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Re:		
Abstract	MIMO Operation Scenario for OFDMA	
Purpose	Adoption of proposed changes into P802.16e	
	<del>Crossed-out indicates deleted text</del> , <u>underlined blue indicates new text change to the Standard</u>	
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# Clarification on STC Encoding for MIMO OFDMA

## 1. Introduction

This contribution is prepared to serve two purposes: To help the Editor to properly adopt the already accepted contribution to the current draft standard (editorial purpose), and to suggest some clarification on STC encoding for MIMO OFDMA system (technical purpose).

As for the editorial purpose, the main body of this document was accepted by WG at July meeting (C802.16e-04/159r2), but failed to be added to the draft standard. Then a comment was submitted to correct this at September meeting through Comment #882 and it was accepted, but again failed to be included in the current draft. The original text is reproduced here as the baseline document to help the Editor to reflect the necessary changes.

And for the technical purpose, the notion of subcarrier mapping for MIMO OFDMA is clarified and the various MIMO modes available at the current draft standard [1] are identified. In addition, data and pilot modulation and puncturing processes are described for each MIMO mode along with some text changes. Any new modification suggested at this document are indicated in the conventional way.

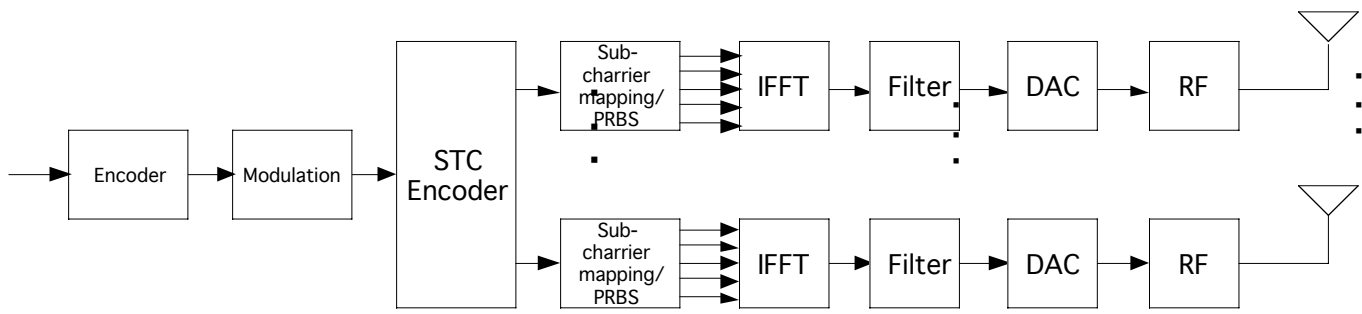
## 2. Clarification on STC Encoding for Optional Zones in DL

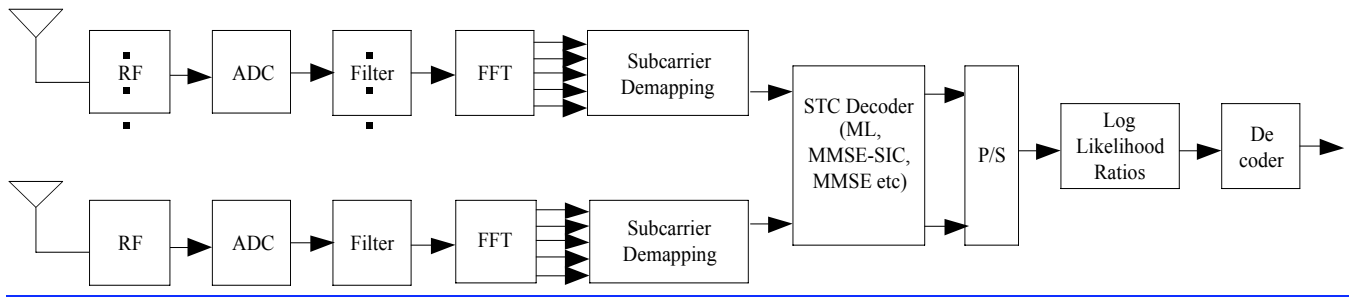
*[Replace the section 8.4.8.3 in page 236 of [1] as follows]*

### 8.4.8.3 STC for the optional zones in the downlink

Two optional zones for the downlink, the optional FUSC and the optional AMC zones, are described in 8.4.6.1.2.3 and 8.4.6.3 [2], respectively. STC may be used to improve system performance for these zones and an example of transmit diversity (TD) with  $2 \times$  multiple tx and  $1 \times$  multiple rx is shown in Figure aaa. Subcarrier mapping block in the figure denotes data truncation, if needed, pilot insertion and IFFT input packing.

*[Replace Figure 232 in page 236 of [1] with the following]*



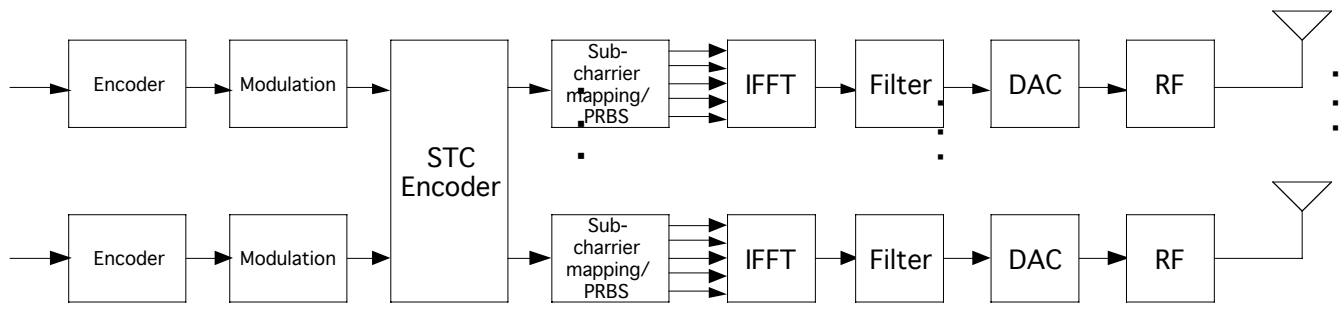


**Figure aaa Illustration of STC for optional zones in DL (Matrix A for 2,3,4 Tx and Matrix B for 3,4 Tx)**

In this Figure the STC encoder operates on input symbols sequentially and distributes the antenna specific symbols to each antenna path. The block of subcarrier mapping and PRBS function denotes data truncation or puncturing, if needed, pilot insertion, IFFT input packing and each subcarrier multiplied by the factor  $2 \cdot (1/2 - w_k)$  according to the subcarrier index  $k$  in 8.4.9.4.1. The data truncation for CTC or the puncturing for CC encoder shall be required for 3 Tx and 4 Tx BS.

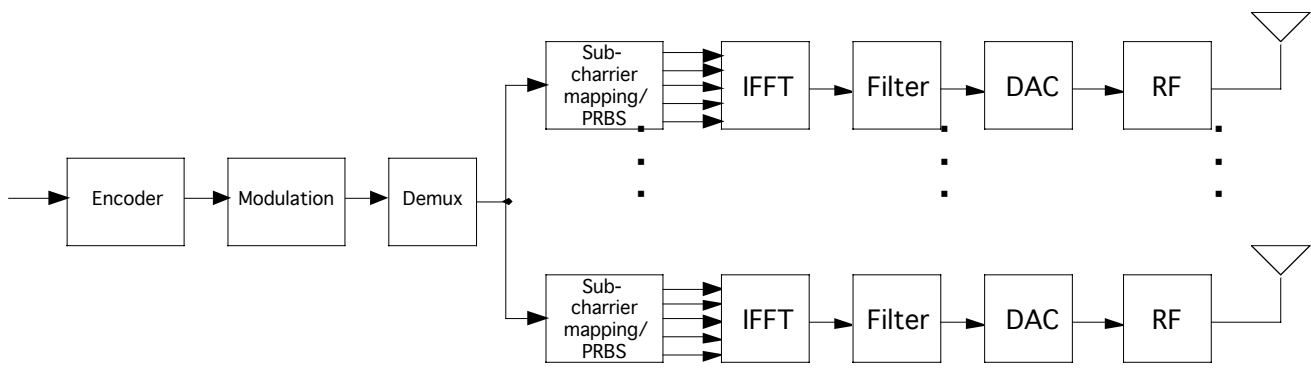
This Figure also represents the usage of matrix B with vertical encoding for 3 or 4 Tx BS.

For the usage of matrix B with horizontal encoding for 3 or 4 Tx BS, Figure bbb shall be applied.



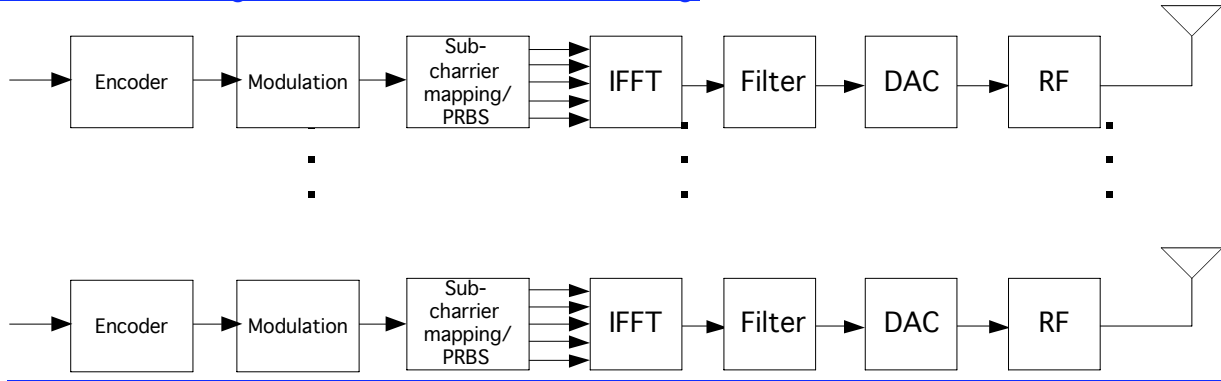
**Figure bbb - Illustration of Matrix B with Horizontal Encoding for 3 or 4 Tx BS for optional zones in DL**

Figure ccc illustrates the usage of matrix C with vertical encoding. The modulated symbols are distributed sequentially from the top to the bottom output paths



**Figure ccc - Illustration of Matrix C with Vertical Encoding for 2,3,4 Tx BS for optional zones in DL**

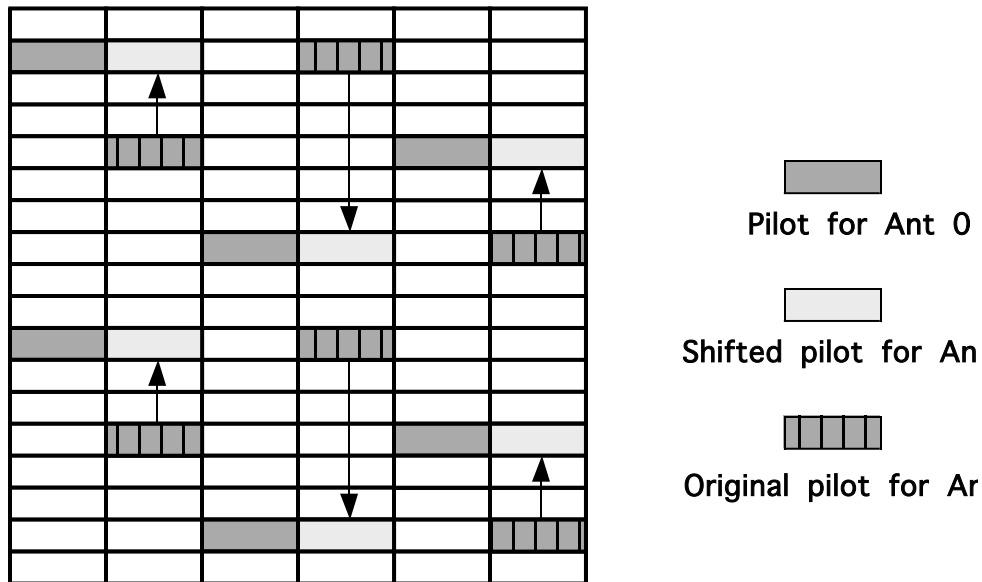
[Figure ddd illustrates the usage of matrix C with horizontal encoding.](#)



**Figure ccc - Illustration of Matrix C with Horizontal Encoding for 2,3,4 Tx BS for optional zones in DL**

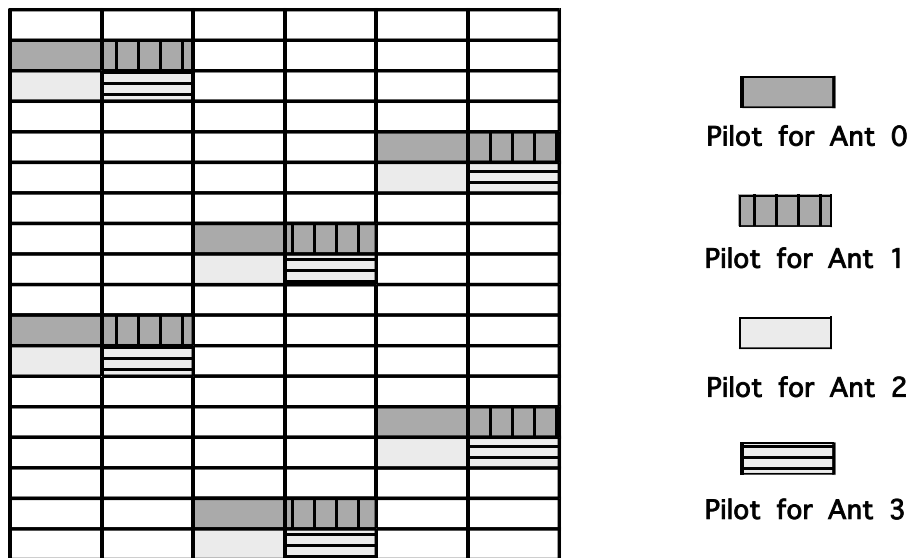
**8.4.8.3.1 Allocation of pilot subcarriers**

For 2-antenna BS, all pilots in the even symbols shall be allocated for antenna 0 whereas all pilots in the odd symbols shall be allocated for antenna 1. The positions of pilots in the odd symbols are further switched with those of data subcarriers whose locations coincide with pilots in the previous symbol. This is shown in Figure bbb.



**Figure bbb - Pilot allocation for 2-antenna BS for the optional FUSC and the optional AMC zones**

For BS with more than 2 antennas, pilot pattern shall first be changed as in the 2-antenna BS case, and then the neighboring two subcarriers shall be further allocated to pilots for other antennas. Figure ccc shows the pilot allocation scheme for 4-antenna BS.



**Figure ccc - Pilot allocation for 4-antenna BS for the optional FUSC and the optional AMC zones**

#### 8.4.8.3.2 Allocation of data subchannels

For transmit diversity (TD) mode with rate one, data subchannels shall be allocated as the following manner:

In the optional FUSC zone the data subchannels shall be allocated for two consecutive OFDMA symbols for 2 Tx using space-time block code (STBC). See 8.4.8.3.3. For 3 Tx and 4 Tx TD transmission mode, the data subchannel shall be allocated for two consecutive OFDMA symbols using two subcarriers. See 8.4.8.3.4 and 8.4.8.3.5.

In the optional AMC zone for 2-antenna TD transmission, the data subchannels shall be either 1x6 (1 bin for 6 symbols) or 3x2 (3 bins for 2 symbols) bin combination. For more than 2 antenna TD transmission, the data subchannels shall take 2x6 (2 bins for 6 symbols) format, in which 4 consecutive data symbols shall be frequency-time mapped using 2 adjacent subcarriers for 2 OFDMA symbols. When the subcarrier pair (over two symbols) at frequency  $k+1$  is allocated to pilots, then the pair at frequency  $k+3$  shall be jointly encoded with the pair at frequency  $k$ . See 8.4.8.3.4 and 8.4.8.3.5.

#### 8.4.8.4 STC for the optional zones in the uplink

Two optional zones in the uplink, the optional PUSC and the optional AMC zones, are described in 8.4.6.2.5 and 8.4.6.3[2], respectively. STC may be used to improve system performance for these zones. Furthermore, two single transmit antenna SS's can perform collaborative spatial multiplexing onto the same subcarrier.

##### 8.4.8.4.1 Allocation of pilot subcarriers

For 2-antenna SS and the optional PUSC, pilots for each antenna shall be allocated as shown in Figure ddd.

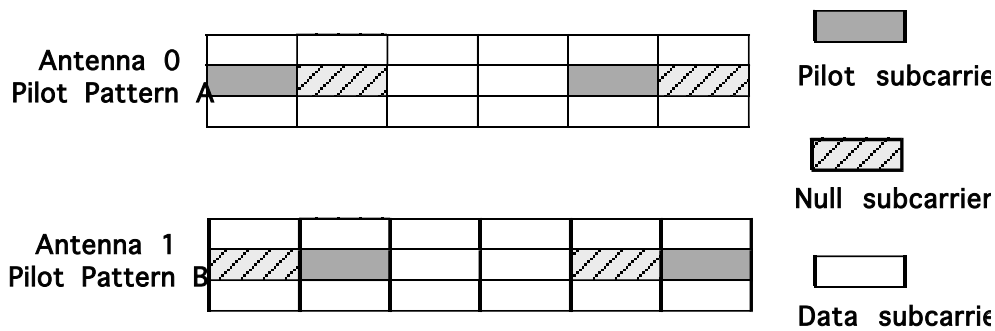


Figure ddd - Uplink pilot allocation for 2-antenna SS for the optional PUSC zones

For 2-antenna SS and the optional AMC, all pilots in the 1<sup>st</sup>, 5<sup>th</sup> symbols shall be allocated for antenna 0, while pilots in the 2<sup>nd</sup> and 6<sup>th</sup> symbols shall be allocated for antenna 1. This is shown in Figure eee.

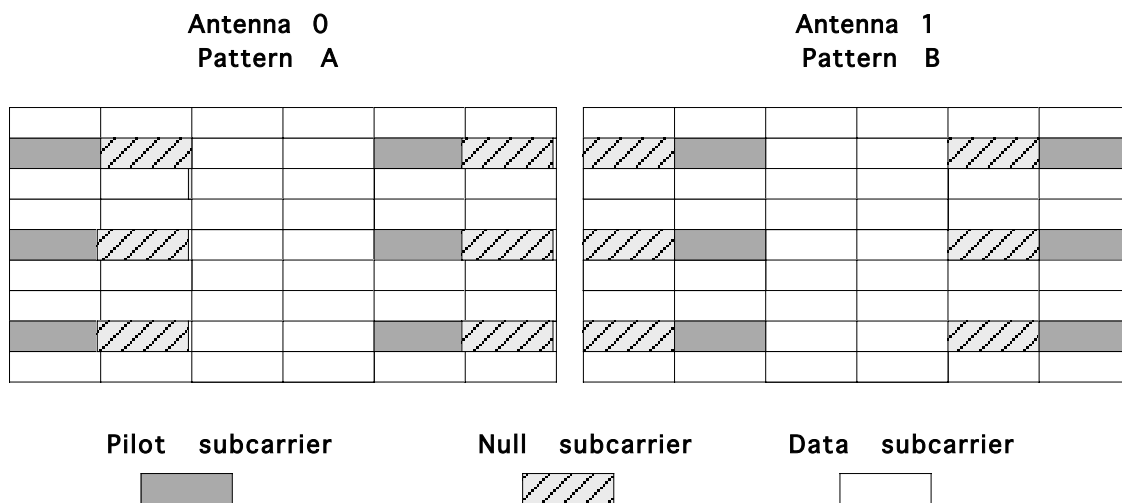


Figure eee - Uplink pilot allocation for 2-antenna SS for the optional AMC zones

Two single transmit antenna MSSs can perform collaborative spatial multiplexing onto the same subcarrier. In this case, one MSS should use uplink pilot allocation with pattern-A, and the other MSS should use the uplink pilot allocation with pattern-B.

#### 8.4.8.4.2 Allocation of data subchannels

In the uplink optional PUSC zone with transmit diversity (TD) mode, the data subchannels shall be allocated for mini subchannel (type 01) as shown in Figure eeeddd. For the optional AMC zone with TD mode, the data subchannels shall take 1x6 (1 bin in 6 symbols) format.

### References:

[1] IEEE P802.16e/D5 Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Amendment for Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands

2004-11-04

IEEE C802.16e-04/558

[2] IEEE P802.16-REVd/D5-2004 Draft IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems

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