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Title	**UL ACK Channel Enhancement**
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Re:	
Abstract	UL ACK Channel Enhancement
Purpose	Adopting of proposed method into P802.16e
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UL ACK Channel Enhancement

Introduction

In IEEE 802.16d/D5, section 8.4.5.4.13 describes UL ACK channels. However, current UL ACK channel employs orthogonal modulation using 9-ary PSK symbols which makes implementation complicated. In addition, each UL ACK channel modulation uses 9 symbols for orthogonal modulation which is fit only for the optional PUSC uplink subchannel, not for the PUSC uplink subchannel with each tile composed of 4 pilot symbols and 8 data symbols.

In this contribution, enhancement of the UL ACK channel is proposed to become fit for both uplink subchannel and easy implementation. Proposed UL ACK channel uses 8 symbols for orthogonal modulation which is fit for the PUSC uplink subchannel as well as optional PUSC uplink subchannel. Moreover, each symbol is selected among QPSK constellation rather than 9-PSK. Simulation results are provided to exhibit the performance of the proposed scheme.

Suggested change to the standard

[ADD the following text after 8.4.5.4.13]

8.4.5.4.14 Optional Enhanced UL ACK channels

The uplink ACK (Acknowledgement) provides feedback for Downlink Hybrid ARQ. This channel shall only be supported by SS supporting H-ARQ. The SS transmits ACK or NAK feedback for Downlink packet data. One ACK channel occupies half subchannel, which is 3 pieces of 3x3 uplink tile in the case of optional PUSC or 3 pieces of 4x3 uplink tile in the case of PUSC.
The acknowledgement bit of the n-th ACK channel shall be '0' (ACK) if the corresponding downlink packet has been successfully received; otherwise, it shall be '1' (NAK). This 1 bit is encoded into a length 3 codeword over 8-ary alphabet for the error protection as shown in Table xx.

Table xx – ACK channel subcarrier modulation

ACK 1-bit symbol	Vector Indices per Tile Tile(0), Tile(1), Tile(2)
0	0, 0, 0
1	4, 7, 2

The UL ACK channel is orthogonally modulated with QPSK symbols. Let $M_{n,8m+k}$ ($0 \le k \le 7$) be the modulation symbol index of the k-th modulation symbol in the m-th uplink tile of the n-th UL ACK channel. The possible modulation patterns composed of $M_{n,8m}$, $M_{n,8m+1}$, … , $M_{n,8m+7}$ in the m-th tile of the n-th UL ACK channel are defined in Table aa.

Table aa—Orthogonal Modulation Index in UL ACK Channel

Vector index	$M_{n,8m}$, $M_{n,8m+1}$, …, $M_{n,8m+7}$
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

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

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

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

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

$M_{n,8m+k}$ is mapped to UL ACK channel tile as shown in Figure bb1 for PUSC uplink subchannel and in Figure bb2 for optional PUSC uplink subchannel. An UL ACK channel is mapped to half subchannel composed of 3 tiles.

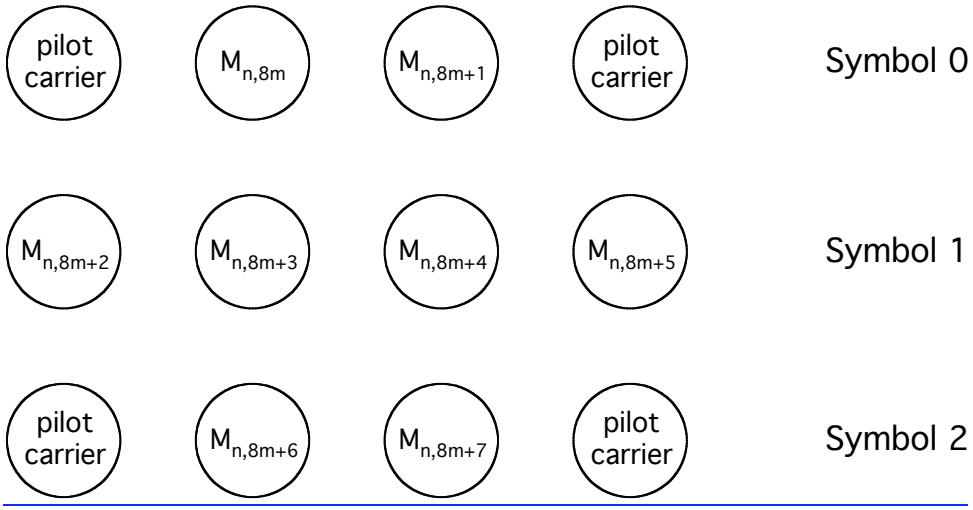

Figure bb1—Subcarrier Mapping of UL ACK Modulation Symbols for PUSC

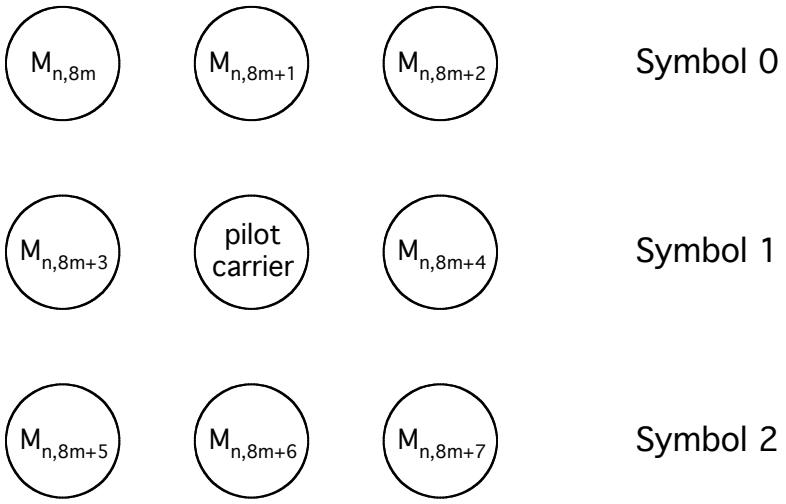

Figure bb2—Subcarrier Mapping of UL ACK Modulation Symbols for Optional PUSC

[Add a new section 11.8.3.7.6 in page 687 of [1]]

11.8.3.7.6 Uplink control channel support

This field indicates the different uplink control channels supported by a WirelessMAN-OFDMA PHY SS for uplink transmission. A bit value of 0 indicates "not supported" while 1 indicates "supported."

Type	Length	Value	Scope
xxx	1	Bit #0: FAST_FEEDBACK Bit #1: Enhanced FAST_FEEDBACK Bit #2: UL ACK Bit #3: Enhanced UL ACK Bit #4-7: Reserved; shall be set to zero	SBC-REQ (see 6.3.2.3.23) SBC-RSP (see 6.3.2.3.24)

Performance

Simulation results of UL ACK channel link performance are shown in Figure cc. In the simulations, AWGN and Ped-B (3km/h) channels with 2 receive antennas are considered. Figure cc shows UL ACK error rate versus SINR (Signal to Interference and Noise Ratio per subcarrier) with 9-ary and 8-ary schemes. 9-ary denotes the current scheme in 802.16d D5, whereas 8-ary denotes the proposed scheme in this contribution. We can see that in most region, the proposed scheme and the current scheme have almost the same performance. Therefore the proposed scheme can become fit for both uplink subchannel and easy implementation at no cost of performance.

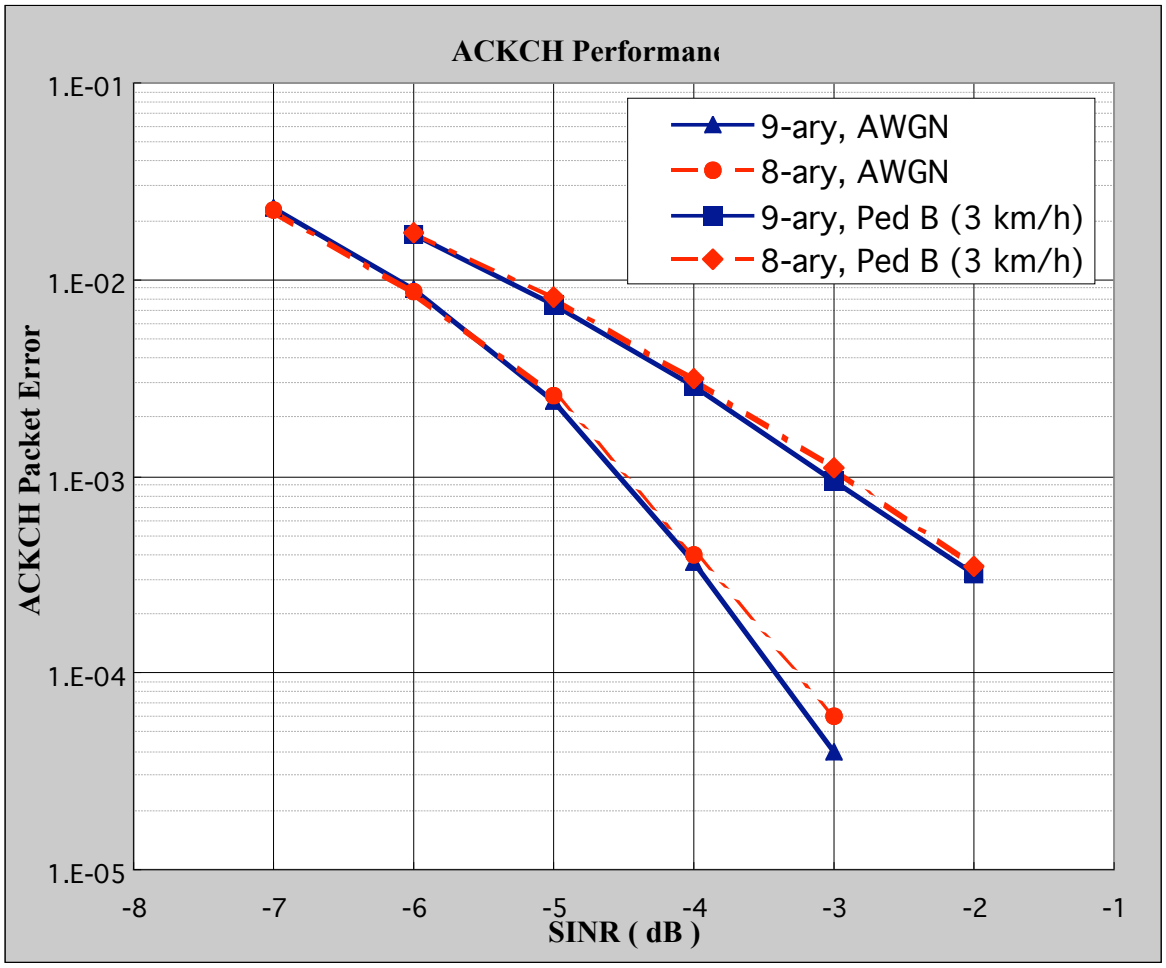

Figure cc—UL ACK channel link performance