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BER and PAPR Analysis by Estimating the Channel in OFDM System

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Abstract— Fourth Generation (4G) wireless technology is totally based on worldwide interoperability for microwave access (WIMAX) systems. Wimax systems have attracted significant interests from all the fields of wireless communication including students, engineers, researchers and operators. High BER (Bit Error Rate) and PAPR (Peak to Average Ratio) are the main drawbacks in Wimax using Orthogonal Frequency Division Multiplexing (OFDM). Such wireless systems using large number of subcarriers lead to undesired problems for practical applications. In this paper discussion is based on basic model and model of wimax (IEEE802.16d) physical layer using matlab 7.5 version. These models are useful for BER performance evaluation by wimax physical layer under different modulation techniques. In this bit error rate can be reduced by reducing the ISI and ICI of the system and peak to average power can be reduced by using selected mapping technique (SLM). By the reduction of BER and PAPR the performance of the OFDM based Wimax system can be improved.

Keywords— Wimax (worldwide interoperability for microwave access), OFDM (orthogonal frequency division multiplexing), BER (bit error rate), ICI (inter-carrier interference), PAPR (peak to average power ratio), SLM (selective mapping).

I. INTRODUCTION

IEEE 802.16 is a standard for broadband wireless access (BWA) commonly known as worldwide interoperability for microwave access (Wimax). Wimax is a wireless broadband standard that provide higher bandwidth for long range data transmission [1]. In such wireless system orthogonal frequency division multiplexing (OFDM) is used as multi-carrier modulation (MCM). Multi-carrier modulation provides high spectral efficiency; multipath delay spread tolerance and power efficiency. In wireless communication like digital video broadcasting (DVB) and mobile or fixed wimax, OFDM has been chosen for high data rate communications [2]. In OFDM systems, because of the high variations in the transmitted signal, peak to average power ratio (PAPR) is typically large. Due to PAPR transmission of signal over linear region of high power amplifier is difficult. When transmitted signal operate in non linear region of amplifier, non linear distortion are introduced resulting in ICI. The relative speed between transmitter and receiver in wireless system produces the Doppler shift in received frequencies. Doppler shift destroys the subcarrier's orthogonality and produces ICI in the system [3]. ISI and ICI increases the BER of the system due to which the performance of an OFDM system to be degraded. High PAPR is the main disadvantage of OFDM system. High PAPR requires large number of power amplifier at the transmitter. The large number of power amplifier increases the cost and decreases the power efficiency (battery life time decreases). So the PAPR reduction has a greater effect on the mobile communication [4].

In this paper firstly analysis of BER performance of the basic model is done. This is the model in which is not any application is included. In this BER results can be concluded on the basis of increase in the SNR of the system. When the model is used for some applications like Wimax, then there are many methods for reduction of BER and PAPR. Out of which the decrease in noise power and increase in the signal strength can reduce the BER performance of OFDM based Wimax system. For the reduction of PAPR, selected mapping (SLM) is a better technique. In this technique the main data block will be divided into several independent blocks. Then each block will be converted into OFDM symbol and finally the symbol which has less PAPR will be transmitted at the transmitter.

II. SYSTEM MODEL

In basic model binary data is transmitted by modulating the input signal by QAM modulator. Simply then data is carried by the AWGN channel and then phase noise is introduced in input signal. At the receiver side the data is demodulated by the QAM demodulator and then received at the receiver. This is the basic QAM model design. In mat lab version 7.5 this design is simulated and checks the bit error rate of the basic OFDM system. High speed communication leads to the rising needs of invention. Orthogonal frequency division multiplexing assembles the rising needs. OFDM converts the high speed information to the lower speed information stream that can be transmitted over a large no. of subcarriers. Basically the wimax physical layer is based on the OFDM modulation technique. OFDM based wimax physical layer is an efficient scheme for high data rate transmission in a non-line of sight or multipath environment [5, 1]. The model

OFDM based wimax physical layer consists of main three components that are transmitter, communication channel and receiver.

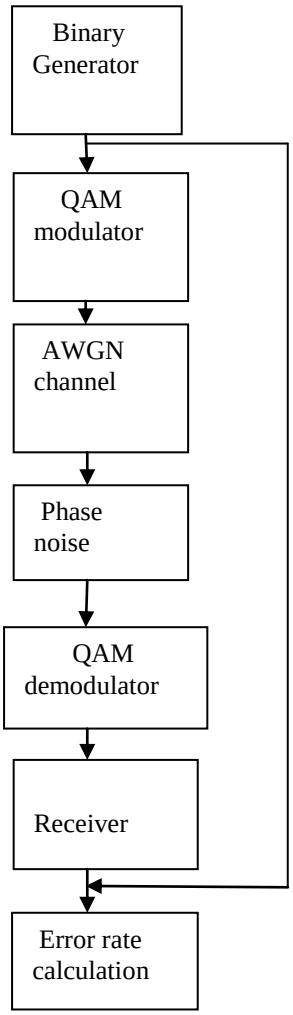

Fig. a. Basic QAM Simulink Model

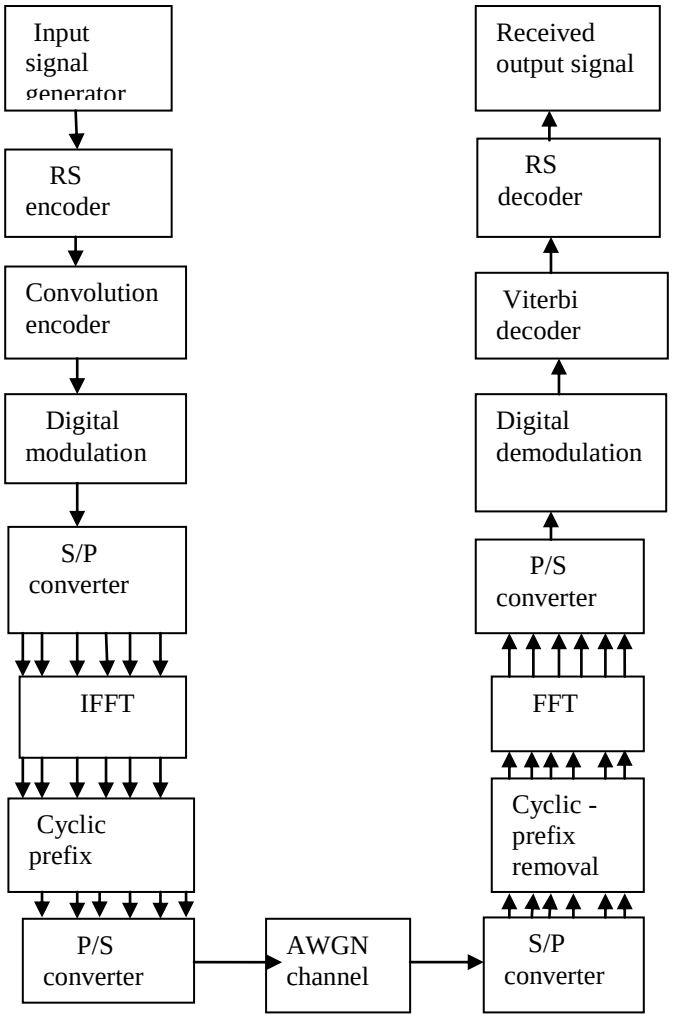

Fig. b. OFDM based Wimax Physical layer transceiver model

Transmitter-: At the transmitter the input signal is digitized by the PCM encoder. The channel coding is done at the convolution encoder. The phenomena by which noise gets reduced by changing the signal motion before passing through communication channel is known as modulation. This is achieved in order to provide the guarantee to recover the original input signal. In OFDM multiplexing the large amount of information is converted into smaller blocks, these smaller blocks are spaced orthogonal to each other. This can be accomplishing by means of QAM modulation. Further the signal is processed by sending it in the serial to parallel converter. IFFT is then applied to the transformed signal. Cyclic prefix is used to overcome the ISI of the system. Then signal is applied to the parallel to serial converter.

Communication channel-: Communication channel is the medium through which the data can be transferred. Information signal or data can be affected and data can be distorted due to presence of noise in the channel.

Receiver-: The original information can be recovered at the receiver. The process of recovering the input signal at the receiver is demodulation. At receiver the signal is converted in parallel form using parallel to serial converter, then pass the signal through low pass filter to the cyclic prefix. After that the signal is applied to FFT. Parallel to serial converted data is demodulated by QAM demodulator and then the de-interleaving is done. After the decoding of the signal the original data is received at the receiver [5].

III. BER AND PAPR ANALYSIS

- ***BER*-:** In communication systems the bit error rate is introduced due to transmission channel noise, interference, distortion, bit synchronisation problems, attenuation, wireless multipath fading etc. The bit error rate (BER) is defined as the number of bits received at the receiver without any error correction divided by the number of bits transmitted at the receiver. The bit error rate can be improved by strong signal strength, by choosing slow and robust line coding or modulation technique and by using channel coding techniques. In this paper analysis of BER for OFDM based basic model and OFDM based wimax model is done. By the reduction of BER in OFDM system using 16, 64, 256 QAM techniques, the performance of the OFDM system is improved. In wimax model transmission of higher data rate is done by using different modulation techniques. Cyclic prefix is used for reducing the ISI and by reducing the channel power ICI interferences reduces in OFDM system. By reduction of ISI and ICI of the system, the BER performance also reduces of an OFDM based wimax system.

- **PAPR-:** Peak to average power ratio is the main problem at the transmitter of an OFDM based Wimax systems. PAPR is the ratio between the maximum power and the average power for the envelope of a baseband complex signal of the system. PAPR gets increased due to occurrence of huge amount of subcarrier that are modulated independently in OFDM system and of signal which undergoes coherent addition resulting in same phase. High PAPR leads to increase the complexity of converters and reduction in efficiency of amplifiers [5]. In this paper PAPR reduction can be done by using SLM technique. PAPR for the envelope of complex baseband signal is given below-:

$$PAPR\ \{\tilde{x}(t)\} = \frac{\max|\tilde{x}(t)|^2}{E\left\{|\tilde{x}(t)|^2\right\}} \quad [4]$$

***SLM Technique*-:** By using this selected mapping technique the main data block is divided into several independent blocks. Then each block is converted into OFDM symbol. Finally the symbol which has less PAPR will be transmitted.

IV. RESULTS AND DISCUSSION OF SIMULATED STUDY

In this section simulation results of basic OFDM model and OFDM based Wimax model along with BER curves analysis of AWGN channel are presented. In basic model by increasing the signal power with respect to noise power of channel the interference reduces due to which the BER of the system reduces as shown in fig1. In analysis of basic model at 5db SNR using 16, 64 and 256 QAM modulation techniques the BER values are 0.4804, 0.7005 and 0.8007.

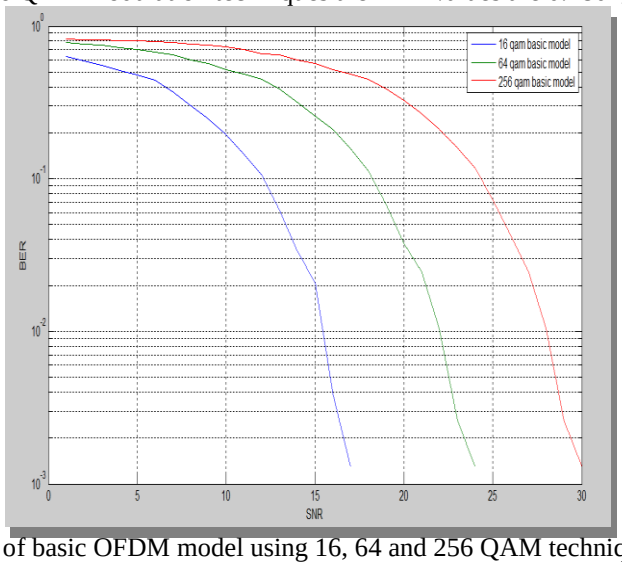

Fig.1. BER curve simulation of basic OFDM model using 16, 64 and 256 QAM technique over an AWGN channel.

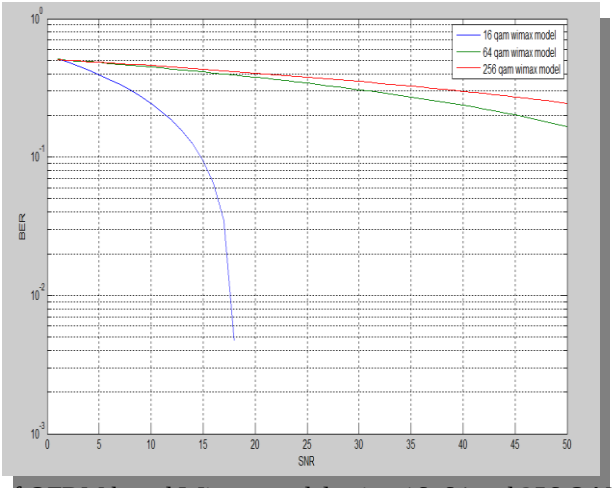

Fig.2. BER curve simulation of OFDM based Wimax model using 16, 64 and 256 QAM technique over an AWGN channel.

High data rate transmission for a longer distances use OFDM technique for Wimax model. In Wimax based OFDM model cyclic prefix can be used to overcome the effect of ISI and ICI. In Wimax model analysis by reducing the average power of channel the BER performance of the system reduces. Increase in SNR values reduces the bit error rate of the OFDM system as shown in Fig. 2. At 5 db SNR the BER values of OFDM based Wimax system using 16, 64 and 256 QAM modulation techniques are 0.513, 0.4974 and 0.5052. For higher data rate transmission by increasing the modulation rate the BER also increases as shown in Fig. 3.

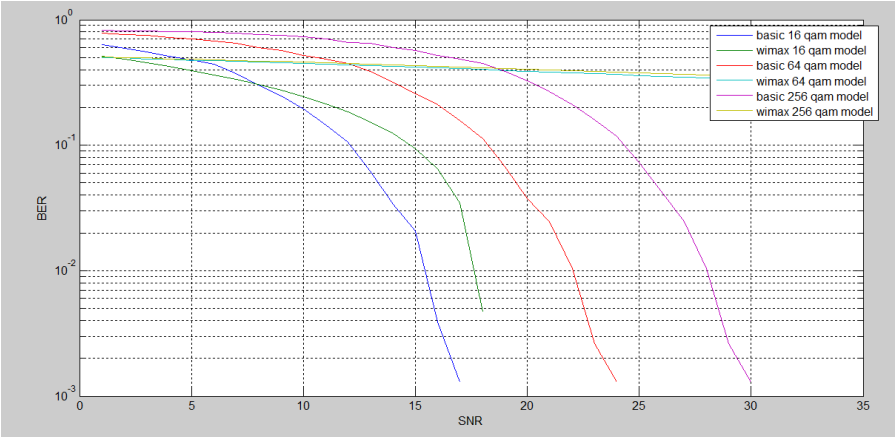

Fig.3. BER curve comparison of Basic and Wimax model using different modulation techniques over AWGN channel.

The channel of OFDM system is estimated by reducing the BER performance of the system. After the estimation of channel the PAPR reduction is done by using SLM technique. The PAPR of the system can be reduces by reducing the length of cyclic prefix shown in Fig. 4. The strength of signal also affects the PAPR performance. With increase in average power of modulator the signal strength of input signal increases, by increasing signal strength the PAPR of the system reduces shown in Fig.5.

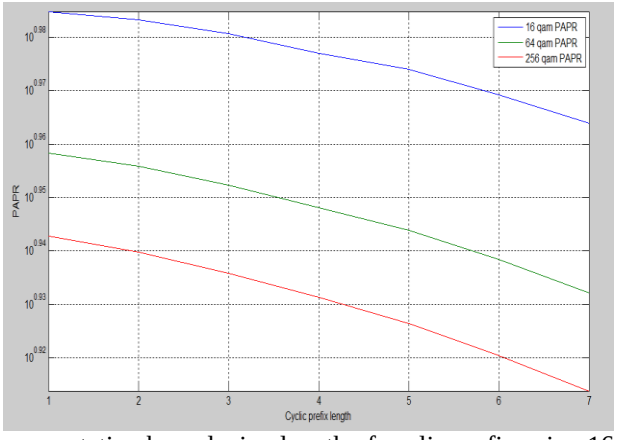

Fig.4. PAPR reduction curve representation by reducing length of cyclic prefix using 16, 64 and 256 QAM modulation techniques.

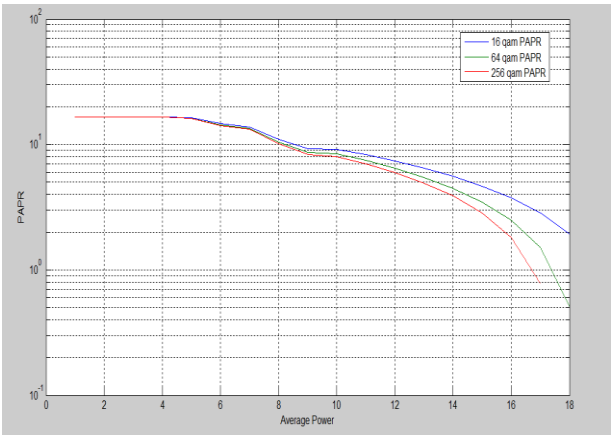

Fig.5. PAPR reduction curve representation of OFDM system by increasing the average power of signal using different modulation techniques.

V. CONCLUSION

In Wimax system the main aim is to get high data rate transmission for a long range of communication. The physical layer of OFDM based Wimax system provides high data rate with reduction of PAPR using selected mapping technique. In this research we analyse the BER performance of the basic and wimax based OFDM for the estimation of channel. Then PAPR reduction is done using SLM technique. The channel of OFDM system is estimated by the reduction of BER. With increase in power of signal and decrease in length of cyclic prefix, PAPR reduction provides the high data rate transmission in the system efficiently. It is concluded that the system performance improves by decreasing the BER and PAPR of the system.

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