Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Enhancement of handoff capability and procedures**
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Re:	IEEE 802.16e D2 Draft
Abstract	Enhancement of handoff capability and procedures
Purpose	To incorporate the changes here proposed into the 802.16e D2 draft.
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Enhancement of handoff capability and procedures

1 Background

In this contribution, two physical layer enhancements for the handoff operation are proposed for a frequency reuse-one OFDMA multi-cell system. These enhancements are based on the MIMO/MISO capabilities for both BS and MSS to exploit the macro-diversity. The first is joint BS soft-handoff based on the space time coding structure to enhance the user data rate in the very poor geometry users. The second is to allow the minimum data rate connection during the very low geometry handoff process. It should be noted that the proposed handoff solutions are also applicable to the MBS service.

2 MIMO Soft Handoff

MIMO-OFDMA soft handoff (SHO) scheme is configured with multiple BS transmissions in division in frequency domain, and the space-time coding (STTD/SM) associated with each BS antenna. The packet delivering to SHO MSS is duplicated to all the active SHO-BS. Two SHO transmission are allowed: (3-way SHO example)

1. *Joint* multiple BS transmission division in frequency domain.
   - Data packet is divided into three sub-packets, and each BS transmits one sub-packet, each BS organizes the space-time coding for two antennas and mapped onto OFDM time-frequency AMC sub-channel while 2/3 of the band is empty without signal transmission. Each transmitted AMC sub-channel is power boosted by $10\log_{10}(3)$dB to realize the full power transmission. The MSS receives the entire frequency band and performs space-time decoding to retrieve the packet data.
   - The same data packet is space-time encoded by eachBS, each BS's transmission is mapped into different AMC sub-channel in frequency domain. The 2/3 of the band is empty without signal transmission. Each transmitted AMC sub-band is power boosted by $10\log_{10}(3)$ dB. The MSS receives the entire frequency band and performs diversity combining for each sub-bands and space-time decoding to retrieve the packet data.
2. *Joint* multiple BS antenna space-time coding transmission division in frequency domain.
   - Data packet is divided into three sub-packets. BS-1 antenna α and BS-2 antenna β performs the space-time encoding for the 1st sub-packet; BS-2 antenna α and BS-3 antenna α performs the space-time encoding for the 2nd sub-packet; BS-3 antenna β and BS-1 antenna β performs the space-time encoding for the 3rd sub-packet. Each antenna pair transmits one sub-packet, i.e. mapped onto one OFDM time-frequency sub-band accordingly, see Figure 1, the 2/3 of the band is empty without signal transmission. Each transmitted sub-band is power boosted by $10\log_{10}(3)$ dB. The SS receives the entire frequency band and performs space-time decoding to retrieve the packet data.
   - Data packet is encoded by 3 versions of space-time coding combinations (i) BS-1 antenna α and BS-2 antenna β (ii) BS-2-antenna α and BS-3 antenna α (iii) BS-3 antenna β and BS-1 antenna β antenna. Each combination transmits the same data packet. Each antenna pair is mapped onto one OFDM time-frequency sub-band accordingly and the 2/3 of the band is empty without signal transmission. Each transmitted sub-band is power boosted by $10\log_{10}(3)$ dB. The MSS receives the entire frequency band and performs diversity combining for each sub-bands and space-time decoding to retrieve the packet data.

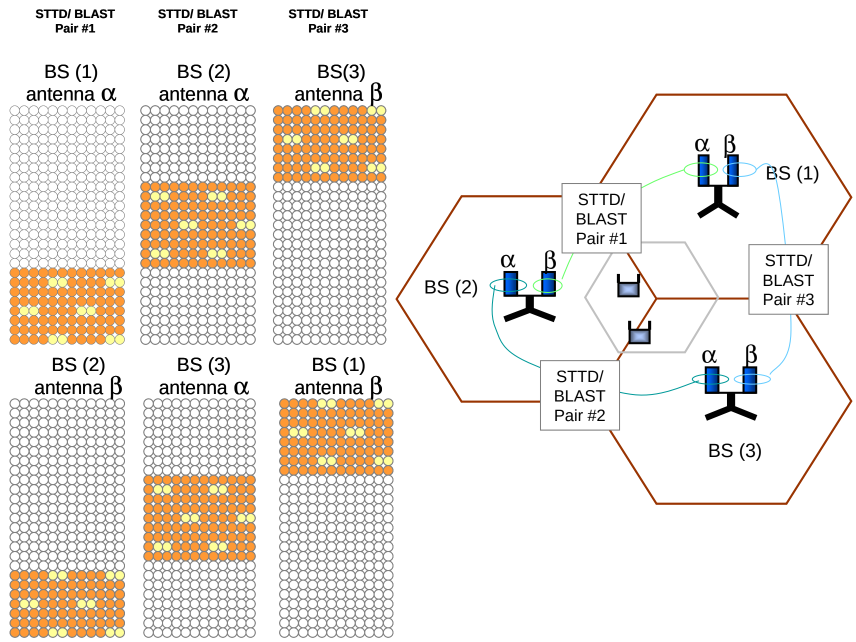

Figure 1 MIMO-soft-handoff

The MIMO-OFDMA soft-handoff is determined by the network and mapped onto AMC sub-channel. The AMC sub-channel allocation for SHO is scheduled in the round robin. Based on the same principle, the solution can be applied to the MSS with single antenna by employing 2x1 STTD.

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

In the very low SNR level, the coherent reception of OFDM signal becomes very difficult due to unreliable channel estimation. In the case of limited link budget, the range is limited, in order extend the range, in addition to the repetition coding, non coherent demodulation will allow the reception of OFDM signal in the very low signal to noise level. 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 $Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$ where $X_i = \begin{bmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \end{bmatrix}$ and the element $x_1, x_2 \ldots$ 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.

2.2 Specific text changes

[Add the following text into section 8.4.9.2]

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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	X_i
1-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	Table xxx-2
2-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	$X_i = \begin{bmatrix} x_1 & x_2 \\ -x_2^* & x_1^* \end{bmatrix}$
4-transmit antenna	$Z_i = \frac{1}{\sqrt{2}} Z_{i-1} X_i$	$X_i = \begin{bmatrix} x_1 & x_2 & \frac{x_3}{\sqrt{2}} & \frac{x_3}{\sqrt{2}} \\ -x_2^* & x_1^* & \frac{x_3}{\sqrt{2}} & -\frac{x_3}{\sqrt{2}} \\ \frac{x_3^*}{\sqrt{2}} & \frac{x_3^*}{\sqrt{2}} & \frac{-x_1 - x_1^* + x_2 - x_2^*}{2} & \frac{x_1 - x_1^* - x_2 - x_2^*}{2} \\ \frac{x_3^*}{\sqrt{2}} & -\frac{x_3^*}{\sqrt{2}} & \frac{x_1 - x_1^* + x_2 + x_2^*}{2} & \frac{-x_1 - x_1^* - x_2 + x_2^*}{2} \end{bmatrix}$

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, X_i
00	1
01	j
11	-1
10	-j

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