Proposal for IEEE 802.16m STC HARQ

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*<http://standards.ieee.org/faqs/affiliationFAQ.html>

Re: "SDD Session 56 Cleanup, Call for PHY Details"; supporting contribution for reply comment to comment 080 of commentary file 80216m-08_034r3, and HARQ RG output C80216m-08/1094r1

Purpose: Adopt the proposal into the IEEE 802.16m System Description Document

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Scope

- This contribution proposes STC HARQ for IEEE 802.16m
  - IEEE 802.16e currently supports a STC HARQ solution
  - This contribution proposes STC code mappings mapping for HARQ transmissions so that each symbol is eventually transmitted on each antenna to fully exploit spatial diversity
    - Detailed description of previously submitted mentioned in in contribution IEEE C802.16m-08/352r2

Background and Introduction

- In general, the H-ARQ exploits the time-diversity with soft packet combing to improve the transmission reliability
- However, in the MIMO mode, we can exploit additional space-time diversity in the packet re-transmission.
  - The re-transmitted packet can be design as a space time code words so that the receiver can treat the packet re-transmission as decoding a space time code, therefore, additional gain can be gained.
  - Such a re-transmission can be designed as redundancy version in space- time coding domain
    - The simplest version is STTD e.g. the space time block code

The Two Basic MIMO Transmission Modes

- STTD
  - Improve the reliability to link performance
  - Independent of MIMO channel matrix illness
  - Does not increase the user bit rate
- Spatial Multiplexing
  - Provides higher user bit rate
  - Sensitive to MIMO channel matrix illness
- The H-ARQ strategy for MIMO transmission
  - Use Spatial multiplexing as first transmission to gain best bit rate
  - Use STTD format to send subsequent retransmission packet
  - The receiver exploits the signal design and space diversity gain

Space Time Coding Based H-ARQ

- The table shows how the symbols are transmitted for STBC-HARQ during multiple transmissions for 2 transmit antennas.
- IEEE 802.16e currently supports this STC HARQ method

	Initial Transmission	Odd Re-transmission	Even Re-transmission
patial time code ncremental edundancy	$S_2^0 = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$	$S_2^{odd} = \begin{bmatrix} -s_2^* \\ s_1^* \end{bmatrix}$	$S_2^{even} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$

Proposed STC HARQ (1/3)

- The proposed STC HARQ mapping fully exploits the spatial diversity of the channel by mapping each modulated symbol to each of the transmit antennas over the course of the HARQ transmissions
- The method can be applied to 3 and 4 transmit antennas configurations
  - STC mapping for a maximum of 4 HARQ transmissions are shown. Further mappings are possible for HARQ transmissions beyond 4.

Proposed STC HARQ (2/3)

- The proposed STC mapping for 3 transmit antennas.
- STC code mapping scheme fully exploits the spatial diversity by transmitting each modulated symbol for a different antenna over the course of 3 transmissions

	Initial transmission	2nd Re-transmission	3rd Re-transmission	4th Re-transmission
Spatial time code incremental redundancy	$S_2^0 = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}$	$S_2^1 = \begin{bmatrix} -s_2^* \\ s_1^* \\ s_3^* \end{bmatrix}$	$S_2^2 = \begin{bmatrix} s_3 \\ s_1 \\ s_2 \end{bmatrix}$	$S_2^3 = \begin{bmatrix} -s_1^* \\ s_3^* \\ s_2^* \end{bmatrix}$

Proposed STC HARQ (3/3)

- For 4 transmit antennas, the proposed STC code mapping scheme fully exploits the spatial diversity by transmitting each modulated symbol for a different antenna over the course of 4 transmissions

	Initial Transmission	2nd Re-transmission	3rd Re-transmission	4th Re-transmission
Spatial time code incremental redundancy	$S_2^0 = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}$	$S_2^1 = \begin{bmatrix} -s_2^* \\ s_1^* \\ -s_4^* \\ s_3^* \end{bmatrix}$	$S_2^2 = \begin{bmatrix} s_3 \\ s_4 \\ s_1 \\ s_2 \end{bmatrix}$	$S_2^3 = \begin{bmatrix} -s_4^* \\ s_3^* \\ -s_2^* \\ s_1^* \end{bmatrix}$

Summary

- Space Time Code based HARQ re-transmissions provide significant gain with a simple retransmit and receive structure

Proposed SDD text

11.x.1.2.5 MIMO HARQ

11.x.1.2..5.1 STC Subpacket Combining

[*Retain introduction text as shown in IEEE C802.16m-08/1094*]

[*Add the following text*]

In STC-HARQ, a first HARQ open-loop (OL) transmission is sent using spatial multiplexing (SM). In a second re-transmission, the re-transmitted symbols are arranged such that they form STC code with the pair of original symbols. This can give a performance improvement over conventional re-transmissions. In 3 and 4 transmit antenna schemes, STC code mappings for subsequent HARQ transmissions fully exploit the spatial diversity for all bits or modulated symbols.