International Journal of Ethics in Engineering & Management Education
Website: www.ijeee.in (ISSN: 2348-4748, Volume 1, Issue 4, April 2014)

BER ANALYSIS OF WIMAX SYSTEM OVER AWGN AND FADING CHANNEL FOR IMAGE, AUDIO & VIDEO TRANSMISSION

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***Abstract*- This paper presents the simulation model of Worldwide Interoperability for Microwave Access (WiMAX) system based on Orthogonal Frequency Division Multiplexing (OFDM) has been developed with different digital modulation techniques for real time image, audio and video transmission over wireless channel like AWGN, Rayleigh and Rician. The simulation is based on the WiMAX physical layer which adopted an OFDM model in the transmitter and receiver. The Matlab software is used to develop the OFDM model and analysis the performance of WiMAX system. The Bit Error Rate (BER) performance of wimax system was compared by using different input like image, audio and video and also with different QAM modulation technique by plotting graphs between Bit Error Rate and Signal to Noise Ratio. The basic feature of the next generation of wireless communications technologies (4G) will be merge with different wireless networks and multimedia services such as speech, audio, video, image, Internet services, and data at high data rates and with high mobility, high capacity and high QoS. Also it is noted that as the order of QAM modulation is increased from 256 to 1024, the system has best BER performance for good channel conditions but for noisy channel conditions, its performance is comparatively degraded. The simulation model built for this work, demonstrates that AWGN channel has better performance than Rayleigh and Rician fading channels**

Keywords*- *Worldwide Interoperability for Microwave access (WiMAX). Orthogonal Frequency Division Multiplexing (OFDM), Bit error rate (BER), QAM-256, QAM-512, QAM-1024

I. INTRODUCTION

WiMAX stands for Worldwide Interoperability for Microwave Access formed by WiMAX forum in 2001. It provides wireless broadband to fixed and mobile terminals in a large geographical area. The 2005 version of WiMAX provides data rate up to 40Mbits/s and 2011 version can support data rate up to 1 Gbit/s for fixed stations [1]. WiMAX system uses OFDM in the physical layer. OFDM is based on the adaptive modulation technique in non-lineof- sight (NLOS) environments. Base stations of WiMAX can provide communication without the need of line-of-sight (LOS) connection. WiMAX base station has enough available bandwidth so at a time it can serve number of subscribers and also cover large area range. WiMAX standard have two versions: IEEE 802.16-2004 and IEEE 802.16d. It supports Orthogonal Frequency Division Multiplexing (OFDM) in physical layer. It provides wireless DSL technology where broadband cables are not available. WiMAX standard 802.16e uses (Orthogonal Frequency Division Multiple Access) OFDMA technique. It provides support for nomadic. and mobility services so it also known as mobile WiMAX WIMAX is the abbreviation of Worldwide Interoperability for Microwave Access and is based on Wireless Metropolitan Area Networking (WMAN). The WMAN standard has been developed by the IEEE 802.16 group which is also adopted by European Telecommunication Standard Institute (ETSI) in High Performance Radio Metropolitan Area Network, i.e., the Hipper MAN group. The main purpose of WIMAX is to provide broadband facilities by using wireless communication [1]. WIMAX is also known as “Last Mile” broadband wireless access technology WIMAX gives an alternate and better solution compared to cable, DSL and Wi-Fi technologies as depicted in Figure-1:

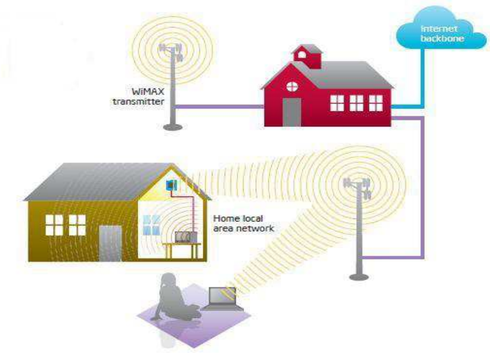

Figure-1: WiMAX System

Like other wireless communication network, transmission medium faces two major problems in WIMAX communication system. These problems are:

a) AWGN noise and
b) Rayleigh and Rician Fading.

In last decades, Orthogonal Frequency Division Multiplexing (OFDM) based communication systems has been identified as one of key transmission techniques for next generation wireless communication systems [4]. The main attractions of OFDM are handling the multi-path interference, and mitigate inter-symbol interference (ISI) causing bit error rates in frequency selective fading environments [5]. Wireless mobile communication systems of the 21st century have to confirm a wide range of multimedia services such as speech, image, and data transmission with different and variable bit rates up to 2 Mbit/s [6]. It is all recognized that there is a great impact of channel coding on the performances of OFDM based wireless communication system to provide high data rates over severe multipath channels.

The main objective of this paper is to built up the real time model for the WiMAX based OFDM system along with different wireless channels compatible to various atmospheric conditions for the signal propagation and also to Investigate the effect of wimax based OFDM system performance over the AWGN, Rayleigh and Rician fading channel with different SNR and modulation technique. The model discussed in the research paper is built on QAM modulation scheme and OFDM technique based on the platform of Matlab R2010 simulation.

II. WIRELESS CHANNEL MODELING

Wireless communication is one of the most active areas of technology development and has become an ever-more important and prominent part of everyday life. Simulation of wireless channels accurately is very important for the design and performance evaluation of wireless communication systems and components. Fading or loss of signals is a very important phenomenon that related to the Wireless Communications Field. That leads us to the fading models which try to describe the fading patterns in different environments and conditions. Although no model can „perfectly□ describe an environment, they strive to obtain as much precision as possible. The better a model can describe a fading environment, the better can it be compensated with other signals, so that, on the receiving end, the signal is error free or at least close to being error free .This would mean higher clarity of voice and higher accuracy of data transmitted over wireless medium. An important issue is in wireless application development is the selection of fading models.

1.1Fading and Multipath

A Fading Channel is known as communications channel which has to face different fading phenomenon, during signal transmission. In real world environment, the radio propagation effects combine together and multipath is generated by these fading channels. Due to multiple signal propagation paths, multiple signals will be received by receiver and the actual received signal level is the vector sum of the all signals .These signals incident from any direction or angle of arrival. In multipath, some signals aid the direct path and some others subtract it.

a). Additive White Gaussian Noise Model:

The simplest type of channel is the Gaussian channel. It is often referred to the additive white Gaussian noise (AWGN) channel .This type of channel having the noise distribution with a constant power spectral density with Gaussian nature of PDF over the whole channel bandwidth. Additive white Gaussian noise (AWGN) is the commonly used to transmit signal while signals travel from the channel and simulate background noise of channel. The mathematical expression in received signal
$r(t) = s(t) + n(t)$ that passed through the AWGN channel where $s(t)$ is transmitted signal and $n(t)$ is background noise.
An AWGN channel adds white Gaussian noise to the signal that passes through it. It is the basic communication channel model and used as a standard channel model. The transmitted signal gets disturbed by a simple additive white Gaussian noise process.

b). Rayleigh fading:

Rayleigh channel used between the transmitter and receiver of the wimax system which describes the most prominent phenomenon of mobile radio communication system, i.e. fading .The fading is the resultant of rapid fluctuations in the amplitude, frequency or phase of the signal due to multipath propagation of radio waves. Rayleigh channel model is suitable for modeling in urban areas that are characterized by many obstructions where a line of sight path does not exist between the transmitter and receiver so the resultant signal received at the receiver will be the sum of all the reflected and scattered waves. The most commonly used distribution for multipath fast fading is the Rayleigh distribution, whose probability density function (pdf) is given by

$$f_{ray}(r) = \frac{r}{\sigma^2}\exp\left[-\frac{r^2}{2\sigma^2}\right], r\geq 0$$

Here, it is assumed that all signals suffer nearly the same attenuation, but arrive with different phases. The random variable corresponding to the signal amplitude is r. Here σ2 is the variance of the in-phase and quadrature components. Theoretical considerations indicate that the sum of such signals will result in the amplitude having the Rayleigh distribution of the above equation .This is also supported by measurements at various frequencies. The phase of the complex envelope of the received signal is normally assumed to be uniformly distributed in [0,2π].

c). Rician fading:

Rician channel is used for sub urban area where there is a LOS as well as the non-LOS path in between the transmitter and

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receiver, i.e. the received signal comprises on both the direct and scattered multipath waves. In the modeling of Rician channel the multipath variations of the signal are superimposed over the line of sight component which increases the overall strength of the whole information at the receiver

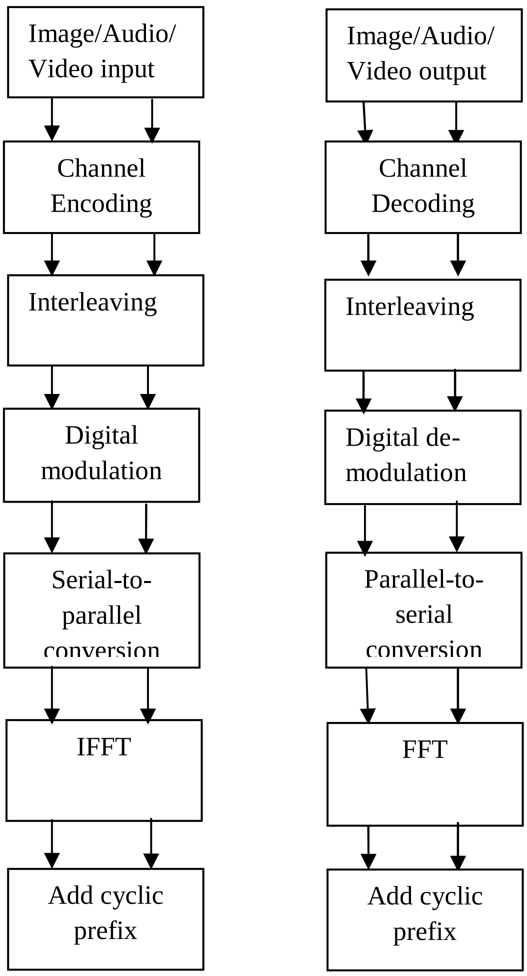
When strong LOS signal components also exist, the distribution is found to be Rician, the pdf of such function is given by:

$$f_{ric}(r) = \frac{r}{\sigma^2}\exp\left[\frac{-(r^2+A^2)}{2\sigma^2}\right] I_o\left(\frac{Ar}{\sigma^2}\right), r\geq 0, A \geq 0$$

Where σ2 is the variance of the in-phase and quadrature components .A is the amplitude of the signal of the dominant path and I0 is the zero-order modified Bessel function of the first kind.

III. SIMULATION MODEL

The implementation model shown in fig.2 comprises of transmitter, receiver and communication channel like AWGN, Rayleigh and Rician. Transmitter consists of input image or audio or video, convolution encoder, and interleaver bit to symbol mapper, modulator, and serial to parallel conversion, parallel to serial conversion, inverse Fourier transform.



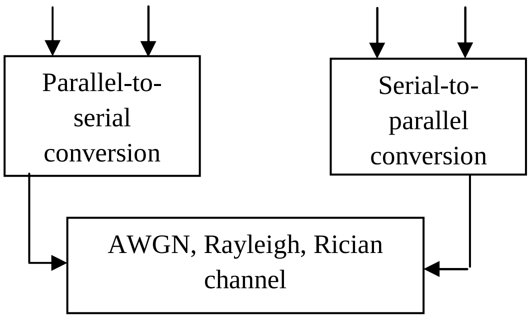


Figure 2: A block diagram represents WIMAX based OFDM System

First of all, 256 x 256 image input or 8 second audio with 8000 samples or 1.30 minute input video is taken. Once the data is received in terms of either image or audio or video, it is fed into transmitter in form of binary pulses. The convolution encoder acts upon the input data and helps to improve the capacity of a channel by adding some carefully designed redundant information to the data being transmitted through the channel. The convolutionally encoded data is then fed to the interleaver which arranges the data in non-contiguous way to improve the performance. Encoded data is given to QAM modulation. The serial to parallel converts the serial bit stream into parallel form to be transmitted as OFDM symbol. In OFDM process, the in phase and quadrature phase components of the symbols will undergo through the process of IFFT so that requirement of effective bandwidth can be made approximately half without any inter symbol interference. Cyclic prefix is the most effective guard period attached in front of every OFDM symbol. The cyclic prefix is the copy of the last part of the OFDM symbol added in front of the transmitted symbol, provided that the length is of equal or greater than the maximum delay spread of the channel as shown in figure 2.

The transmitter is followed by AWGN, Rayleigh and Rician channel. At the receiver end the exact reverse process take place to recover the data with the help of FFT in which it converts the signal into the frequency domain it then demodulated according to the block diagram as shown in Figure

IV. SIMULATION RESULTS

This section presents and discusses all of the results obtained by the computer simulation program written in Matlab7.5, following the analytical approach of a wimax based OFDM system considering AWGN, Rayleigh Fading and Rician Fading channel.

a) Performance of OFDM based WIMAX System for image transmission using 256-QAM, 512-QAM and 1024-QAM modulation technique:

The following figure shows the BER performance of WIMAX system for image transmission through AWGN channel, Rayleigh and Rician fading channels using Quadrature Amplitude Modulation (QAM) technique. From figure-a, b &

International Journal of Ethics in Engineering & Management Education
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c, we can see that, AWGN channel has lower BER than Raleigh and Rician fading channel. As seen from figure that when SNR increases the Bit Error Rate decreases. Also it is noted that as the order of QAM modulation is increased from 256 to 1024, the system has best BER performance for good channel conditions but for noisy channel conditions, its performance is comparatively degraded.

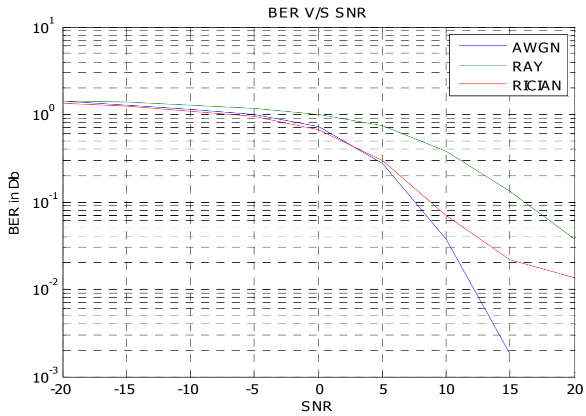

Figure-a: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 256-QAM modulation technique.

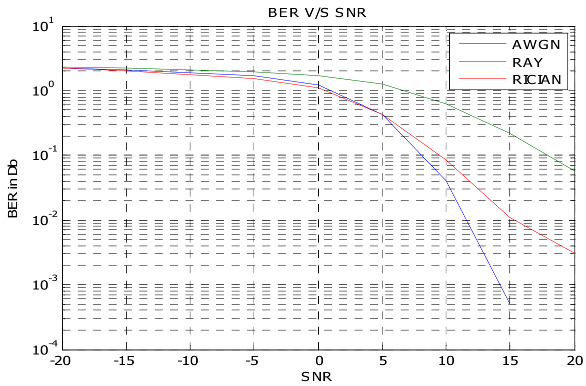

Figure-b: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 512-QAM modulation technique.

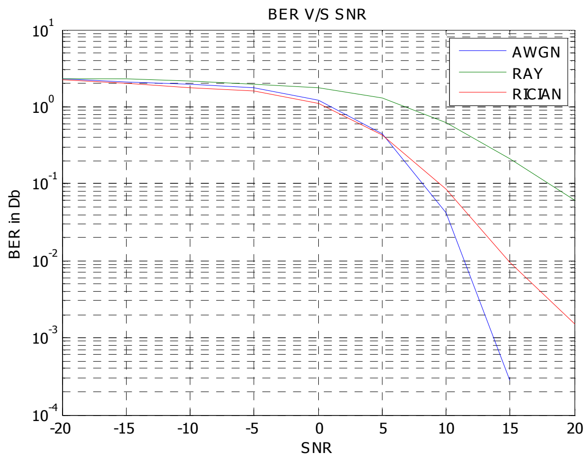

Figure-c: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 1024-QAM modulation technique.

b) Performance of OFDM based WIMAX System for Audio transmission using 256-QAM, 512-QAM and 1024-QAM modulation technique:

The following figure shows the BER performance of WIMAX system for audio transmission through AWGN channel, Rayleigh and Rician fading channels using Quadrature Amplitude Modulation (QAM) technique. From figure-d, e & f, we can see that, AWGN channel has lower BER than Raleigh and Rician fading channel. As seen from figure that when SNR increases the Bit Error Rate decreases. Also it is noted that as the order of QAM modulation is increased from 256 to 1024, the system has best BER performance for good channel conditions but for noisy channel conditions, its performance is comparatively degraded.

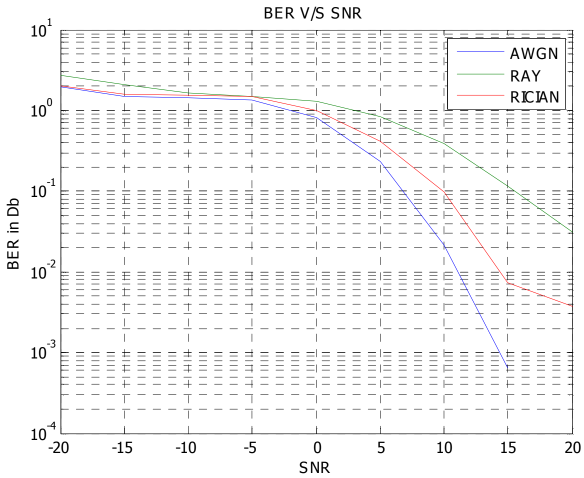

Figure-d-: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 256-QAM modulation technique.

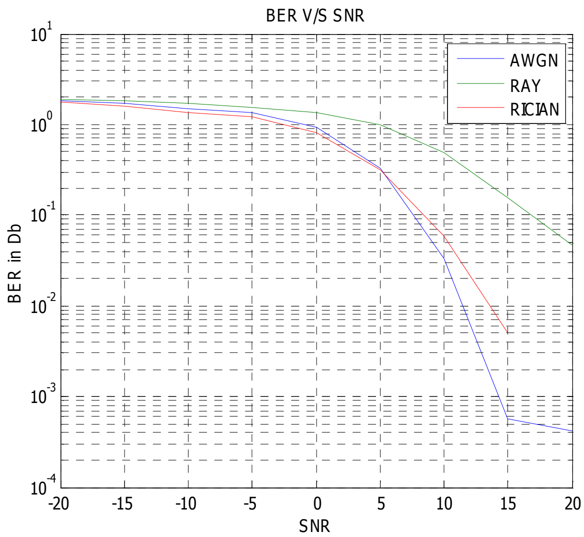

Figure-e: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 512-QAM modulation technique

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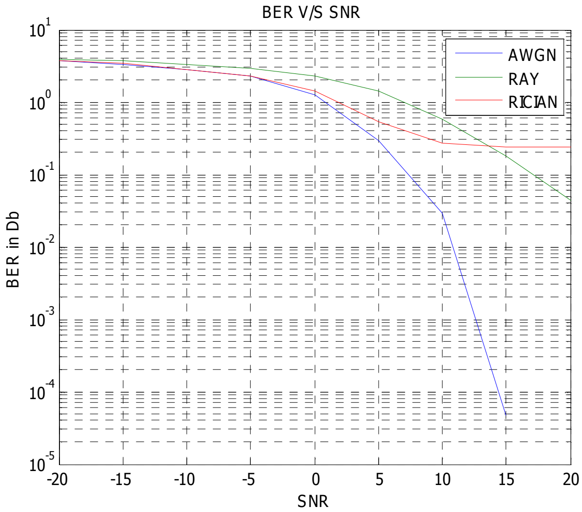

Figure-f: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 1024-QAM modulation technique

c) Performance of OFDM based WIMAX System for Video transmission using 256-QAM, 512-QAM and 1024-QAM modulation technique:

The following figure shows the BER performance of WIMAX system for image transmission through AWGN channel, Rayleigh and Rician fading channels using Quadrature Amplitude Modulation (QAM) technique. From figure-a, b & c, we can see that, AWGN channel has lower BER than Raleigh and Rician fading channel. As seen from figure that when SNR increases the Bit Error Rate decreases. Also it is noted that as the order of QAM modulation is increased from 256 to 1024, the system has best BER performance for good channel conditions but for noisy channel conditions, its performance is comparatively degraded

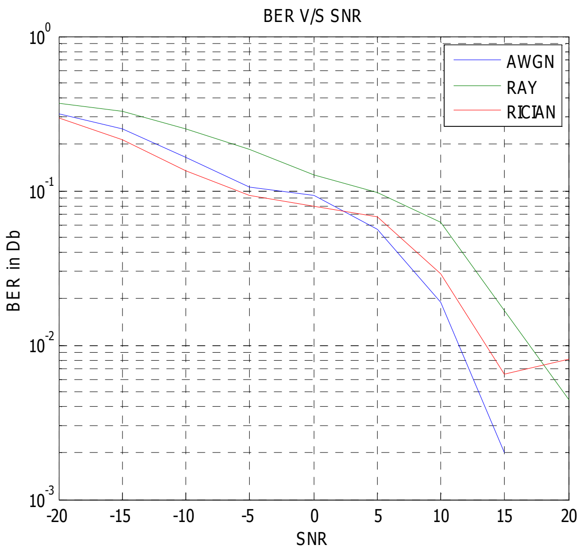

Figure-g: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 256-QAM modulation technique

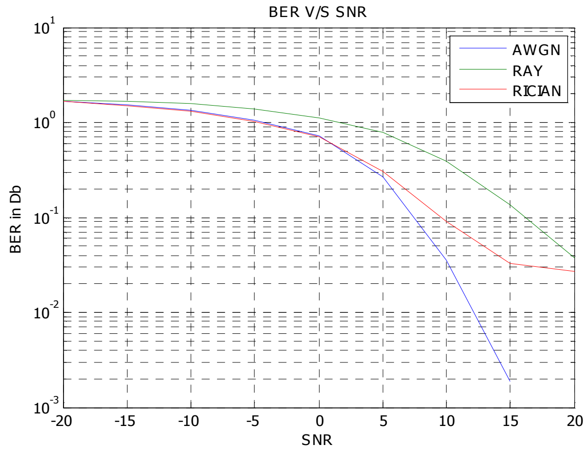

Figure-h: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 512-QAM modulation technique

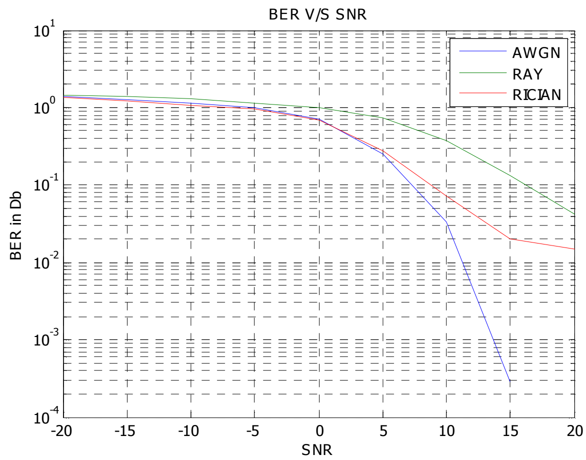

Figure-i: Bit error rate (BER) performance of AWGN, Raleigh and Rician channels for 1024-QAM modulation technique

V. CONCLUSION

In this paper the complete wimax system has been analyzed by transmitting real time image, audio and video signals with modelling of AWGN, Rayleigh and Rician channel under the variation of different modulation schemes and SNR

1. The performance of AWGN channel is the better than all channels as it has the lowest bit error rate (BER) under QAM, 256-QAM, 512-QAM and 1024 modulation schemes. The amount of noise occurs for transmission of image, audio and video in the BER of this channel is quite slighter than fading channels.
2. The performance of Rayleigh fading channel is the worst than all channels as comparing the BER of this channel has been much affected by noise under QAM, 256-QAM, 512-QAM and 1024-QAM modulation schemes.

3. The performance of Rician fading channel is worse than that of AWGN channel and better than that of Rayleigh fading channel. Because Rician fading channel has higher BER than AWGN channel and lower than Rayleigh fading channel. BER of this channel has not been much affected by noise under QAM, 256-QAM, 512-QAM and 1024-QAM modulation schemes.

REFERENCES

[1]. "Nextel Flash-OFDM: The Best Network You May Never Use". PC Magazine. March 2, 2005. Retrieved July 23, 2011
[2]. Raza Akbar, Syed Aqeel Raza, Usman Shafique, "PERFORMANCE EVALUATION OF WIMAX", Blekinge Institute of Technology, March 2009.
[3]. J. Li and S.-G. Häggman, ―Performance of IEEE 802.16 Based System in Jamming Environment and its Improvement with Link Adaption, The 17th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'06), 2006, Helsinki, pp.1-5.
[4]. S. Hara and R. Prasad, ―Multicarrier Techniques for 4G Mobile Communications, Artech House, first edition, 2003.
[5]. M. Engels, ―Wireless OFDM Systems: How To Make Them Work?, Kluwer Academic Publishers, 2002.
[6]. V.Jagan Naveen, K.Murali Krishna, K.RajaRajeswari, ―performance analysis of mc-cdma and OFDM in wireless rayleigh channel, International Journal of Advanced Science and Technology, Vol. 5, December,2010 .
[7]. J. G. Proakis, Digital Communications, McGraw-Hill Inc., New York, NY, 1995 (Third Edition).
[8]. Nirali A. Kotak, Bhavin Sedani, Ved Vyas Dwivedi, Simulation & Performance Analysis of DVB-T System Using Efficient Wireless Channels, 2011 International Conference on Computational Intelligence and Communication Networks, October 07-09, Gwalior-India. IEEE Xplore- ISBN: 978-0-7695-4587-5
[9]. Jelena Mi¡si and Vojislav B. Misic, Wireless Personal Area Networks Performance,Interconnections and Security with IEEE 802.15., John Wiley & Sons, Ltd
[10]. Muhammad Nadeem Khan, Sabir Ghauri, "The WiMAX 802.16ePhysical Layer Model", IEEE Xplore.