International Journal of Information & Computation Technology.
ISSN 0974-2239 Volume 4, Number 12 (2014), pp. 1195-1203

http://www. irphouse.com

An Efficient Analysis of Resource Management in WiMAX Network

Mohit Kumar Saini[1] and R. K. Chauhan[2]

[1, 2]Department of Electronics and Communication Engineering,
Madan Mohan Malaviya University of Technology,
Gorakhpur (Uttar Pradesh), Pin-273010

Abstract

Wireless communication has brought a revolution in the world. There has been tremendous technological advancement in wireless networks in the past two or three decades. The demand of wireless communication has been increasing very fast as everybody wants to use the broadband wireless services anywhere and anytime. IEEE 802. 16 based Worldwide Interoperability for Microwave Access (WiMAX) is a new technology that promises to provide best Quality of services (QoS) to its fixed as well as mobile users with minimum utilization of available resources. The problem of assuring best QoS is basically that of how to allocate available resources among users in order to meet the QoS criteria such as latency, delay jitter and throughput requirements. Since we have very limited resources and we have to make best use of them by proper management.

In this paper first we will discuss the resource allocation in WiMAX network using Water Filling and Adaptive scheduling by considering different parameters like SNR, QoS, and applications. The goals of scheduling are to achieve optimal usage of resources, to assure QoS guarantees, maximize throughput and increase channel capacity. Finally efficient analysis is done on the basis of simulation results.

Keywords- WiMAX, IEEE 802. 16, QoS, OFDM, resource management

Introduction

Wireless networks are gaining popularity to its peak today, as the user's wants wireless connectivity irrespective of their geographic position. And future generation wireless networks will be characterized by variable and high data rates, various Quality of Services (QoS), seamless mobility both within a network and between

networks of different technologies and service providers. A new technology is developed to fulfill these requirements is standardized by IEEE, is 802. 16, also referred to as WiMAX (Worldwide Interoperability for Microwave Access) [4]. WiMAX provides fixed, nomadic, portable and mobile wireless broadband connectivity without the need for direct line-of-sight with a base station (BS).

Wireless communication networks had been facing high level of Inter symbol interference (ISI) which originates from multipath propagation and inherent channel delay spread. A high-data-rate communication system will generally have $\tau \geq Ts$, where *Ts* is symbol duration and τ is channel delay spread and due to this inter symbol interference (ISI) becomes very severe in WiMAX systems etc. WiMAX networks defines two important layers: **1)** Physical Layer **2)** Media Access Control (MAC) Layer. WiMAX physical layer [1] uses OFDM [5] as a transmission technique. The OFDM technology belongs to the family of multicarrier modulation transmission schemes. In this scheme we divide the given higher bit rate data stream into parallel lower bit rate data streams. After that different subcarriers, which are orthogonal to each other, are used to modulate each individual data stream. Orthogonality is a property that allows the signals to be perfectly transmitted over a common channel simultaneously and detected without interference. By using this technique, we minimize the ISI and get high bandwidth efficiency. The MAC layer of IEEE802. 16 resides above the PHY layer and responsible for allocating resources for SSs (subscriber stations) and provide security and key management.

WiMAX defines five quality of services in which all applications are supported. The QoS determines the fact that how successfully a wireless technology can transfer high value services like voice and video. For good QoS, the latency, jitter and packet loss should be minimized. After solving these issues, a good QoS is guaranteed. The QoSs [9] with its application supported by WiMAX are given in Table 1.

Table 1. 1: QoSs and corresponding Applications

Serial No.	QoS	Applications
1	Unsolicited Grant Services (UGS)	Voice over IP (VoIP)
2	Best-effort service (BE)	Web browsing, data transfer (e-Mail)
3	Real-time Polling service (rtPS)	Streaming audio and video (MPEG)
4	Non-real-time Polling service (nrtPS)	FTP/HTTP
5	Extended real-time Polling service (ErtPS)	VoIP (voice with activity detection)

Problem Formulation:

Resources (Transmitter power and channel bandwidth) are scarce resources that need to be used efficiently. Highly demanding QoSs cannot be realistically provided unless the limited system resources are intelligently used and properly optimized. Though a lot of work has been done, there still remains a scope for improvement in wireless

network. Resource management [6, 8] in WiMAX schedule the users in the network on the basis of different parameters: (i) on the basis of received SNR of the channel (ii) on the basis of QoSs. In this paper Water Filling approach will be discussed that allocate the resources (power and bandwidth) based on channel state or condition. Also an adaptive approach will be discussed which allocates the resources on the basis of both channel state and QoSs.

OFDM Communication System:

The basic communication system consists of three main components. They are transmitter, channel (wireless/wired) and receiver. Transmitter transmits the desired information to specified channel. Channel is the interface between transmitter and receiver over which information is transmitted. Receiver receives the information transmitted by the transmitter through a specified channel.

The basic OFDM communication system is shown as below:

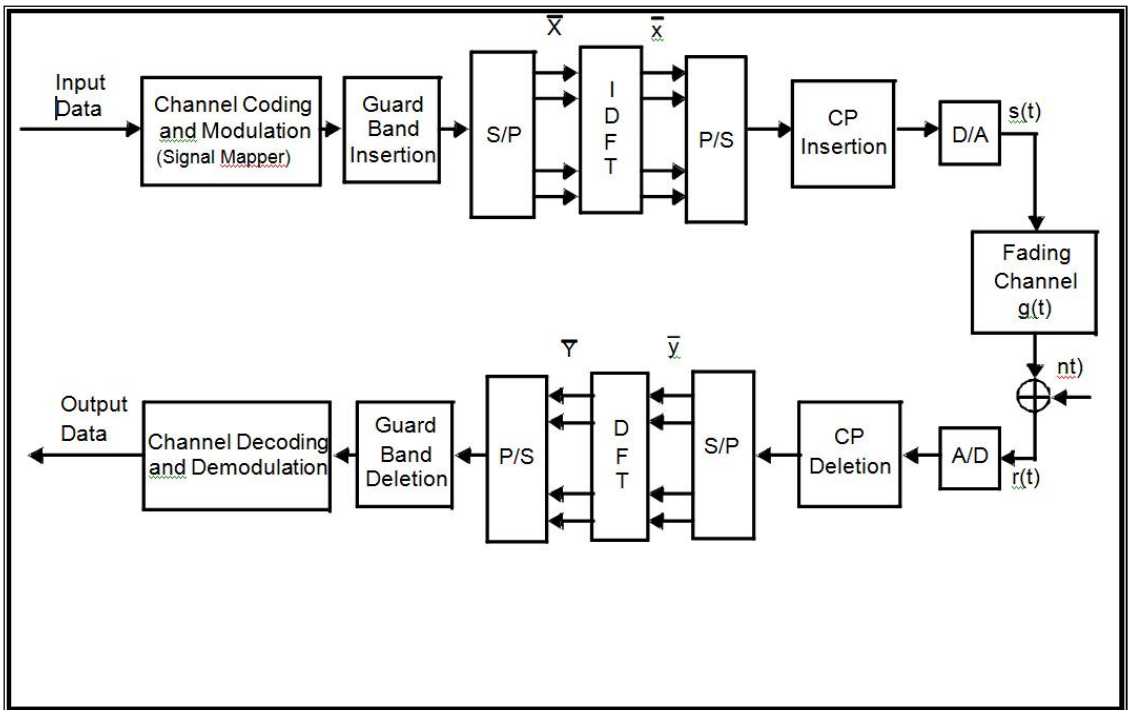

Fig. 3. 1 OFDM Communication System

Important Terms:

Modulation:- In our system we use BPSK digital modulation. In this scheme, one bit is represented by one symbol and one symbol is equivalent to one phase. It has only two symbols which are '0'and '1'. BPSK is the most robust modulation technique and it has less error as compared to other phase shift keying schemes.

Channel Coding:
Channel coding technique is used to ensure transmission is received with minimal or zero errors. There are two types of popular channel codes: Convolutional code and Block Code.

IFFT/FFT:
Analysis of any signal is easy in time domain compare to frequency domain. So Inverse Fast Fourier Transform (IFFT) technique is used to convert the frequency domain signal into time domain signal. FFT performs its opposite operation i. e. time domain signal back to frequency domain signal.

Cyclic Prefix:
CP [4] is a repeat of a repeat of the end of the symbol at the beginning. CP is used to mitigate multipath, while maintaining the orthogonality of the subcarriers. The CP interval must be chosen to be larger than the expected maximum delay spread, such that multi path reflection from one symbol would not interfere with another.

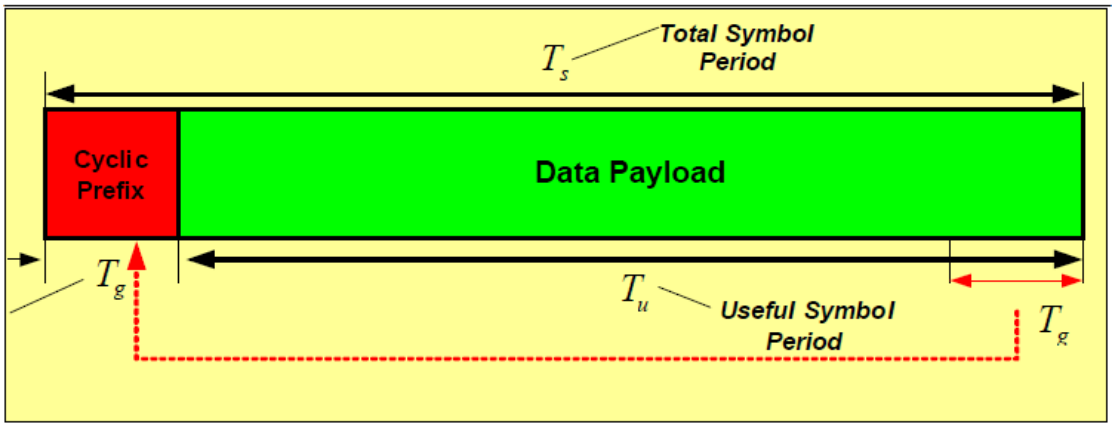

Fig. 3. 2 Addition of CP

We have implemented the OFDM signal using MATLAB tool.
Snap shot of OFDM signal transmission and reception is shown as:

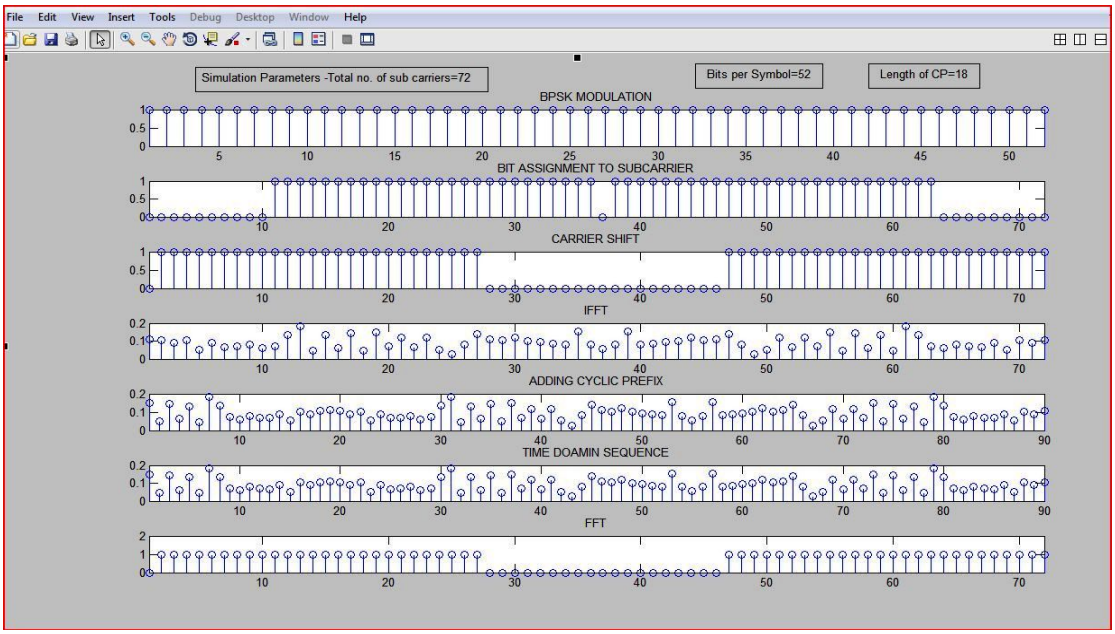

Fig 3. 3 Generation and Reception of OFDM Signal using MATLAB

Resource Allocation in WiMAX network using Water Filling Algorithm:

In this section we will implement a Water Filling Algorithm [7] to maximize the capacity of frequency selective channel. This algorithm allocates the resources (Transmitter power or channel bandwidth) to the respective subchannel based on channel condition. This algorithm assigns more power (or bandwidth) to sub-channels which experience good condition and may assign no power (or bandwidth) to bad conditioned sub-channels (sub-channels with deep fading). Simulation results show that capacity of channel is improved. In this paper we have allocated the power to good conditioned channels.

Algorithm Implementation (Flow Chart):

- **Step 1:** First we define the following parameters: total no. of subchannel (64), total transmitted power (10W), bandwidth (10 MHz), channel state information (random) and noise density (1W/MHz).
- **Step 2:** Then calculate the initial power to be allocated to all the subchannels based on channel condition without water filling algorithm and calculate Shanon channel capacity.
- **Step 3:** In this step we find the no. of subchannels in which initial power allocated is positive (initPowerAllo>0) and subchannels in which initial power allocated is negative (initPowerAllo<0).
- **Step 4:** Now allocate zero power to those subchannels whose initial power allocated is negative.
- **Step 5:** Then Allocate new powers to those subchannels whose initial power allocated is positive based on channel condition and calculate the Shanon capacity of the channel.

Here we have taken the random behaviour of the Rayleigh fading channel. Simulation results show that Shanon channel capacity is different for the same value of the parameters it is due to random behaviour of the channel. Also capacity is improved using this algorithm compare to without this algorithm.

Simulation results are shown in following figures:

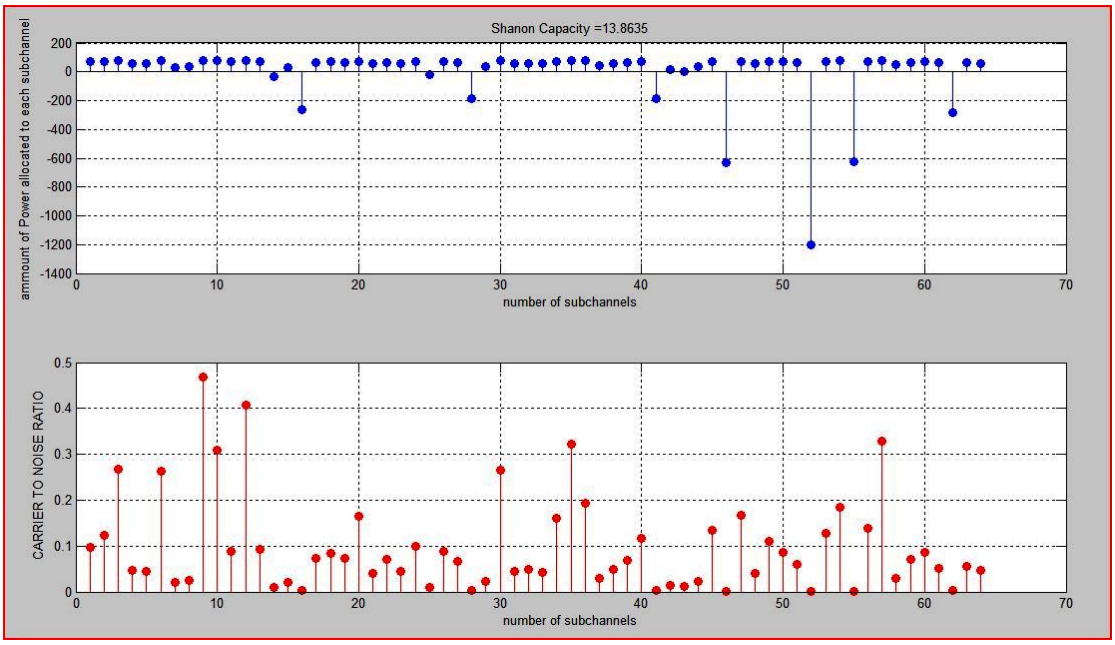

Fig. 4. 1 Power allocation without Water Filling Algorithm

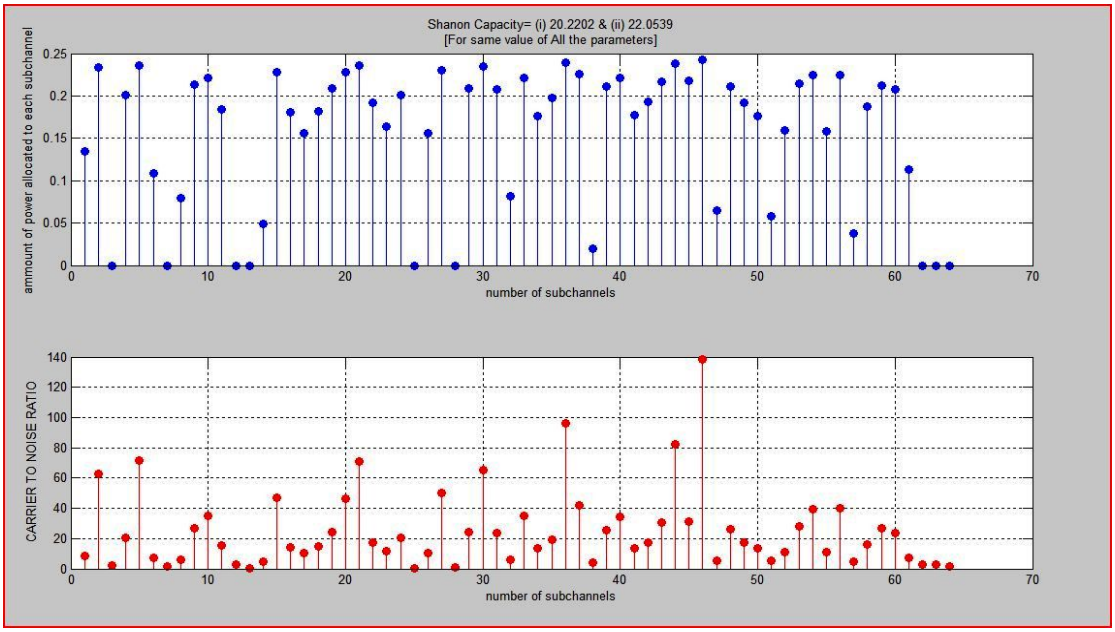

Fig. 4. 2 Power allocation using Water Filling Algorithm

Resource Allocation in WiMAX network using Adaptive Approach

The drawback of water filling algorithm is that total power (or Bandwidth) is distributed randomly depending upon channel condition. And this does not consider the priority of the users to guarantee QoSs. The QoS guarantee is important feature of any cellular network. This kind of resource allocation algorithm may deprive the high priority users to maintain its QoSs and the allocation is very much unacceptable from the service provider as well as user perspective. In this section we will develop an adaptive approach [2, 3] which considers the priority of the users in addition to channel condition before allocating the resources. Thus priority order is decided on the basis of QoSs and SNR. After that users are scheduled in the network and then resources are allocated adaptively. In this approach

Algorithm implementation:

- **Step 1:** First QoSs supported by WiMAX are arranged in descending order of priority as: (1) UGS (2) ertPs (3) rtPs (4) nrtPs (5) BE.
- **Step 2:** In this step we make three cases for SNR to decide the priority of the user: Case (1) SNR>30dbm Case (2) 20< SNR ≤ 30dbm and Case (3) 10< SNR ≤ 20dbm.
- **Step 3:** In this step give the no. of users or channels.
- **Step 4:** Now we give the QoS requesting by each user.
- **Step 5:** We take one of three cases of SNR depending upon channel condition for each channel.
- **Step 6:** Resources are allocated according to priority decided adaptively on the basis of SNR and QoS.
- **Step 7:** Calculate the amount of power saved.

Simulation is performed for 5 users by considering following criteria given in Table 5. 1:

Table 5. 1

User No.	QoS	SNR
User 1	UGS (1)	>30 (1)
User 2	ertPs (2)	>20&&≤30 (2)
User 3	rtPs (3)	>10&&≤20 (3)
User 4	UGS (1)	>10&&≤20 (3)
User 5	ertPs (2)	>30 (1)

Snap shot for this simulation is shown in Fig. 5. 1

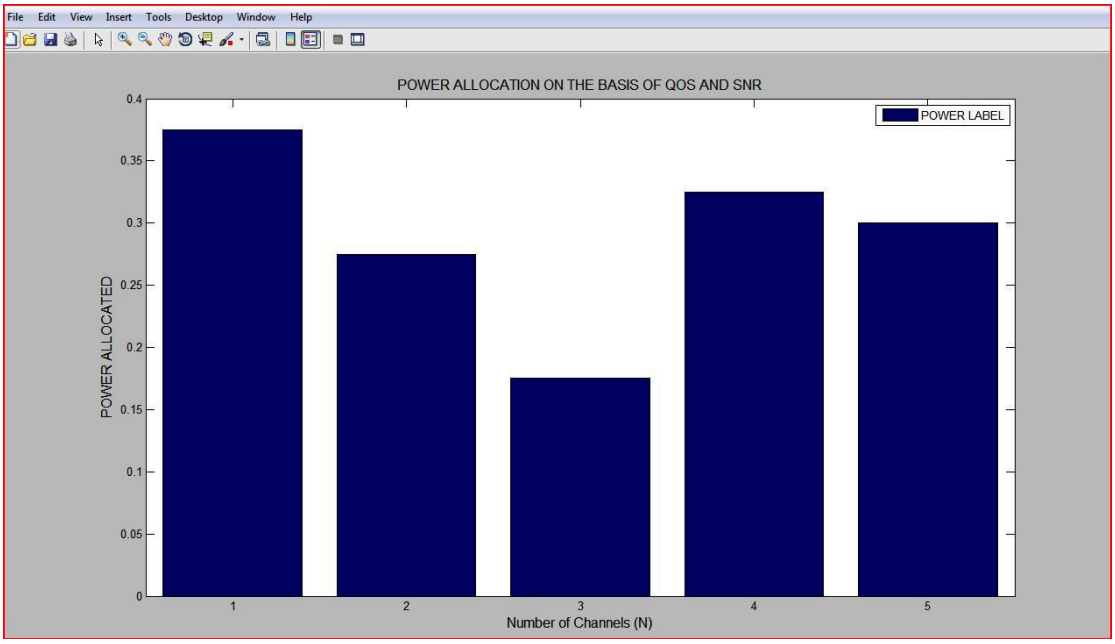

Fig. 5. 1 Power Allocation using Adaptive Approach

Also simulation results show that total transmitted power is saved using this adaptive approach.

Conclusion

Since available resources must be optimized to meet QoSs guarantee and to maximize the throughput of WiMAX network. In this paper we have studied two approaches to optimize these resources. First approach (Water Filling Approach) allocates these resources to particular users based on channel condition. While second approach (Adaptive Approach) considers both QoS and channel state to decide the priority of the users and then allocates these resources depending upon priority. Simulation results show second approach is more effective compare to first one in terms of channel capacity and saving of resources.

References:

[1] Ramjee Prasad and Fernando J. Velez, "OFDMA WiMAX Physical Layer", WiMAX Networks, DOI 10. 1007/978-90-481-8752-2_2, © Springer Science + Business Media B. V. 2010

[2] Jos´e Salazar, Ismael Gómez and Antoni Gelonch, "Adaptive Resource Management and flexible radios for WiMAX" Journal of telecommunication and information technology.

[3] Xinning, Z. et al. (2008), "An Adaptive Resource Allocation Scheme in

OFDMA based Multiservice WiMAX Systems" Advanced Communication Technology, ICACT 10th International Conference.

[4] Jeffrey G. Andrews, Arunabha Ghosh, Rias Muhamed, "Fundamentals of WiMAX- Understanding Broadband Wireless Networking", Copyright © 2007 Pearson Education, Inc., ISBN 0-13-222552-2.

[5] www. complextoreal. com, " Orthogonal Frequency Division Multiplexing (OFDM) tutorial", © 2004 Charan Langton: 1-22

[6] Arijit Ukil, Jaydip Sen, Debasish Bera, "A New Optimization Scheme for Resource Allocation in OFDMA based WiMAX Systems", Wireless Innovation Lab, © 2009 International Conference on Computer Engineering and Technology.

[7] Rong Mei, Zhu Shihua, Li Feng "Dual Water-filling Power Allocation Algorithm in MIMO Systems", School of Electronics and Information Engineering, Xi'an Jiaotong University, Xi'an 710049, China, 2009 :144-149.

[8] Mr. Wankhede Vishal, Mr. Jha Rakesh, Prof. Dr. Upena Dalal, "Resource Allocation Algorithm for WiMAX Systems" © 2011 IEEE.

[9] Noman Shabbir, Hasnain Kashif, "Radio Resource Mangement inWiMAX", Blekinge Institute of Technology, School of Engineering, Department of Signal Processing.