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Re:	Sponsor re-circulation Ballot
Abstract	STC enhancements for the optional AMC and FUSC for the downlink
Purpose	Adoption of proposed changes into P802.16e
Notice	
Release	
Patent Policy and Procedures	

STC Enhancements for Optional FUSC and AMC Zones for OFDMA PHY Layer

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1 Introduction

This document describes the PHY enhancements to enable the space-time coding (STC) functionalities in the optional FUSC [1] and the optional adjacent subcarrier permutation (or AMC) [2] zones for OFDMA. The following features are proposed:

- Pilot and data allocation for 2 and 4-antenna BS in the optional FUSC and the optional AMC modes for the downlink (DL)
- Transmission schemes for open- and closed-loop STC with 2 and 4-antenna BS

2 Specific Text Changes

2.1. Pilots and Data Allocation for STC

[Add a new section 8.4.8.3]

[After implementing all the relevant comments and reply comments, the renumbering of the following sections and the page numbers will be coherent.]

8.4.8.3 STC using the optional FUSC and the optional adjacent-subcarrier permutation zones for DL

Two optional zones, the optional FUSC and the optional AMC zones, are described in 8.4.6.1.4 and 8.4.6.3, respectively. In both zones, pilot subcarriers are allocated first according to Table zzz in 8.4.6.1.4. The remaining subcarriers are used for data transmission.

8.4.8.3.1 Allocation of pilot subcarriers

For an STC-enabled BS with 2 or 4 antennas, pilot subcarriers are allocated to each antenna in one of the following two methods. The selection among these two methods shall be based on channel condition and indicated by the Pilot_tone_set bit in MIMO_DL_Basic/Enhanced_IE() in 8.4.5.3.8(9).

Method 1: use of disjoint pilot sets
Pilots are split into 2 or 4 disjoint sets. For 2-antenna BS, all pilots in the even symbols allocated for Ant 0 whereas all pilots in the odd symbols used for Ant 1. For 4-antenna BS, pilots in the even symbols are further split for Ant 0 and 1, while those in the odd symbols split for Ant 2 and 3. See Figure yyy-1.

Method 2: use of orthogonal sequence on pilots
Pilots are shared with 2 or 4 antennas to increase the granularity and their orthogonality is maintained by the simple block code as shown in Figure yyy-2.

8.4.8.3.2 Allocation of data subchannels

In the optional FUSC mode for STC capable BS, transmit diversity (TD) users shall be allocated for two or four consecutive symbols in a row and the rest of subchannels shall be assigned for non-TD or other STC users such as spatial multiplexing (SM) users.

In the optional AMC mode, each data subchannel consists of 6 contiguous bins in the same band, thereby having one of four combinations as defined in 8.4.6.3. For STC capable BS with two antennas, however, each TD user shall have 3x2 bin combination. For BS with four antennas, depending on the transmission encoding scheme, bin structure can be any of four combinations.

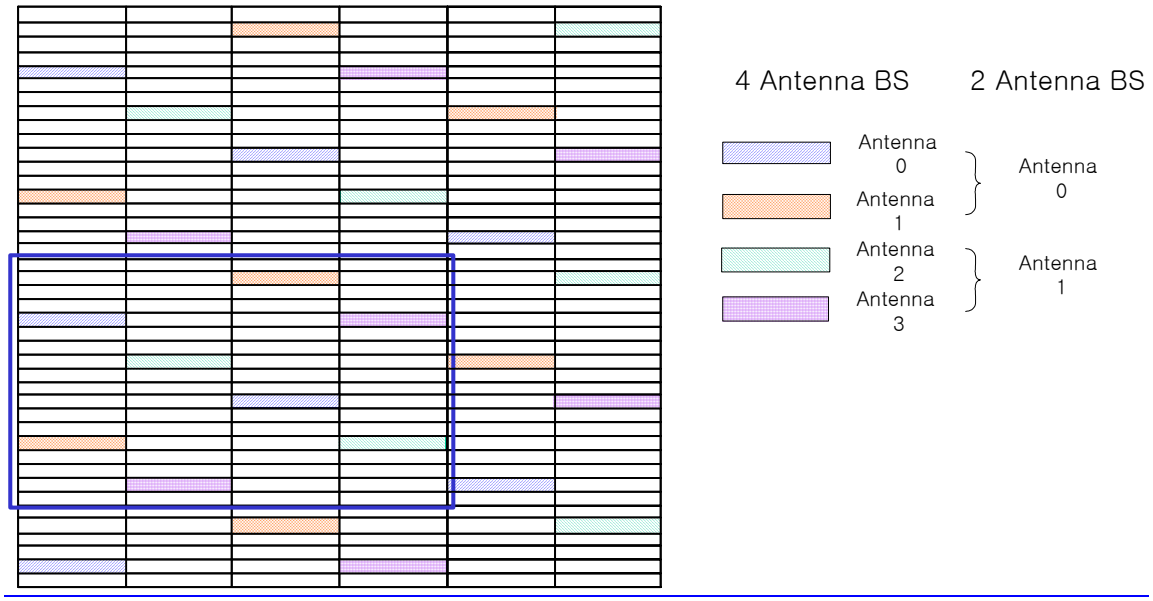

Figure yyy-1 Pilot allocation method #1

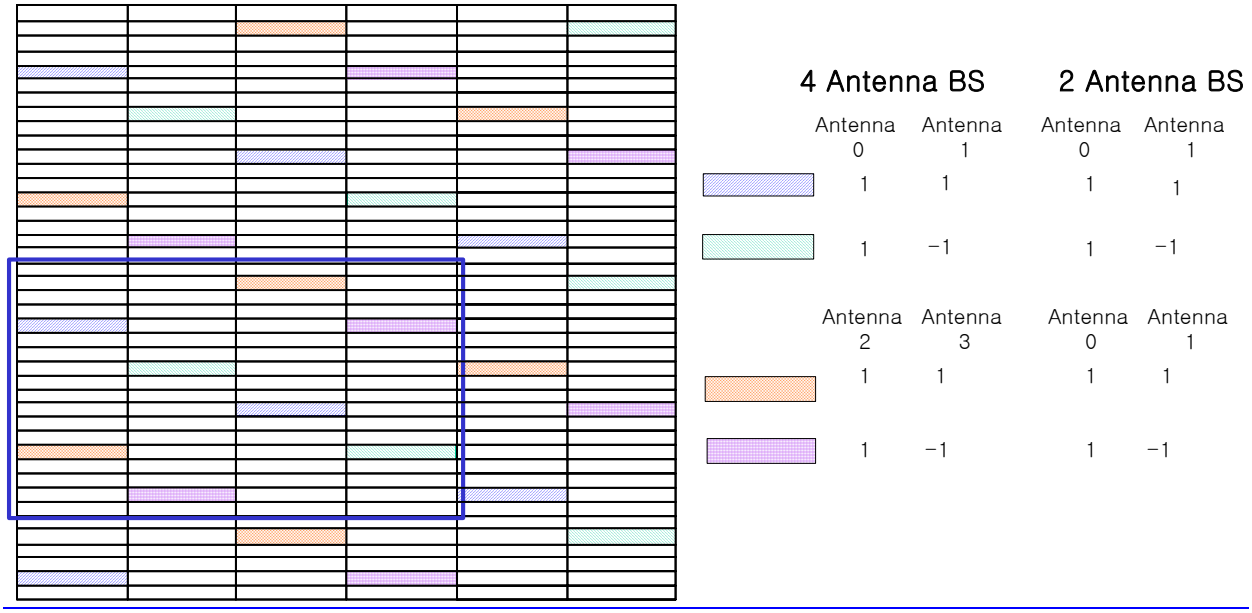

Figure yyy-2 Pilot allocation method #2

2.2. STC Transmission Schemes for 2-antenna BS

[Add a new section 8.4.8.3.3]

8.4.8.3.3 Transmission schemes for 2-antenna BS

8.4.8.3.3.1 Open loop encoding schemes for 2-antenna BS

Open-loop transmission encoding schemes for 2-antenna BS shall take one of the following two matrices:

$A = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}$ for TD users, $B = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$ for SM users. The necessary MAP information shall be transmitted by MIMO_DL_Basic_IE() in 8.4.5.3.8.

8.4.8.3.3.2 Closed-loop encoding schemes for 2-antenna BS

Closed-loop STC shall be enabled with Fast CQI Feedback and use MIMO_DL_Enhanced_IE(). In order to adapt channel variation for mobile SS, BS may issue multiple CQICHs to each MIMO SS. (see 8.4.5.4.10). The actual information contained in CQI can be any of the followings: the measured channel quality, the beamforming weight, or the suggested combination of MIMO mode and permutation by SS. (see 8.4.5.4.9.3). On receiving CQI from SS, BS shall decide the most appropriate transmission scheme, including transmit antenna array (TxAA) technique.

The encoding matrices are defined as follows:

$A = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$ for all permutation zones, where s1 and s2 may be encoded in different rates;

$B = \begin{bmatrix} 1 \\ w_1 \end{bmatrix} s$ for AMC permutation zone, where w_1 is the fed-back beam weight from CQICH.

2.3. STC Transmission Schemes for 4-antenna BS

[Add a new section 8.4.8.3.4]

8.4.8.3.4 Transmission schemes for 4-antenna BS

8.4.8.3.4.1 Open-loop encoding schemes for 4-antenna BS

Open-loop STC with 4 BS antennas shall take one from the following four transmission matrices:

$$A = \begin{bmatrix} s_1 & -s_2^* & 0 & 0 \\ s_2 & s_1^* & 0 & 0 \\ 0 & 0 & s_3 & -s_4^* \\ 0 & 0 & s_4 & s_3^* \end{bmatrix};$$

$$B = \begin{bmatrix} s_1 & -s_2^* & s_5 & -s_7^* \\ s_2 & s_1^* & s_6 & -s_8^* \\ s_3 & -s_4^* & s_7 & s_5^* \\ s_4 & s_3^* & s_8 & s_6^* \end{bmatrix};$$

and

$$C = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}$$;

8.4.8.3.4.2 Closed-loop encoding schemes for 4-antenna BS

The possible types of information contained in CQI includes the measured average channel quality, the channel vector itself, its covariance matrix $\mathbf{R_H}$, the beamforming weight vector **w**, or the suggested combination of MIMO mode and permutation by SS. On receiving CQI from SS, BS shall decide the most appropriate transmission scheme.

The encoding matrices are defined as follows:

$$A = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}$$ for all permutation zones, where each s_i may have different rates (SM);

$$B = \begin{bmatrix} 1 \\ w_1 \\ w_2 \\ w_3 \end{bmatrix} s$$ for AMC permutation zone only, where w_i are the fed-back beam weights from CQICH (TxAA);

$$C = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \\ s_3 & -s_4^* \\ s_4 & s_3^* \end{bmatrix}$$ for AMC permutation zone, where the rates of s_1 and s_2 are the same but may be different from that of s_3 and s_4 (Hybrid #1);

, and

$$D = \begin{bmatrix} s_1 \\ w_1 s_1 \\ s_2 \\ w_2 s_2 \end{bmatrix}$$ for AMC permutation zone only; where s_1 and s_2 may have different rates (Hybrid #2).

References:

[1] IEEE C802.16d-04/72 Panyuh Joo et al, “Additional optional symbol structure”

[2] IEEE P802.16-REVd/D5-2004 Air Interface For Fixed Broadband Wireless Access Systems