Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Clarification on STC Encoding for MIMO OFDMA**
Date Submitted	**2004-11-18**
Source(s)	Wonil Roh, JeongTae Oh, Chan-Byoung Chae, Kyunbyoung Ko, Hongsil Jeong, Sung-Ryul Yun, Seungjoo Maeng, Jaeho Jeon, Jaeyeol Kim, Soonyoung Yoon　　wonil.roh@samsung.com Voice: +82-31-279-3868 **Samsung Electronics Co., Ltd.** Young-Ho Jung, Seung Hoon Nam , Jaehak Chung, Yungsoo Kim, Sung-Jin Kim, Hojin Kim **Samsung Advanced Institute of Technology**
Re:	
Abstract	Clarification on STC Encoding for MIMO OFDMA
Purpose	Adoption of proposed changes into P802.16e Crossed-out indicates deleted text, underlined blue indicates new text change to the Standard
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org > as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

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~~multiple tx and ~~1~~multiple rx is shown in Figure 251a. ~~Subcarrier mapping block in the figure denotes data truncation , if needed, pilot insertion and IFFT input packing.~~

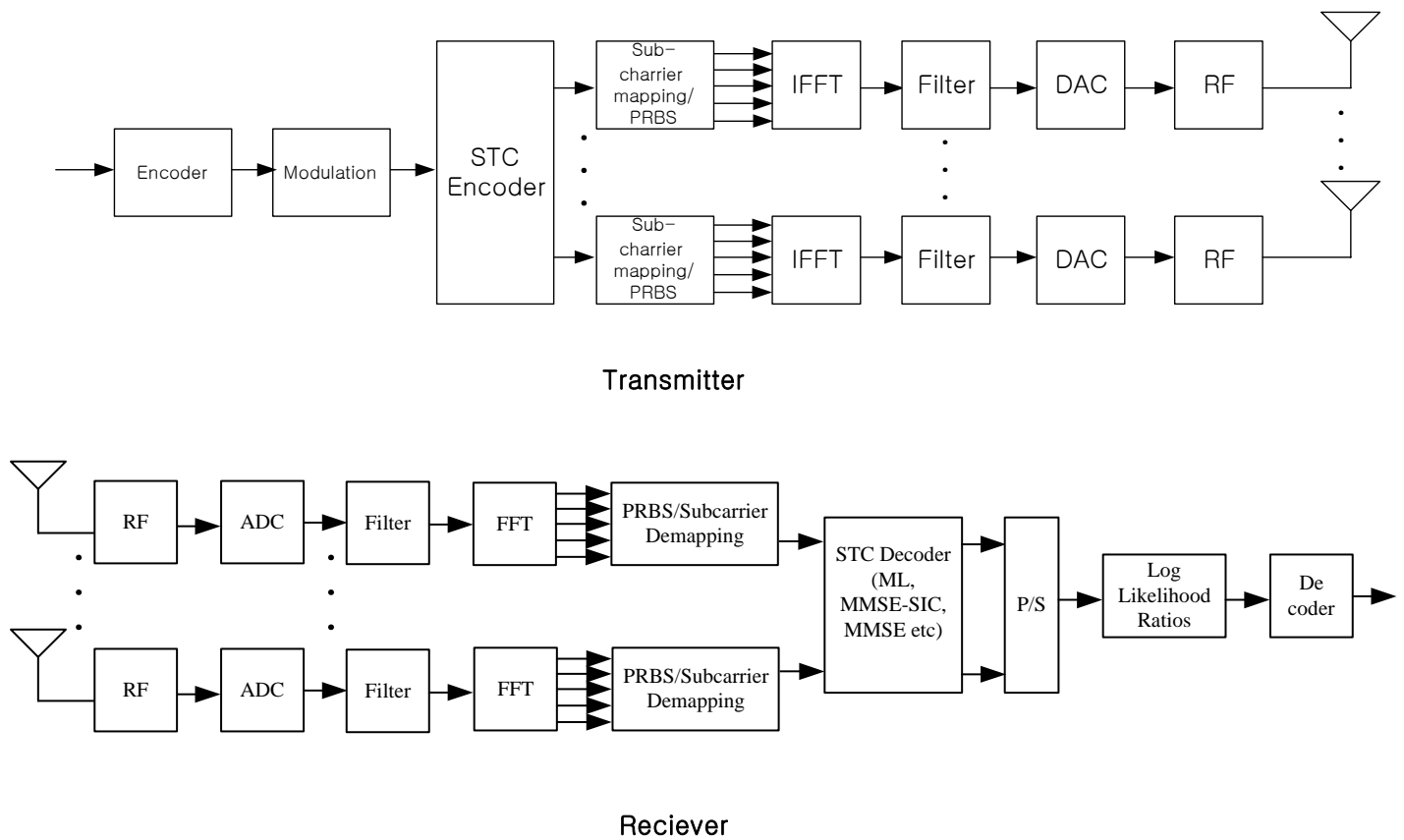*[Replace Figure 232 in page 236 of [1] with the following]*

Transmitter

Reciever

Figure 251a 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 251a 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 $2*(1/2-w_k)$ 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 251a 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, an exemplary figure is shown in Figure 251b.
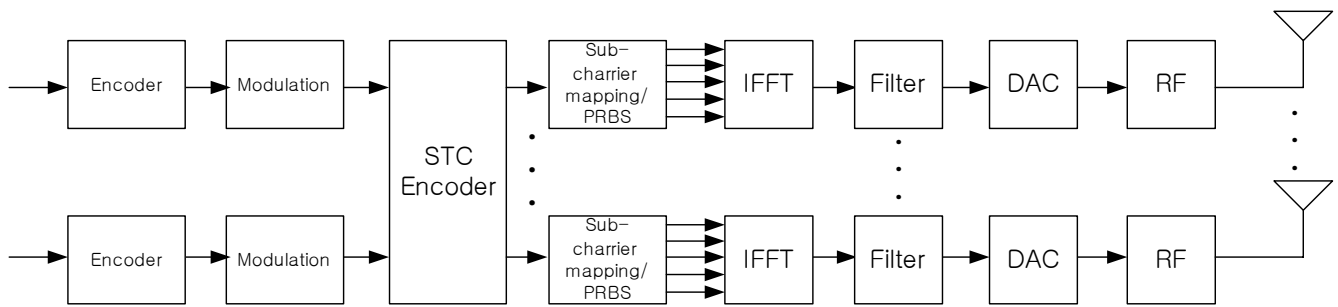

Figure 251b – Example Embodiment of Matrix B with Horizontal Encoding for 3 or 4 Tx BS for optional zones in DL

Figure 251c illustrates the usage of matrix C with vertical encoding. The modulated symbols are distributed sequentially from the top to the bottom output paths
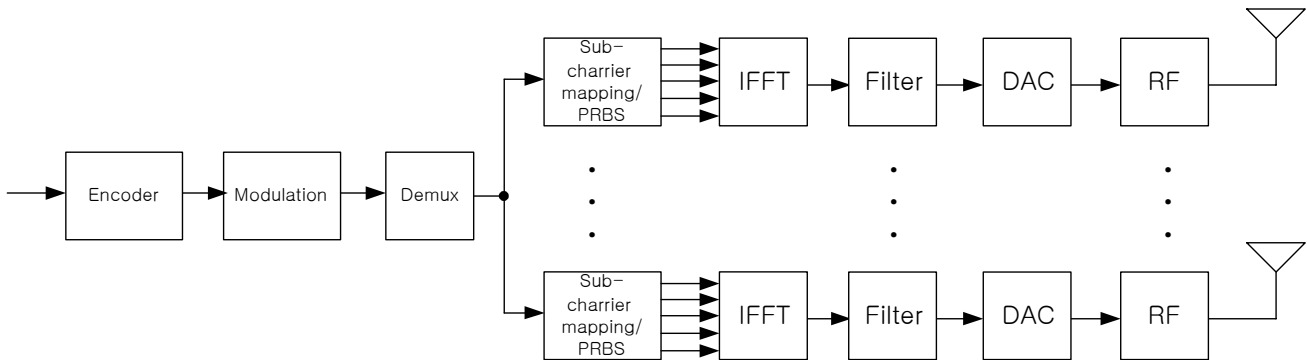

Figure 251c - Illustration of Matrix C with Vertical Encoding for 2,3,4 Tx BS for optional zones in DL

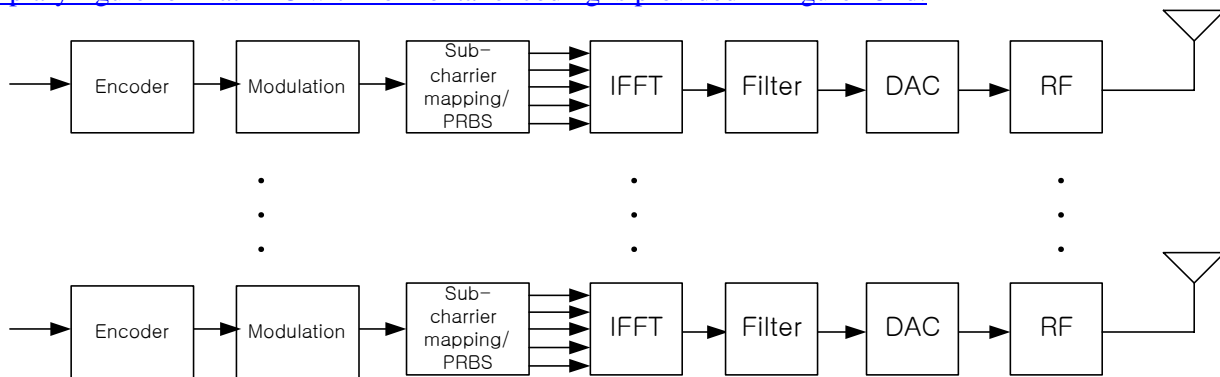An exemplary figure for matrix C with horizontal encoding is provided in Figure 251d.

Figure 251d - Example Embodiment 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.
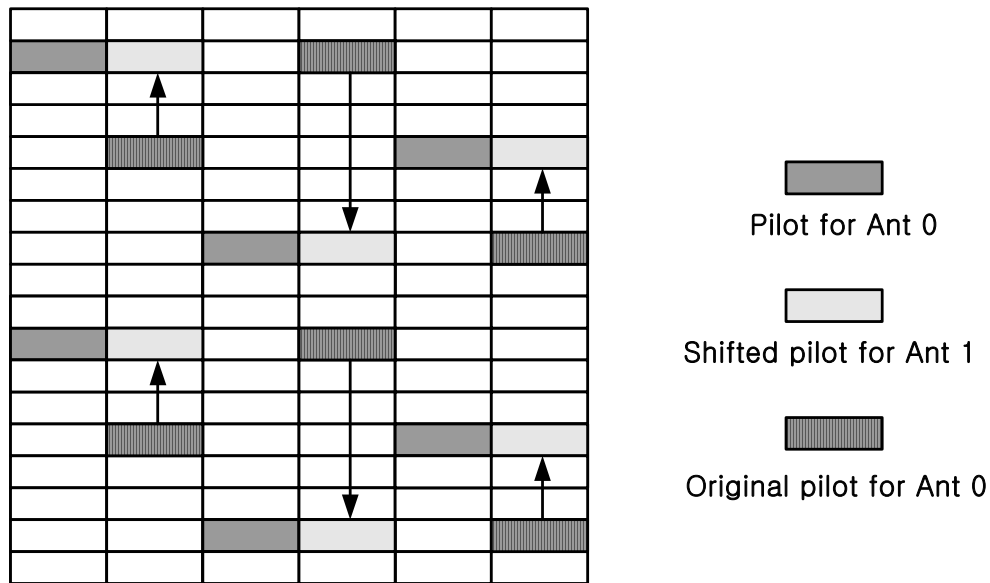
Figure bbb - Pilot allocation for 2-antenna BS for the optional FUSC and the optional AMC zones

For 4-antenna BS, pilot pattern shall first be changed as in the 2-antenna BS case, and then the neighboring two subcarriers shall be further punctured for antenna 2 and 3 as shown in the figure ccc.
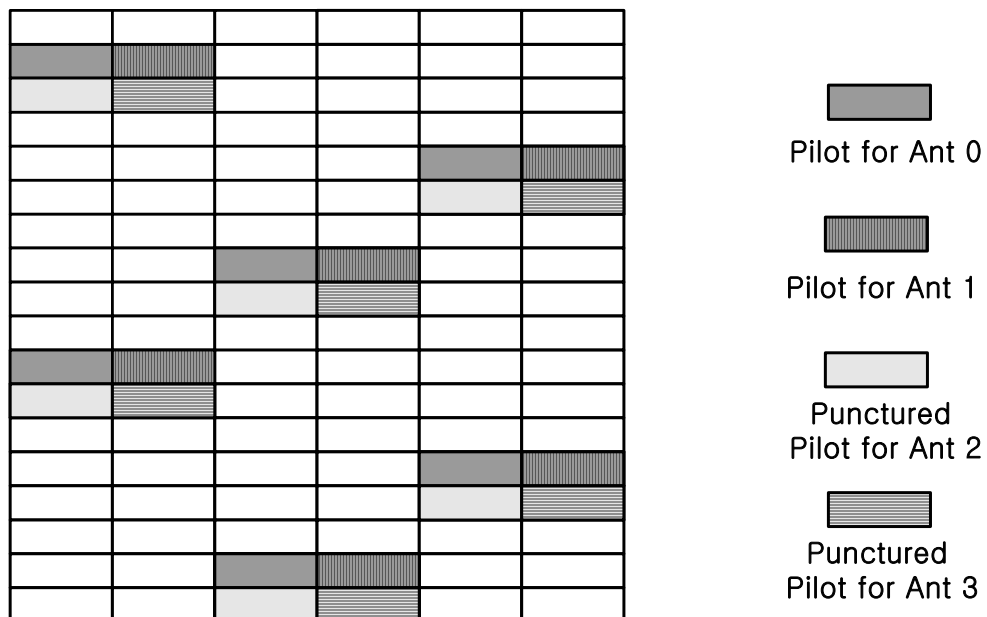

Figure ccc - Pilot allocation for 4-antenna BS for the optional FUSC and the optional AMC zones

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

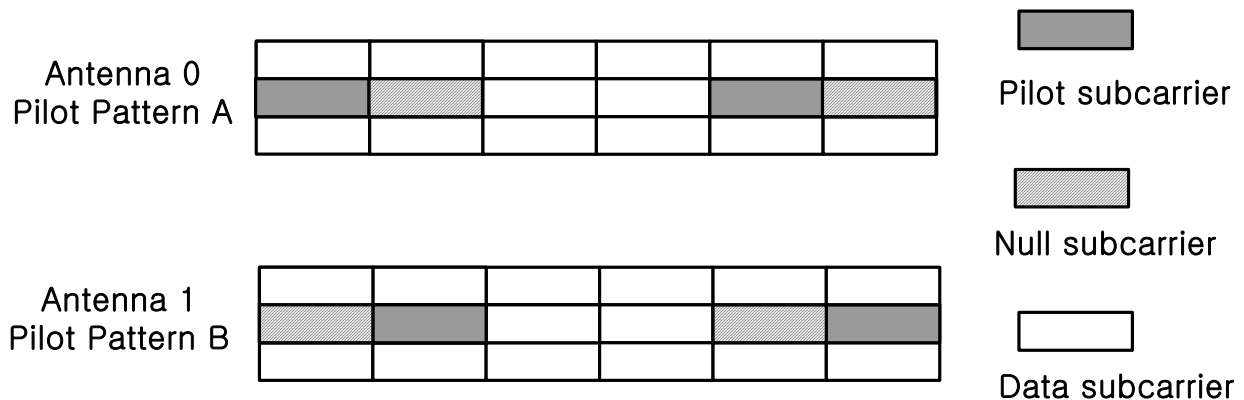For 2-antenna SS and the optional PUSC, pilots for each antenna shall be allocated as shown in Figure 251h.

Figure 251h - Uplink pilot allocation for 2-antenna SS for the optional PUSC zones

For 2-antenna SS and the optional AMC, all pilots in the 1st, 5th symbols shall be allocated for antenna 0, while pilots in the 2nd and 6th symbols shall be allocated for antenna 1. This is shown in Figure 251i.
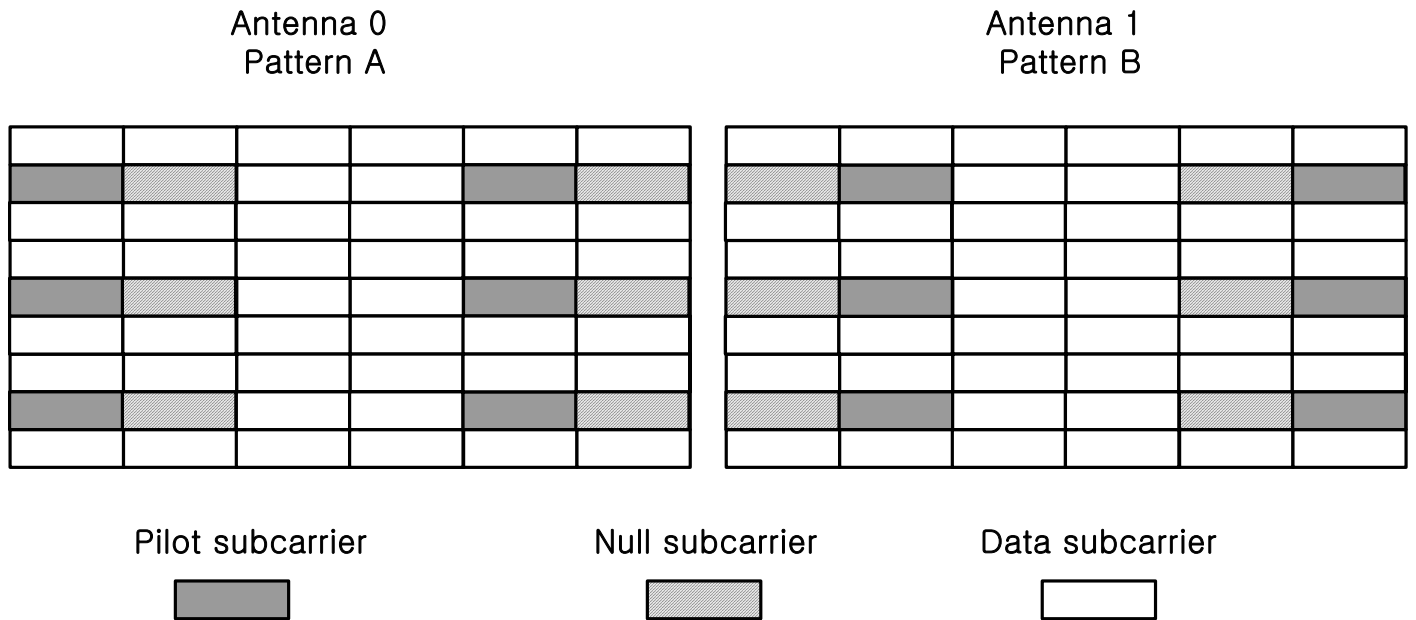
Antenna 0
Pattern A

Antenna 1
Pattern B

Pilot subcarrier   Null subcarrier   Data subcarrier

Figure 251i - 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 251h. 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

[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

,