Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Range Enhancement by using differential modulations**
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Re:	IEEE 802.16e D3 Draft
Abstract	Range enhacement by using differential modulations
Purpose	To incorporate the changes here proposed into the 802.16e D4 draft.
Notice	
Release	
Patent Policy and Procedures	

Range enhancement by using differential modulation

1.1 Background

For the FUSC permutation, the out of coverage range MSS mapped onto specific sub-channels will not be able to perform the channel estimation and coherent demodulation, especially the SIR ratio is less than 0dB. However, such a MSS can still listen the FCH QPSK R=1/8 with 30% reuse, this accounts -9dB, the repetition coding can boost the data SIR but the pilot is berried into interference and noise (See Figure 1). Such scenario can happen cell border MSS during intra-system handoff or inter-system hand over.

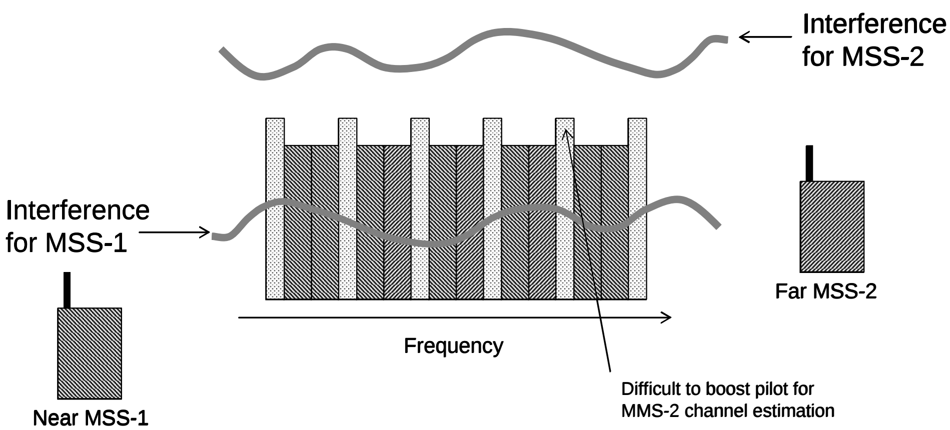

Figure 1 Range limited User Scenario

A simple fix to this is to introduce the differential modulation to allow low data rate transmission even the SIR is less than 0dB. For the MIMO mode the differential MIMO modulation can even increase the data rates.

1.2 Differential STC for non-coherent demodulation to improve the range

We propose to introduce recursive type differential modulation for both MIMO and non-MIMO modes they are applicable to QPSK constellation. The STC code based differential modulation preserve fully the space time coding gain, with only 3dB penalty compared the coherent STC code The encoding is $Z_i = \frac{1}{\sqrt{2}} Z_{i-1} S_i$ where $S_i = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}$ and the element $s_1, s_2 \ldots$ is 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, 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.

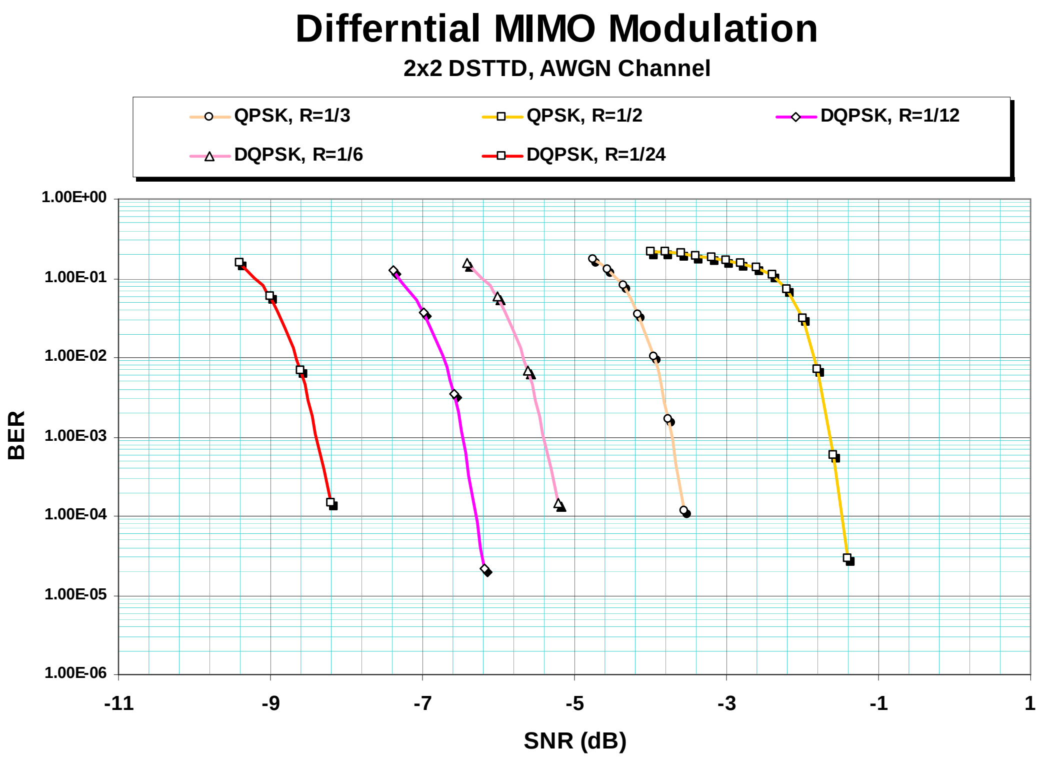

Figure 2 Performance for Differential MIMO Modulation

1.3 Specific text changes

[Add the following text into section 8.4.9.4.3.2]

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

Additional differential modulations for MIMO, SISO and SIMO are listed in table zzz-1

Table zzz-1 differential space time code for 1, 2 and 4 transmit antennas

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

For single antenna transmission the input bit and symbol mapping is shown in Table zzz-2

Table zzz-2 π/4-DQPSK modulation

Codeword $b_0 b_1$	Modulation symbol, S_i
00	1
01	j
11	-1
10	-j

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