

# A New Symbol Timing Synchronization Algorithm for IEEE 802.11a/g Wireless LAN Systems

양주열, 전경훈, 김정창  
 포항공과대학교 전자컴퓨터공학과  
 cheun@postech.ac.kr

# A New Symbol Timing Synchronization Algorithm for IEEE 802.11a/g Wireless LAN Systems

Jooyeol Yang, Kyungwhoon Cheun, and Jeongchang Kim  
 Division of Electrical and Computer Engineering, Pohang University of Science and Technology  
 cheun@postech.ac.kr

## Abstract

In this paper, we propose an efficient symbol timing synchronization algorithm for IEEE 802.11a/g wireless LAN systems in multipath channels is proposed. The algorithm utilizes an elongated training symbol together with soft-limiting of the correlator output and estimates the position of the first arriving path. Simulation results show that the proposed algorithm significantly outperforms conventional algorithms.

## I. Introduction

Orthogonal frequency division multiplexing (OFDM) is widely accepted as a bandwidth efficient modulation scheme suitable for digital wireless communication systems operating under frequency selective multipath channels. The IEEE 802.11a/g wireless LAN (WLAN) standards [1, 2] specify an OFDM physical layer that splits the information stream across 52 separate subcarriers<sup>1</sup> (including 4 pilot subcarriers) providing transmission rates of up to 54 Mbps and beyond.

In these systems, each data packet is preceded by a preamble consisting of ten short training symbols followed by two long training symbols which are preceded by a cyclic prefix [1, 2] (Fig. 1). The short training symbols are usually utilized for signal detection, automatic gain control (AGC), symbol timing synchronization and coarse frequency offset estimation. In [3] and [4], symbol timing synchronization algorithms based on the short training symbols were proposed. The symbol timing estimator proposed in [3] observes the cross-correlation between the received signal and the known short training symbol and seeks for correlation peaks. Since multiple short training symbols are transmitted at the transmitter, several cross-correlation peaks may be observed. In order to resolve the uncertainty, the estimator searches for the first absence of the cross-correlation peak from which the correct symbol timing instant is determined. In [4], the auto-correlation computed between the received signal and its delayed version with a delay equal to the short training symbol length is used for symbol timing synchronization. Here, the fact that multiple short training symbols are transmitted results in a plateau in the auto-correlation peak, again, leads to an uncertainty in the correct symbol timing instant. In order to resolve this uncertainty, the estimator observes the difference between two auto-correlation values measured at timing instants separated by the short training symbol length. The estima-

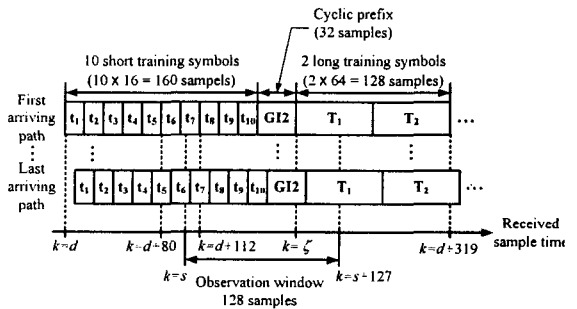


Fig. 1. Received signal corresponding to the preamble under a multipath channel.

tor then seeks the timing instant for which the difference in the two auto-correlation values is the maximum.

The algorithms proposed in [3] and [4] make no effort to estimate the position of the first arriving multipath component, leading to inefficient utilization of the guard interval under multipath channels [5]. The performance degradation due to their inability to estimate the instance of the first arriving multipath component becomes more pronounced with increasing channel delay spread. In [6], a simple modification to the algorithm of [4] was proposed which partially solves this problem. The algorithm applies a fixed negative bias (shift) after utilizing the algorithm of [4] to obtain an initial symbol timing estimate. This negative bias reduces the intersymbol interference (ISI) that may exist due to the fact that the algorithm estimates the position close to the strongest multipath components instead of that of the first arriving multipath component. However, the value of the negative bias to be used is dependent on the multipath intensity profile of the channel which is unknown a priori. Hence, the modification proposed in [6] may be severely degraded if the applied fixed negative bias is mismatched to the actual multipath channel.

In this paper, an efficient symbol timing synchronization algorithm targeted for IEEE 802.11a/g WLAN systems operating in

This work was supported by the center for Broadband OFDM Mobile Access (BrOMA) at POSTECH through the ITRC program of the Korean MIC, supervised by IITA. (IITA-2005-C1090-0502-0008)

<sup>1</sup>In the IEEE 802.11a/g WLAN systems, an OFDM symbol utilizes 52 out of a total of 64 available subcarriers.