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Re:	Response to the call for comments 802.16maint-04/10 Corrigendum to IEEE 802.16-2004	
Abstract		
Purpose	Adopt proposed changes to TGmaint document	
Notice		
Release		
Patent Policy and Procedures		

Enhanced Pilot allocation of PUSC in downlink STC that can be compatible with Non-STC

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1. Statement of the problem

Let B_c denote the coherent bandwidth of the transmission channel. According to the sampling theory, if the sampling rate in the frequency domain fulfills the following inequality:

$$L\Delta f < B_c \qquad (1)$$

The channel frequency response of the whole carriers can be calculated by interpolation, where Δf and $L\Delta f$ are the carrier spacing and the pilot spacing respectively. Unfortunately, for some channel models, inequality (1) is not always satisfied for downlink OFDMA systems when STC is adopted.

The following is an example.

Suppose the allocated bandwidth is 20 MHz, and FFT size is 2048 with SUI-5 channel model. Then, Δf is about 10kHz. Since the coherent bandwidth B_c is about 70kHz suppossing the correlation coefficient is equal to 0.5. Apparently,

$$L\Delta f > B_c \qquad (2)$$

As a result of it, a significant channel estimation loss will appear in the presence of channels with relatively high delay spread (delay spread that is however much smaller than the maximum supported cyclic prefix length) when using pilot-aided estimation approaches.

Hence, an improved set of pilots allocation schemes is proposed for the downlink transmission here.

2. Proposed solution

2.1. PUSC mode

In the PUSC mode, pilots are allocated within clusters, as shown in figure-1 and figure-2 for two and four transmit antennas, respectively.

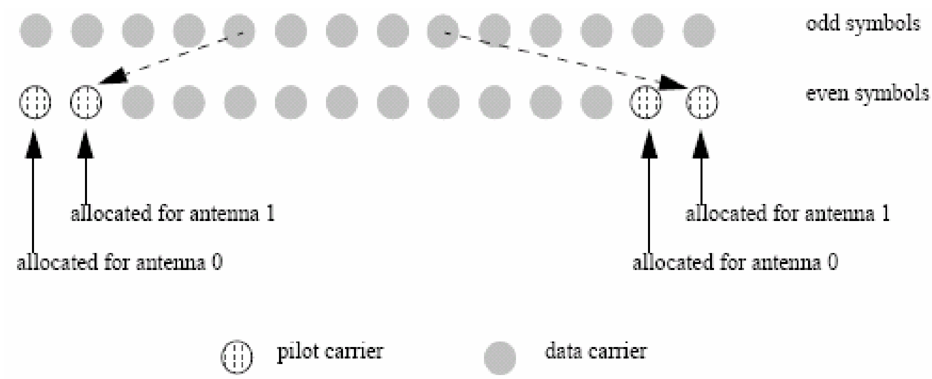

Figure-1 Cluster structure and pilots allocation in DL PUSC for 2 Tx antennas

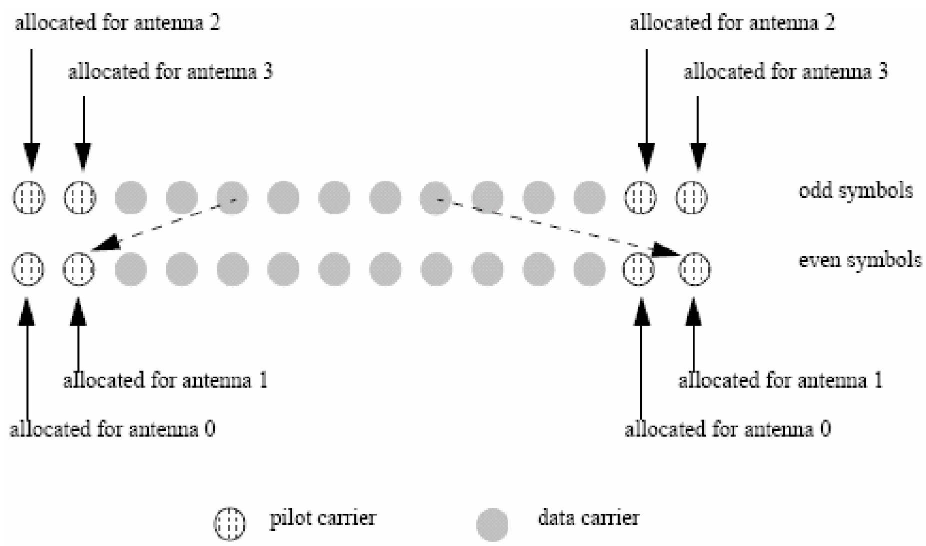

Figure-2 Cluster structure and pilots allocation in DL PUSC for 4 Tx antennas

According to figure-1 and figure-2, we can find the pilots spacing is 12 carriers for each antenna and inequation (1) is not satisfactory.Hence, we propose one improved pilot allocations for two and four antennas, respectively

For two antennas, pilot locations within the cluster shall be defined depending on the symbol index within each quartar of symbols, as following:

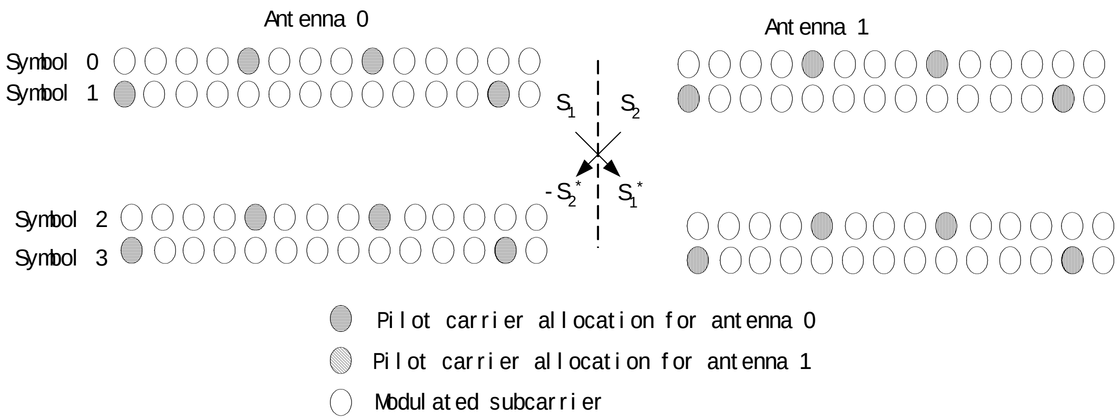

Figure-3: Proposed pilots scheme for STC two antenna systems

Here is a example:

Assuming both the pilots at the 4-th carrer during symbol 0 interval transmitted by antenna 0 and antenna 1 is P(according to 802.16-2004, P is a real number).

the transmission matrix of STC is

$$A = \begin{pmatrix} s_1 - s_2^* \\ s_2 \quad s_1^* \end{pmatrix} \qquad (3)$$

After the spacing time coding(STC), the pilot at the 4-th carrer during symbol 2 interval transmitted by antenna 0 is –P.The pilots at the 4-th carrer during symbol 2 interval transmitted by antenna 1 is P.

At the receiver, the received symbol R_0 during symbol 0 interval can be expressed as:

$$R_0 = P \times H_0 + P \times H_1 + N_0 \qquad (4)$$

the received symbol R_2 during symbol 2 interval can be expressed as:

$$R_2 = -P \times H_0 + P \times H_1 + N_2 \qquad (5)$$

where:

H_0 is the channel frequency response at the 4-th carrier between transmitter antenna 0 and receiver.

H_1 is the channel frequency response at the 4-th carrier between transmitter antenna 0 and receiver.

N_0 and N_1 is the noise.

The LS esstimate of H_0 and H_1 can be expressed as :

$$\hat{H}_0 = (R_0 - R_2)/2P = H_0 + (N_0 - N_1)/2P \qquad (6)$$

$$\hat{H}_1 = (R_0 + R_2)/2P = H_1 + (N_0 + N_1)/2P \qquad (7)$$

The scheme mentioned above can also be extended to four antennas. For four antennas, the carriers is allocated as following figured.It should be noted that he data subcarriers which overlap with pilots allocated to antennas 2,3 are punctured.

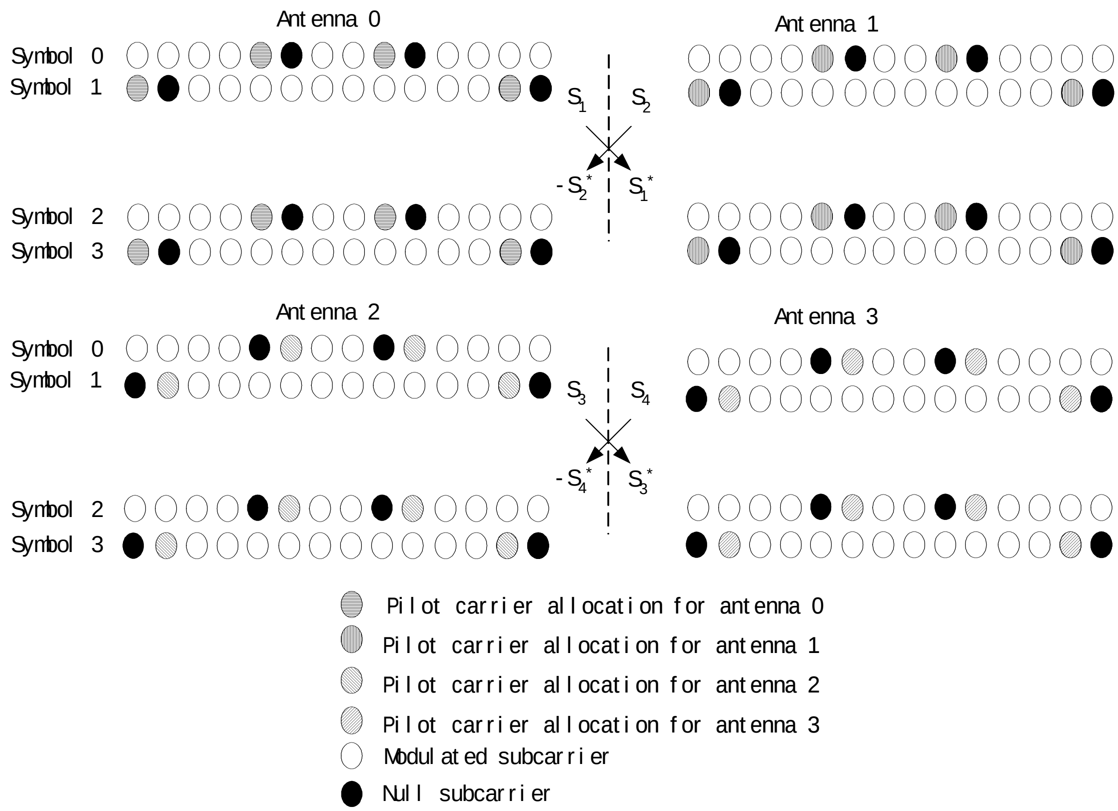

Figure-4: Proposed pilots scheme for STC four antenna systems

Commpared with the pilot allocation currently in 80216-2004, 3dB gain in SNR can be obtained based our proposal because pilots are encoded in our scheme. What is more, our scheme is compatible with non-STC mode. When we insert the pilot into the symbol, atfer STC, it can be convert the sign of pilot set automatically. For example, according to the above matrix of formula(3). Firstly, the antenna 0 and antenna 1 transmit pilot set P; secondly, antenna 0 transmits the pilot set –P and antenna 1 transmits the pilot set P, and the conversion can be realized automatic with STC. So, by the way can we improve the performance of channel estimation and realize the channel estimation more easy.

3 Specific text change

8.4.8.1.2.1.1 STC using 2 antennas in PUSC

Replace figure 245 with Figure-3.
Replace figure 246 with Figure-5.

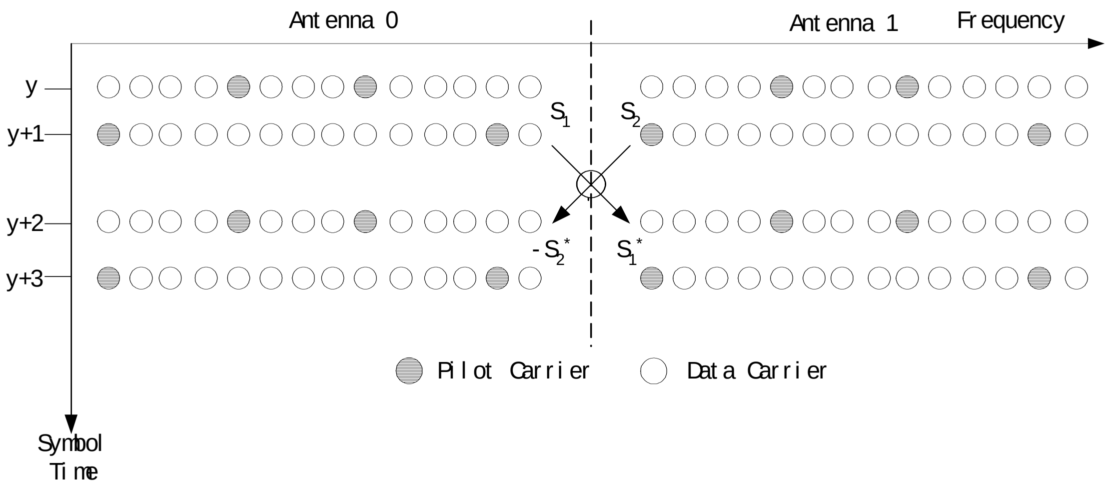

Figure-5: STC usage with PUSC

In PUSC the data allocation to cluster is as same as the one antenna transmission with the same estimation capabilities, each cluster shall be transmitted twice from each antenna.

The clusters composing the subchannels used by the STC mode shall be allocated and subcarriers numbered as defined in 8.4.6.2. The cluster structure of the subchannels allocated for STC is slightly modified to fit the STC requirements. The structure shall be modified as depicted in Figure 245 In this scheme, transmission on regular subchannels and STC subchannels is possible and is determined by the MAC layer (the allocation is performed by allocating major groups of subchannels for regular or STC transmission). The transmisstion of the data shall be performed in pairs of symbols as illustrated in Figure 246.

8.4.8.4.8.2.1 STC using 2 antennas in PUSC

Replace figure 251 with Figure-4.

For this configuration the basic cluster structure is changed as indicated in Figure 251 to accumudate the transmission from 4 antennas (pilots for antennas 2/3 override data subcarriers in the even symbols and odd symbols, erasing of the data subcarriers shall be performed after constellation mapping, therfore maintaining all the encoding scheme and the subchannel allocation scheme).