Project	IEEE 802.16 Broadband Wireless Access Working Group <**http://ieee802.org/16**>
Title	Fix for Uplink PUSC Space Time Coding
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Source(s)	Jun WU, Wenzhong Zhang, Wenfeng Zhang, Sean Cai, Jing Wang, Yunsong Yang jwu@ztesandiego.com wzhang@ztesandiego.com ZTE San Diego Inc. 10105 Pacific Heights Blvd. San Diego, CA 92121 USA
Re:	Response to Sponsor Ballot Recirculation on IEEE802.16e_D10 document
Abstract	In this contribution, we propose to a fix for Uplink PUSC STC
Purpose	To incorporate the text changes proposed in this contribution into the IEEE802.16e_D11 draft.
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Fix for Uplink PUSC Space Time Coding

Jun WU, Wenzhong Zhang, Wenfeng Zhang, Sean Cai, Jing Wang, Yunsong Yang
ZTE San Diego Inc.

1. Problem Statement

In the current standard, the data and pilot subcarriers mapping for uplink pusc space time coding are defined as Fig. 249 in 8.4.8.1.5. S1 and S2, S3 and S4, S5 and S6, S7 and S8 are four pairs of signals, which construct 2-antenna space time coding. In Base Station receiver, if OFDM symbol and frequency synchronization is perfect, the channel of adjacent subcarriers can be regarded similar, then space time decoding is easy.
In reality, the Base Station is impossible to guarantee that all the SSs arrive at BS at exactly the same time, and residual frequency offset very possibly exists due to oscillator inaccuracy and Doppler shift. For non STC coding, channel estimation can cover both symbol and frequency offset because 4 pilot tones are available. For STC coding, only two pilot tones are available, performance degradation is dramatic.

2. Remedy

We propose to use pilot pattern A and B alternately for antenna 0 and 1, as shown in Fig. 249. For the even tiles, antenna 0 uses pilot pattern A and antenna 1 uses pilot pattern B; For the odd tiles, antenna 0 uses pilot pattern B and antenna 1 uses pilot pattern A.
The intention is to estimate the phase offset caused by symbol and frequency offset respectively. Suppose the phase offset $_s$ and $_f$ represent phase rotation of symbol and frequency of antenna 0, differentiate the pilot tones of the even tiles, we get $e^{j\ s}\ e^{j\ f}$, differentiate the pilot tones of the odd tiles, we get $e^{j\ s}\ e^{j\ f}$, so it is easy to solve both phase offsets for antenna 0. The same procedure can apply to antenna 1.

3. Detailed Text Changes

Change the following text and figure 249 in 8.4.8.1.5.

8.4.8.1.5 Uplink using STC

A user-supporting transmission using STC configuration in the uplink, shall use a modified uplink tile,. 2-transmit diversity data ('STTD mode'), or 2-transmit spatial multiplexing ('SM mode') data that can be mapped onto each subcarrier. The mandatory tile shall be modified to accommodate those configurations. In STTD mode, the tiles shall be allocated to subchannels and the data subcarriers enumerated as defined in8.4.6.2. The pilot in each tile shall be split between the two antennas, for the even tiles, antenna 0 uses pattern A and antenna 1 uses pattern B; for the odd tiles, antenna 0 uses pattern B and antenna 1 uses pattern A. The data subcarriers shall be encoded in pairs after constellation mapping, as depicted in figurre 249. ~~The pilots in each tile shall be split between the two antennas and the data subcarriers shall be encoded in pairs after constellation mapping, as depicted in figure 249.~~ The data subcarriers transmitted from Antenna #0 follow the original mapping defined in 8.4.6.2.

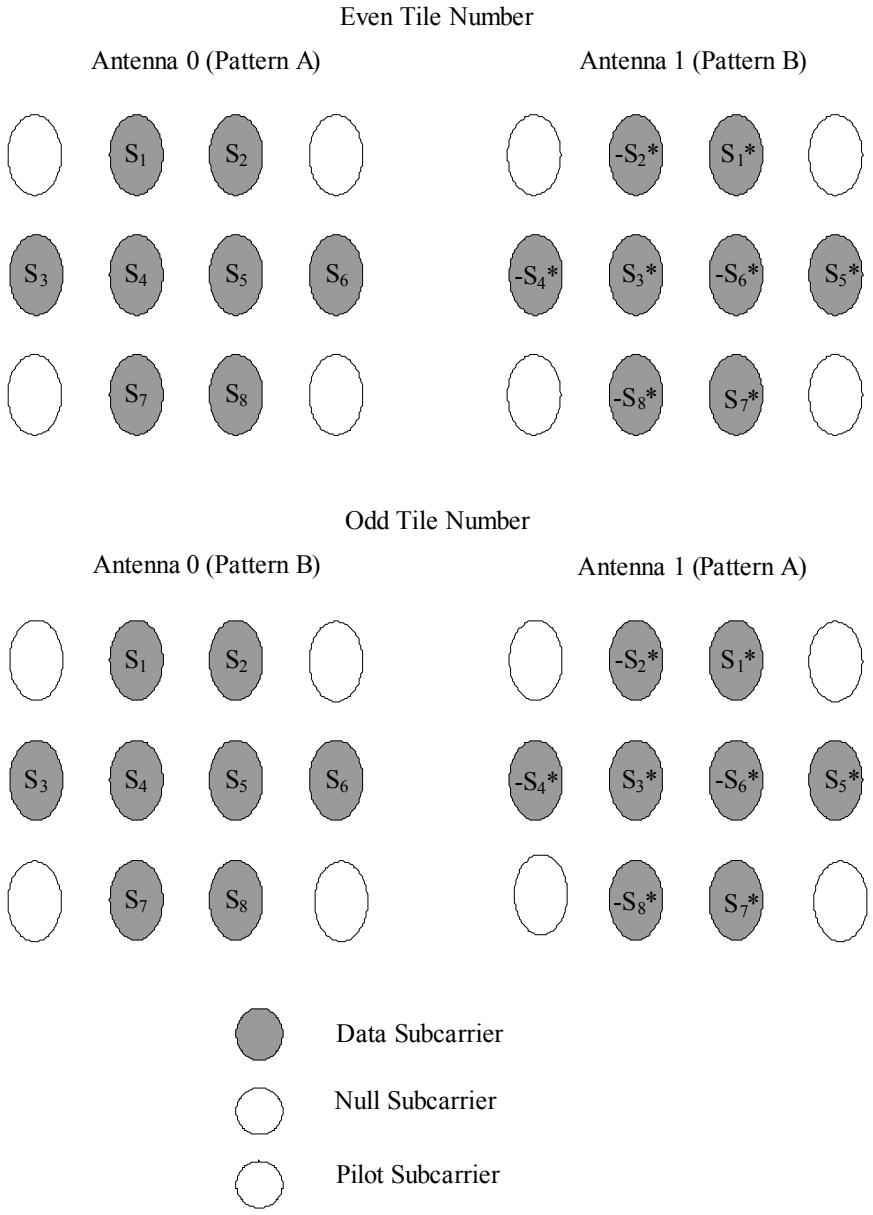

Fig. 249 UL STC tile