BANDWIDTH AND SUBSCRIBER ESTIMATION IN UPLINK AND DOWNLINK FOR MULTI CLASS SINGLE CELL USERS IN MOBILE WIMAX (IEEE 802.16E 2005)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF ELECTRICAL ENGINEERING AND THE COMMITTEE ON GRADUATE STUDIES OF UNIVERSITY OF MANAGEMENT AND TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

BY
UMAIR SHAHID
091450038
NOVEMBER 2011

Acknowledgements

All admires to Almighty ALLAH, the most gracious and the most merciful, who bequeathed us with wellbeing and abilities to complete this thesis successfully.

I wish to express my deep gratitude to my project Supervisor Jameel Ahmad(Assistant Professor) for his continuous heart and soul support to complete the project in the best possible way. He is always a source of inspiration and motivation for me. His encouragement and support never faltered.

I am especially thankful to the Faculty and Staff of School of Science and Technology at the University of Management and Technology (UMT) Lahore, who have been supported us immensely during this research. I am especially thankful to Dr. Abdul Aziz Bhatti for his moral and teaching support. I am also thankful to Dr.Sajjad Shami without whose moral support and encouragement, this research would not have been possible.

I am also very thankful to my entire fellow colleague's who have helped me mentally as well as academically, in every hour of need.

Finally, I am wildly grateful to my parents for their everlasting moral support and encouragements. It is to them I dedicate this project.

Abstract

The fundamentals required for steady growth of broadband wireless remain constant. According to the Ericsson's official predictions, the global market of broadband connectivity will be around 320 million users by the end of this decade. The issues related with increased Deployment of WiMAX gives rise to issues related to QoS and Scalability. A unique methodology has been adopted to maximize the number of users per sector for multi-traffic users which include both Residential class as well as the Business class. The approach makes use of the Useful Bandwidth Estimations and implements an algorithm to provide a solution to QoS by restricting the number of users according to Bandwidth allocated in both Uplink and Downlink directions. A modernize methodology to compute the system's actual throughput and a traffic model for diverse application users are proposed with a step by step depiction to derive an algorithm to determine the maximum number of subscribers that each specific Mobile WiMAX sector may support. The results are shown using Matlab which intakes various system parameters along with Service class parameters and show the results in terms of the maximum number of users supported along with UL and DL bandwidth demanded and capacity available. The presented methodology would help those operators that plan to implement a wide coverage network in a city. Using the presented methodology, service providers will be in a position to estimate the exact number of base stations and hence the network investment and profitability.

LIST OF FIGURES

LIST OF TABLES

Acronyms:

ASP	Application Services Provider
CAPEX	Capital Expenditures
CGSs	Closed Subscriber Groups
CID	Connection Identifiers
CRC	Cyclic Redundancy Check
CR	Contention Ratio
DL	Downlink
DCD	Downlink Channel Descriptor
FBSS	Fast Base Station Switching
FCH	Frame Control Header
FEC	Forward Error Correction
FUSC	Fully Used Sub-Carrier
GID	Global Unique Identity
GM	Grant Management
HSPA	High Speed Packet Access
ISI	Inter Symbol Interference
LTE	Long Term Evolution
LOS	Line of Sight
NGMN	New Generation Mobile Networks
NSP	Network Services Provider
OPEX	Operational Expenditures
OFDMA	Orthogonal frequency Division Multiple Access.
OSR	Over Subscription Ratio
OCR	Overall Coding Rate
PCI	Physical Cell Identity
P2P	Peer to Peer
PL	Path Loss
PUSC	Partially Used Sub-Carriers
RNC	Radio Network Controller
RSRP	Reference Signal Received Power
RSSI	Received Signal Strength Indicator
QoS	Qualiy of Service
TDD	Time Division Duplexing
UE	User Equipment
UL	Uplink
VBR	Variable Bit Rate
VoIP	Voice over IP
WiMAX	Worldwide Interoperability for Microwave Access
3GPP	3rd Generation Partnership Program

TABLE OF CONTENTS

Chapter 1

Introduction

1.1 History

It would be hard to imagine a world without wireless applications and services. Nowadays people are enjoying wireless internet access for telephony, radio and television services when they are in fixed, mobile or nomadic conditions. Around the globe, mobile services are playing increasingly important roles in many facets of our society. The rapid growth of wireless internet causes a demand for high-speed access to the World Wide Web. Just a decade ago, mobile services consisted primarily of basic voice communication. Today, we depend on mobile services not only for communication, but also for education, entertainment, healthcare, location and m-commerce. Mobile services have also made significant inroads into developing nations, by improving the quality of life for many of their citizens. To serve the demand for access to the internet „anywhere any time‟ and ensure quality of service, the IEEE 802.16 working group brought out a new broadband wireless access technology called "WiMAX" meaning Worldwide Interoperability for Microwave Access.

Wireless communication is one of the most exciting areas in the communication field today. While it has been a topic of study since the 1960s, the past decade has seen a rush of research activities in the area. This is due to a convergence of several factors. First, there has been an explosive increase in demand for tether less connectivity, driven so far mainly by cellular telephony but expected to be soon obscured by wireless data applications. Second, the theatrical progress in VLSI technology has enabled small-area and low-power execution of sophisticated signal processing algorithms and coding techniques. Third, the success of second-generation (2G) digital wireless standards, in particular, the IS-95 Code Division Multiple Access (CDMA) standard, provides a solid demonstration that good ideas from communication theory can have a substantial impact in practice. The research push in the past decade has led to a much richer set of outlooks and tools on how to communicate over wireless channels, and the picture is still very much evolving. There are two fundamental aspects of wireless communication that make the problem challenging and interesting. These aspects are by and large not as significant in wire line communication. First is the phenomenon of fading: the time variation of the channel strengths due to the small-scale effect of multipath fading, as well as larger-scale effects such as path loss via distance attenuation and shadowing by difficulties. Second, unlike in the wired world where each transmitter–receiver pair can often be thought of as an isolated point-to-point link, wireless users communicate over the air and there is significant interference between them. The interference can be between transmitters connecting with a common receiver (e.g., uplink of a cellular system), between signals from a single transmitter to multiple receivers (e.g., downlink of a cellular system), or between different transmitter–receiver pairs (e.g., interference between users in different cells). How to deal with fading and with interference is primary to the design of wireless communication systems and has been the focus of the Engineers of the current era. Although this requires a look at physical-layer perspective, it will be seen that in fact the management of fading and interference has ramifications across multiple layers. Traditionally the design of wireless systems has focused on increasing the dependability of the air interface; in this context, fading and interference are viewed as nuisances that are to be countered. Recent focus has shifted more towards increasing the spectral efficiency; linked with this shift is a new point of view that fading can be viewed as an opportunity to be exploited.

1.2 Wireless Systems

Wireless communication, despite the hype of the popular press, is a field that has been around for over a hundred years, starting around 1897 with Marconi's successful demonstrations of wireless telegraphy. By 1901, radio reception across the Atlantic Ocean had been established; thus, rapid progress in technology has also been around for quite a while. In the intervening hundred years, many types of wireless systems have flourished, and often later disappeared. For example, television transmission, in its early days, was broadcast by wireless radio transmitters, which are increasingly being replaced by cable transmission. Similarly, the point-to-point microwave circuits that formed the backbone of the telephone network are being replaced by optical fiber. In the first example, wireless technology became outdated when a wired distribution network was installed; in the second, a new wired technology (optical fiber) replaced the older technology. The opposite type of example is occurring today in telephony, where wireless (cellular) technology is partially replacing the use of the wired telephone network (particularly in parts of the world where the wired network is not well developed). The point of these examples is that there are many situations in which there is a choice between wireless and wire technologies, and the choice often changes when new technologies become available.

We need to concentrate on the Cellular Systems to have a clear insight into the WiMAX 1]. They are of great current interest and also because the features of many other wireless systems can be easily understood as special cases or simple generalizations of the features of cellular networks. A cellular network consists of a large number of wireless subscribers who have cellular telephones (users), that can be used in cars, in buildings, on the street, or almost anywhere. There are also a number of fixed base-stations, arranged to provide coverage of the subscribers. The area covered by a base-station, i.e., the area from