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Title	Enhancement for 4-antenna soft packet combining scheme to improve HARQ performance
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Re:	IEEE 802.16e D5 Draft
Abstract	In this contribution, we propose to extend table 314m and allow the case where the initial transmission has a spatial rate of 2 symbols/channel use.
Purpose	To incorporate the changes here proposed into the 802.16e D4 Draft. ~~Crossed-out indicates deleted text,~~ underlined blue indicates new text change to the Standard, and underlined green indicates newly added text from the original contribution
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Enhancement for 4-antenna Soft Packet Combining Scheme to Improve the HARQ Performance

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1. Background

In Table 314m of Section 8.4.8.9 in [4], the STC subpacket combining is defined for the 4 transmit antenna case. However, it only includes the case where the initial transmission is of spatial rate of 4 symbols/channel use (spatial multiplexing, matrix C). In this contribution, we propose to extend this table and allow the case where the initial transmission has a spatial rate of 2 symbols/channel use.

2. Proposed Text Change

Table 314m ---- STC subpacket combining (4-tansmit antenna case)

	Initial transmission	Odd re-transmission	Even re-transmission
Space-time code incremental redundancy for matrix B	$S_4^{(0)} = \begin{bmatrix} s_1 & -s_2^* & s_5 & -s_7^* \\ s_2 & s_1^* & s_6 & -s_8^* \\ s_3 & -s_4^* & s_7 & s_5^* \\ s_4 & s_3^* & s_8 & s_6^* \end{bmatrix}$	$S_4^{(odd)} = \begin{bmatrix} s_1 & -s_2^* & s_5 & -s_7^* \\ s_2 & s_1^* & -s_6 & s_8^* \\ -s_3 & s_4^* & s_7 & s_5^* \\ -s_4 & -s_3^* & -s_8 & -s_6^* \end{bmatrix}$	$S_4^{(even)} = \begin{bmatrix} s_3 & -s_4^* & s_6 & -s_8^* \\ s_4 & s_3^* & s_5 & -s_7^* \\ s_1 & -s_2^* & s_8 & s_6^* \\ s_2 & s_1^* & s_7 & s_5^* \end{bmatrix}$
Space-time code incremental redundancy for matrix C	$S_4^{(0)} = \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}$	$S_4^{(odd)} = \begin{bmatrix} -S_2^* \\ S_1^* \\ -S_4^* \\ S_3 \end{bmatrix}$	$S_4^{(even)} = \begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \end{bmatrix}$

The MSS shall process the initial transmission, 1st re-transmission and 2nd re-transmission etc in the form of space time decoding. The re-transmission of FEC code word shall use the Chase combing re-transmission.

3. Receiver Processing

We use the first sub-carrier as an example to explain how the receiver processing is performed. First, we rewrite the first two columns of matrix B (corresponding to transmission on the first subcarrier) as

$$\begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \\ s_3 & -s_4^* \\ s_4 & s_3^* \end{bmatrix} \triangleq \begin{bmatrix} \mathbf{E} \\ \mathbf{F} \end{bmatrix}$$ then the first two columns of the first re-transmission can be written as $\begin{bmatrix} \mathbf{E} \\ -\mathbf{F} \end{bmatrix}$. Assuming the channel vector to be

$$\mathbf{h} = \begin{bmatrix} h_1 \\ h_2 \\ h_3 \\ h_4 \end{bmatrix} \triangleq \begin{bmatrix} \mathbf{h}_{12} \\ \mathbf{h}_{34} \end{bmatrix},$$

which stays constant over these two transmissions, then the signals received on the first sub-carrier over the two transmissions are:

$$\mathbf{r}^{(0)} = [\mathbf{E},\ \mathbf{F}]\begin{bmatrix} \mathbf{h}_{12} \\ \mathbf{h}_{34} \end{bmatrix}, \quad \mathbf{r}^{(odd)} = [\mathbf{E}, -\mathbf{F}]\begin{bmatrix} \mathbf{h}_{12} \\ \mathbf{h}_{34} \end{bmatrix}$$

, which means

$$\mathbf{r}^{(0)} + \mathbf{r}^{(odd)} = 2\mathbf{E}\mathbf{h}_{12} ---> \text{detect } s_1, s_2$$
$$\mathbf{r}^{(0)} - \mathbf{r}^{(odd)} = 2\mathbf{F}\mathbf{h}_{34} ---> \text{detect } s_3, s_4$$

with a simple linear combiner. Which means the initial transmission and first re-transmission together forms an orthogonal STBC code.

4. Simulation Results

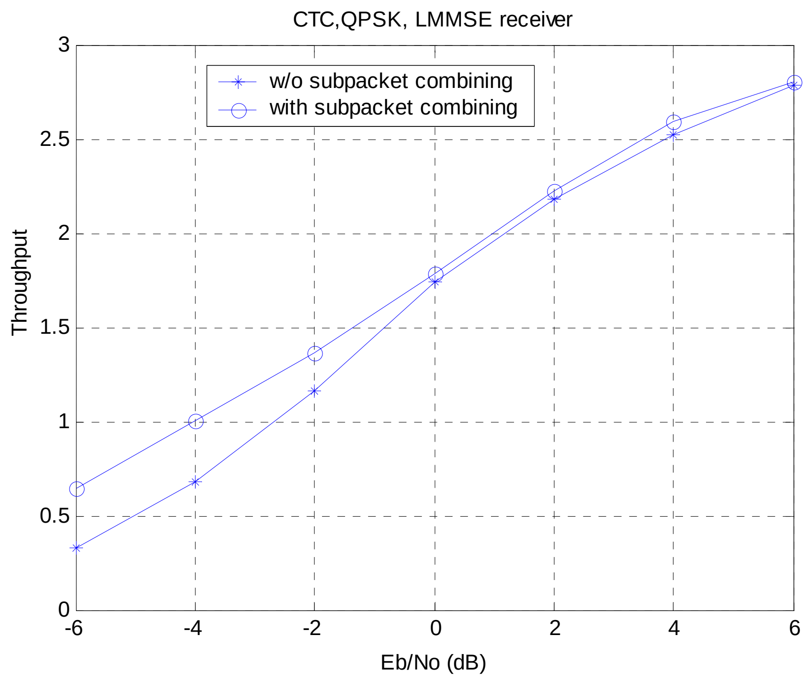

Figure 1. Throughput comparison with and without subpacket combining with matrix B.

In Figure 1, we compare the throughput of the MIMO system for cases with and without subpacket combining, assuming matrix B is used in the initial transmission. It is observed that in the low SNR region, up to 2 dB of gain is possible. The performance gain diminishes as SNR increase, which makes intuitive sense since the higher the SNR, the better the chance that the first transmission will go through.

References

[1]. IEEE C802.16e-04/113r2, “Soft packet combining for STC retransmission to improve HARQ performance in MIMO mode”, Nortel Networks, July 2004.

[2]. IEEE C802.16e-04/269r1, “Enhancement for 4-antenna soft packet combining scheme using unitary transformation,” Texas Instruments, August 2004.

[3]. IEEE P802.16-REVd/D5-2004 Draft IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems

[4] IEEE P802.16e/D5, “Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands,” September 2004