Analysis Of Wimax Technology Using BPSK And QPSK Modulation Scheme With Fading Channel

Arvind Yadav[1], Er. Praveen kumar patidar[2]
[1]Dept of Electronics and Communication Engineering
[2] Professor, Dept of Electronics and Communication Engineering
[1, 2]Lakshmi Narain College of Technology, Indore (M.P.), India

Abstract- *The WiMAX can also be considered to be main technology in the implementation of other networks like wireless sensor networks. At present, telecommunication industries are highly concerned with the wireless transmission of data which can use various transmission modes, from point-to-multipoint links. It contains full mobile internet access. Various applications have already been applied so far using WiMAX, as alternative to 3G mobile systems in developing countries, Wireless Digital Subscriber Line (WDSL), Wireless Local Loop (WLL). IEEE 802.16e-2005 has been developed for mobile wireless communication which is based on OFDM technology and this enables going towards the 4G mobile in the future. In this thesis work, we built a simulation model based on 802.16e PHY layer, demonstrated in different simulation scenarios with different modulation techniques such as BPSK, QPSK and QAM to find out the best performance of Physical layer. All the necessary conditions were implemented in the simulation according to the 802.16e PHY specification. The noise channel AWGN, multipath fading channel, data randomization techniques, Convolution, Interleaving, FFT and IFFT, and Adaptive modulation is used for the whole simulation procedure. The performance has been concluded based on BER (Bit-Error-Rate) Versus SNR (Signal-to-Noise Ratio) and output through MATLAB R2013a Simulation toll used.*

Keywords- BPSK, QPSK, Fading Channel, BER, SNR, IFFT, FFT.

I. INTRODUCTION

The IEEE 802.11 protocols are designed by IEEE and are handled by Wi-Fi forum. The 802.11 tools are now moving into the second stage, where the wireless LAN is being treated as a large wireless communication system. As a system, there is more to consider than simply the communication over the air between a single access point and the associated mobile devices. Wi-Fi (802.11) has couple of varieties and some of them are 802.11a, 802.11b, 802.11g and 802.11n. 802.11a,b,g operates in 2.4 GHz frequency and range from 40-140 meters (in reality) and 802.11n operates in 5 GHz with OFDM modulation technology thus results higher speed (40Mbps in reality) ranged to 70-250 meters. Physical layer set up the connection between the communicating devices and is responsible for transmitting the bit sequence. It also defines the type of modulation and demodulation as well as transmission power. WiMAX 802.16 physical layer considers two types of transmission techniques OFDM and OFDMA. Both of these techniques have frequency band below 11 GHz and use TDD and FDD as its duplexing technology. After implementing OFDM in IEEE 802.16d, OFDMA has been included in IEEE 802.16e to provide support in NLOS conditions and mobility. The earlier version uses 10 to 66 GHz but the later version is expanded to use up the lower bandwidth from 2 to 11 GHz which also supports the 10 to 66 GHz frequency bands.

Functions of WiMAX

1. Support data downlink transfer speed of 144Mbps and uplink transfer speed of 35Mbps.
2. Provides Point to Multipoint coverage or acts a Wireless backhaul.
3. Possible replacement candidate for GSM and CDMA.
4. Higher data throughput and longer coverage than WIFI.

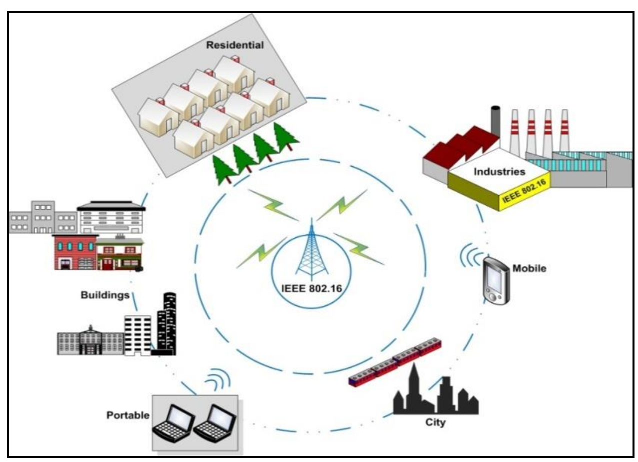

Fig. 1: Architecture of WiMAX System

II. WIMAX NETWORK ARCHITECTURE

WiMAX architecture comprises of several components but the basic two components are BS and SS (Subscriber Station). Other components are MS, ASN, CSN and CSN-GW etc. The WiMAX Forum's Network Working Group (NWG) has developed a network reference model according to the IEEE 802.16e-2005 air interface to make sure the objectives of WiMAX are achieved. To support fixed, nomadic and mobile WiMAX network, the network reference model can be logically divided into three parts [14] as following, and Figure 3.2 show in WiMAX network architecture based on IP.

A. Mobile Station (MS)

It is for the end user to access the mobile network. It is a portable station able to move to wide areas and perform data and voice communication. It has the entire necessary user Equipments such as an antenna, amplifier, transmitter, receiver and software needed to perform the wireless communication. GSM, FDMA, TDMA, CDMA and W-CDMA devices etc. are the examples of Mobile station.

B. Access Service Network (ASN)

It is owned by NAP, formed with one or several base stations and ASN gateways (ASN-GW) which creates radio access network. It provides all the access services with full mobility and efficient scalability. Its ASN GW controls the access in the network and coordinates between data and networking elements.

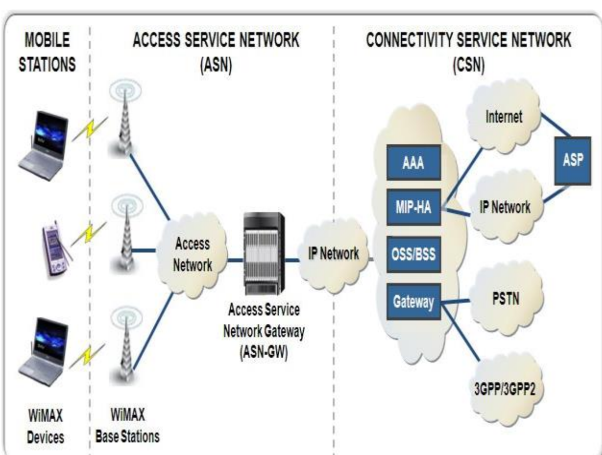

Fig. 2: WiMAX Network Architecture based on IP [5]

C. Connectivity Service Network (CSN)

It is Provides IP connectivity to the Internet or other public or corporate networks. It also applies per user policy management, address management, location management between ASN, ensures QoS, roaming and security.

III. WIMAX MECHANISM

WiMAX is capable of working in different frequency ranges but according to the IEEE 802.16, the frequency band is 10 GHz to 66 GHz. A typical architecture of WiMAX includes a base station built on top of a high rise building and communicates on point to multi-point basis with subscriber stations which can be a business organization or a home. The base station is connected through Customer Premise Equipment (CPE) with the customer. This connection could be a Line-of-Sight (LOS) or Non-Line-of-Sight (NLOS).

A. Line of Sight (LOS)

Line-of-sight: service, where a fixed dish antenna points straight at the WiMAX tower from a rooftop or pole. The line-of-sight connection is stronger and more stable, so it's able to send a lot of data with fewer errors. Line-of-sight transmissions use higher frequencies, with ranges reaching a possible 66 GHz. LOS requires its most of the Fresnel zone, free from obstacles but if the signal path is blocked by any means, the strength of the signal decreases significantly resulting poor connectivity [11]. There must be a direct link between a WiMAX base station and the receiver in LOS environment. LOS means line of sight, line of sight in radio communication refers to the condition where minimum 60% of first Fresnel zone (refer to Fresnel zone in blog) is clear, In modern radio communication systems operating above the 2.4 Ghz frequency requires clear LOS.

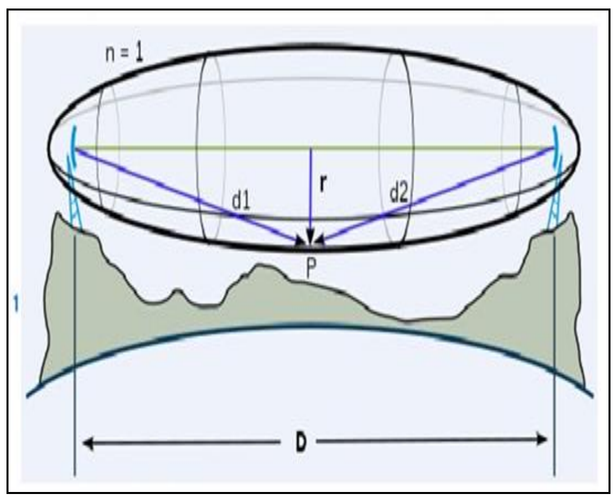

Fig. 3: WiMAX in LOS Condition [11]

The features of LOS connections are:

a. Uses higher frequency between 10 GHz to 66 GHz,
b. Huge coverage areas,
c. Higher throughput,
d. Less interference,

e. Threat only comes from atmosphere and the characteristic of the frequency,

f. LOS requires most of its first Fresnel zone should be free of obstacles.

B. Non-Line of Sight (NLOS)

Non-line-of-sight service is a Wi-Fi sort of service. Here a small antenna on your computer connects to the WiMAX tower. In this mode, WiMAX uses a lower frequency range 2 GHz to 11 GHz (similar to Wi-Fi). In LOS connection, signal travels in a straight line which is free of obstacles, means, a direct connection between a transmitter and a receiver. In NLOS connection, signal experiences obstacles in its path and reaches to the receiver through several reflections, refractions, diffractions, absorptions and scattering etc. These signals arrive to the receiver in different times, attenuation and strength which make it hard to detect the actual signal.

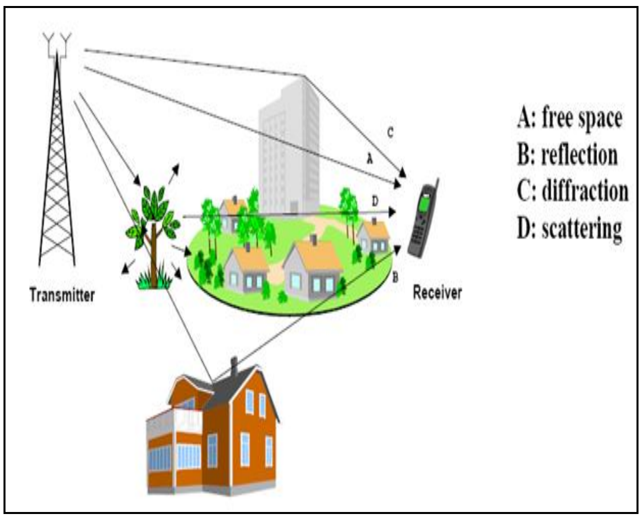

Fig. 4: WiMAX in NLOS Condition

WiMAX shows good performance in NLOS condition as it is based on OFDM which can handle delays caused in NLOS [17], perfectly. WiMAX offers other benefits which works well in NLOS condition. Near Los means near line of sight , it refers to the condition in radio communication where a straight line from Site A to Site B is unobstructed but 60% of first Fresnel zone is not clear. Wimax technology (refer Wimax Technology in blog) if developed to combat the interference occurred due to the near LOS reflection.

IV. SIMULATION MODEL

The structure of the baseband part of the implemented transmitter and receiver is shown in Figure 4.2. This structure corresponds to the physical layer and MAC layer of the IEEE 802.16-2004 Wireless MAN-OFDM air interface. In this setup, we have just implemented the mandatory features of the specification, while leaving the implementation of optional features for future work. Channel coding part is composed of three steps- randomization, Forward Error Correction (FEC) and interleaving. FEC is done in two phases through the outer Reed-Solomon (RS) and inner Convolutional Code (CC). The complementary operations are applied in the reverse order at channel decoding in the receiver end.

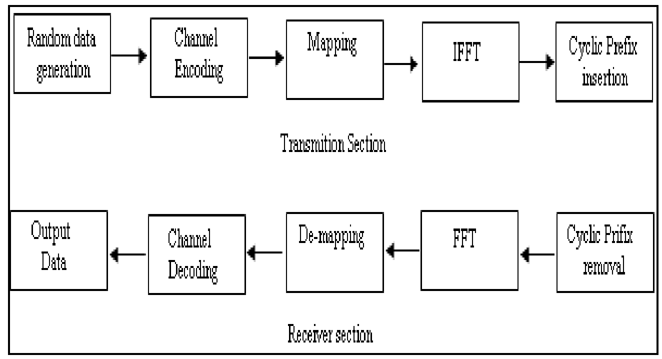

Fig. 5: Simulation Setup

A. Channel Coding

Chanel coding can be described as the transforming of signal to improve communication performance by increasing the robustness against channel improvement such as noise, interference and fading. In digital communications, a channel code is a broadly used term mostly referring to the forward error correction code and bit interleaving in communication and storage where the communication media or storage media is viewed as a channel. The channel code is used to protect data sent over it for storage or retrieval even in the presence of noise (errors). The complete channel encoding setup is shown in Figure 4.4 while corresponding decoding setup is shown in Figure 4.5. Through the rest of the sections, the individual block of the setup will be discussed with implementation technique.

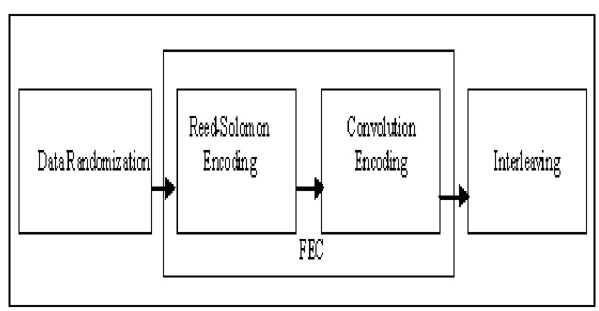

Fig. 6: Channel Encoding Setup

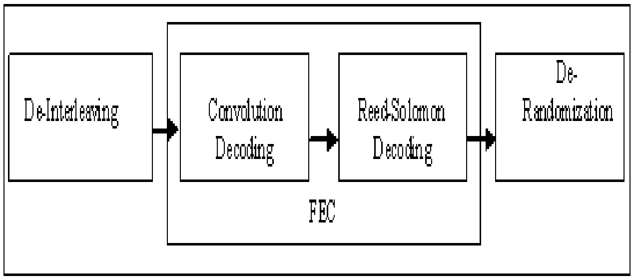

Fig. 7: Channel Decoding Setup

V. SIMULATION RESULTS

In practical communication systems, convolutional codes tend to be one of the more widely used channel codes. These codes are used primarily for real-time error correction and can convert an entire data stream into one single codeword. The Viterbi algorithm provided the basis for the main decoding strategy of convolutional codes. The encoded bits depend not only on the current informational k input bits but also on past input bits. Block codes tend to be based on the finite field arithmetic and abstract algebra. Block codes accept a block of k information bits and return a block of n coded bits. Block codes are used primarily to correcting or detecting errors in data transmission. Commonly used block codes are Reed-Solomon codes, BCH codes, and Hamming codes.

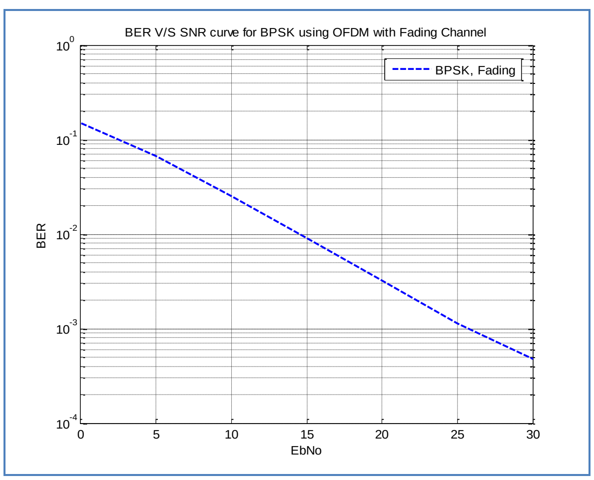

Fig. 8: BER V/S SNR Crave for BPSK using OFDM with Fading Channel

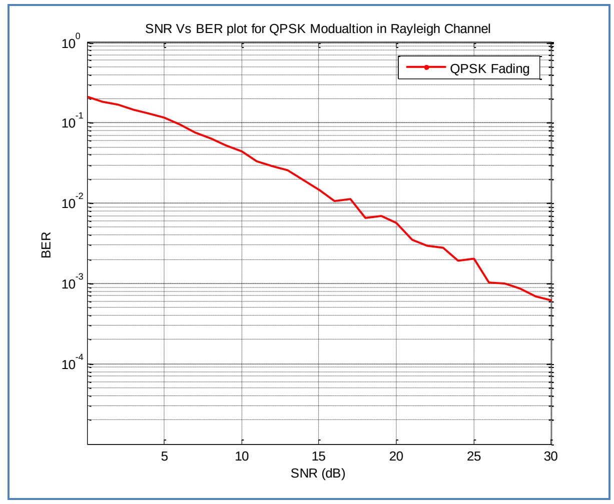

Fig. 9: BER V/S SNR Crave for QPSK using OFDM with Fading Channel

VI. CONCLUSION

In telecommunication field the major challenges is to convey the information as efficiently as possible through limited bandwidth, though the some of information bits are lost in most of the cases and signal which is sent originally will face fading. To reduce the BER the loss of information and signal fading should be minimized. In our paper we analyze two modulation techniques, QPSK and BPSK to reduce the error performance of the signal and compare which technique is better through Rayleigh Fading Channel in the presence of AWGN.

REFERENCES

[1] S.M. Lalan Chowdhiury, P. Venkateswaran, “Performance Analysis of WiMAX PHY”, IEEE CASCOM Post Graduate Student Paper Conference 2010, Dept of electronics & Tele-Communication Engg., Jadavpure University, Kollata, India.

[2] Jian Li, Guoqing Liu, and Georgios B. Giannakis, Fellow, IEEE, “Carrier Frequency Offset Estimation for OFDM-Based WLANs”, IEEE SIGNAL PROCESSING LETTERS, VOL. 8, NO. 3 MARCH 2001.

[3] IEEE 802.16-2006: "IEEE Standard for Local and Metropolitan Area Networks, Air Interface for Fixed Broadband Wireless Access Systems".

[4] Koffman I., Roman, V., “Broadband wireless access solutions based on OFDM access in IEEE 802.16” Communications Magazine, IEEE, Vol.40, Issue. 4, April 2002, Pages 96-103

[5] IEEE 802.16e-2005, “IEEE Standard for Local and Metropolitan Area Networks, part 16, Air Interface for Fixed and Mobile Broadband Wireless Access Systems”, IEEE Press, 2006

[6] IEEE Computer Society, "IEEE standard for information technology - telecommunications and information exchange between systems - local and metropolitan area network-specific requirements part 11: Wireless LAN medium access control and physical layer specifications", IEEE Std 802.11, June 2007.
[7] IEEE 802.162004, "IEEE Standard for Local and Metropolitan Area Networks Part 16: Air Interface for Fixed Broadband Wireless Access Systems", 1 October, 2004
[8] Koffman I., Roman, V., "Broadband wireless access solutions based on OFDM access in IEEE 802.16" Communications Magazine, IEEE, Vol.40, Issue. 4, April 2002, Pages 96-103
[9] ETSI TS 102 177 Version 1.3. 1, February 2006, "Broadband Radio Access Networks (BRAN); HiperMAN; Physical (PHY) Layer".
[10] Muhammad Nadeem Khan, Sabir Ghauri, "The WiMAX 802.16e Physical Layer Model", University of the West of England, United Kingdom, ndm62 1 @hotmail.com,
[11] Pavani Sanghoi, Lavish Kansal " Analysis of WIMAX Physical Layer using Spatial Diversity under Different Fading Channels", International Journal of Computer Applications (0975 – 8887) Volume 45– No.20, May 2012
[12] M.A. Mohamed, M.S Abou-El-Soud, and H.M. Abdel-Atty "Performance and Efficiency of WiMAX-MAC-Layer: IEEE-802-16e" , IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.12, December 2010
[13] Neha Rathore "Simulation of WiMAX 802.16e MAC Layer Model: Experimental Results", International journal of electronics & communication technology, IJECT Vol. 3,issue, Jan.-March 2012
[14] Md. Ashraful Islam, Md. Zahid Hasan, "Riaz Uddin Mondal (corresponding author), Performance Evaluation of Wimax Physical Layer under Adaptive Modulation Techniques and Communication Channel"s, (IJCSIS) International Journal of Computer Science and Information Security, Vol. 5, No.1, 2009.