Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**H-ARQ MAC Support for MIMO OFDMA**	
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Re:	Contribution supporting TGe WG ballot #14c	
Abstract	H-ARQ MAC Support 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, and underlined green indicates newly added text from the original contribution	
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H-ARQ MAC Support for MIMO OFDMA

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1. Introduction

H-ARQ MAC support for various MIMO mode operations is provided in this contribution. Current standard lacks mechanism of any kind to enable H-ARQ for MIMO modes.

First, clear definition of MIMO zones within H-ARQ region is presented both in the downlink and the uplink. Some exemplary figures are drawn to help visualize and to remove any ambiguity. Then, two extended MAP IEs for DL and UL are specified to give SS the MIMO related control information.

Some clarification is also made on burst mapping for H-ARQ when multiple MIMO layers are transmitted on the same physical resource. The multiple layer transmission is enabled when spatial multiplexing (SM) schemes are employed for MIMO systems. There can be two modes in multiple layer transmission. The vertical encoding (VE) mode is to demux the modulated symbols into multiple streams (or layers) for each transmit antenna. Only one coding and modulation block is needed for this mode. The other is horizontal encoding (HE) mode, where raw data is de-multiplexed into multiple coding/modulation blocks for each antenna so that rates can differ for different antennas.

An effort to make SM-HE SS transparent and co-existing with other MIMO and non-MIMO SS without breaking backward compatibility is made throughout this contribution.

Response to Reply Comments:
"The position of the MIMO burst before the non MIMO burst breaks backward compatibility. All MIMO transmissions should be after non MIMO transmissions."
Our response: *Both MIMO and non-MIMO bursts are allocated by the regular Compact DL-MAP IEs. MIMO bursts just have the additional extension IE for controlling information, so there is no issue on backward compatibility at all. Whether MIMO burst comes first or later does not really make a difference in terms of backward compatibility.*

2. Specific Text Changes

2.1. MIMO Compact DL MAP IE format

[Add a new section 6.3.2.3.43.6.7 as follows]

6.3.2.3.43.6.7 MIMO Compact DL MAP IE format

When MIMO enabled DL burst are present within a frame, they shall be allocated before non-MIMO DL burst in both diversity and AMC zones. Figure 1 exemplifies the DL H-ARQ sub-frame structure, where the optional MIMO midamble is shown and 2x3 AMC type is depicted. Both MIMO diversity and MIMO AMC zones shall contain even number of symbols. For any remaining physical resources for each zone, padding subchannels shall be allocated to the region.

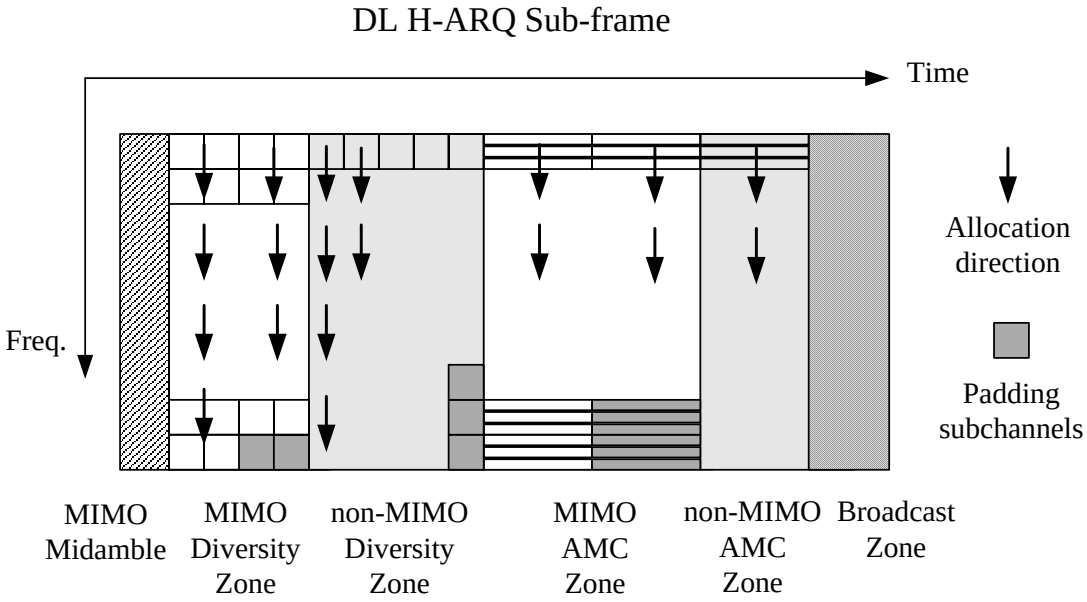

Figure 1 Downlink H-ARQ Sub-frame Structure

Each MIMO enabled DL burst shall be first allocated by the regular Compact DL-MAP IE for diversity subchannels (Table 94) and AMC subchannels (Table 95), followed by the extended MIMO Compact DL-MAP IE.

The format of MIMO Compact DL-MAP IE is presented in Table 99a. This extended IE shall follow right after the basic allocation IE for each MIMO enabled DL burst.

Table 99a—MIMO Compact_DL-MAP IE format

Syntax	Size (bits)	Notes
MIMO_Compact_DL-MAP_IE() {		
Compact DL-MAP Type	3	Type = 7
DL-MAP Sub-type	5	MIMO = 0x01
Length	4	Length of the IE in Bytes
Matrix indicator	2	DL STC matrices (see 8.4.8.3)
Num_layer	2	Number of multiple coding/modulation layers 00 – 1 layer 01 – 2 layers 10 – 3 layers 11 – 4 layers

for (j=1;j<Num_layer; j++) {		This loop specifies the Nep for layers 2 and above when required for STC. The same Nsch and RCID applied for each layer

if (H-ARQ Mode =CTC Incremental Redundancy) {
Nep }
elseif (H-ARQ Mode = Generic Chase) {
DIUC
}
	4	H-ARQ Mode is specified in the H-ARQ Compact_DL-MAP IE format for Switch H-ARQ Mode.

CQI Feedback_type	3	Type of contents on CQICH for this SS 000 = Default feedback 001 = Precoding weight matrix W 010 = Channel matrix H 011 = MIMO mode and permutation zone 100 -111 = Reserved
CQICH_Num	2	Total number of CQICHs assigned to this SS is (CQICH_Num +1)
for (i=1;i<CQICH_Num;i++) {		
Allocation index	6	Index to uniquely identify the additional CQICH resources assigned to the SS
}		
Padding	variable	The padding bits are used to ensure the IE size is integer number of bytes
}		

Matrix Indicator
This filed indicates MIMO matrix for the burst.
For 2-antenna BS, 00 = Matrix A; 01 = Matrix B; 10-11 = Reserved.
For 3-antenna BS, 00 = Matrix A; 01 = Matrix B; 10 = Matrix C; 11 = Reserved.
For 4-antenna BS, 00 = Matrix A; 01 = Matrix B; 10 = Matrix C; 11 = Reserved.

CQI Feedback Type
For 4-bit or 5-bit CQI payload, the type dependent feedback in 16 or 32 levels shall be feedback, respectively. For 6-bit CQI payload, however, the MSB of 6-bit payload from a SS is the indicator of the usage for the remaining 5 bits. When the MSB is set to '0' with 6-bit payload, the remaining 5 bits shall be used for the type dependent feedback, and '1' indicates the remaining 5 bits shall be used for type independent feedback in Table 294d.

Allocation Index
It indicates its position from the start of the CQICH region.

For each layer, a codeword shall be constructed according to 8.4.9.2.3.5 with the Nep and Nsch combination and mapped onto the corresponding layer. Multiple codewords from multiple layers shall be interpreted as one H-ARQ channel whose parameters are given in the preceding Compact DL-MAP IE.
At the receiver, an ACK shall be transmitted only when there is no CRC error detected on every layer. Otherwise, a NACK shall be transmitted.

2.2. Compact UL-MAP IE for CQICH Region Allocation

[Modify section 6.3.2.3.43.7.6 as follows]

6.3.2.3.43.7.6 Compact UL-MAP IE for CQICH Region Allocation

The CQI region information is delivered through the Compact_UL-MAP_IE as shown in Table 105. SS sends CQI report in CQI region.

When there exist a need to allocate multiple CQICHs to a SS, the number of used subchannels for CQICH region shall be increased by the total number of additional CQICHs for all SS within the frame, and their positions shall be specified by Allocation Indices of their respective MIMO_Compact_DL-MAP IE.

2.3. MIMO Compact UL MAP IE format

[Add a new section 6.3.2.3.43.7.8 as follows]

6.3.2.3.43.7.8 MIMO Compact UL MAP IE format

When MIMO enabled UL burst are present within a frame, they shall be allocated before non-MIMO DL burst in both diversity and AMC zones. Figure 1 exemplifies the UL H-ARQ sub-frame structure, where the 1x6 AMC type is depicted.

Within the MIMO diversity zone, subchannels shall take the form of Mini-subchannel Type 01 in Table 312, which spans over 6 symbols. Within the MIMO AMC zone, subchannels shall take 1x6 AMC type. Both MIMO diversity and MIMO AMC zones shall contain multiple of 6 symbols.

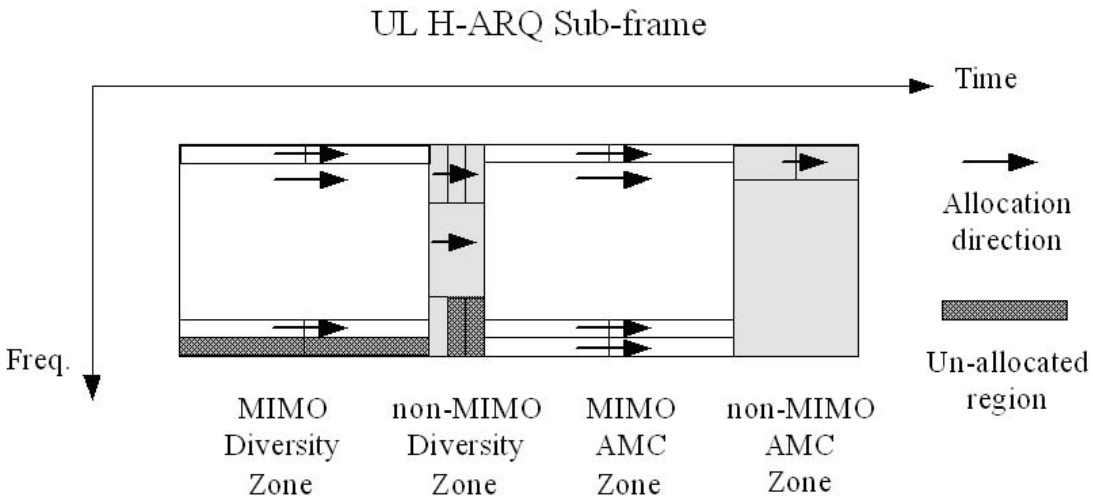

Figure 2 Uplink H-ARQ sub-frame Structure

Each MIMO enabled UL burst shall be first allocated by the regular Compact UL-MAP IE for diversity subchannels (Table 100) and AMC subchannels (Table 101), followed by the extended MIMO Compact UL-MAP IE. The indication of zone boundary shall be made by the presence of UL Zone IE in Table 292.

The format of MIMO Compact UL-MAP IE is presented in Table 106a. This extended IE shall follow right after the basic allocation IE for each MIMO enabled UL burst.

Table 106a—MIMO Compact_UL-MAP IE format

Syntax	Size (bits)	Notes

MIMO_Compact_UL-MAP_IE() {		
_Compact UL-MAP Type	3	Type = 7
_UL-MAP Sub-type	5	MIMO = 0x01
_Length	4	Length of the IE in Bytes
_Matrix indicator	1	UL STC matrices (see 8.4.8.4) For 2-antenna SS, 0 = Matrix A 1 = Matrix B For Collaborative SM capable SS 0 = Pilot pattern A 1 = Pilot pattern B
_Num_layer	1	Number of multiple coding/modulation layers 0 – 1 layer 1 – 2 layers
_for (j=1;j<Num_layer; j++) {		This loop specifies the Nep for layers 2 and above when required for STC. The same Nsch and RCID applied for each layer

_if (H-ARQ Mode =CTC Incremental Redundancy) {
_Nep }
_elseif (H-ARQ Mode = Generic Chase) {
_DIUC
}
	4	H-ARQ Mode is specified in the H-ARQ Compact_DL-MAP IE format for Switch H-ARQ Mode.

Padding	variable	The padding bits are used to ensure the IE size is integer number of bytes
}		

For each layer, a codeword shall be constructed according to 8.4.9.2.3.5 with the Nep and Nsch combination and mapped onto the corresponding layer. Multiple codewords from multiple layers shall be interpreted as one H-ARQ channel whose parameters are given in the preceding Compact UL-MAP IE.
At the receiver, an ACK shall be transmitted only when there is no CRC error detected on every layer. Otherwise, a NACK shall be transmitted.

References:

[1] 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

[2] IEEE P802.16e/D4 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

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