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Re:	This is a response to a Call for Comments on IEEE P802.16e-D5a
Abstract	We suggest supporting an ACK signal in HARQ MIMO.
Purpose	This document is submitted for review by 802.16e Working Group members. Pink line indicates the revised text.
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Supporting an ACK signal per layer in HARQ MIMO

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1. Introduction

In the current H-ARQ, the ACK/NACK signals are informed as H-ARQ ACK BITMAP in downlink and H-ARQ Region allocation in uplink. For example, when a MSS receives an H-ARQ enabled burst, the MSS transmits H-ARQ ACK at a half-subchannel in H-ARQ Region that is allocated by the BS. And when a BS receives an H-ARQ enabled burst, the BS transmits H-ARQ ACK at one bit of the BITMAP.

In the case of H-ARQ MIMO, only one ACK/NACK signal shall be transmitted for the data information of every layer at the receiver. In 6.3.2.3.43.6.7 and 6.3.2.3.43.7.8, 16e/D5a, that expresses clearly as “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.”

However, that is ineffective for especially Collaborative SM (CSM) because the other MSSs, which have no errors, shall be re-transmitted if the burst of any MSS has CRC error. Therefore, we propose that the BS shall transmit each ACK/NACK signal to each MSS. Then, we can save the BW resource by not retransmitting the bursts which have no errors. The suggestion imposes the overhead of only a few bits of H-ARQ ACK BITMAP.

Moreover, it can be applied to the general MIMO including Collaborative SM. For example, out of all four layers, if there is CRC error detected on a layer and no CRC error detected on other three layers, a NACK signal shall be transmitted and then all data of four layers shall be re-transmitted. There is a low possibility that the CRC of all layers have all errors or have no errors at the same time because they have the different channel situations. So the current method has the waste of BW.

The table below represents the comparison of the overhead between the current method and the proposed one. We defined n as the number of layers, P_{suc} as the success probability of transmission in each layer, and S_{burst} as a burst size, which has one or more subchannels. The table shows that the overhead of burst retransmission of the proposed method is much smaller than the current method, even if it requires more ACK channel.

Consequently, we can control the data signal per each layer properly, and reduce the unnecessary bandwidth allocation. Therefore, we suggest that each ACK/NCK signal be supported in each layer.

Table. The comparison of the overhead between the current and the proposed one

		The current method	The proposed method
The overhead of ACK/NACK signal	In UL ACK	$1/2$ subchannel	$1/2 \cdot n$ subchannels
	In DL ACK	1 bit	n bits
The average overhead of burst retransmission		$\left(1-P_{suc}^{n}\right)\cdot n \cdot S_{burst}$	$\left(1-P_{suc}\right)\cdot n \cdot S_{burst}$

Where, n is the number of layers,

P_{suc} is the success probability of transmission in each layer

S_{burst} is a burst size

2. Proposition

2.1 The allocation of downlink ACK signals for MIMO

In order to transmit UL ACK signals per layer with guarantee of maintaining backward compatibility with REVd SS, UL ACK signals for DL MIMO enabled bursts shall be allocated after ACK signals of all bursts are allocated. When bursts are MIMO enabled, however, ACK signals of the first layer of bursts are allocated instead of ACK signals of overall bursts. And after ACK signals of all bursts are allocated, ACK signals of other layers of bursts are allocated as shown in the figure 1.

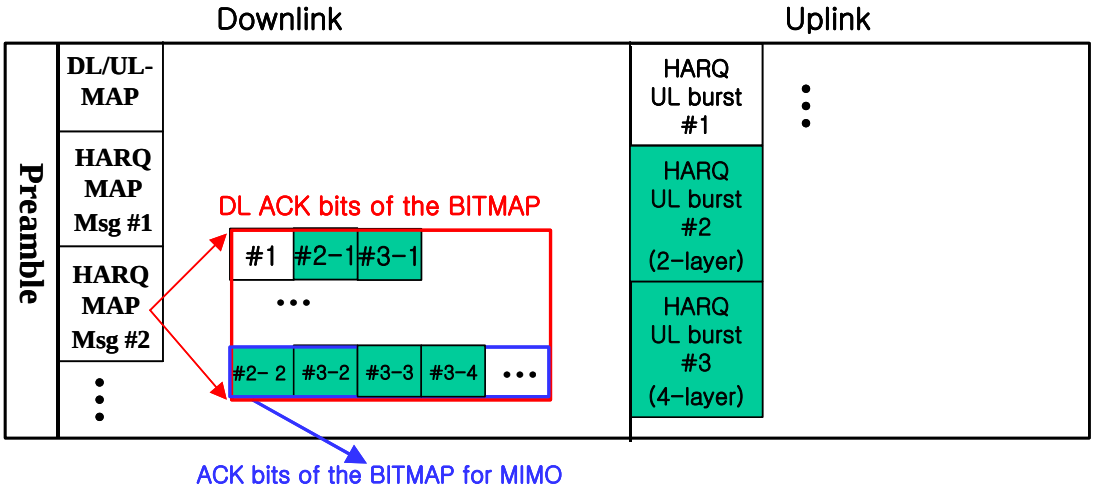

Figure 1. The example of DL ACK bits allocation of the BITMAP for MIMO

2.2 The allocation of uplink ACK signals for MIMO

The allocation of uplink ACK signals is similar to the allocation of downlink ACK signals. But if MSS has ACK half-subchannels as many as the number of other layers except the first layer, the overhead of BW is larger as (the number of other layers)*(a half-subchannel).

Therefore we suggest that ACK signals of other layers be transmitted using codeword of a half-subchannel as shown in the figure 2. The method increases the efficiency since BS can get the ACK signal per layer by using just a half-subchannel per MIMO enabled burst.

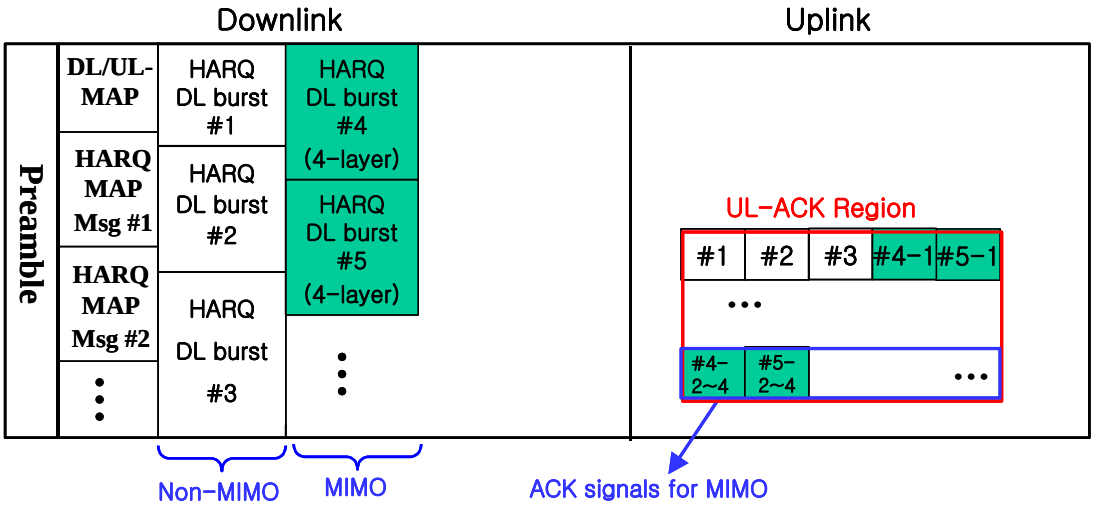

Figure 2. The example of UL ACK Region allocation for MIMO

~~2.~~3. Proposed Text Change

6.3.2.3.43.6.5 Compact DL-MAP IE for H-ARQ ACK BITMAP

[Insert the following text before Table 98:]

~~However w~~When a MIMO enabled MSS transmits a H-ARQ enabled burst, ~~the SS shall receive H-ARQ ACK bits of the BITMAP as many as the number of layers, and a~~the ACK bit~~s~~ of the BITMAP ~~shall be allocated~~ is used to the first layer of a H-ARQ enabled burst. And after ACK bits of all bursts are allocated in BITMAP, ACK bits of other layers are allocated by the order of layers in the same burst in MIMO Compact_DL-MAP_IE and then bursts in Compact DL-MAP_IE.

6.3.2.3.43.6.7 MIMO Compact_DL-MAP IE format

[Change Table 97a as follows:]

Table 97a-MIMO Compact_DL-MAP

Syntax	Size (bits)	Notes
MIMO Compact_DL-MAP IE () {		
Compact_DL-MAP Type	3	Type = 7
DL-MAP Subtype	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 layer 10 – 3 layer 11 – 4 layer
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 }
Else if (H-ARQ Mode = Generic Chase) {
DIUC
}
	4	H-ARQ Mode is specified in the H-ARQ Compact_DL-MAP IE format for Switch HARQ Mode.

CQI Feedback_Type	3	Type of contents on CQICH for this SS 000 = Default feedback 001 = Percoding 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 MSS 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
}		
H-ARQ_Control_IE	variable	
}		
Padding	variable	The padding bits are used to ensure the IE size is integer number of bytes.
}		

[Remove and insert the following text at the end of section 6.3.2.3.43.6.7]

~~At the receiver, a codeword shall be transmitted only when there is no CRC error detected on every layer. Otherwise, a NACK shall be transmitted.~~

At the receiver, an ACK/NACK signal shall be transmitted on each layer. For each layer, when there is no CRC error detected, an ACK signal shall be transmitted and otherwise a NACK signal shall be transmitted.

6.3.2.3.43.7.5 Compact UL-MAP IE for H-ARQ Region allocation

[Insert the following text before Table 104:]

~~However w~~When a MIMO enabled SS transmits a H-ARQ enabled burst, ~~the SS shall transmit H-ARQ ACK signals at half-subchannels in H-ARQ Region as many as the number of layers, and the~~ an ACK half-subchannel~~s~~ in H-ARQ Region ~~shall be allocated~~ is used to the first layer of a H-ARQ enabled burst. And after ACK half-subchannels of all bursts are allocated in H-ARQ Region, ACK signals of other layers are allocated in H-ARQ Region by the order of bursts in ~~layers~~ in MIMO Compact_UL-MAP_IE. ACK signals of other layers except the first layer are represented to modulated signals of a half-subchannel in Table xxx. When the number of layer in a MIMO enabled burst is less than 4, BS doesn't care the signal of other layers.

Table xxx. ACK Channel subcarrier modulation for MIMO enabled bursts

Layer4, layer3, layer2	Vector indices per Tile Tile(0), Tile(1), Tile(2)
ACK, ACK, ACK	0, 0, 0
ACK, ACK, NACK	4, 7, 2
ACK, NACK, ACK	7, 2, 4
ACK, NACK, NACK	2, 4, 7
NACK, ACK, ACK	1, 3, 5
NACK, ACK, NACK	3, 5, 1
NACK, NACK, ACK	5, 1, 3
NACK, NACK, NACK	6, 6, 6

Table yyy. Orthogonal Modulation index in ACK Channel

Vector index	Modulation patterns
0	P0, P1, P2, P3, P0, P1, P2, P3
1	P0, P3, P2, P1, P0, P3, P2, P1
2	P0, P0, P1, P1, P2, P2, P3, P3
3	P0, P0, P3, P3, P2, P2, P1, P1
4	P0, P0, P0, P0, P0, P0, P0, P0
5	P0, P2, P0, P2, P0, P2, P0, P2
6	P0, P2, P0, P2, P2, P0, P2, P0
7	P0, P2, P2, P0, P2, P0, P0, P2

Where:

$$P0 = \exp\left(j \cdot \frac{\pi}{4}\right),$$

$$P1 = \exp\left(j \cdot \frac{3\pi}{4}\right),$$

$$P2 = \exp\left(-j \cdot \frac{3\pi}{4}\right),$$

$$P3 = \exp\left(-j \cdot \frac{\pi}{4}\right)$$

6.3.2.3.43.7.8 MIMO Compact_UL-MAP IE format

[Change Table 14b as follows:]

Table 14b-MIMO Compact UL-MAP IE format

Syntax	Size (bits)	Notes
MIMO Compact_UL-MAP IE() {		
Compact_UL-MAP Type	3	Type = 7
UL-MAP Subtype	5	MIMO = 0x01
Length	4	Length of the IE in Bytes
Matrix indicator	2	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~~0 – 1 layer ~~0~~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_UL-MAP IE format for Switch HARQ Mode.

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

[Remove and insert the following text at the end of section 6.3.2.3.43.7.8]

~~At the receiver, a codeword shall be transmitted only when there is no CRC error detected on every layer. Otherwise, a NACK shall be transmitted.~~

At the receiver, an ACK/NACK signal shall be transmitted on each layer. For each layer, when there is no CRC error detected, an ACK signal shall be transmitted and otherwise a NACK signal shall be transmitted.

---------- The End of the text change ----------