Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**SDMA support in AAS mode for OFDMA PHY**
Date Submitted	**2005-01-10**
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Re:	IEEE P802.16e/D5a BRC
Abstract	
Purpose	
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SDMA support in AAS mode for OFDMA PHY

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1 Introduction

In this contribution we correct important parts in the support of SDMA ('space division multiple access') under AAS mode.

The two missing features that this contribution adds to the standard are:

- The ability to share beamformed pilots between users with overlapping allocations, thus enabling an MSS to estimate its own beamformed channel.
- A low overhead mechanism for specifying overlapping allocations with separate pilots and preambles per user.

In SDMA operation under AAS mode, mobile needs to estimate his equivalent channel that stems from the beamforming weights at the BS and its own channel. The standard currently allocates the same pilot sequence for all overlapping mobiles, which enables only poor channel estimation quality in general.

Additionally, granting a data region to multiple MSSs is currently done by transmission of several IEs, which is relatively wasteful. Also, assignment of a different preamble modifier (if desired) for each user is not clearly defined; the only currently available method is to use separate DL-MAP_IEs with intervening PHY_MOD_IEs for specifying a different preamble per each user. This incurs quite a large management overhead.

The solution proposed in this contribution enables low overhead management by defining a single IE that supports overlapping allocations within data regions. This IE properly assigns pilot patterns and if preferred - preamble modifiers as well.

2 Proposed solution

The proposed solution for providing SDMA in AAS mode consists of the following definitions:

1. Pilot patterns for SDMA of 2 to 4 users over the AMC and PUSC-ASCA permutations in AAS mode.

2. A new map IE for specifying overlapping AAS allocations with different pilot patterns.

3 Detailed text changes

1. Add the following subsection

8.4.5.3.20 AAS SDMA Downlink IE

In the DL-MAP, an AAS-enabled BS may transmit DIUC=15 with the AAS_SDMA_DL_IE() to describe multiple downlink allocations assigned to AAS-enabled MSSs. Each allocation is assigned a pilot pattern and possibly a preamble shift index. An MSS is only required to decode the first allocation assigned to it in each region.

Table XXX – AAS SDMA DL IE format

Syntax	**Size**	**Notes**
AAS_SDMA_DL_IE () {		
Extended DIUC	4 bits	AAS_SDMA = 0x??
Length	4 bits	Variable
Num_Region	4 bits	Number of regions allocated by this IE.
If (Preamble Indication != 0b00) {		
Preamble Modifier Type	4 bits	Applies to all allocations defined by this IE. See section 8.4.5.3.11.
}		
for (I = 0; i< Num_Region; i++) {		
OFDMA Symbol offset	8 bits	
If (Permutation = 0b11) {		For the AMC permutation
Subchannel offset	8 bits	
No. OFDMA triple symbol	5 bits	Number of OFDMA symbols is given in multiples of 3 symbols
No. subchannels	6 bits	
Else {		
Subchannel offset	6 bits	
No. OFDMA Symbols	7 bits	
No. subchannels	6 bits	
}		
Num_Assign	2 bits	Number of overlapping allocations
Reserved	1 bit	Shall be set to zero
for (j = 0; j < Num_Assign; j++) {		
DIUC	4 bits	
CID	16 bits	Denotes the basic CID of an MSS or a multicast CID.
Pilot pattern	3 bits	Assigned pilot pattern (see sections 8.4.6.3.2 and 8.4.6.3.3): 000 – Pilot pattern #0 001 – Pilot pattern #1 010 – Pilot pattern #2 011 – Pilot pattern #3 100 – Use all pilots (applies only to PUSC-ASCA permutation) 101-111 - Reserved
If (Preamble Indication != 0b00) {		
Preamble Shift Index	4 bits	Frequency or time shift index used for preamble of this allocation, as defined by 'preamble modifier type'. See section 8.4.5.3.11
}		
Reserved	1 bit	Shall be set to zero
}		
}		
If (! Byte boundary) {		
Padding	4 bits	Shall be set to zero
}		

2. Add the following subsection

8.4.6.3.2 AMC support for SDMA

The pilots in an AMC AAS zone are regarded as part of the allocation, and as such shall be beamformed in a way that is consistent with the transmission of the allocation's data subcarriers. In an SDMA region, the pilots of each allocation may correspond to a different pilot pattern. A pilot pattern consists of location and polarity. The pilot patterns are depicted in figure XXX. Data subcarriers shall be punctured to obtain patterns #2 and #3. Subcarriers shall only be punctured if there is an allocation associated with the corresponding pattern, as described in the AAS_SDMA_DL_IE(). Data subcarriers shall be punctured after constellation mapping in the case of CC encoding, and prior to constellation mapping in the case of CTC encoding. In the latter case, the FEC block shall be truncated to accommodate the punctured subchannel structure, and the data subcarrier enumeration of Eq. (116) shall not be applied. Instead, data subcarriers within a slot shall be enumerated starting from the first OFDMA symbol at the data subcarrier that is lowest in frequency, continuing in ascending frequency order throughout the slot's subcarriers in the same symbol, then going to the next symbol at the subcarrier lowest in frequency, and so on.

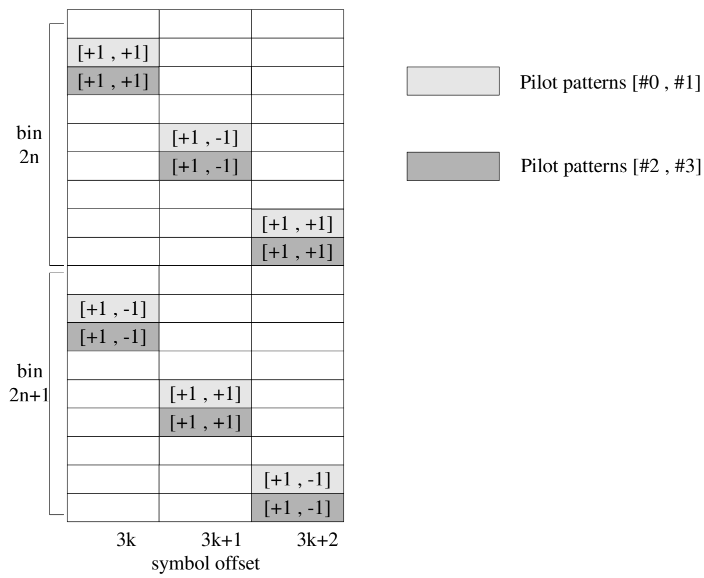

Figure XXX – Pilot patterns for AAS mode in AMC zone. Symbol offset is relative to the beginning of the zone. Pilot polarity for each pattern is given in brackets.

3. Add the following subsection

8.4.6.3.3 PUSC-ASCA support for SDMA

The pilots in a PUSC-ASCA AAS zone are regarded as part of the allocation, and as such shall be beamformed in a way that is consistent with the transmission of the allocation's data subcarriers. In an SDMA region, the pilots of each allocation may correspond to a different pilot pattern. Pilot patterns are depicted in figure 251, with references to 'antenna' replaced with 'pattern'. Data subcarriers shall be punctured to obtain patterns #2 and #3. Subcarriers shall only be punctured if there is an allocation associated with the corresponding pattern, as described in the AAS_SDMA_DL_IE(). Data subcarriers shall be punctured after constellation mapping in the case of CC encoding, and prior to constellation mapping in the case of CTC encoding. In the latter case the FEC block shall be truncated to accommodate the punctured subchannel structure.

4. Change text on page 618 lines 5-9 of 802.16-2004, to the following text

$$\mathrm{Re}\{c_k\} = \frac{8}{3}\left(\frac{1}{2} - w_k\right) \cdot p_k \qquad (135)$$
$$\mathrm{Im}\{c_k\} = 0$$

where p_k is the pilot's polarity (as described in section 8.4.6.3.2) for SDMA allocations in AMC AAS zone, and $p_k = 1$ otherwise.

4 References

[1] IEEE P802.16e/D5a