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Title	**Reference Signals for Fast Timing Synchronization in OFDMA**
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Re:	*This is a response to a Call for Comments IEEE802.16e-04/xx on IEEE P802.16e-D2*
Abstract	*Reference Signals for Fast Timing Synchronization in OFDMA*
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Reference Signals for Fast Timing Synchronization in OFDMA

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1. Introduction

In order to perform a handover or a power-on procedure, an MSS shall scan BSs to obtain its synchronization and CINR. For adopting OFDMA specified in the current 802.16 standard, an MSS can synchronize with a BS by using preamble allocated to a single symbol in each frame. The acquisition of preamble is a very essential and important process because the flow of most signals between BS and MSS starts after timing synchronization.

An MSS scan periodically a BS's signal until preamble's acquisition, i.e., an MSS obtain a symbol synchronization by moving window in each sample and reiterate the process until to acquire preamble. For example, in case of 2048 samples in symbol, an MSS compute correlation value in every sample and find symbol timing if correlation value is peak. The process is repeated during 2048 times the remained symbols to next preamble. If the MSS does not detect the preamble, it should wait for the next frame. Additionally, if there are several BSs that an MSS needs to synchronize with, it should repeat the procedures for synchronization per each BS, which makes the MSS waste power.

2. Proposed Remedy

The number of used subcarriers of PUSC, FUSC and optional FUSC are different. i.e., the number of left and right guard subcarriers of PUSC is each 184, 183, ones of FUSC is each 173, 172 and ones of optional FUSC is each 159, 160. So some extra guard band of PUSC and FUSC may utilize other usages like reference signals and that don't affect in the current structure of OFDMA system specified in IEEE 802.16 standard.

So we propose that reference signals consists of some extra guard band of PUSC and FUSC in comparison with optional FUSC. They may be spread in time on every DL subframe and they are allocated to the extra subcarriers. They represent the number of remained symbols to next preamble. Therefore an MSS know next preamble's location and wait during remained symbols' duration without the procedure for symbol synchronization. And proposed remedy makes an MSS to save power in comparison with current process.

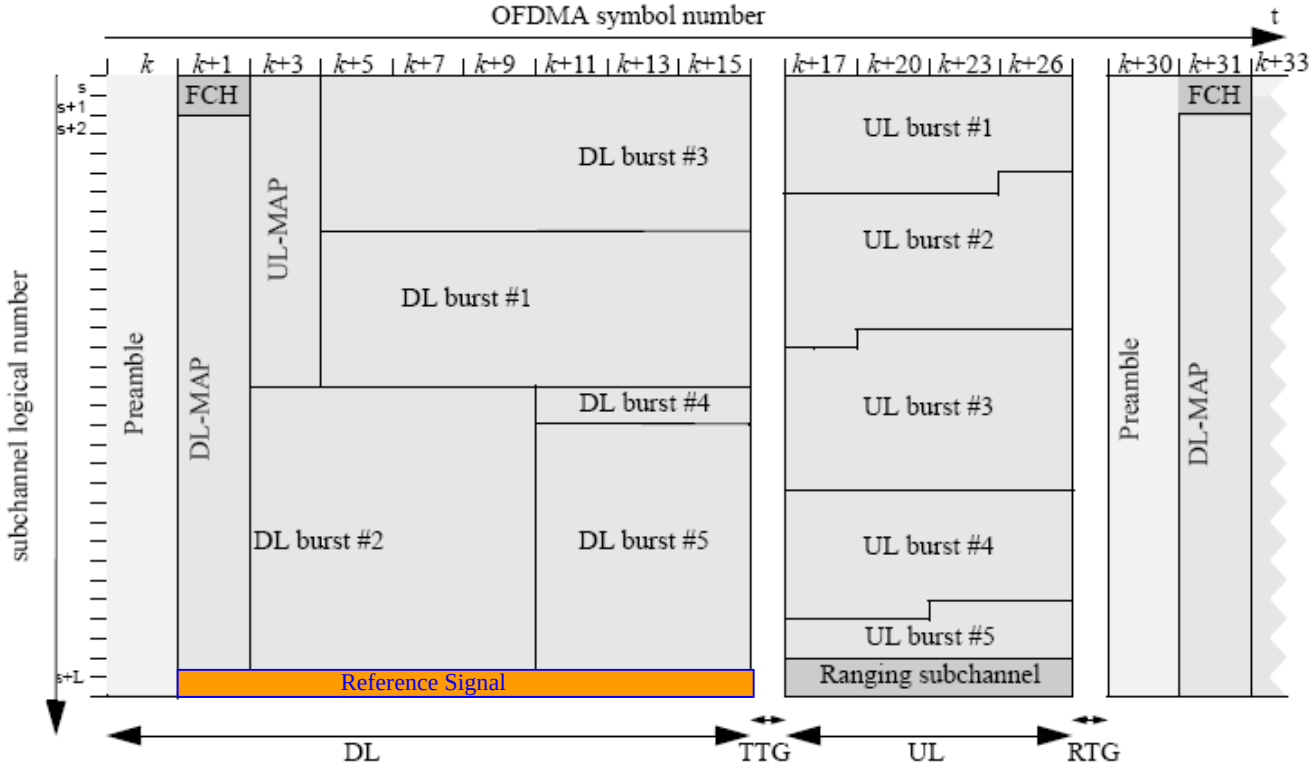


Figure 1. Example for reference signals allocation in OFDMA

Proposed Text :

[Add a new section 8.4.6.1.1.1 Optional reference signals]

8.4.6.1.1.1 Optional reference signals

Reference signals in symbols are allocated to the reserved subcarriers in downlink subframe. In case of 2048 FFT size in PUSC and FUSC, the number of symbols in a frames is approximately 50. Therefore 6 bits are enough to represent the number of remained symbols to next preamble. For reliable transmission, each bit in 6-bit binary representation is mapped to 4 modulation signals following the rule that 0 is to 0 0 0 0 and 1 is to +1 -1 -1 -1, where 0 modulation signal means not to transmit. Then 24 subcarriers are reserved for reference signals that are defined in Table xxx.

Table xxx – Reference signals allocation

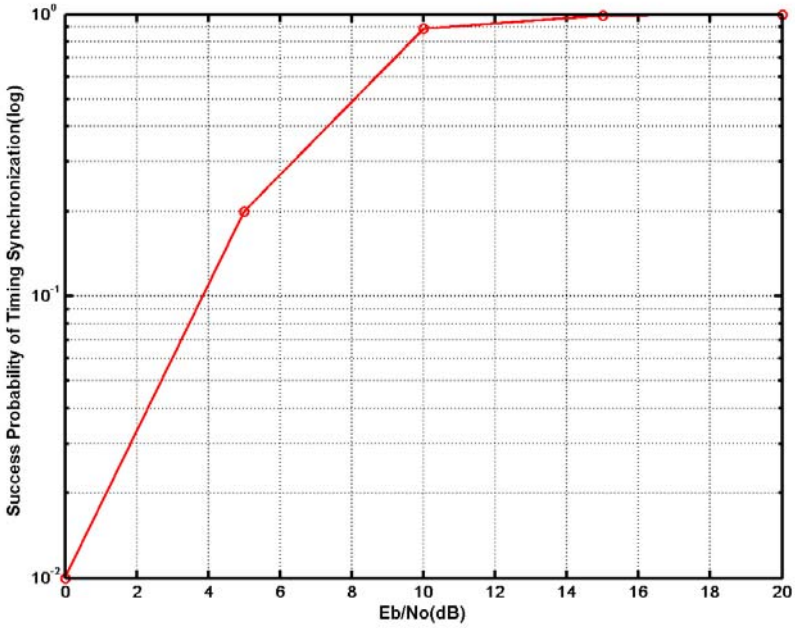
Parameter	Value	Comments
Reference Signals	24 subcarriers	For Reference Signals, {173:184, 1865:1876} among 2048 subcarriers are allocated.

3. Simulation Result

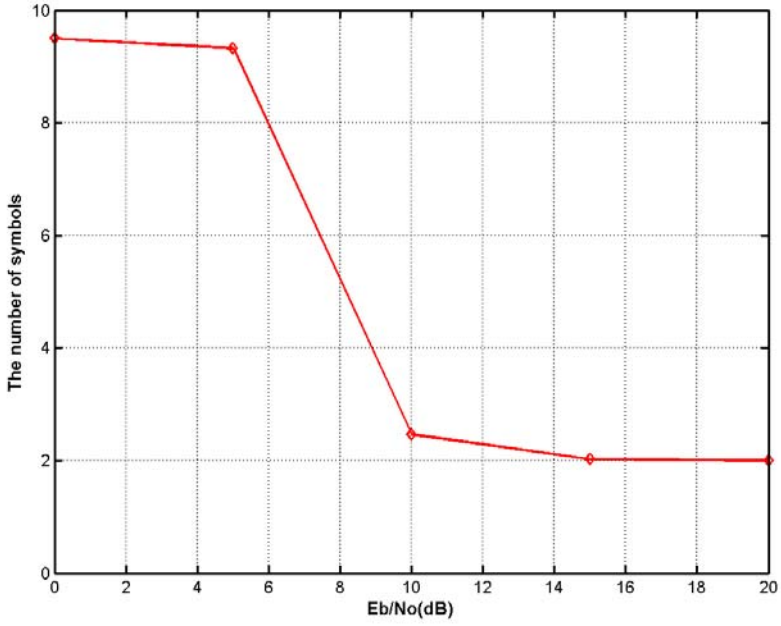
We suppose that OFDMA downlink channel consists of 30 symbols per frame, the channel model is two-tap multipath fading and modulation is BPSK. To synchronize Cyclic Prefix in symbol is used to Beek's algorithm [1]. And then the MSS performs 2048-FFT for that symbol. If the MSS can catch reference signals and read them correctly, the MSS synchronize with BS. For more correct synchronization, an MSS perform the process in next

symbol. If an MSS read reference signals successfully in two continuous symbols, the MSS synchronize perfectly with BS.

The graph 1 represents the probability of reading reference signals correctly during continuous two symbols and the graph 2 represent the average number of scanned symbols when reading reference signals correctly. In current spec, an MSS start to scan in average 15th symbols, the MSS find preamble after scanning average 15 symbols. If an MSS use reference signals, an MSS can get some gain of power saving because it does not scan during remained symbols. For example, if Eb/No is 10dB, the probability of reading reference signals in frame is 89% and an MSS find correct reference signals after scanning average 2.464 symbols. Therefore an MSS can wait for average 12.536 symbols without scanning them and the MSS makes profit of 83.57% power saving.



Graph 1. The probability of reading reference signals



Graph 2. The average number of remained symbols to next preamble

4. Reference

[1] J. Beek, P. Borjesson, M. Boucheret, D. Landstrom, J. Arenas, P. Odling, C. Ostberg, M. Wahlqvist, and S. Wilson, “A time and frequency synchronization scheme for multiuser OFDM,” *Selected Areas in Communications*, IEEE Journal on, Vol. 17, Nov. 1999, Pages: 1900 – 1914.