HELSINKI UNIVERSITY OF TECHNOLOGY
Department of Electrical and Communications Engineering
Communications Laboratory

Mohammad Azizul Hasan

Performance Evaluation of WiMAX/IEEE 802.16 OFDM Physical Layer

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology, Espoo, June 2007

Supervisor: Prof. Riku Jäntti

Instructor: Lic. Tech. Boris Makarevitch

HELSINKI UNIVERSITY OF TECHNOLOGY Abstract of the Master's Thesis

Author: Mohammad Azizul Hasan

Name of the Thesis:
Performance Evaluation of WiMAX/IEEE 802.16 OFDM Physical Layer

Number of pages: 96

Date: 08-06-2007

Department: Department of Electrical and Communications Engineering

Professorship: S-72 Communications Engineering

Supervisor: Prof. Riku Jäntti

Instructor: Lic. Tech. Boris Makarevitch

Abstract

Fixed Broadband Wireless Access (BWA) is a promising technology which can offer high speed voice, video and data service up to the customer end. Due to the absence of any standard specification, earlier BWA systems were based on proprietary standard. IEEE 802.16 WirelessMAN standard specifies a Medium Access Control (MAC) layer and a set of PHY layers to provide fixed and mobile Broadband Wireless Access (BWA) in broad range of frequencies. The WiMAX forum has adopted IEEE 802.16 OFDM PHY layer for the equipment manufacturer due to its robust performance in multipath environment. The thesis investigates the simulation performance of IEEE 802.16 OFDM PHY layer. The Stanford University Interim (SUI) channel models are selected for the wireless channel in the simulation. The evaluation was done in simulation developed in MATLAB. Perfect channel estimation is assumed.

Keywords: BWA, IEEE 802.16, WirelessMAN, FEC, OFDM

Chapter 1

Introduction

This chapter provides a brief introduction on the motivation of this thesis work and its objective as well. At last the structure of the document is provided.

1.1 Motivation

Broadband Wireless Access (BWA) has emerged as a promising solution for last mile access technology to provide high speed internet access in the residential as well as small and medium sized enterprise sectors. At this moment, cable and digital subscriber line (DSL) technologies are providing broadband service in this sectors. But the practical difficulties in deployment have prevented them from reaching many potential broadband internet customers. Many areas throughout the world currently are not under broadband access facilities. Even many urban and suburban locations may not be served by DSL connectivity as it can only reach about three miles from the central office switch [3]. On the other side many older cable networks do not have return channel which will prevent to offer internet access and many commercial areas are often not covered by cable network. But with BWA this difficulties can be overcome. Because of its wireless nature,

it can be faster to deploy, easier to scale and more flexible, thereby giving it the potential to serve customers not served or not satisfied by their wired broadband alternatives.

IEEE 802.16 standard for BWA and its associated industry consortium, Worldwide Interoperability for Microwave Access (WiMAX) forum promise to offer high data rate over large areas to a large number of users where broadband is unavailable. This is the first industry-wide standard that can be used for fixed wireless access with substantially higher bandwidth than most cellular networks [2]. Wireless broadband systems have been in use for many years, but the development of this standard enables economy of scale that can bring down the cost of equipment, ensure interoperability, and reduce investment risk for operators.

The first version of the IEEE 802.16 standard operates in the 10–66GHz frequency band and requires line-of-sight (LOS) towers. Later the standard extended its operation through different PHY specification to 2-11 GHz frequency band enabling non line of sight (NLOS) connections, which require techniques that efficiently mitigate the impairment of fading and multipath [4]. Taking the advantage of OFDM technique the PHY is able to provide robust broadband service in hostile wireless channel.

The OFDM-based physical layer of the IEEE 802.16 standard has been standardized in close cooperation with the European Telecommunications Standards Institute (ETSI) High PERformance Metropolitan Area Network (HiperMAN) [5]. Thus, the HiperMAN standard and the OFDM-based physical layer of IEEE 802.16 are nearly identical. Both OFDM-based physical layers shall comply with each other and a global OFDM system should emerge [4]. The WiMAX forum certified products for BWA comply with the both standards.

1.2 Objective

The objective of this thesis is to implement and simulate the IEEE 802.16 OFDM physical layer using Matlab in order to have better understanding of the standard and the

system performance. This involves studying, through simulation, the various PHY modulation, coding schemes and interleaving in the form of bit-error-rate (BER) and block-error-rate (BLER) performance under reference channel models.

1.2 Structure of the thesis

The first chapter is an introduction of the thesis work. The rest of the chapters are organized as follows:

Chapter 2 discusses the evolution and architecture of the IEEE 802.16 standard for BWA.

Chapter 3 provides an overview of the IEEE 802.16 physical layer and OFDM technique.

Chapter 4 deals with the PHY layer simulation model and SUI channel model employed by this thesis.

Chapter 5 provides results obtained from the PHY layer simulation.

Chapter 6 concludes with a summary of the research done and recommendation for future work.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.