Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Uplink pilot structure for 802.16m**
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Re:	IEEE 802.16m-08/016r1 –Call for Contributions on Project 802.16m System Description Document (SDD); Uplink Pilot Structures
Abstract	This contribution covers the considerations about the uplink Pilot design for IEEE 802.16m
Purpose	To be discussed and adopted by TGm for use in the IEEE 802.16m SDD
Notice	
Release	
Patent Policy	

Uplink pilot structure for 802.16m

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1. Introduction

This contribution proposes an uplink pilot structure for IEEE 802.16m SDD.

- The pilot structure presented in this proposal is based on uplink resource unit size 18subcarriers by 6 OFDMA symbols(For convenience, in the following, resource unit size will be represented as 18×6). The 18×6 resource unit is the basic resource unit which is called BRU in the following.
- The BRU is flexible to be divided into several sub-blocks with size 9×6, 6×6 or 18×3. The 18×3 sub-block can be used for inner-subframe frequency diversity .The other two types of sub-block can be used for either inner-subframe or inter-subframe diversity, and they also can be used for sub-frame aggregation.
- The pilot overhead is 5.56% for 1 Transmit antenna case and 11.12% for 2 Transmit antenna case.

2. Proposed pilot structure

2.1 Proposed pilot structure for 1 Transmit antenna

The pilot structure for 1 Transmit antenna is shown in Figure 1, it has the following features:

- Low pilot density(1/18) with respect to 16e(PUSC-1/3 Optional 1/9).
- The pilot structure is suitable for isolated RU demodulation without the adjacent resource units' aids.
- In this figure and the following figures, horizontal direction is OFDM symbol, vertical direction is subcarrier.

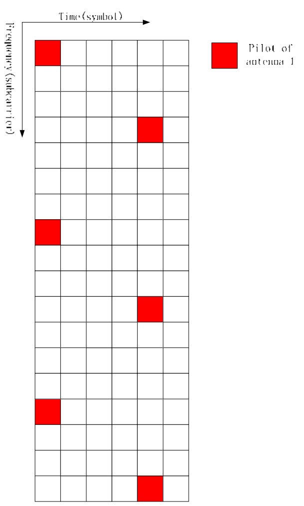


Figure 1

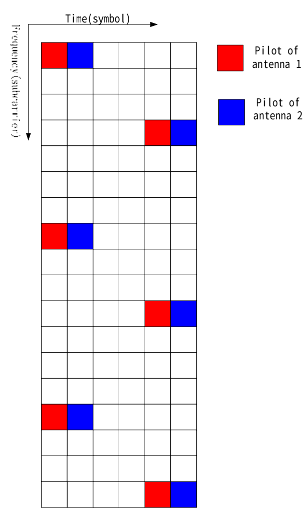


Figure 2

2.2 Proposed pilot structure for 2 Transmit antennas

The pilot structure for 1 Transmit antenna is shown in Figure 1,it has the following features:

- Total pilot density is 1/9 with similar structure for two antennas.
- The pilot structure is suitable for isolated resource unit demodulation without the adjacent resource units' aids.
- Easy to be used for STBC.

2.3 Pilot structure for sub-block

- The BRU is flexible to be divided into several sub-blocks with size 9×6, 6×6 or 18×3.

Figure 3-a, 3-b, 3-c are respectively pilot structures for 18×3, 9×6 and 6×6 sub-block. They are established based on the pilot structure of BRU. For example, in Figure 3-a, at first the pilot structure of 18×6 BRU is divided into 2 or 3 sub-blocks; and then these sub-blocks' pilot maps will be put together into a sub-block; in the end, some pilot positions will be modified to maximize the space in the time and frequency domain and redundant pilot positions will be erased.

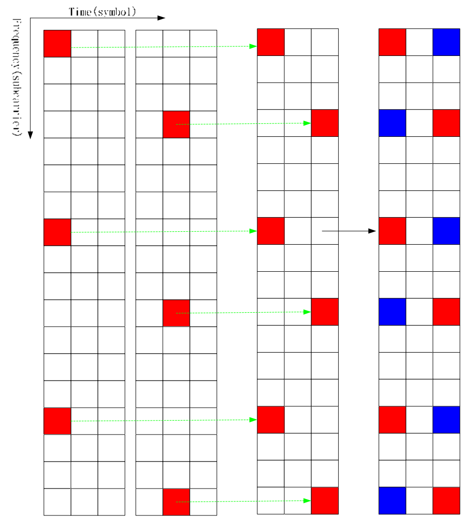


Figure 3-a

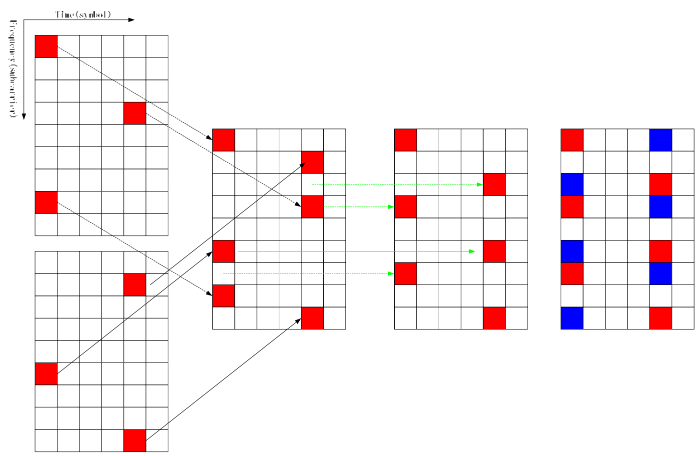


Figure 3-b

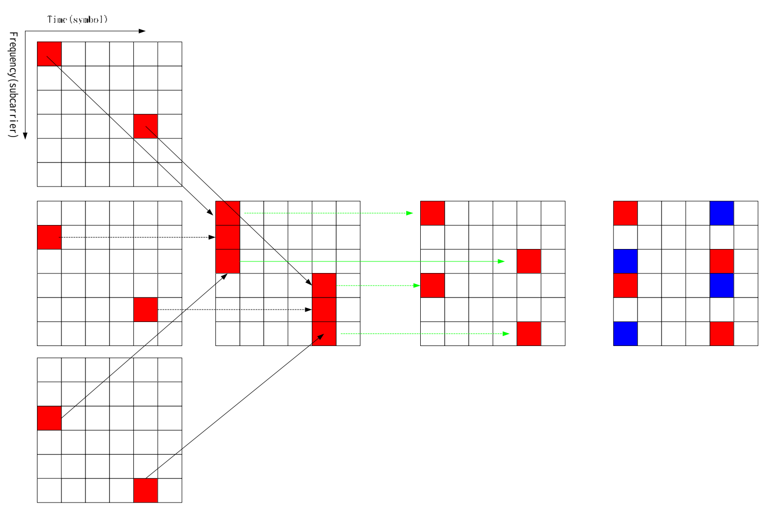


Figure 3-c

2.4 Sub-block for diversity

- One BRU can be equally divided into two 9×6, two 18×3 or three 6×6 sub-blocks with the same pilot density as BRU. The 6×6, 9×6 or 18×3 sub-blocks can be used for diversity. The 18×3 sub-block is used in inner-subframe diversity. The other two types of sub-block can be used in either inner-subframe or inter-subframe diversity.

Figure 4-a is a inner-subframe diversity example for three 6×6 sub-blocks, Figure 4-b is a inner-subframe diversity example for two 9×6 sub-blocks, Figure 4-c is a inner-subframe diversity example for two 18×3 sub-blocks.

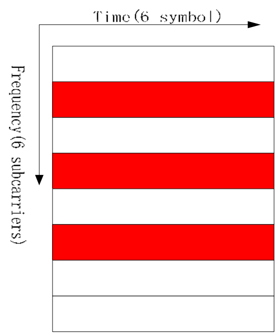


Figure 4-a

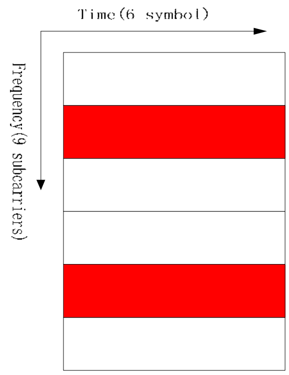


Figure 4-b

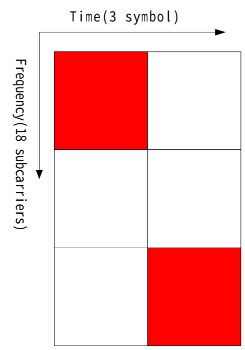


Figure 4-c

Figure 4-d is a inter-subframe diversity example for 6×6 and 9×6 sub-blocks and it also include inner-diversity for 9×6 sub-blocks because the diversity frequency band is common for the contiguous 3 OFDM symbol. When the diversity is applied to odd number of contiguous OFDM symbols, the inner-subframe diversity will occur for 9×6 sub-block. When the diversity is applied to non-triple number of contiguous OFDM symbols, the inner-sub-frame diversity will occur for 6×6 sub-block.

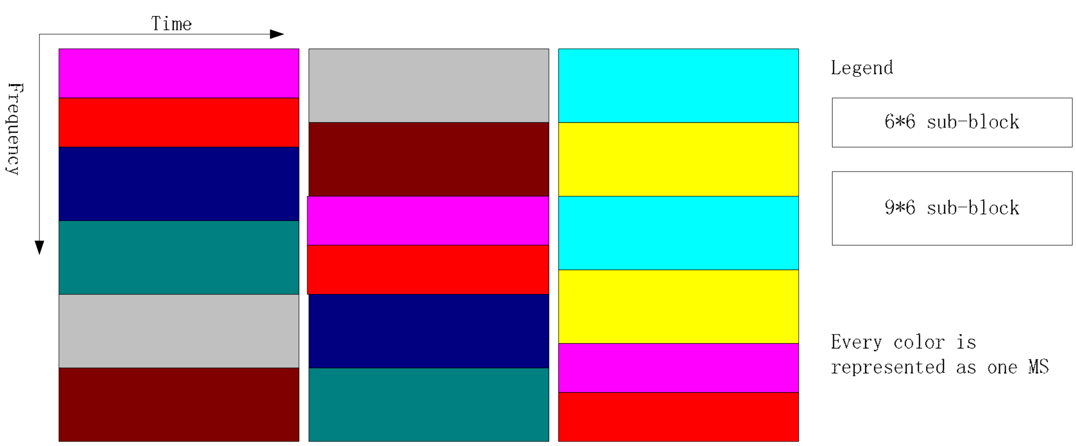


Figure 4-d

2.5 sub-block for sub-frame aggregation

- One sub-frame is constituted with 6 adjacent OFDMA symbols as shown in BRU.
- The 6×6 (9×6)blocks in adjacent triple(even) sub-frames could be aggregated for time domain spread and flexible resource allocation.
- Figure 5-a is the aggregation of 6×6 mini blocks in 3 adjacent sub-frames.
- Figure 5-b is the aggregation of 9×6 mini blocks in 2 adjacent sub-frames.

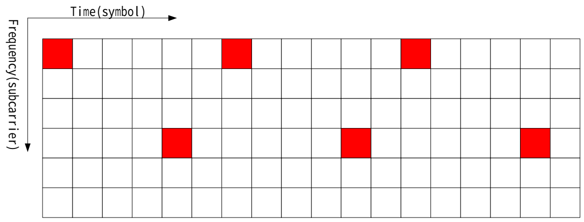


Figure 5-a

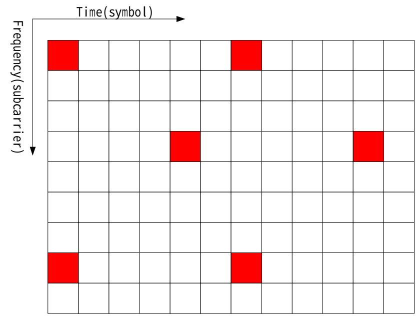


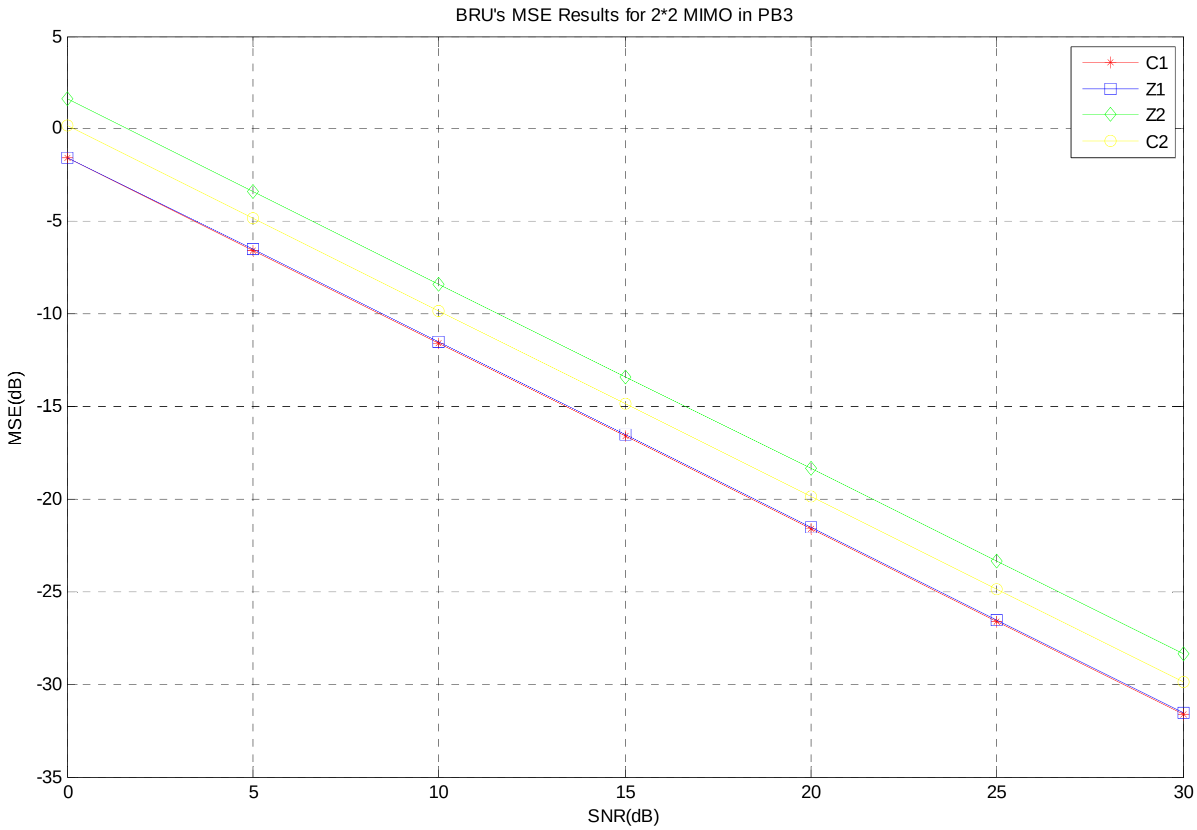
Figure 5-b

3. Simulation results

Table 1 some simulation parameters

Central carrier frequency	2.5 GHz
Band width	10 MHz
FFT size	1024
Sampling rate	11.2 MHz
CP length	1/8
Symbol interval(include CP)	0.10286 ms
Frame length	5ms
Antenna	2 Transmit antennas and 2 Receive antennas
Fading propagation channel	Modified Pedestrian B 3kmph
RU size	18 subcarriers by 6 OFDMA symbols
Modulation scheme	QPSK 1/3
Channel estimation method	LS. Isolated RU channel estimation and interpolation.
Data and Pilot power	Keep the total power of data and pilot tones a constant value in one OFDMA symbol and pilot power in any pilot structures are a constant value. That is, data power may be different between some pilot structures.

Figure 6 shows the MSE results of 4 pilot structures. The Z1 pilot structure is the proposed structure shown in Figure 2. The C1, C2, Z2 pilot structures are shown in Annex A. The Z2 pilot structure can be easily used for SFBC. The results show that the proposed structure has the same best performance as C1, and has the additional advantage of supporting STBC comparing with C1. The Z2 pilot structure has the poorest performance.



Text Proposal for the 802.16m SDD

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Section 11.x: Uplink Resource Block

Section 11.x.1 UL pilot structure for STC/MIMO

Basic resource unit (BRU) is 18 subcarriers by 6 symbols.

- The UL pilot structure of BRU for 1 antenna is shown in Figure xxx.1.
- The UL pilot structure of BRU for 2 antennas is shown in Figure xxx.2.
- These pilot structures can be equally divided into two 9×6, two 18×3 or three 6×6 sub-blocks. The 18×3 sub-block can be used for inner-subframe frequency diversity .The other two types of sub-block can be used for either inner-subframe or inter-subframe diversity, and they also can be used for sub-frame aggregation. The 18×3 sub-block's pilot structure are shown in Figure xxx.3-a, The 9×6 sub-block's pilot structure are shown in Figure xxx.3-b, The 6×6 sub-block's pilot structure are shown in Figure xxx.3-c.

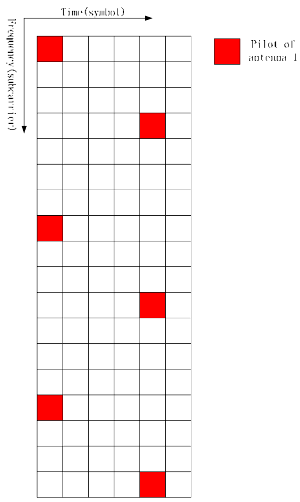

Figure xxx.1

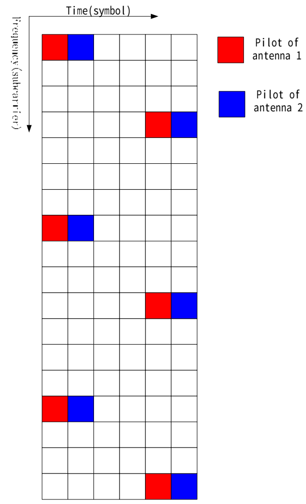

Figure xxx.2

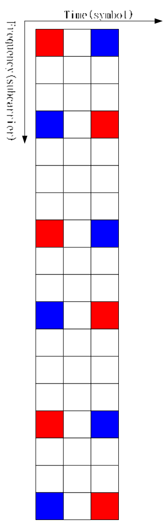

Figure xxx.3-a

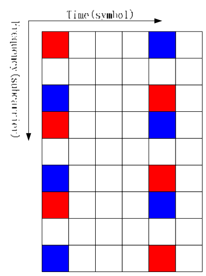

Figure xxx.3-b

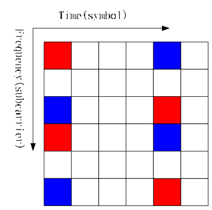

Figure xxx.3-c

Annex A

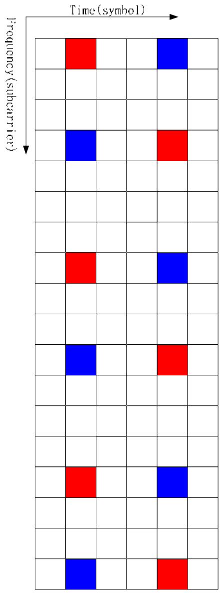

Figure A.1 pilot structure C1

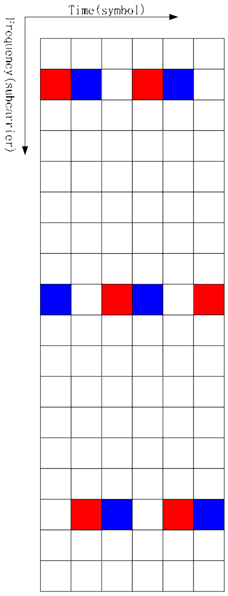

Figure A.2 pilot structure C2

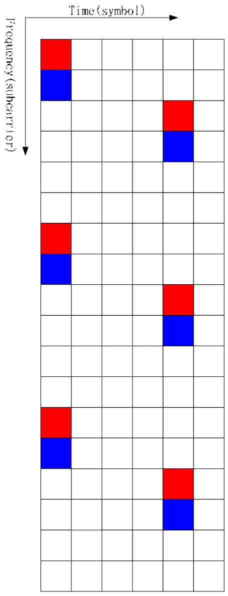

Figure A.3 pilot structure Z2