Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Corrections to definitions of Uplink MIMO in OFDMA PHY**
Date Submitted	**2005-01-13**

Source(s)	Ran Yaniv, Tal Kaitz, Naftali Chayat, Vladimir Yanover, Danny Stopler **Alvarion Ltd.**	danny.stopler@alvarion.com ran.yaniv@alvarion.com tal.kaitz@alvarion.com

Re:	Call for comments, maintenance task group
Abstract	
Purpose	
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 <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of 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:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Corrections to definitions of Uplink MIMO in OFDMA PHY

Ran Yaniv, Tal Kaitz, Naftali Chayat, Vladimir Yanover, Vladimir Yanover, Danny Stopler

Alvarion Ltd.

1 Problem Statement

Several inconsistencies and ambiguities exist in the definitions of uplink MIMO in 802.16REVd/D5, specifically:

1. The data-subcarrier mapping scheme for UL STTD is not defined (8.4.8.1.5). Note that encoding subcarrier pairs across multiple tiles is not possible due to the existence of the subchannel rotation scheme.

2. MIMO_UL_Basic_IE (8.4.5.4.11) is ambiguous and can be interpreted in many different ways .

    a. *Duration* is specified for each burst in the IE. It is unclear how an SS should sum over semi-overlapping durations when computing slot offset. To interpret the duration correctly an SS should understand the MIMO_Control field for other SS's. However since the interpretation of the MIMO_Control field depends of the other SS capabilities (e.g. with one antenna it implies collaborative mimo, while with two antennas t implies either STTD or SM), that is not possible in general.
    b. The MIMO_Control field is defined differently for a 'dual transmission capable' SS and for a 'Collaborative SM capable SS'. It is not clear what an SS that supports both schemes should use.

3.

4. Pilot boosting level for UL PUSC in SM and collaborative SM modes: a boost of 3dB per pilot is warranted since each power amplifier (antenna) transmits only half of the pilots in each symbol. This is not noted in the original text.

5. Definition of uplink MIMO capability negotiation is missing.

2 Detailed Text Changes

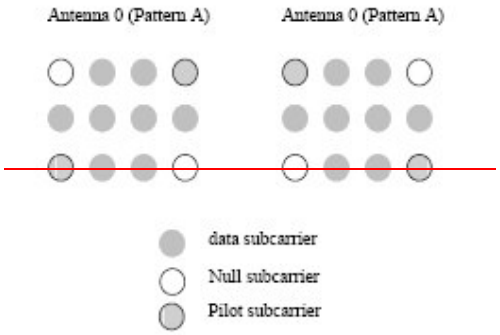
1. Correct section 8.4.8.1.5: provide missing definition of STTD mode, define data subcarrier mapping in STTD mode.

[Modify section 8.4.8.1.5 as follows]

-------- BEGIN --------

8.4.8.1.5 Uplink using STC

A user supporting transmission using STC configuration in the uplink, shall use a modified uplink tile~~.~~, 2-transmit diversity (‘STTD mode’) data or 2-transmit spatial multiplexing (‘SM mode’) data can be mapped onto each subcarrier~~.~~. The mandatory tile shall be modified to ~~accumudate~~ accommodate those configurations. ~~Figure 249 depicts the UL tile for STC transmission.~~



~~Figure 249 – UL STC tile~~

In STTD mode, the tiles shall be allocated to subchannels and the data subcarriers enumerated as defined in 8.4.6.2. The pilots in each tile shall be split between the two antennas and the data subcarriers shall be encoded in pairs after constellation mapping, as depicted in figure 249. The data subcarriers transmitted from Antenna #0 follow the original mapping defined in 8.4.6.2.

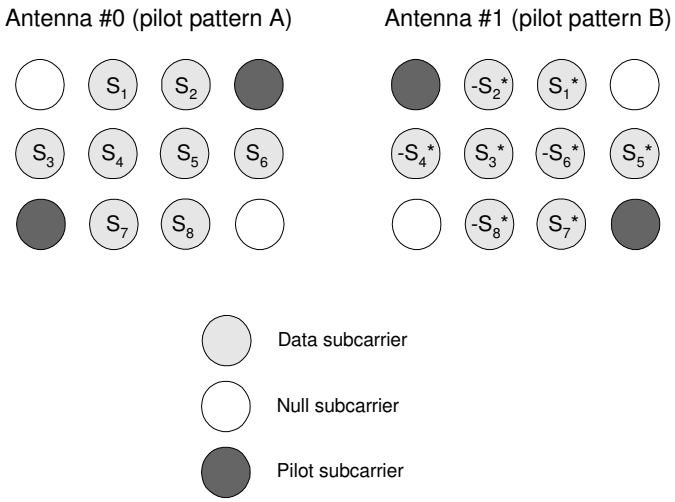


Figure 249 – Mapping of data subcarriers in STTD mode.

Two single transmit antenna SS's can perform collaborative spatial multiplexing onto the same subcarrier. In this case, ~~the~~ one SS shall ~~should~~ use the uplink tile with pilot-pattern A, and the other SS shall ~~should~~ use the uplink tile with pilot-pattern B. The pilot patterns are depicted in figure 249. Transmit data shall be coded, interleaved, modulated and mapped to time / frequency as in the non-MIMO case.

A single user having two antennas can do UL spatial multiplexing either using horizontal coding or vertical coding. For horizontal coding two bursts are first individually modulated, and then transmitted one per antenna (first burst on antenna 0, the second burst on antenna 1). For vertical coding a single burst is modulated and then transmitted according to the mapping order defined in 8.4.3.4 with the modification that on each subchannel, 2 consecutive slots are mapped instead of a single slot. The first slot of each slot pair is transmitted using antenna #0, while the second slot is transmitted using antenna #1.

To do spatial multiplexing with either vertical or horizontal coding a subscriber needs to signal both its antennas. In order to signal both antennas the subscriber uses both pilot patterns A and B. Antenna 0 will be signaled using pattern A and antenna 1 using pattern B. For non-MIMO transmissions, only antenna 0 shall be used.

-------- END --------

2. Section 8.4.5.4.11: Clarify text and role of MIMO_UL_Basic_IE():

[Modify section 8.4.5.4.11 as follows]

-------- BEGIN --------

8.4.5.4.11 MIMO UL Basic IE format

In the UL-MAP, a MIMO-enabled BS may transmit UIUC=15 with the MIMO_UL_Basic_IE() to indicate the MIMO mode of the ~~subsequent~~ uplink allocations described in this IE ~~to a specific MIMO-enabled SS CID~~. The MIMO mode indicated in the MIMO_UL_Basic_IE() shall only apply to the ~~subsequent~~ uplink allocations within the MIMO_UL_Basic_IE() ~~until the end of frame~~. This IE may be used either for MIMO enabled SS or for SS that support only collaborative SM. The IE may also be used to assign allocations in AAS zones to AAS-enabled SSs that are capable of collaborative SM.

Table 297—MIMO UL basic IE format

Syntax	Size	Notes
MIMO_UL_Basic_IE() {		
Extended UIUC	4 bits	MIMO = 0x02
Length	4 bits	~~Length of the message in bytes (variable)~~
Num_Assign	4 bits	Number of burst assignment
For (j=0; j<Num_assign; j++) {		
Collaborative_SM_Indication	1 bit	0: Non collaborative SM (Vertical coding assignment to a dualtransmission capable SS) 1: Collaborative SM (assignment to 2 collaborative SM capable SSs) or Horizontal coding assignment for one SS
If (**Collaborative_SM_Indication** == 0)		
{		
CID	16 bits	SS basic CID
UIUC	4 bits	
MIMO_Control	1 bit	For dual transmission capable SS 0: STTD 1: SM ~~For Collaborative SM capable SS~~ ~~0: pilot pattern A~~ ~~1: pilot pattern B~~
} else {		
CID_A	16 bits	Basic CID of SS that shall use pilot patternA
UIUC_A	4 bits	UIUC used for the allocation that uses pilot pattern A
CID_B	16 bits	Basic CID of SS that shall use pilot patternB. This field shall be identical to CID_A in the case of horizontal coding to same SS.
UIUC_B	4 bits	UIUC used for the allocation that uses pilot pattern B
Padding	1 bits	Shall be set to zero
}		

Duration	10 bits	In OFDMA slots (see 8.4.3.1)
}		
If !Byte Boundary {		
Padding	4 bits	Shall be set to zero
}		
}		

Num_assign
This field specifies the number of assignments in this IE.

MIMO_Control
MIMO_Control field specifies the MIMO mode of the corresponding UL bursts.

The following table specifies the different MIMO uplink operation modes. Note a subscriber that has full UL MIMO capabilities may either do spatial multiplexing or STTD, or collaborative MIMO according to BS request. The BS may request such an SS to do collaborative mimo while using its CID for both CID_A and CID_B. This case corresponds to spatial multiplexing with horizontal coding, while the former spatial multiplexing uses vertical coding.

The following table summarizes the modes of operation specified by MIMO_UL_Basic_IE(). For each it details: the number of antennas; the values of Collaborative_SM_indication and MIMO_control; the number of different CID's stated in the appropriate case of the "if" statement; the implicit type and rate of coding.

Mode	Number of Antennas per SS	**Collaborative_ SM_Indication**	**MIMO_control**	CIDs	Coding Type	Rate	Remark
Collaborative MIMO, 2 SSs	1	1	N.A.	CID_A != CID_B	Two SS, each transmits from his antenna 0	1 per SS	
Spatial Multiplexing, Horizontal coding	2	1	N.A.	CID_A = CID_B	SM with Horizontal coding for Single user	2	Two overlapping bursts
Spatial Multiplexing, Vertical coding	2	0	1	Single CID	SM with Vertical coding for Single user	2	
STTD	2	0	0	Single CID	Alamouti	1	

Vertical coding – Indicates transmitting the same coded stream over multiple antennas.
Horizontal coding – Indicates transmitting a different coded stream per antenna.
Rate – The number of qam symbols signaled per array channel use.

-------- END --------

[Modify section 8.4.9.4.3, page 621 lines 1-3]

-------- BEGIN --------

In the downlink, and for the optional uplink tile structure each pilot shall be transmitted with a boosting of 2.5 dB over the average power of each data tone. For the mandatory uplink tile structure in SM and collaborative SM modes, each pilot shall be transmitted with a boosting of 3dB over the average power of each data tone. The Pilot subcarriers shall be modulated according to the following formula:

-------- END --------

3. Add section 11.8.3.7.7: define uplink MIMO capability negotiation.

[Add new section 11.8.3.7.7]

-------- BEGIN --------

11.8.3.7.7 OFDMA SS MIMO uplink support

This field indicates the different MIMO options supported by a WirelessMAN-OFDMA PHY SS in the uplink. This field is not used for other PHY specifications. A bit value of 0 indicates "not supported" while 1 indicates "supported."

Type	Length	Value	Scope
155	1	Bit #0: 2-antenna STTD Bit #1: 2-antenna SM with vertical coding Bit #2: 2-antenna SM with horizontal coding Bit #3: single-antenna cooperative SM Bit #3-#7: *reserved*	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

-------- END --------