Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**MIMO differential modulations**
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Re:	IEEE 802.16-REVe/D5a, BRC recirc
Abstract	Scattered pilot based channel estimation is a challenge in the very low SNR reception, in addition for the MIMO transmission case, with the limited scattered pilot density, in certain deployment scenario, the channel estimation is also a challenge task. In this contribution, we expand the MIMO transmission into differential modulation format such that it enables the MSS receiver to perform space time coded MIMO signal reception without the need for channel estimation. The update is in green font to provide the further response to the reply comments.
Purpose	To incorporate the changes here proposed into the 802.16e D5a draft.
Notice	
Release	
Patent Policy and Procedures	

MIMO differential modulations

1 Introduction

Scattered pilot based channel estimation is a challenge in the very low SNR reception, in addition for the MIMO transmission case, with the limited scattered pilot density, in certain deployment scenario, the channel estimation is also a challenge task. In this contribution, we expand the MIMO transmission into differential modulation format such that it enables the MSS receiver to perform space time coded MIMO signal reception without the need for channel estimation. This not only greatly simplifies the receiver channel estimation complexity, but the space time coding diversity order gain is fully achieved with any loss. The penalty of the differential modulation is consistently 3dB inferior to the ideal coherent demodulation. Therefore the differential MIMO transmission can be employed in the very low CIR reception condition in combination with repetition coding.

2 Differential MIMO modulation and demodulation

We propose to introduce recursive type differential modulation for MIMO modes they are applicable to QPSK constellation only. The STC code based differential modulation preserve fully the space time coding gain, with only 3dB penalty compared the ideal coherent STC code. The encoding operation is $Z_i = \frac{1}{\sqrt{2}} Z_{i-1} S_i$ where S_i is the matrix-A (for 2, 3 and 4 transmit antennas) with the element $s_1, s_2 \ldots$ as the input symbol. The decoding is $S_i = \frac{1}{\sqrt{2}} S_{i-1} Y_i$ where Y_i is the receiver matrix stacked from the received signal vectors, as we can see from Figure 1, both encoding and decoding is very simple. This is another advantage for the differential STC coding. The typical gain for differential can improve the range dramatically, even with single receive antenna for MSS.

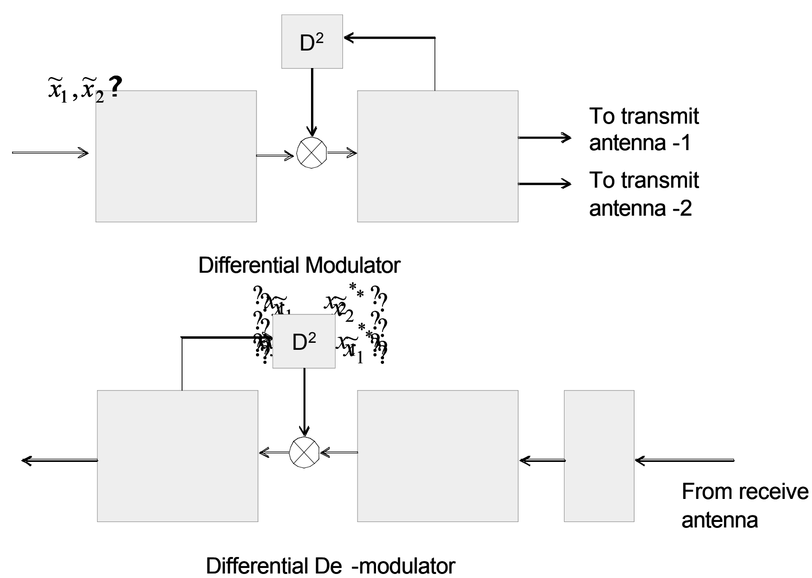

Figure 1 Modulator and demodulator for differential MIMO transmission (2-transmit case)

2.1 Performance Simulation Results

In Figure 2 the differential MIMO for 2x1 and 4x1 transmission is shown. The repetition of 6 is used in concatenation with rate _ QPSK modulations and CTC encoding. As we can see for very low SNR range the in the absence of scattered pilot for the coherent demodulation, since the maximum benefit of the coherent demodulation over the differential demodulation is 3dB, in practice the channel estimation always contains channel estimation error. However the differential MIMO modulation has the advantage of avoid the channel estimation and provide excellent performance in the very mobility high speed and provide the user bit rate in the deep path loss geometry. Figure 3 *clearly demonstrates that after channel fails, the differential MIMO modulation can sustain the data rate throughout into very low SNR region.*

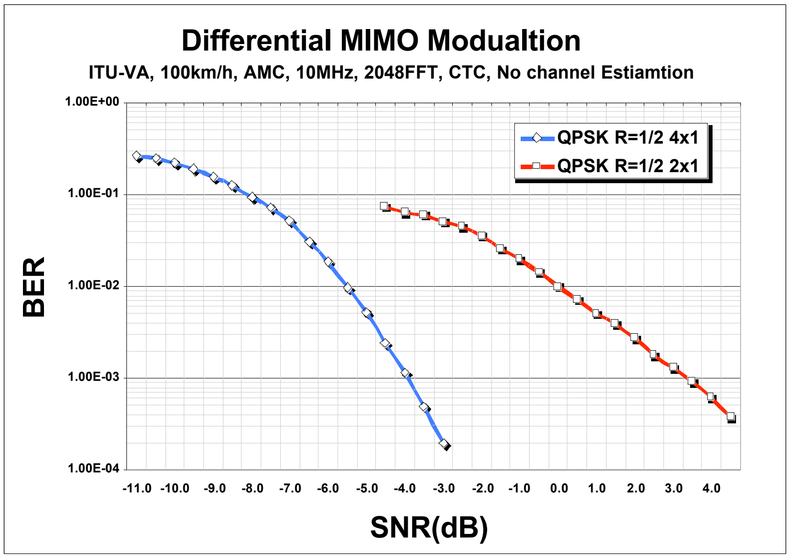

Figure 2 Performance for Differential MIMO Modulation

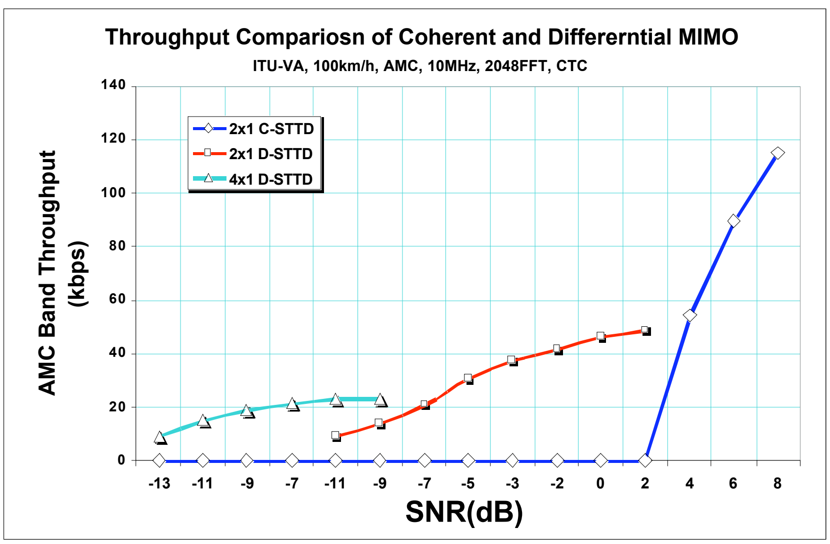

Figure 3 Throughput performance for differential MIMO modulation

3 Specific text changes

[Add the following text into section 8.4.9.4.3.2]

---------Start text proposal-------

Additional optional differential modulations are listed in table zzz-1, where the index i following the mapping follows the sub-carrier mapping of AMC and PUSC-ASCA sub-channelization rule after permutation operation.

Table zzz-1 ~~differential space time code~~ Differential MIMO Modulation for 2,3 and 4 transmit antennas

Antenna Configuration	Modulation Rule	S_i
2-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} S_i$	$S_i = \begin{bmatrix} s_1 & -s_2 \\ s_2 & s_1^* \end{bmatrix}$
3-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} S_i$	$s_i = \begin{bmatrix} s_1 & s_2^* & 0 & 0 \\ s_2 & -s_1^* & s_3 & s_4^* \\ 0 & 0 & s_4 & -s_3^* \end{bmatrix}$
4-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} S_i$	$S_i = \begin{bmatrix} s_1 & -s_2^* & 0 & 0 \\ s_2 & s_1^* & 0 & 0 \\ 0 & 0 & s_3 & -s_4^* \\ 0 & 0 & s_4 & s_3^* \end{bmatrix}$

---------End text proposal-------

[Add the following text into section 11.8.3.7.2]

---------Start text proposal-------

Type	Length	Value	Scope
151	1	Bit #0: 64-QAM Bit #1: BTC Bit #2: CTC Bit #3: STC Bit #4: AAS Diversity Map Scan Bit #5: AAS Direct Signaling Bit #6: H-ARQ Bit #7: MIMO Differential Modulation	SBC-REQ(see 6.3.2.3.23) SBC-RSQ(see 6.3.2.3.24)

---------End text proposal-------