BER Performance of 802.16e with Different Modulation Techniques and Channel Coding

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***Abstract*—Wimax technology is a type of wireless metropolitan area network and is an emerging global broadband wireless access system based on IEEE802.16 standard. It ensures high data rate services with wide area coverage in frequency range of 10-66 GHZ (LOS) and 2-11GHZ (NLOS). This paper analyzes the performance of 802.16e in AWGN channel. Further performance improvement is achieved using channel coding. The channel coding used is Turbo code and convolutional codes. The Performance parameter is BER vs SNR and the modulation schemes used are BPSK and QPSK.**

Keywords-AWGN, BER, OFDM, Turbo Code, Wimax.

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (Wimax) is the IEEE 802.16 Standards based wireless technology that provides MAN (Metropolitan Area Network) broadband. Wimax is a promising technology which can offer high speed Voice, video and data service up to the customer end. It is a wireless broadband technology. It has several improvement then Wi-Fi and UMTS, HSDPA. Wi-Fi provides wireless high speed internet and network connections UMTS is based on 3G GSM standard. HSDPA is an enhanced3G communication protocol that supports high data transfer speed and capacity. Wimax supports both point-to-point (P2P) and point-to-multipoint (P2MP) modes. WiMAX can connect rural areas in developing countries as well as underserved metropolitan areas. The physical layer of WiMAX is based on the IEEE 802.16-2004 and IEEE 802.16e-2005 standards and was designed with much influence from Wi-Fi. The IEEE 802.16d standard was published for Fixed Wireless Access (FWA) applications and the transmission method for line-of–sight connection. IEEE 802.16e standard provides fixed, nomadic, portable and mobile wireless broadband connectivity without the need for direct line-of-sight with the base station.[1,2,3].

TABLE I . EVOLUTION in IEEE 802.16 standard.

Parameter	802.16 – 2001	802.16d – 2004	802.16e - 2005
Bandwidth	10 – 66 Ghz	2 – 11 Ghz	2 – 6 Ghz
Bit Rate	Upto 134 Mbps	Upto 75 Mbps	Upto 15 Mbps
Mobility	Fixed	Fixed/Nomadic	Portable/Moblie
Application	Fixed LOS	Fixed NLOS	Fixed and Mobile NLOS
Modulation	QPSK, 16 QAM, 64 QAM	QPSK, 16 QAM, 64 QAM	QPSK, 16 QAM, 64 QAM

II. OFDM

The Wimax physical layer is based on OFDM, in which multiple accesses are achieved by assigning a subset of sub carriers to each individual user .OFDM is the transmission scheme of choice to enable high speed data, video and multimedia communication and is used by a variety of commercial broadband systems. In an OFDM system, the data is divided into multiple parallel sub streams at a reduce data rate and each is modulated and transmitted on a separate orthogonal system robustness. OFDM is often presented as the best performing transmission technique used for wireless system.[4,6].

III. WIMAX SYSTEM MODEL

System model of Wimax is shown in fig.1. The various blocks of this model are explained below:

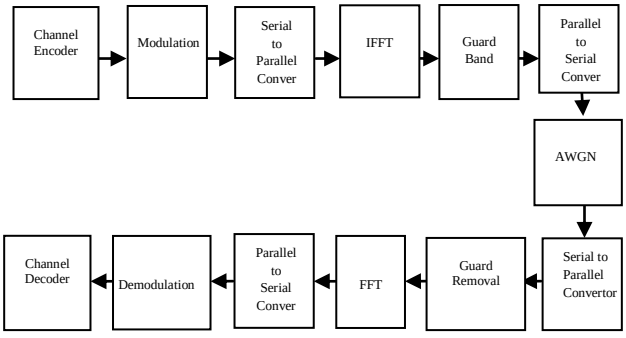

Fig. 1. Model of Wimax system

A. *Channel coding*

Channel coding can be described as the transforming of signal to improve communication performance by increasing the robustness against channel impairment such as noise, interference and fading. Channel coding includes the randomization of data, forward error correction (FEC) and interleaving.

B. *Randomization*

Randomization process is used to minimize the possibility of transmission of non-modulated subcarriers. The process of randomization is performed on each burst of data on the downlink and uplink. The main component of the data randomization is a pseudo random binary sequence generator which is implemented using linear feedback shift register. The generator defined for the randomizer is given by equation (1) below:

$$G=1+x^{14}+x^{15} \quad (1)$$

C. *Convolutional code*

Convolution codes are used to correct the random error in the data transmission. Convolutional coding is done by combining the fixed number of input bits .A convolutional code is generated by passing the information sequence through a finite stage shift register. The ratio R=k/n is called the code rate for a convolutional code, where R=code rate= number of input bits and n=number of output bits. [5, 9, 10].

D. *Turbo Coding*

The Turbo codes are basically convolutional codes in series or in parallel and are generally known as convolutional Turbo codes. The convolutional codes can be used to encode a continuos stream of data, but in the case it is assumed that is configured in finite blocks corresponding to the interlever size. The advantage of Turbo code are modulation scheme becomes feasible even at low SNR level, high data rate and BER is less compared to other coding techniques.

E. *Modulation*

Wimax 802.16 uses digital modulation. The interleaver reorders the data and sends the data frame to the IQ mapper. The function of the IQ mapper is to map the incoming bits of data from interleave onto a constellation. Three modulations are supported by the IEEE802.16 standard BPSK, QPSK, QAM[5,6].

F. *IFFT*

The modulated data in the frequency domain is then converted into time domain data is then converted into time domain data by performing IFFT on it. We can compute time duration of the IFFT time signal by multiply the number of FFT bits by the sample period. Zeros are added at the end and beginning of OFDM symbol. These zero carriers are used as guard band to prevent inter channel interference (ICI).[1,8].

G. *AWGN channel*

Additive white Gaussian noise is the commonly used to transmit signal while signals travel from the channel and simulate background noise of channel. The AWGN channel is a good model for many satellites and deep space communication link. The received signal in the interval $0 \geq t \geq T$ may be expressed as:

$$r(t) = s_m(t) + n(t) \quad (2)$$

Where $n(t)$ denotes the sample function of additive white gaussian noise process.[9].

IV. RESULT

Wimax with BPSK and QPSK digital modulation techniques are simulate over AWGN channel using MATLAB. Calculate BER performance of above system with BPSK and QPSK modulation techniques over AWGN channel using Convolutional Coding and plot the curve BER vs. SNR as shown in fig. 2 and fig. 3 respectively.

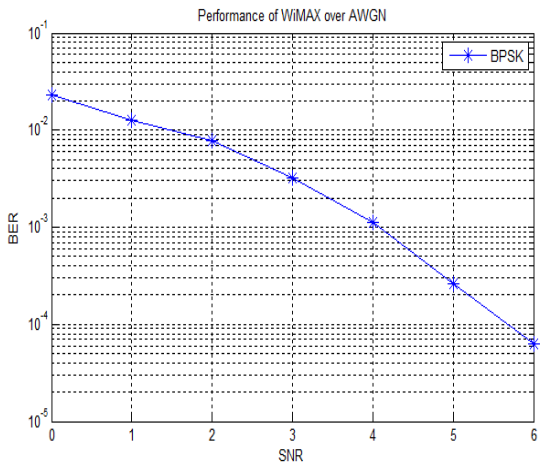

Fig. 2. BER result of BPSK over AWGN with convolutional code

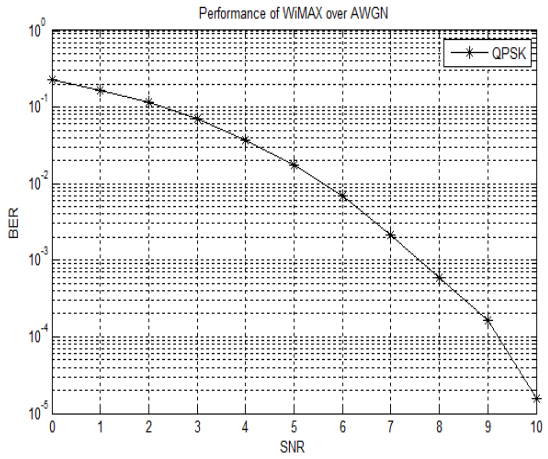

Fig. 3. BER result of QPSK over AWGN with convolutional code

The performance of Wimax system with digital modulation techniques BPSK & QPSK by using Turbo coding with AWGN channels in terms of BER Vs SNR as shown in fig. 4 and fig. 5.

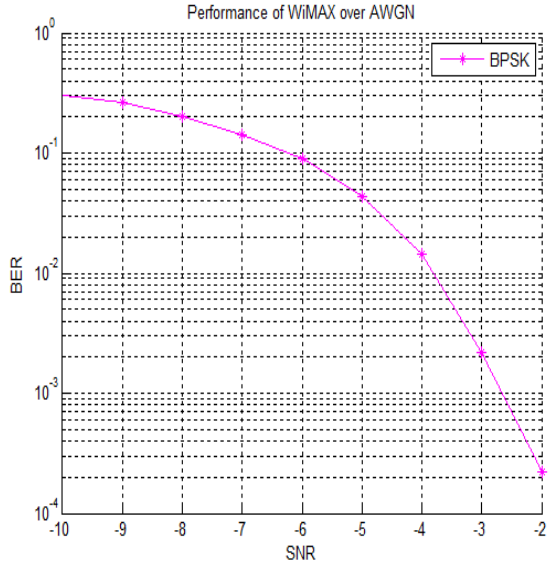

Fig. 4. BER result of BPSK over AWGN with Turbo code

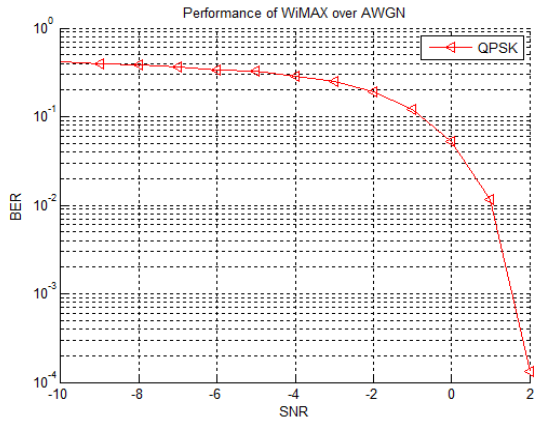

Fig. 5. BER result of QPSK over AWGN with Turbo code

Result shows that the BER for different modulation schemes Turbo and Convolutional channel coding can be arranged as follows:

Table II. The BER vs SNR values for the result

Modulation at BER (10^{-2}dB)	Convolutional Coding	Turbo Coding
BPSK	1.8	-3.8
QPSK	5.5	1.5

Based on modulation scheme

$$BER_{BPSK} > BER_{QPSK}$$

V. CONCLUSION

The data transmitted through Wimax system mainly depends upon the Bit Error Rate of a wireless communication system, by varying BER for different SNR we can implement and compare difference BPSK and QPSK modulation techniques. It is observed from Matlab test bench that the BER is minimum for Turbo coding and maximum for Convolutional coding. For AWGN channel it has been concluded that the QPSK gives better performance for higher modulation, but increase in no. of bits degrades the performance of the system. For higher values of SNR, the BER is decreasing in performance of AWGN channel.

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