Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Proposed SDD Text for UL Control**
Date Submitted	**2008-09-17**

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Re:	SDD Session 56 Cleanup, Call for PHY details; in response to the TGm Call for Contributions and Comments 802.16m-08/033 for Session 57
Abstract	This contribution proposes SDD text for UL Control channel and sounding channel
Purpose	For discussion and approval into TGm SDD text
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Proposed SDD Text for UL Control Structure

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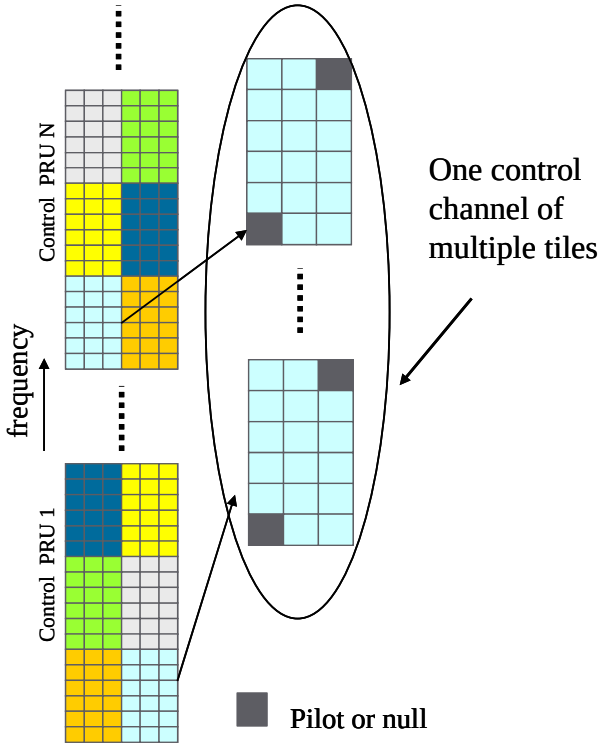
1. Introduction

This contribution proposes uplink control structure, including uplink control tile, pilot pattern and uplink sounding channel.

2. Uplink control tile structure

After permutating PRUs into localized and distributed groups, a set of pre-configured distributed PRUs are assigned for uplink control message transmission. Each of these PRUS consists of six 6x3 control tiles. Each control message is carried by a control channel. Each control channel consists of multiple control tiles which are distributed to one or more control PRUs. Two pilot tones are allocated in each control tile as shown in the following figure. Different control channel for different MS can the same control PRU.



2. Uplink control tile: 6x3 vs. 3x6 and other tile options

Uplink control tile size is chosen according to several considerations

- Provide enough diversity
- Provide pilots when needed. The pilot can provide coherent detection, or pilot assisted non-coherent

detection. When pilot tone is vacant, more transmission power can be used for allocated to control message

- Provide reliable or better connection at mobility speed up to 350km/h. Control channel is the key to keep system connected.

For evaluating performance different between 6x3 tile and 3x6 tile, we choose Reed-Muller code RM(5, 1) concatenated by repetition 2 code as encoding sequence. Each encoded binary sequence is modulated by QPSK and mapped to two control tiles, either 3x6 tile or 6x3 tile. Simulation results with coherent detection show 6x3 tile perform better than 3x6 tile at high speed of 240km/y and 350km/h due to 6x3 span less OFM symbols in time direction.

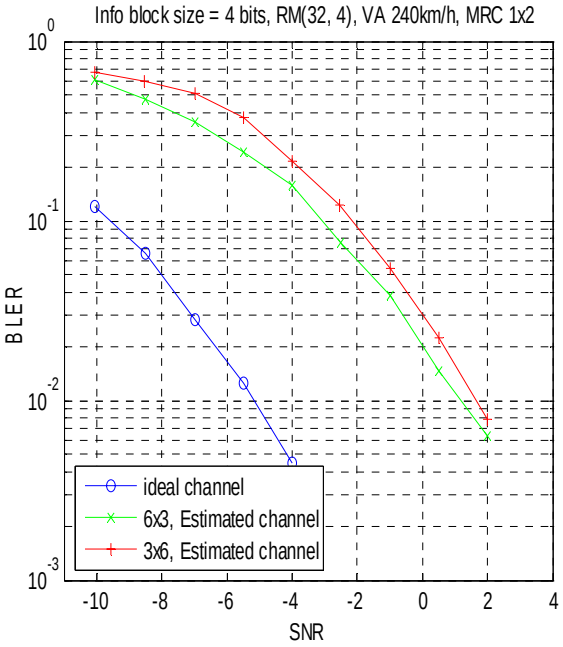


Figure 1 UL control tile: 6x3 vs 3x6 at 240km/h

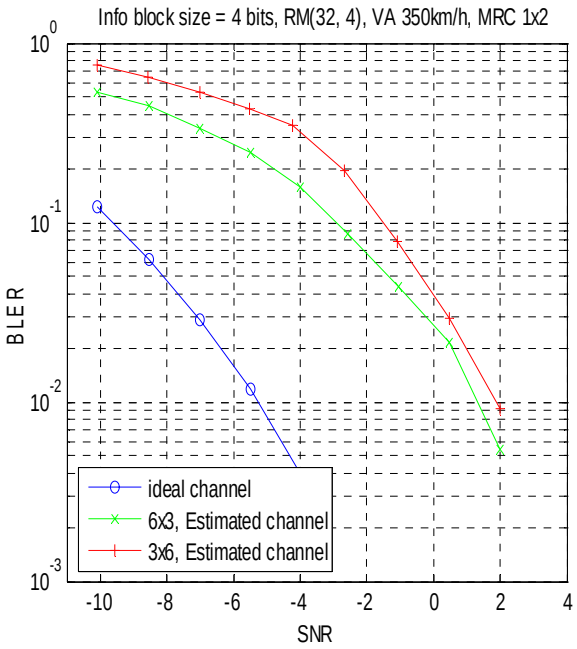


Figure 2 UL control tile: 6x3 vs. 3x6 at 350km/h

3. Uplink control tile: 6x3 + orthogonal sequence vs. 2x6 + semi-orthogonal sequence

Uplink control tile size and sequence design should be optimized together. For non-coherent detection, as referred at low SNR operation range, orthogonality of encoding sequence play an important role of control channel performance. As an example, we compare two cases:

Case 1: Reed Muller (5, 1) code based orthogonal sequence for 4 bits, 6x3 tile (with two pilot tones), diversity order 2, QPSK. Note that other sequence for 5 or more bits can be generated by higher order Reed-Muller codes.

Case 2: Hadamard + Reed-Solomon based semi-orthogonal sequence for 5 bits(first 16 sequences are used for 4 bit packet, may not optimal), 2x6 tile, diversity order 3, BPSK (refer to IEEE C802.16m-08/982r2).

Simulation condition: 1x4 MRC, MLD sequence detection. Non-coherent detection (no pilot assist), data packet size = 4 bits. Results are adjusted to Eb/No for fair comparison between QPSK and BPSK

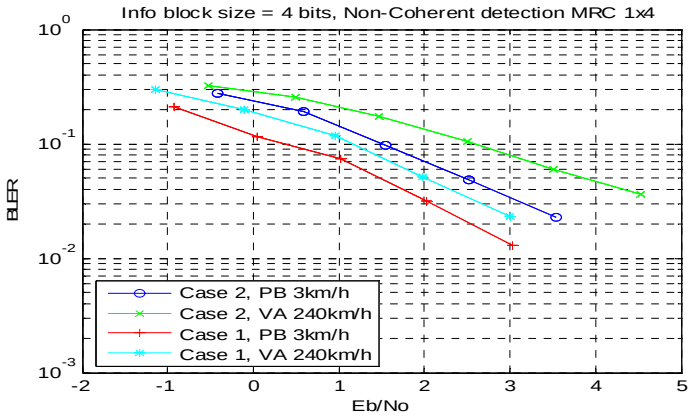


Figure 3 UL control tile size + sequence comparison

From Figure 3, It can be seen that orthogonal sequence based on RM code in case 1 outperform semi-orthogonal sequence in case 2. Case 2 has more diversity while case 1 has long sequence. Also note that pilot assisted non-coherent detection is possible for case 1.

On the other hand, by comparing performance under different mobile speeds, it can be seen that 6x3 tile is more robust than 2x6 tile. This is because non-coherent detection depends on the good correlation of sequences and variation among more symbols has more negative impact when the tile span more symbols

It is recommended that 6x3 tile is used as UL control tile and Reed-Muller code based sequence should be used for encoding sequence.

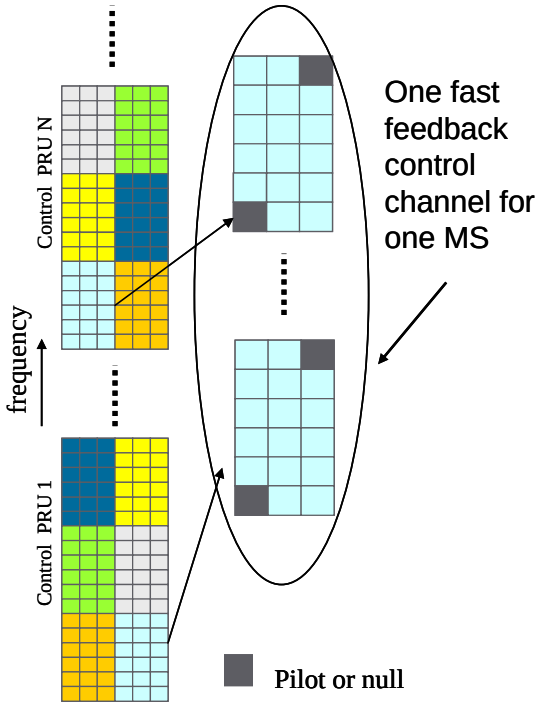
Text Proposal modification to SDD

---------- Start of text proposal----------

(L25, P76 of 003r4)

11.9.2.1.2 PHY structure

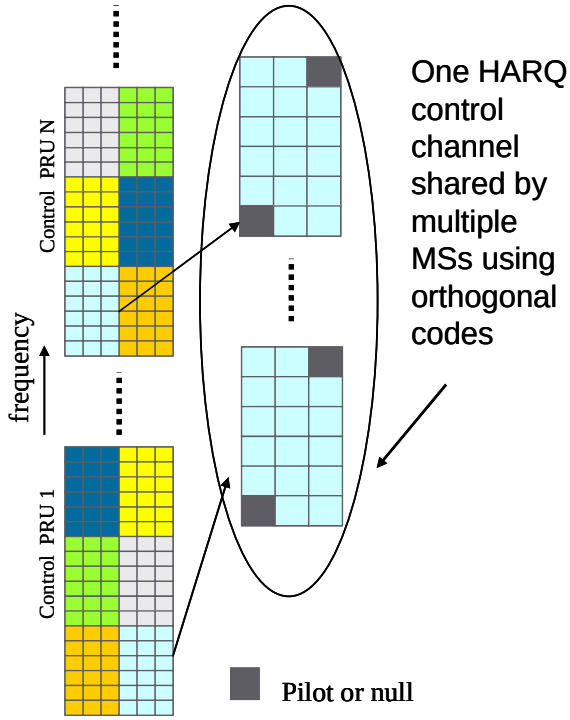
UL fast feedback channel consists of 2/4/8 control tiles, which are distributed in multiple control PRUs. Each UL fast feedback channel is occupied by one MS. Control tile and pilot for fast feedback channel is shown in the following figure. Control tiles in one control PRU are shared by different UL control channels.



(L36, P76 of 003r4)

11.9.2.2.2 PHY structure

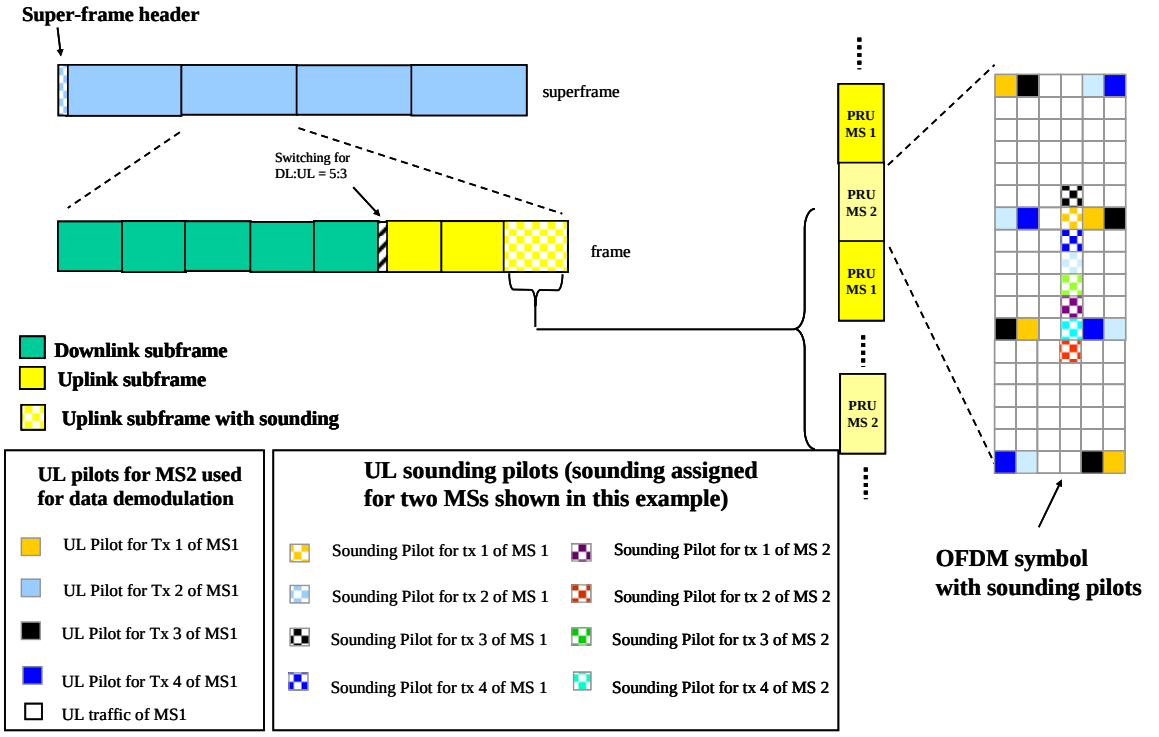
UL HARQ channel consists of multiple UL control tiles, which are distributed in multiple control PRUs. Each HARQ channel is shared by multiple MSs by orthogonal codes.



(L36, P76 of 003r4)

11.9.2.3.2 PHY structure

Sounding from single or multiple antennas and multiple users are supported to provide full MIMO channel information for DL transmission. Power allocation, sounding sequence design ~~and mapping to subcarriers~~ is TBD. An example of subcarrier mapping is shown in the following figure:



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