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Title	**Fix the problem of Pilot Allocation in Downlink PUSC and FUSC for 3Tx Antennas**
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Re:	Call for contribution and comments.
Abstract	Fix the problem of Pilot Allocation in Downlink PUSC and FUSC for 3Tx Antennas.
Purpose	Adoption
Notice	
Release	
Patent Policy and Procedures	

Fix the problem of Pilot Allocation in Downlink PUSC and FUSC for 3Tx Antennas

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1. Introduction

In IEEE P802.16e/D9, multiple antenna transmission is supported for 2Tx, 3Tx and 4Tx antennas. However, for the DL-PUSC and DL-FUSC STC mode, only the 2Tx and 4Tx pilot allocations are defined, while the 3Tx antennas pilot scheme is missing.

This contribution fills in the related missing parts in the IEEE P802.16e standard draft, by introducing the two transmission and pilot schemes for the 3Tx DL-PUSC STC and 3Tx DL-FUSC STC modes respectively.

2. Proposed pilot allocation schemes

a) pilot allocation in downlink PUSC

In PUSC mode, the proposed pilot allocation scheme is illustrated in Figure 1. In each symbol of a cluster, the 1st and 13th subcarriers are reserved for pilot subcarriers. The data subcarriers which overlap with the pilots are replaced with pilots, i.e. the 7th subcarriers in each symbol of a cluster are replaced with pilots. The pilot locations change in period of three symbols.

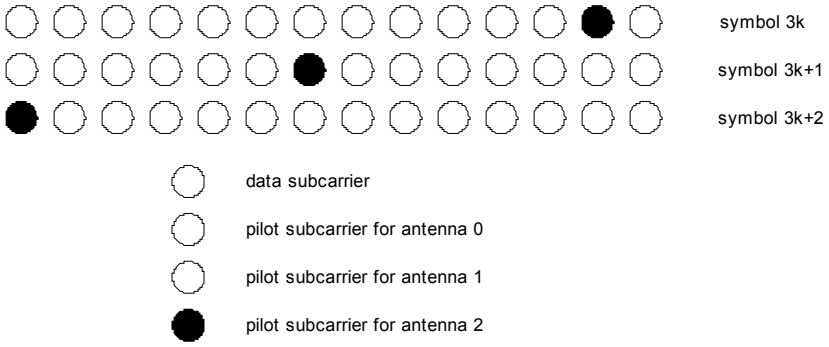

Fig.1 proposed pilot allocation scheme for 3Tx in PUSC

b) pilot allocation in downlink FUSC

Similar to the structures for two and four antenna cases in IEEE P802.16-2004/Cor1/D3, the pilots in FUSC shall be transmitted with a structure including three times symbols (repeating itself every three symbols) as follows:

Symbol 3k: antenna 0 uses VariableSet#0 and ConstantSet#0, antenna 1 uses VariableSet#1 and ConstantSet#1, antenna 2 uses (VariableSet#0+6) and (VariableSet#1+6).
Symbol 3k+1: antenna 0 uses (VariableSet#0+6) and (VariableSet#1+6), antenna 1 uses VariableSet#0 and ConstantSet#0, antenna 2 uses VariableSet#1 and ConstantSet#1.
Symbol 3k+2: antenna 0 uses VariableSet#1 and ConstantSet#1, antenna 1 uses (VariableSet#0+6) and (VariableSet#1+6), antenna 2 uses VariableSet#0 and ConstantSet#0.

Figure 2 shows the STC usage in FUSC mode. For this configuration, in each symbol, the pilot locations listed in Tables 311 of IEEE P802.16e/D9 are reserved for pilot subcarriers. The data subcarriers which overlap with the pilots shown in Fig.2 are replaced with pilots, i.e. the subcarriers defined in (VariableSet#0+6) and (VariableSet#1+6) in each symbols are replaced with pilots.

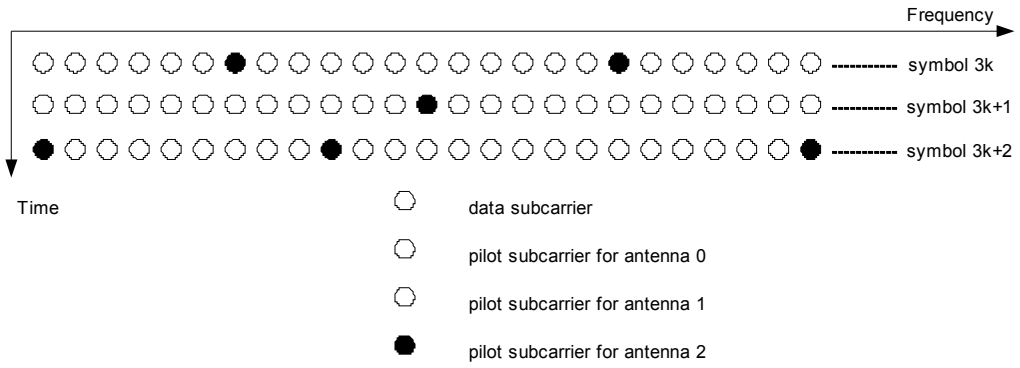

Fig.2 proposed STC usage with FUSC

3. Proposed Text Changes

[Insert a new section 8.4.8.2 in page436 line 31 and renumber all subsequent sections accordingly]

8.4.8.2 STC for three antennas

The STC schemes could be further enhanced by using three antennas at the transmission site.

8.4.8.2.1 STC for three antennas using PUSC

For this configuration, the basic cluster structure is changed (as indicated in Figure 251a) to accommodate the transmission from three antennas. In each symbol, 1st and 13th subcarriers in each cluster are the reserved pilot subcarriers. The data subcarriers which overlap with the pilots indicated in figured 251a are replaced with pilots, i.e. 7th subcarriers in each symbol of a cluster are replaced with pilots. The data puncturing for CC or the data truncation for CTC shall be performed after STC encoding and before IFFT subcarrier mapping.

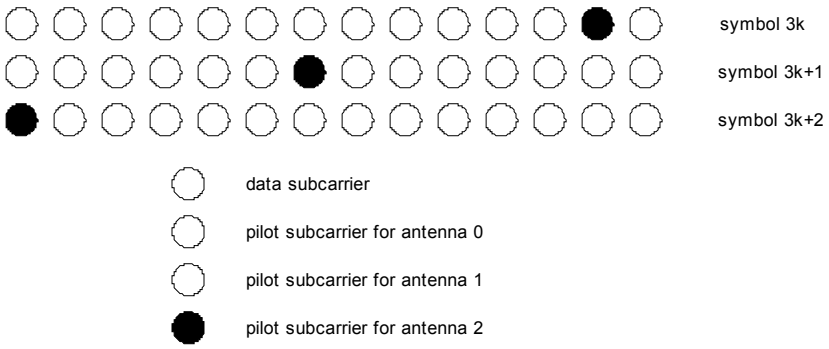

Figure 251a Cluster structure for STC PUSC using 3 Antennas

8.4.8.2.2 STC for three antennas using FUSC

For the FUSC configuration, the pilots embedded within the symbol shall be further divided. The pilots shall be transmitted with a structure including three times symbols (repeating itself every three symbols) as follows:

Symbol 3k: antenna 0 uses VariableSet#0 and ConstantSet#0, antenna 1 uses VariableSet#1 and ConstantSet#1, antenna 2 uses (VariableSet#0+6) and (VariableSet#1+6).
Symbol 3k+1: antenna 0 uses (VariableSet#0+6) and (VariableSet#1+6), antenna 1 uses VariableSet#0 and ConstantSet#0, antenna 2 uses VariableSet#1 and ConstantSet#1.
Symbol 3k+2: antenna 0 uses VariableSet#1 and ConstantSet#1, antenna 1 uses (VariableSet#0+6) and (VariableSet#1+6), antenna 2 uses VariableSet#0 and ConstantSet#0.

For this configuration, in each symbol, the pilots location listed in Table 311 are the reserved pilot subcarriers. The data subcarriers which overlap with the pilots indicated in figured 251b are replaced with pilots, i.e. the subcarriers (VariableSet#0+6) and (VariableSet#1+6) in each symbols are replaced with pilots. The data puncturing for CC or the data truncation for CTC shall be performed after STC encoding and before IFFT subcarrier mapping.

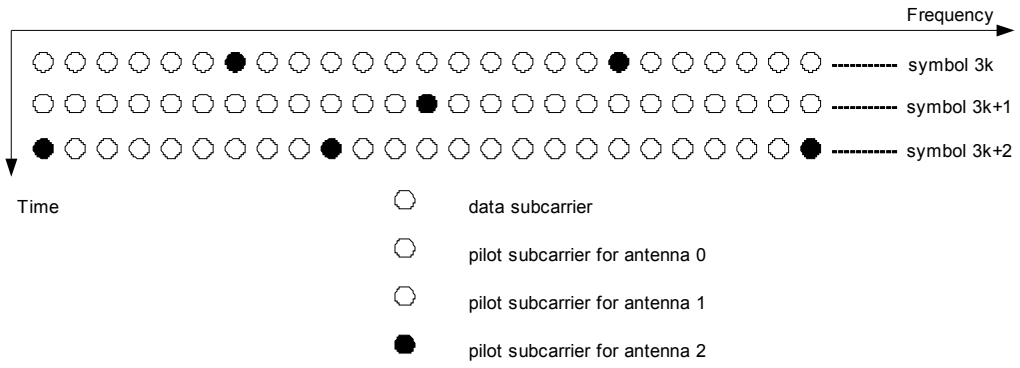

Figure 251b STC usage with FUSC

8.4.8.2.3 STC configurations

Several transmission formats are allowed for this configuration, each format has its own capacity/diversity

tradeoffs.

The following matrices define the transmission format with the row index indicating the antenna number and column index indicating the subchannel symbol time (2 symbols per entry), the entries defines the transmission from a subchannel used for this transmission configuration (the same operation is repeated for all subchannels used in this format).

STC for 3Tx-Rate 1, 2 and 3:

For three antenna BS, one of the three transmission matrices A, B, or C, shall be used:

Let the complex symbols to be transmitted be $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8$ which take values from a square QAM constellation. Let $s_i \quad x_i e^{j}$ for i=1, 2, … , 8, where $\tan^{1}(\frac{1}{3})$ and let

$\tilde{s}_1 \quad s_{1I} \quad js_{3Q}; \tilde{s}_2 \quad s_{2I} \quad js_{4Q}; \tilde{s}_3 \quad s_{3I} \quad js_{1Q}; \tilde{s}_4 \quad s_{4I} \quad js_{2Q}; \tilde{s}_5 \quad s_{5I} \quad js_{7Q}; \tilde{s}_6 \quad s_{6I} \quad js_{8Q};$
$\tilde{s}_7 \quad s_{7I} \quad js_{5Q}; \tilde{s}_8 \quad s_{8I} \quad js_{6Q}$ where $s_i \quad s_{iI} \quad js_{iQ}$

Transmission format A uses Matrix A (space time coding rate =1):

$$A \quad \begin{matrix} \tilde{s}_1 & \tilde{s}_2 & 0 & 0 \\ \tilde{s}_2 & \tilde{s}_1 & \tilde{s}_3 & \tilde{s}_4 \\ 0 & 0 & \tilde{s}_4 & \tilde{s}_3 \end{matrix}$$

Transmission format B uses Matrix B (space time coding rate =2):

$$B \quad \begin{matrix} \sqrt{\frac{3}{4}} & 0 & 0 & & & & \\ & & & \tilde{s}_1 & \tilde{s}_2 & \tilde{s}_5 & \tilde{s}_6 \\ 0 & \sqrt{\frac{3}{4}} & 0 & \tilde{s}_2 & \tilde{s}_1 & \tilde{s}_6 & \tilde{s}_5 \\ & & & \tilde{s}_7 & \tilde{s}_8 & \tilde{s}_3 & \tilde{s}_4 \\ 0 & 0 & \sqrt{\frac{3}{2}} & & & & \end{matrix}$$

Transmission format C uses Matrix C (space time coding rate =3):

$$C \quad \begin{matrix} s_1 \\ s_2 \\ s_3 \end{matrix}$$

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