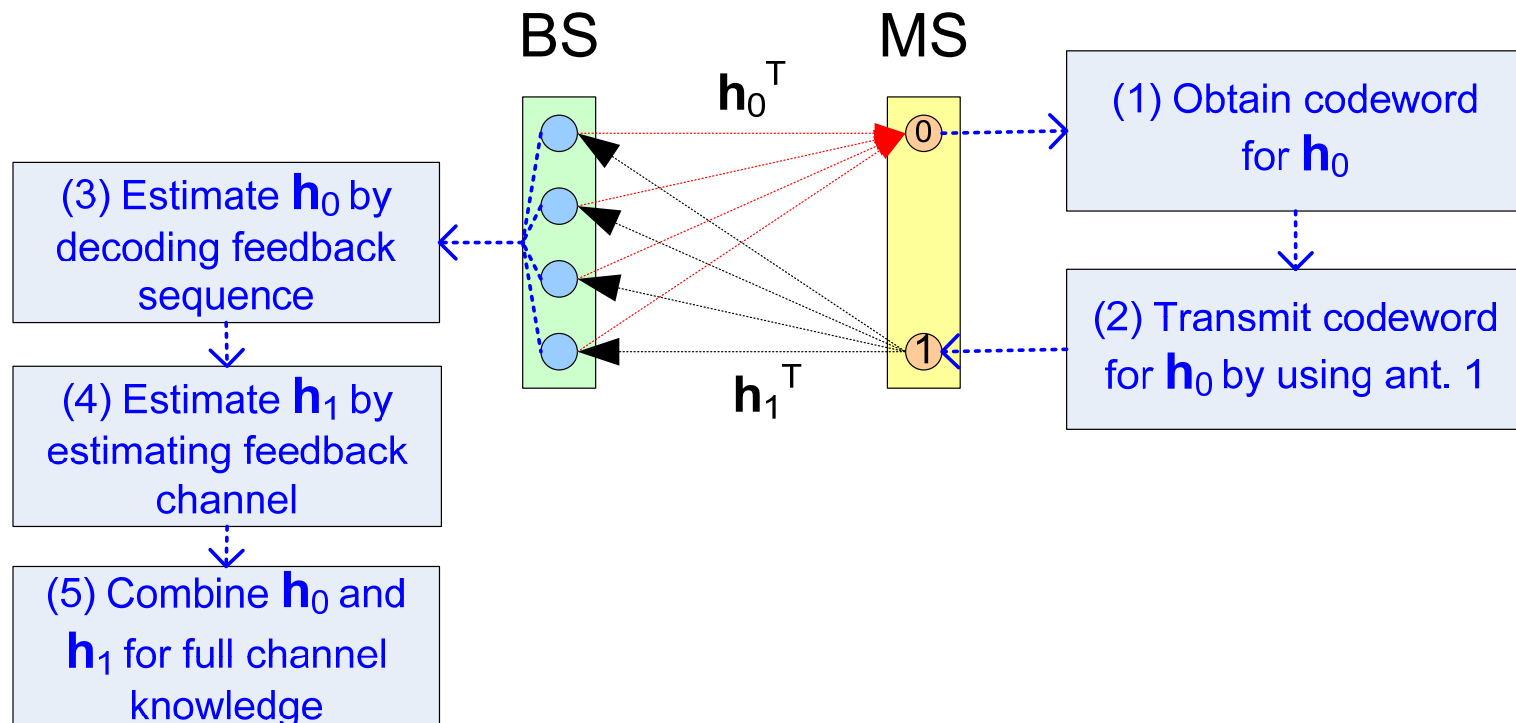
- BS has K transmit & K receive antennas
- MS has M transmit & N receive antennas ($N > M$)

- Basic Idea

- MS generates CSI for $K \times (N-M)$ channel.
- This CSI is feedback by using M transmit antennas by using the CSI feedback channel (e.g. Sounding or CQICH).
- BS detects delivered CSI via CSI feedback channel, thus BS can identify $K \times (N-M)$ channel.
- BS estimates $K \times M$ channel by using the whole CSI feedback channel after re-encoding detected CSI.
- By combining these two pieces of information, the BS can acquire CSI of whole $K \times N$ channel.

Proposed Scheme

- Example scenario: $K=4$, $N=2$, $M=1$
 - MS ant. 0 is used for Rx only and ant. 1 is used for both Tx & Rx.
 - A set of codewords is predefined such as $C = \{\mathbf{c}_1, \mathbf{c}_2, \dots, \mathbf{c}_X\}$.



Proposed Scheme

1-1 At every channel feedback period, MS obtains one codeword such that

$$\bar{\mathbf{h}}_0 = \arg \min_{1 \leq i \leq X} \|\mathbf{c}_i - \mathbf{h}_0\|^2$$

1-2 The selected codeword ($\bar{\mathbf{h}}_0$) will be encoded into feedback channel (including pilot symbols depending on feedback channel structure), and the size of sequence allocated to j -th subcarrier is denoted by \mathbf{z}_j (size of $1 \times L_j$)

2 At every channel feedback period, the MS feedbacks the obtained \mathbf{z} information by using antenna 1. Then, at j -th subcarrier, the received signal at BS will be

$$\mathbf{Y}(j) = \mathbf{h}_1(j)\mathbf{z}_j + \mathbf{N}_j$$

Proposed Scheme

3 BS decodes the quantized channel information \mathbf{z} and obtains the estimated channel of $\bar{\mathbf{h}}_0$. Depending on feedback channel structure, BS may need to estimate $\bar{\mathbf{h}}_1$ in obtaining \mathbf{z} , however the signal quality for this may not fit for sounding because it considers combined channel estimation only.

4 BS will re-encode \mathbf{z} to further estimate the channel $\bar{\mathbf{h}}_1$.

$$\begin{aligned}\bar{\mathbf{h}}_1(j) &= \mathbf{Y}(j)\mathbf{z}_j^H (\mathbf{z}_j\mathbf{z}_j^H)^{-1} \\ &= \mathbf{h}_1(j) + \mathbf{N}_j\mathbf{z}_j^H (\mathbf{z}_j\mathbf{z}_j^H)^{-1} \\ &= \mathbf{h}_1(j) + \mathbf{N}_j'\end{aligned}$$

5 By combining $\bar{\mathbf{h}}_0$ and $\bar{\mathbf{h}}_1$, BS can identify full channel information.

Advantages

- Because this scheme uses both quantized channel feedback & channel reciprocity at the same time, the BS can obtain full channel status information even in the case of 1 transmitter antenna at MS side.
- Because this scheme uses a quantized channel for reduced number of antennas, the dimension for quantized channel is reduced (from $K \times N$ to $K \times (N-M)$), which can reduce codebook size for CSI feedback.
- Because BS can utilize decision-feedback type channel estimation, the accuracy of the channel estimation can be further enhanced, which can reduce uplink overhead.

Operation Impacts

- BS needs to identify the mobile station's antenna configuration.
- BS and MS need to define a reference antenna for CSI calculation.
- CSI feedback needs to use the same resource type and region with DL traffic.

Text Proposal

Insert the following text in Chapter 11 (Physical Layer):

11.X CSI feedback information for TDD mode DL-MIMO

In TDD mode, the CSI feedback channel can deliver quantized channel information which is measured by antennas that an MS is not using for uplink transmission.

...

11.Y CSI feedback channel

In TDD mode, CSI feedback information can be delivered in UL sounding zone.