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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, an MSS shall scan a Neighbor BS to obtain its synchronization and CINR. For adopting OFDMA specified in the current 802.16 standard, an MSS can synchronize with a Neighbor 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 SS starts after timing synchronization.

However, since MSS has only a single chance in each frame to acquire a preamble, timing synchronization can be done only in frames; i.e., it may take several frames for an MSS to get timing synchronization based on preambles. If the MSS misses a 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 and degrades communication quality due to delay during a handover to neighbor BS.

2. Proposed Remedy

Therefore, we propose new and simple reference signals to reduce the time for synchronization. Since the proposed reference signals enable an MSS to obtain synchronization not only in frames but also in symbols, the MSS can obtain synchronization faster. Also, the current structure of OFDMA system specified in IEEE 802.16 standard does not change because the proposed signals do not modify it. We consider using some extra subcarriers for new reference signals in FUSC. Unlike current preambles, new reference signals may be spread in time on every DL subframe. They are allocated to the reserved subcarriers and indexed in ascending order. If an MSS decodes reference signals in each symbol, an MSS can find a symbol’s index, which is defined as offset in a downlink subframe. The MSS will repeat this procedure until it obtains right synchronization.

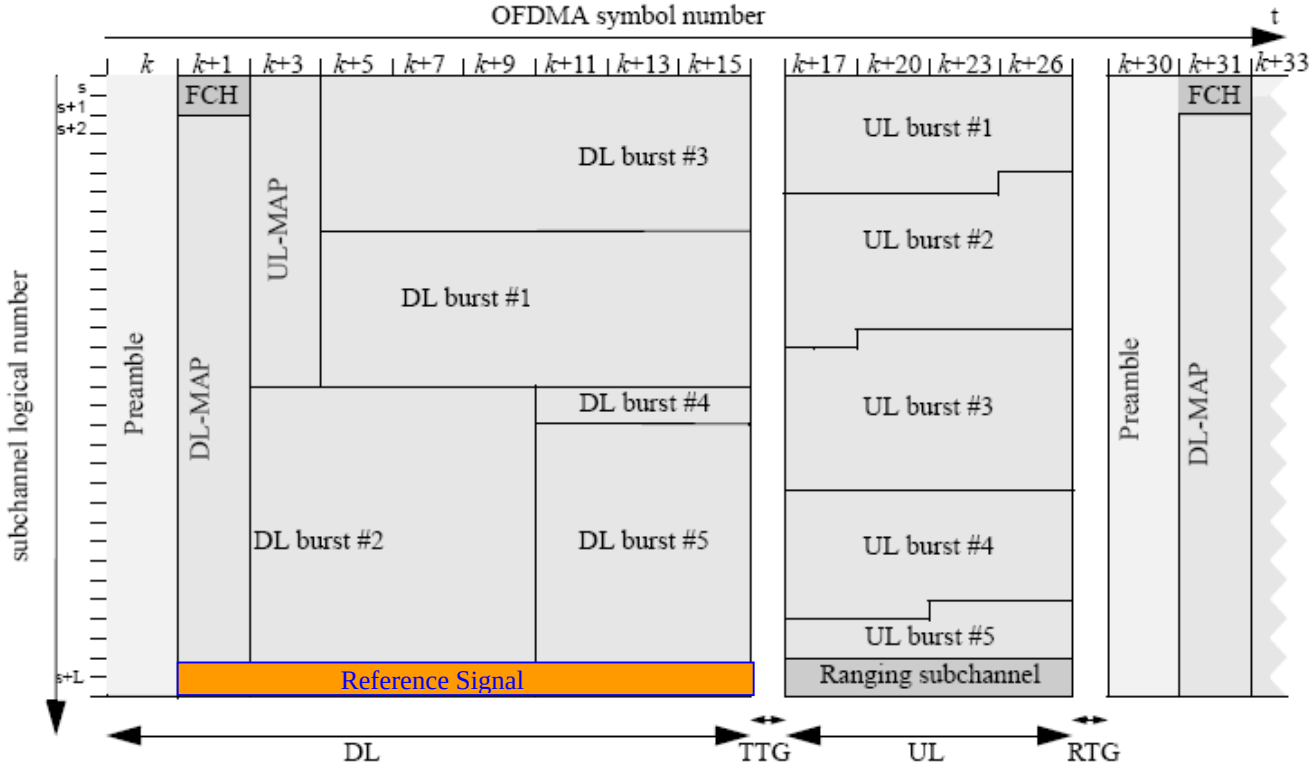


Figure 1. Example for reference signals allocation in OFDMA

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 for timing synchronization in symbols are allocated to the reserved subcarriers in downlink subframe. In case of 2048 FFT size in FUSC and Optional FUSC, the maximum symbol's index is approximately 25. Therefore 6 bits is enough to represent the symbol's index. For reliable transmission, each bit in 6-bit binary representation of the symbol's index 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.

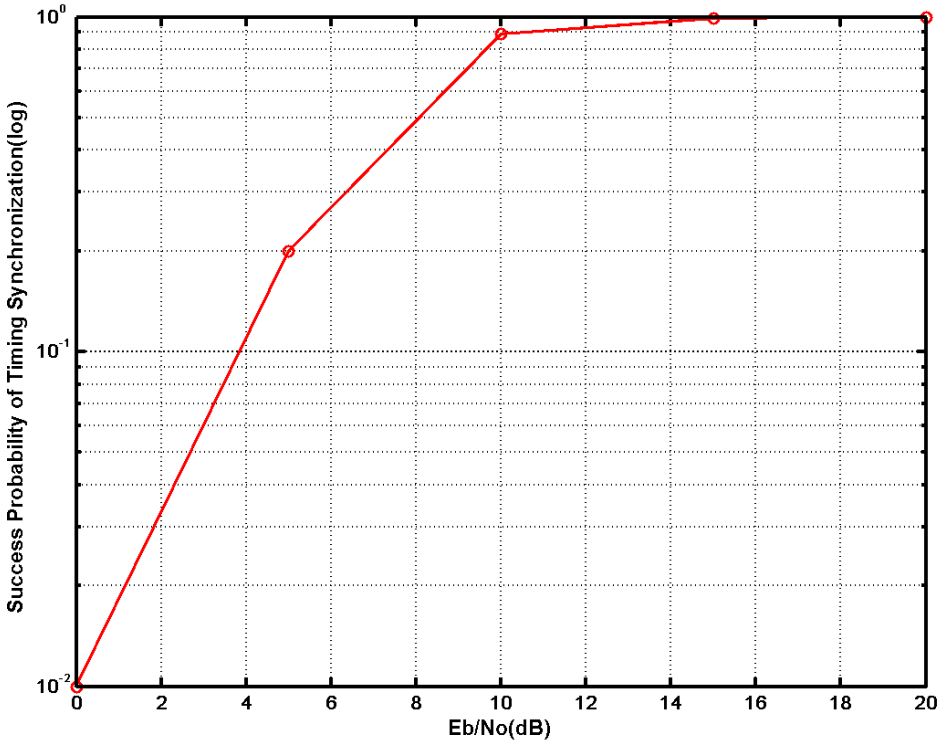
Table xxx – Reference signals allocation

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 perfectly with BS. The graph below represents the probability of reading reference signals correctly.



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.