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Re:	This is a response to a Call for Comments on IEEE P802.16e-D5a
Abstract	Pilot carriers can be used as secondary Fast-feedback channel or secondary UL ACK channel in OFDMA
Purpose	This document is submitted for review by 802.16e Working Group members
Notice	
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Patent Policy and Procedures	

Secondary fast feedback channel and UL ACK channel in OFDMA

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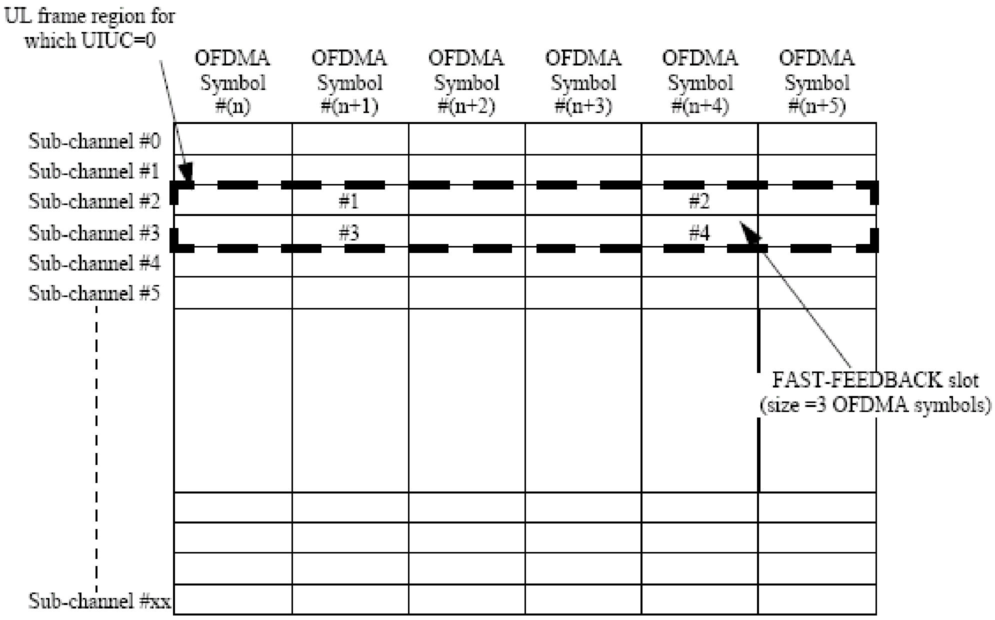
1. Introduction

1.1 Problem statement

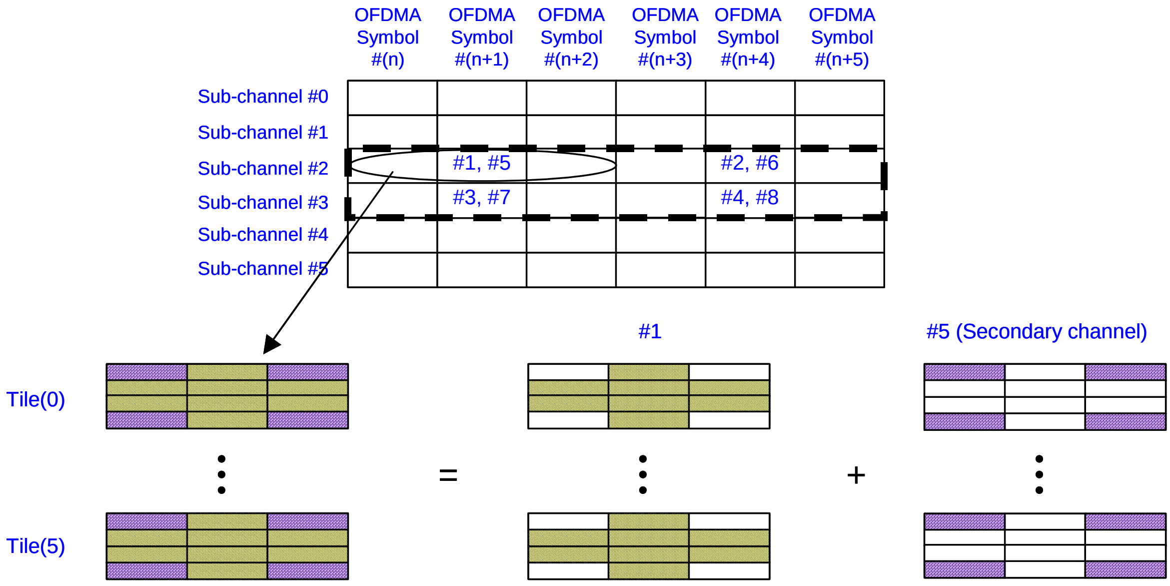
Optional fast feedback is defined on UL PUSC and optional UL PUSC, and configured with orthogonal modulation on the 48 data carriers for use of non-coherent detection. When using the non-coherent detection, the four pilot sub-carriers per tile of PUSC mode are redundant for detection and result in power waste of MSS. This is the case for UL ACK channel also. This contribution proposes the resource efficient structure using these pilot sub-carriers as secondary Fast-feedback channel and secondary UL ACK channel

1.2 Proposed solutions

To save the uplink resources and MSS transmit power, it is required to change the current enhanced Fast-feedback channel and enhanced UL ACK channel defined in UL PUSC as the Figure 1. Figure 1 shows that there are more Fast-feedback channels in the proposed scheme since it uses the pilot carriers as the secondary Fast-feedback channel. This scheme can be applied to UL ACK channel similarly. Since the secondary Fast-feedback channel and secondary UL ACK channel employ the four pilot carriers, these are built in UL PUSC mode only.



(a) Current scheme



(b) Proposed scheme

Figure 1. Mapping order of Fast-feedback messages to the Fast-feedback region

2. Proposed text changes

2.1 Remedy for Fast-feedback channel

[Modify the Figure 231a in page 264 of '8.4.5.4.10.4 Optional Enhanced Fast-feedback channels' as following]

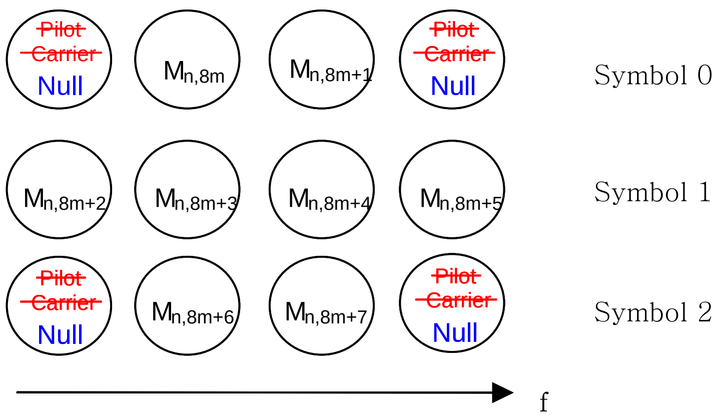


Figure 231a—Subcarrier mapping of Fast-feedback modulation symbol for PUSC

[Add the following after line 50 in page 264 of '8.4.5.4.10.4 Optional Enhanced Fast-feedback channels']

Secondary Fast-feedback slot consists of 1 OFDMA slots mapped in a manner similar to the mapping of normal uplink data. A secondary Fast-feedback slot uses QPSK modulation on the 24 pilot sub-carriers of UL PUSC tiles it contains, and can carry a data payload of 4 bits. Table xxx defines the mapping between the payload bit sequences and the subcarriers modulation.

Table xxx- Secondary Fast-feedback channel subcarrier modulation with 4 bit

4 bit payload	Vector indices per tile Tile(0), Tile(1),Tile(2), Tile(3),Tile(4), Tile(5)
0b0000	a,a,a,b,b,b
0b0001	b,b,b,a,a,a
0b0010	c,c,c,d,d,d
0b0011	d,d,d,c,c,c
0b0100	a,b,c,d,a,b
0b0101	b,c,d,a,b,d
0b0110	c,d,a,b,c,d
0b0111	d,a,b,c,d,a
0b1000	a,a,b,d,c,c
0b1001	b,d,c,c,d,b
0b1010	c,c,d,b,a,a
0b1011	d,d,b,a,b,b
0b1100	a,a,d,c,a,d
0b1101	b,c,a,c,c,a
0b1110	c,b,d,d,b,c
0b1111	d,c,c,b,b,c

The secondary Fast-feedback channel is orthogonally modulated with QPSK symbols. Let $M_{n,4m+k}$ $(0 \le k \le 3)$ be the modulation symbol index of the kth modulation symbol in the mth uplink PUSC tile of the nth secondary Fast-feedback channel. The possible modulation patterns composed of $M_{n,4m+k}$ in the mth tile of the nth secondary Fast-feedback channel are defined in Table yyy.

Table yyy- Orthogonal Modulation Index in Secondary Fast-feedback Channel

Vector index	$M_{n,4m}$, $M_{n,4m+1}$, $M_{n,4m+2}$, $M_{n,4m+3}$
a	P0, P0, P0, P0
b	P0, P2, P0, P2
c	P0, P1, P2, P3
d	P1, P0, P3, P2

where

$$P_0 = \exp\left(j\frac{\pi}{4}\right),\ P_1 = \exp\left(j\frac{3\pi}{4}\right),$$

$$P_2 = \exp\left(-j\frac{3\pi}{4}\right),\ P_3 = \exp\left(-j\frac{\pi}{4}\right).$$

$M_{n,4m+k}$ are mapped to secondary Fast-feedback channel tile as shown in Figure zzz for PUSC uplink subchannel. A secondary Fast-feedback channel is mapped to one subchannel composed of 6 tiles.

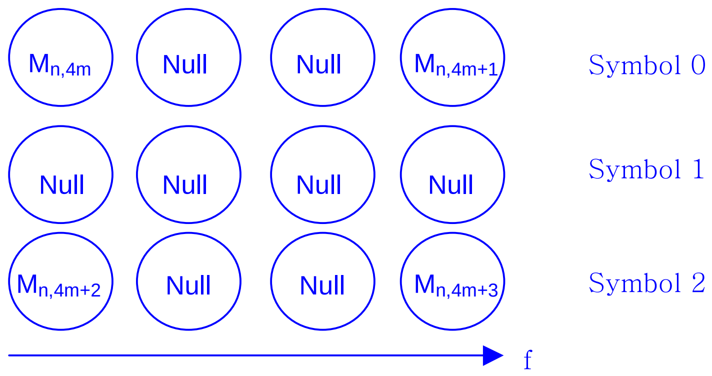


Figure zzz —Subcarrier Mapping of Secondary Fast-feedback Modulation Symbols for PUSC

The secondary Fast-feedback slot includes 4 bits of payload data, whose encoding depended on the instruction given in the FAST_FEEDBACK Fast-feedback subheader, the CQICH_Control IE(), the CQICH_Alloc_IE(), or through the CQICH_Enhanced_Alloc_IE(). Secondary Fast-feedback slots are mapped into the region marked by UIUC=0 in the UL-MAP after mapping the whole Fast-feedback slot, in a time-first order, as shown in Figure aaa.

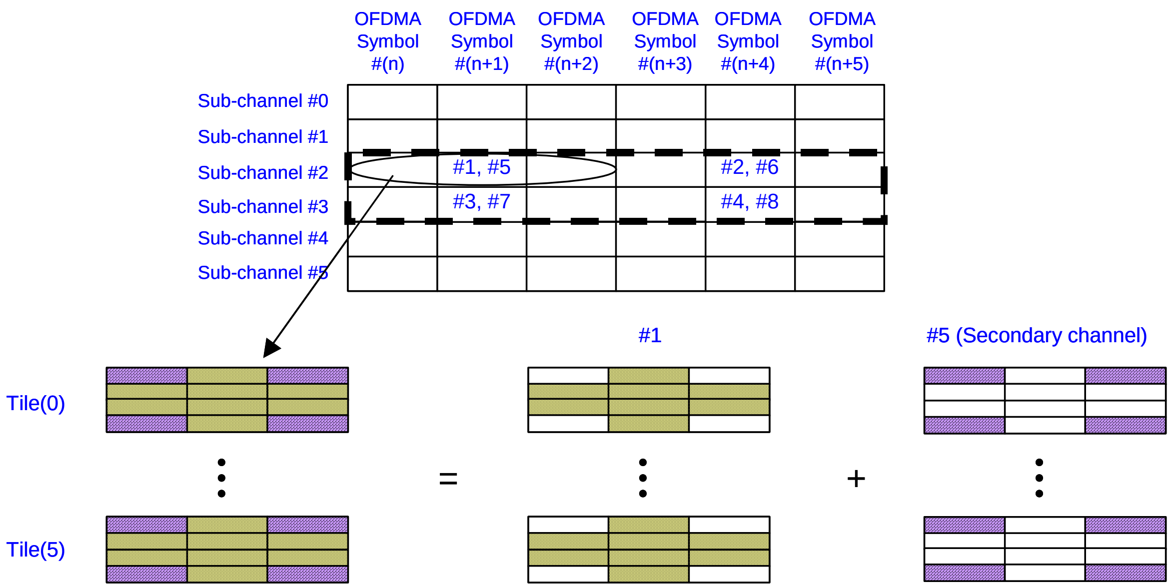


Figure aaa— Mapping order of Fast-feedback messages to the Fast-feedback region when using secondary Fast-feedback in UL PUSC mode

2.1 Remedy for UL ACK channel

[*Modify the Figure 231b in page 274 of '8.4.5.4.17 Optional Enhanced UL ACK channels' as following*]

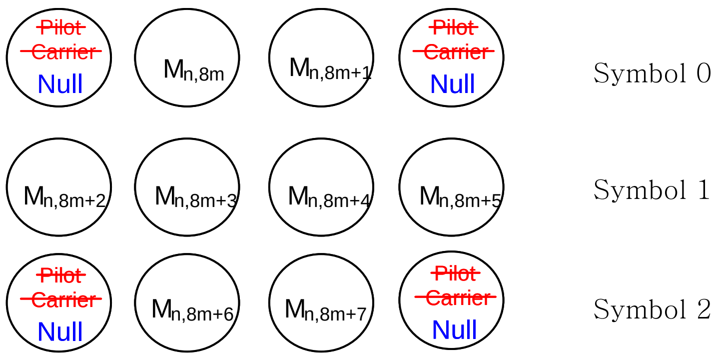


Figure 231b—Subcarrier Mapping of UL ACK Modulation Symbols for PUSC

[*Add the following after line 21 in page 275 of* '8.4.5.4.17 Optional Enhanced UL ACK channels']

The acknowledgement 1 bit is encoded into a length 3 codeword over a 4-ary alphabet for the error protection for the secondary UL ACK channel.

Table 298e- Secondary ACK channel subcarrier modulation

ACK 1-bit Symbol	Vector Indices per Tile Tile(0), Tile(1), Tile(2)
ACK	a,a,a
NACK	b,b,b

The secondary UL ACK channel is orthogonally modulated with QPSK symbols. Let $M_{n,4m+k}$ $(0 \le k \le 3)$ be the modulation symbol index of the k^th^ modulation symbol in the m^th^ uplink PUSC tile of the n^th^ secondary UL ACK channel. The possible modulation patterns composed of $M_{n,4m+k}$ in the m^th^ tile of the n^th^ secondary UL ACK channel are defined in Table 298f.

Table 298f- Orthogonal Modulation Index in Secondary UL ACK Channel

Vector index	$M_{n,4m}$, $M_{n,4m+1}$, $M_{n,4m+2}$, $M_{n,4m+3}$
a	P0, P0, P0, P0
b	P0, P2, P0, P2
c	P0, P1, P2, P3
d	P1, P0, P3, P2

where

$$P_0 = \exp\left(j\frac{\pi}{4}\right),\ P_1 = \exp\left(j\frac{3\pi}{4}\right),$$

$$P_2 = \exp\left(-j\frac{3\pi}{4}\right),\ P_3 = \exp\left(-j\frac{\pi}{4}\right).$$

$M_{n,4m+k}$ are mapped to secondary UL ACK channel tile as shown in Figure 231d for PUSC uplink subchannel. Secondary UL ACK channel is mapped to half subchannel composed of 3 tiles.

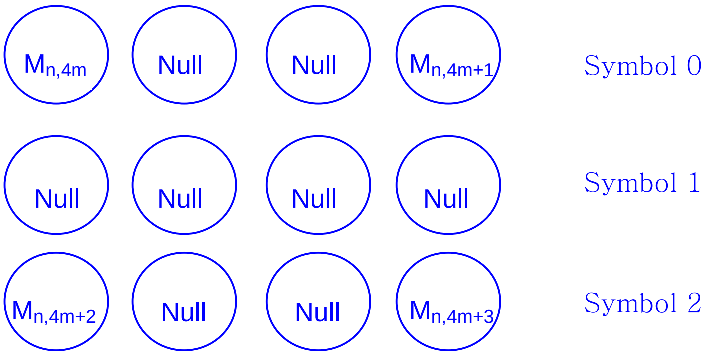


Figure 231d —Subcarrier Mapping of Secondary UL ACK Modulation Symbols for PUSC

[Apply the following to line 37-45 in the 6.3.2.3.43.7.5]

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

The H-ARQ enabled SS that receives H-ARQ DL burst at i-th frame should transmit ACK signal through the half-subchannel in the H-ARQ region at (i+j)-th frame. The frame offset 'j' is defined by the "H-ARQ ACK Delay for DL Burst" field in the UCD message. The half-subchannel offset in the H-ARQ Region is determined by the order of H-ARQ enabled DL burst in the H-ARQ MAP. For example, when a SS receives a H-ARQ enabled burst at i-th frame and the burst is n-th H-ARQ enabled burst in the H-ARQ MAP, the SS should transmit H-ARQ ACK at n-th half-subchannel in H-ARQ Region that is allocated by the BS at the (i+j)-th frame. In the H-AQR region of UL PUSC zone, the secondary UL ACK channels are assigned by the order of H-ARQ enabled DL burst in the H-ARQ MAP after completing assignment of UL ACK channels.

3. Simulation results

In the simulation for the secondary Fast-feedback, performances of 4 bit payload Fast-feedback channel and 4 bit payload secondary Fast-feedback channel are compared in AWGN and Veh-A (60km/h). Because the secondary channel has half number of carriers, transmit power per carrier of the secondary channel was boosted by 3dB to make total transmit power of two Fast-feedback channels be equal. As shown in Figure 2, there was a performance loss about 1dB because the secondary channel has smaller Hamming distance. Therefore, the secondary Fast-feedback channel is appropriate for the mode selection feedback or for MSS with good channel quality.

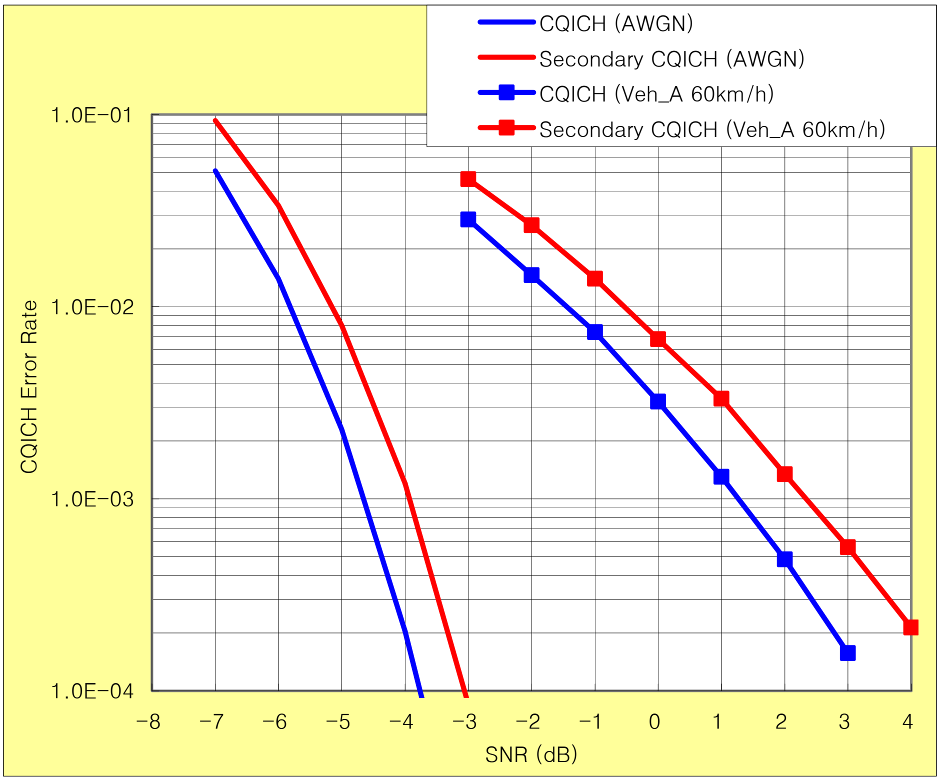


Figure 2. Fast-feedback and secondary Fast-feedback channel error rate for 4 bit payload

In the simulation for the secondary ACK channel, performances of UL ACK channel and secondary UL ACK channel are shown in Figure 3. AWGN and Veh-A (60km/h) with two receive antenna are considered and non-coherent detection are used. Because the secondary ACK channel has half number of carriers, transmit power per carrier of the secondary ACK channel was boosted by 3dB to make total transmit power of two ACK channels be equal. Figure 3 shows that there is almost no performance gap between ACK channel and secondary ACK channel.

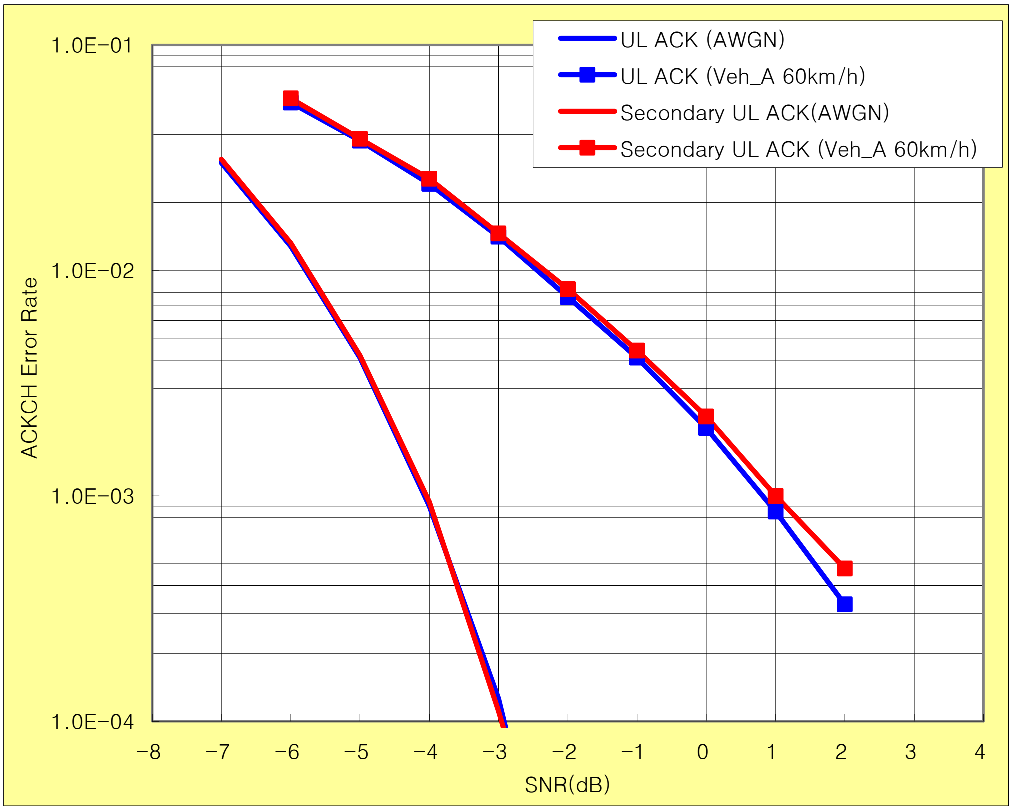


Figure 3. ACK channel and Secondary ACK channel error rate