Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Mid-amble to Support OFDMA MIMO Transmission**
Date Submitted	**2004-08-17**
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Re:	Response to Recirculation Ballot #14c
Abstract	To introduce mid-amble for MIMO enhancement
Purpose	To incorporate the changes here proposed into the 802.16e D5 draft.
Notice	
Release	
Patent Policy and Procedures	

Mid-amble to Support OFDMA MIMO Transmission

1 Introduction

In this contribution, the mid-amble is proposed to enhance the MIMO down link transmission. The MIMO mid-amble can be flexible allocated prior the MIMO burst data zone/region. The proposed MIMO mid-amble has the following properties:

1. It is mapped onto FUSC/PUSC permutation with minimized interference to the other cell/sector and non-MIMO MSS
2. It can be used by both MIMO and non-MIMO MSSs for the channel estimation with increased pilot density in frequency domain.
3. It consists of one OFDM symbol to minimize the overhead.
4. Its presence is determined by the BS based on the target MIMO MSSs reception condition, such as sub-channel permutation, channel time/frequency dispersion and mobility speed.
5. The MIMO mid-amble sequence is identical to the cell specific preamble sequence and has very low PAPR value to allow the power boost of the mid-amble transmission.
6. The MIMO mid-amble can provide high accuracy of the MIMO channel sounding for AMC channel and to allow the scattered MIMO pilot to track the channel variations in the pilot added or decision added fashion.

2 Proposed Solution

The mid-amble presence is indicated in the OFDMA downlink TD_ZONE IE. The overall mid-amble structure is to allow maximum 4 transmit antennas concurrent channel sounding at least for FUSC mode, since in the STC zone, due to the antenna grouping type sub-MIMO selection is allowed and different MSS may assigned to different antenna sub-group. The antenna mapping onto the mid-amble is based on the disjoint orthogonal sub-carrier partition to eliminate the inter antenna interference for the concurrent in-time channel sounding.

For the FUSC mode, the mid-amble frequency domain structure is shown in Figure 1.

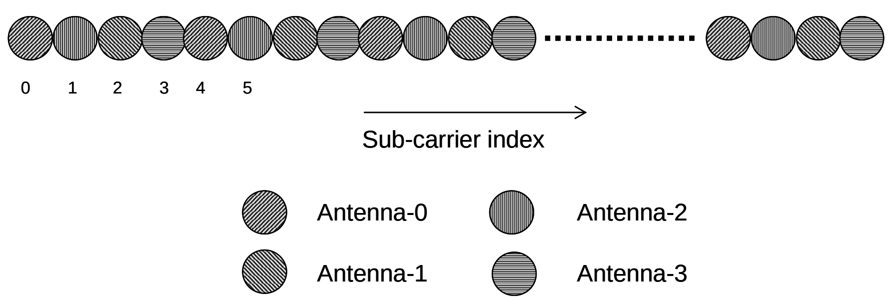

Figure 1 Mid-amble FUSC structure (frequency domain)

In this case, the sub-carriers for the mid-amble are allocated to different antennas, when an antenna is not deployed in the system, the sub carrier set allocated to such antenna shall be set to null value. This can simplify the complexity by indicating both antenna number and reduce the antenna dependant configuration modes for the mid-amble.

For the PUSC mode, mid-amble frequency domain structure is shown in Figure 2, due to the increased separation of the sub-carrier within the disjoint orthogonal sub-carrier set for each antenna, to minimize this impact, the antenna-0 channel sound is relied on the preamble with 3 time higher density in frequency domain, while the mid-amble is allocated for the antenna-1, 2 and 3 to minimize the sub carrier separation distance.

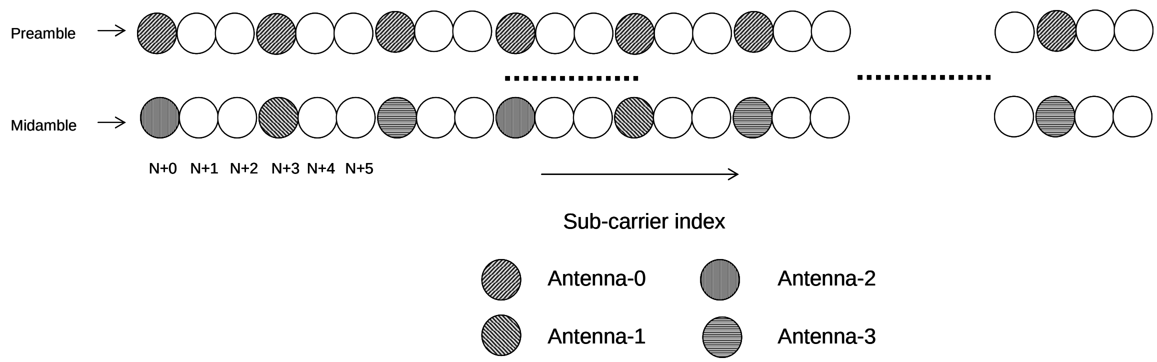

Figure 2 Mid-amble PUSC structure (frequency domain)

Each MIMO branch channel can be directly recovered by using linear interpolation approach in the frequency domain; in this case the computation complexity is minimized.
The frequency domain sampling is sufficiently dense for the channel interpolation, see Table 2.

Table 2 Coherent bandwidth relation (sub-carrier spacing 9.77kHz)

RMS delay spread (µs)	1	2	4	8	10	15	20
Coherent bandwidth (sub-carriers)	102	51	26	13	10	7	5

Therefore both FUSC and PUSC mid-amble have sufficient dense sub-carrier allocation for each antenna for sounding the channel with reasonable delay spread.

3 Proposed Text

3.1 STC Zone IE format

[Modify the Table 277a in Section 8.4.5.3.4]

Table 277a -OFDMA downlink STC_ZONE IE format

Syntax	Size (bits)	Notes
STC_ZONE_IE() {		
Extended DIUC	4	STC/ZONE=0x01
Length	4	Length = 0x02
Permutation	2	00 = PUSC permutation 01 = FUSC permutation 10 = Optional FUSC permutation 11 = Optional adjacent subcarrier permutation
Use All SC indicator	1	0 = Do not use all subchannels 1 = Use all subchannels
STC	2	00 = STC using 2 antennas 01 = STC using 3 antennas

		10 = STC using 4 antennas 11 = FHDC using 2 antennas
Matrix indicator	2	Antenna STC/FHDC matrix (see 8.4.8) 00 = Matrix A 01 = Matrix B 10 = Matrix C (applicable to 4 antennas only) 11 = Reserved
Idcell	6	
Midamble presence	1	0 = not present 1 = present at the first symbol in STC zone
Reserved	2~~3~~	Shall be set to zero
}		

3.2 MIMO Mid-amble

Add section 8.4.8.3.6

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8.4.8.3.6 The MIMO mid-amble

The MIMO mid-able consists of one OFDM symbol which consists of 4 disjoint sub-carriers for mapping maximum 4 transmit antennas in the downlink MIMO transmission.

The mid-amble carrier-set is defined using the following formula:

Mid-amble_Carrier_Set n,m= n+m+4*k*

where:

n is the segment index 0,1,2 for PUSC mode and for FUSC mode n=0

m is the antenna index 0,1,2,3 for FUSC mode and 0,1,2 for PUSC mode.

k is the sub-carrier running index

The mid-amble sequence has the identical IDcell and segment mapping as the preamble [but with different length] See Table xxxx

The mid-amble frequency domain structure is shown in Figure xxxx, for FUSC mode and in Figure yyyy for PUSC mode.

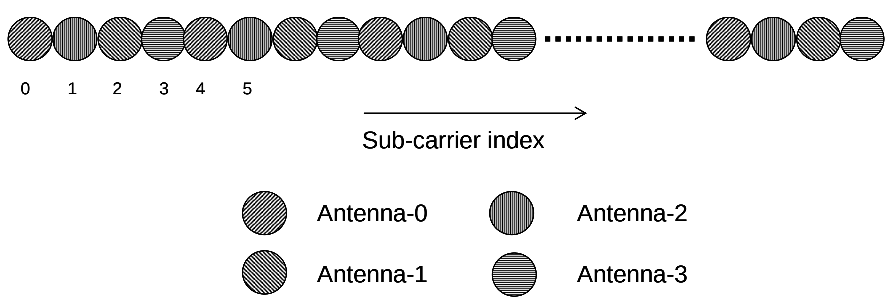

Figure xxxx Mid-amble FUSC structure (frequency domain)

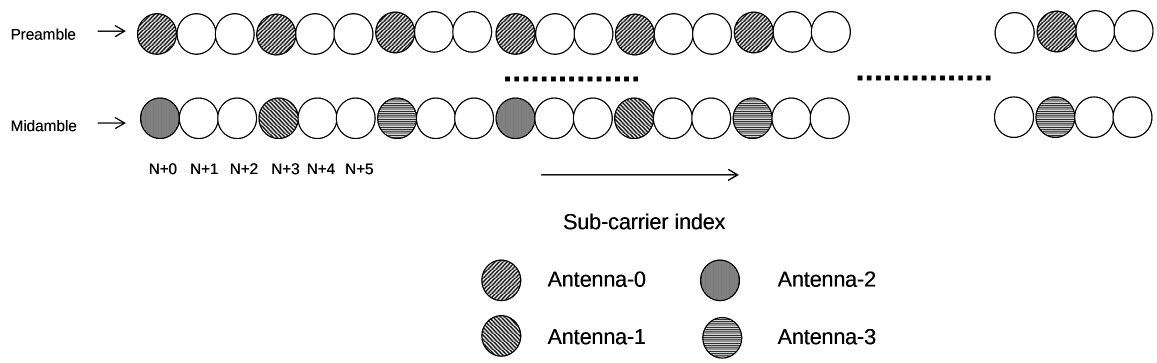

Figure yyyy Mid-amble PUSC structure (frequency domain)

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