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Abstract	A pilot allocation method for FUSC to average interference between neighbor cells
Purpose	Discussion, Decision and Adoption
Notice	
Release	
Patent Policy and Procedures	

Pilot Arrangement in FUSC to Average Interference Between Neighbor Cells

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1. Introduction

In 802.16e-D5, the defined pilot positions are identical for all base stations, and different scrambling sequences modulated on the pilots used for channel estimation are used for different base stations.. So the interference between pilots of neighbor cells is significant because the pilot positions of different neighbor base stations overlap almost completely with a very high probability, which will degrade the channel estimation performance greatly, especially in the case of frequency reuse factor one.

In [1], pilot arrangement related to a cell-specified parameter is used to separate the pilots of different cells in frequency to reduce the interference between pilots to some degree. But since there are very few different pilot arrangement patterns, the collision probability of pilots from different cells is still very high.

In this contribution, first we construct many more pilot arrangement patterns with very few intercell collisions, then we give a randomized allocation method of the constructed pilot arrangement patterns. This random method will average the interference on the current cell which are from the pilots transmitted in neighboring cells. So the interference between pilots of neighboring cells is reduced by the proposed pilot arrangement.

2. Proposed Solution

First, given a base permutation sequence $p = (6,9,4,8,10,11,5,2,7,3,1,0)$, construct the set of sequences with good correlation property by shifts in two dimensions. Let $p_s[i]$ be the series obtained by rotating cyclically p to the left s times, then the set of sequences we need with length 12 is
$P_k[i] = (p_{\lfloor k/12 \rfloor}[i] + k \bmod 12) \bmod 12, i = 0,1,...,11, k = 0,1,...,143$.

So in FUSC, the downlink pilot arrangement patterns are defined by the following formula

$$PilotLocation = VariableSet\#x + P_k[FUSC\_SymbolNumber \bmod 12]$$

Where *VariableSet #x* is defined in 802.16-REVd-D5 8.4.6.1.2.2 [2]. *FUSC_SymbolNumber* counts the FUSC symbols used in the transmission starting from 0.

Now we have many more pilot arrangement patterns. In principle, a simple allocation method which is that different cells can be allocated different pilot arrangement pattern can be used to reduce the collision probability. But since the pilot arrangement patterns are derived by time and frequency shifts of a base pilot arrangement pattern, the complete overlapping of pilots can occur with the simple pilot pattern allocation method, due to the time and frequency non-synchronization of different base stations. So we consider the randomization method to average the interference of pilots. If the pilot arrangement patterns between two base stations overlap completely in one time interval (now the time interval is 12 OFDM symbols), they will again overlap completely in the next interval with only a very small probability due to the proposed randomization.

The index k to indicate the pilot arrangement patterns are determined by the following formula,
$k = z(CellID, Segment, \lfloor FUSC\_SymbolNumber / 12 \rfloor)$

Where *CellID* is from 0 ~ 31, *Segment* is 0,1,2. *CellID* and *Segment* can be determined by preambles.

So 12*12 = 144 number of pilot patterns are given for a 12 number of symbol time interval. In each 12 number of symbol time interval pilot positions are allocated by one pilot pattern determined by a index k, which is a pseudo-random variable z determined by *CellID, Segment, FUSC_SymbolNumber*.

The function $z(l,m,n)$ should be obtained by an pseudo-random sequence. Suppose $x(i)$ is the m-sequence generated by $1+X^3+X^{10}$ and $y(i)$ is the m-sequence generated by $1+X^2+X^3+X^6+X^8+X^9+X^{10}$, with initial register state all "1". $z(l,m,n)$ can then be represented in a binary format as follows

$$z(l,m,n)=(b_7b_6b_5b_4b_3b_2b_1b_0)\bmod 144, b_i=[x(n\cdot 8+l\cdot 3+m+i)+y(n\cdot 8+2^9+i)]\bmod 2.$$

3. Proposed Text Changes

Insert the following text in

8.4.6.1.2.2 page 217, line 43

$$PilotLocation = VariableSet\#x + P_k(FUSC\_SymbolNumber \bmod 12)$$

$$P_k[i]=(p_{\lfloor k/12\rfloor}[i]+k \bmod 12)\bmod 12, i=0,1,...,11,$$

$p_s[i]$ is the series obtained by rotating cyclically p to the left s times, $p=(6,9,4,8,10,11,5,2,7,3,1,0)$.

$$k = z(CellID, Segment, \lfloor FUSC\_SymbolNumber/12 \rfloor)$$

FUSC_SymbolNumber counts the FUSC symbols used in the transmission starting from 0. *CellID* is from 0 ~ 31, *Segment* is 0,1,2.

$x(i)$ is the m-sequence generated by $1+X^3+X^{10}$ and $y(i)$ is the m-sequence generated by $1+X^2+X^3+X^6+X^8+X^9+X^{10}$, both with initial register state all "1".

$$z(l,m,n)=(b_7b_6b_5b_4b_3b_2b_1b_0)\bmod 144, b_i=[x(n\cdot 8+l\cdot 3+m+i)+y(n\cdot 8+2^9+i)]\bmod 2.$$

4. Reference:

[1] Ran Yaniv, Tal Kaitz, Naftali Chayat, Vladimir Yanover, Mariama Goldhammer, Pilot Arrangement in FUSC-Reply to Comment #433, IEEE 802.16e/238
[2] IEEE 802.16-REVd_D5
[3] IEEE 802.16e_D5