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Abstract	Support mechanism for space-time processing with 4 antennas at BS is proposed
Purpose	Inclusion of the proposed enhancement into the IEEE P802.16-REVd/D3
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Support for 4 Antenna Space-Time Processing

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Introduction

IEEE P802.16 REVd/D3 optionally offers space time coding (STC) as a mean to provide 2nd order transmit diversity (TD). The same preamble and pilot scheme can be used for spatial multiplexing techniques which MIMO systems can employ in order to increase spectral efficiency. For 4 antenna BS, however, it is not clear from the current draft standard on how to achieve spatial multiplexing as well as 4th order transmit diversity. In this contribution, this issue is addressed and a preamble pattern and a pilot structure for 4 antenna BS are proposed.

Proposed Text Changes

We propose the following remedies in IEEE P802.16-REVd/D3

[Change the subsection title "8.4.8 Transmit diversity (optional)" to "8.4.7 Space-time processing (optional)"]

[Insert the following text as subsection 8.4.7.9]

8.4.7.9 Space-Time Processing (STP)

Space-time processing (STP) techniques may be employed with multiple transmit BS antennas in order to enhance the signal reliability (transmit diversity or TD) and/or increase spectral efficiency (spatial multiplexing). Specifically two- and four-antenna systems are considered. The preamble and the pilots are designed in such a way that multi-channel estimation for STP at the receiver can be made.

8.4.7.9.1 Preamble scheme for STP

When STP is employed, orthogonal preamble patterns are transmitted in each antenna over two symbols as shown in Figure 1. In this figure, each block denotes one subcarrier. The underlying idea is to distribute pilots in the preamble in frequency, time and code dimension so that orthogonality between four patterns is preserved. For example, the channel a from Antenna 0 and the channel c from Antenna 2 are computed at the receiver by simple addition and subtraction, respectively, using two neighboring pilot subcarriers.

For two-antenna BS, first two preamble patterns (Ant 0 and Ant 1 in Figure 1) shall be used.

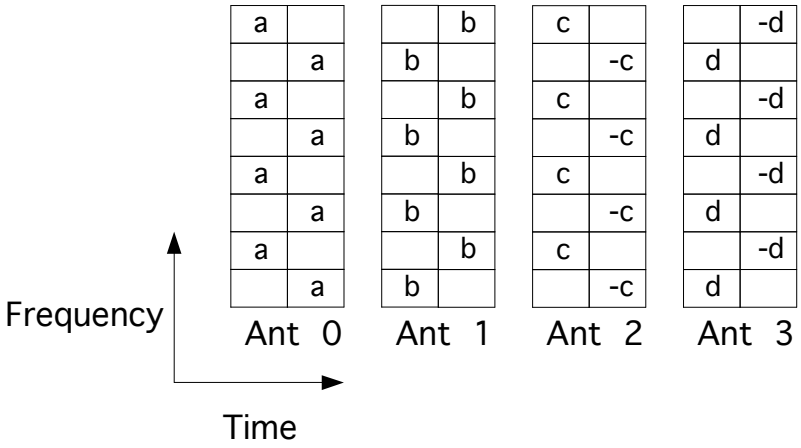

Figure 1 – Preamble patterns for STP

8.4.7.9.2 Pilot scheme for STP

Inside the AMC subchannel, pilot tones for each antenna are well-positioned such that the same structure can be used for UL as well as DL as shown in Figure 2.

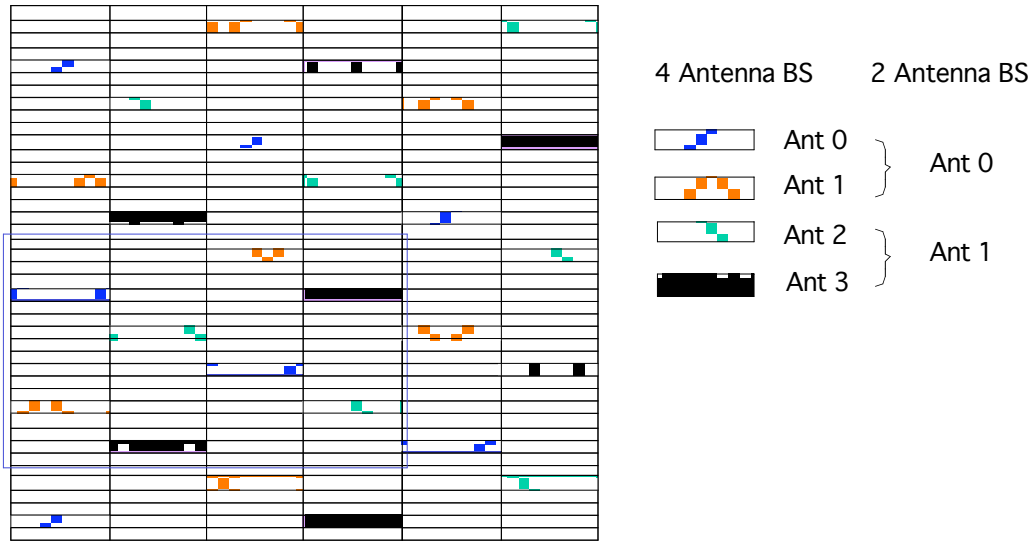

Figure 2 – Pilot patterns for STP

8.4.7.9.3 Transmit diversity (TD) for 4 antennas

Transmit diversity scheme can be implemented with the aforementioned preamble and pilot tone structures. Orthogonal code is chosen so that simple linear detection provides maximal likelihood estimates, thus requiring no joint detection. One of the orthogonal space-time block codes for 4 antennas can be found in [1] where full 4th order diversity is achieved with rate reduced to 3/4 for the optimal delay of 4 symbols. The encoding scheme is shown in (1) where each row represents symbol time and each column represents each antenna, thus the received signal at time t=1 is given as (1), and so forth.

(1)

The computed estimates at the receiver are

(2)

One can easily see that 4th order diversity is achieved for each of the three symbols. Note also that, instead of 4 consecutive OFDM symbols (STBC), 4 neighboring data subcarriers can be used to form a space-frequency block code (SFBC). We expect, as the frequency selectivity of the channel becomes less severe, the advantages of SFBC over STBC become more evident, one of which is the short decoding time delay.

8.4.7.9.4 Spatial multiplexing for 4 antennas

Positioned at the other side of technical spectrum, spatial multiplexing whose goal is to increase the data throughput by the multiple parallel data streams is also possible with the proposed preamble and pilot structures. With this technique, every data subcarrier in the two dimensional frequency-time plane is used by all antennas.

3. Reference

[1] Tirkkonen and Hottinen, “Complex space-time block codes for four Tx antennas”, Globecom 2000