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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

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

2. *Modify reduced AAS-private DL-MAP on table ZZZ, page 284, line 42:*

Preamble Shift Index	4 bits	Updated preamble shift index to be used starting with the frame specified by the Frame Offset.
<i>Reserved</i> Pilot Pattern	3 bits	<i>Set to zero</i> pilot pattern used for this allocation (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 regular (non-SDMA) pilots 101-111 – Reserved

3. *Modify text on page 530 immediately after title of section 8.4.5.3.11, on 802.16-2004:*

The Physical Modifier Information Element indicates that the subsequent allocations shall utilize a preamble, which is either cyclically delayed in time or cyclically rotated in frequency, and a specific pilot pattern.

4. *Modify section 8.4.5.3.11 - PHY_MOD_DL_IE - table 284, on 802.16-2004:*

[Note to the editor: following acceptance of contribution C802.16maint-04/55r2 in TGmaint, there are 3 reserved bits available at the end of the table]

<i>Reserved</i> Pilot Pattern	3 bits	<u>pilot pattern used for all subsequent allocations (see sections 8.4.6.3.2 and 8.4.6.3.3):</u> 000 – Pilot pattern #0 001 – Pilot pattern #1 010 – Pilot pattern #2 011 – Pilot pattern #3 100 – Use regular (non-SDMA) pilots 101-111 – Reserved
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5. *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. Pilot patterns are as depicted in figure 251g, replacing references to ‘antenna’ with ‘pattern’, with a slight change of order so that punctured patterns appear last: the pilot pattern for antenna 1 shall correspond to SDMA pilot pattern #2, and pilot pattern for antenna 2 in the figure shall correspond to SDMA pilot pattern #1. 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(). Only MSSs that support all four pilot patterns, as indicated by their capability in 11.8.3.7.X, shall be assigned allocations in an SDMA region where pilot patterns #2 and #3 are used. 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.

6. *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(). Only MSSs that support all four pilot patterns, as indicated by their capability in 11.8.3.7.X, shall be assigned allocations in an SDMA region where pilot patterns #2 and #3 are used. 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.

11.8.3.7.X AAS SDMA Pilot capability

Type	Length	Value	Scope
<u>YYY</u>	1	Bit #0-#1: SDMA pilot pattern support for AMC zone: 0b00 – no support 0b01 – support SDMA pilot patterns #0 and #1 0b11 – support all SDMA pilot patterns 0b10 – reserved Bit #2-#3: SDMA pilot pattern support for PUSC-ASCA zone: 0b00 – no support 0b01 – support SDMA pilot patterns #0 and #1 0b11 – support all SDMA pilot patterns 0b10 – reserved	SBC-REQ SBC-RSP

		Bits #4-#7: Reserved	
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4 References

- [1] IEEE P802.16e/D5a