ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 1, July 2013

Performance Analysis of WIMAX Based OFDM System Using Various Modulation Techniques

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Abstract:-* In the last few years, the télécommunication industries has focused on the uses of broadband system having high quality features. Due to this issue new technologies with high transmission abilities are designed. The broadband wireless access becomes the way to fulfill the high business demand for increasing the internet connection. In which the wireless solution have been found to remove the technological error or limitations. The basic WiMAX concept: a wireless transmission infrastructure allows a fast utilize as well as low maintenance costs. Based on the IEEE 802.16-2004 standard, WiMAX allows an efficient use of bandwidth in a wide frequency range, and last mile solution for broadband internet access. 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. Many techniques are used to fulfill these requirements. WiMAX is OFDM-based technology that supports point to multi-point Broadband Wireless Access for the next generation access. Basic application of WiMAX is for MAN/WAN base stations and link stations. It delivers the maximum range (50 km) and higher data rates (up to 75 Mbps) than Wi-Fi. The aim of this paper is to analyze and simulate WIMAX OFDM system. A MATLAB code used to simulate Fixed WIMAX OFDM. The simulation results include the performance analysis based on bit error rate (BER) versus bit energy to noise rate (Eb/No) plots and the spectral efficiency of different modulation.

Keywords:- **BER, BPSK, CONVOLUTION CODE, QPSK ,16-QAM ,64-QAM.**

I. INTRODUCTION

WiMAX used for high data rate over the large areas for a large number of users where broadband is not available. This is the first standard which can be used for fixed wireless access with effective higher bandwidth than the various cellular networks. Wireless broadband systems are basically used for many years but the main development of this standard enables economy of scale to bring down the cost of equipment, and decreases the envelop risk for operators. The 1st version of the IEEE 802.16 standard operates on 10–66GHz frequency band also requires line of sight (LOS) towers. But later the standard extended its operation of specification to 2-11 GHz frequency band for non line of sight (NLOS). The aim of this paper is to transmit the data in WIMAX with low bit error rate and high efficient data with noisy area where we have to using Forward Error Correction method as Reed Solomon code and Convolution code. These methods are useful to decreases the BER and improve its efficiency. To reduce the noise these two error correction and error detection codes Reed Solomon coding and Convolution coding are used. Now to increase the performance of the coding technique we are using Cyclic Prefix and interleaving techniques. So this paper is useful for analysis of WIMAX with different modulation techniques like BPSK, QPSK, QAM and also analysis of different efficiency of each modulation technique. According to the growth of multimedia services and the demand of Internet is to increasing interest in high speed communications. The requirement of wide bandwidth and flexibility improve the use of efficient transmission methods which fits the features of wideband channels basically in wireless environment in which the channels are very challenging. BWA is used due to its wireless nature, it is faster, easier to scale and more flexible.

II. SIMULATION MODEL

Simulation of WiMAX with OFDM System

The baseband transmitter/Receiver having three major parts:

1. Channel Coding / Decoding.
2. Modulation / Demodulation.
3. OFDM transmitter / Receiver.

In this block diagram random data is generated in the form of random number. We have to using channel coding where redundancy needs to be added to the data bits so that the receiving end can recover from errors by correcting them. Forward Error Correction (FEC) is implemented in three phases: Randomization, Forward Before passing through the Reed-Solomon (RS) encoder the randomized data arranged in block format. Where the Reed-Solomon codes arrange them suitable for applications in which the errors occur in bursts. Reed-Solomon error correction is constructing a mathematical expression from the data symbols for transmitted, and then sending another version of expression instead of the original symbols. RS-CC encoded data interleaved by a block interleaver. The size of the block is depending on the numbers of bit encoded per sub-channel per OFDM symbol. The Interleaver provide two steps. The first step is that adjacent coded bits are mapped into nonadjacent sub carriers. The second is that adjacent coded bits are mapped alternately onto less or more significant bits, which avoiding long runs of unreliable bits. The Matlab function matintrlv performs for interleaving and *matdeintrlv* performs for de-interleaving. The function

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ISO 9001:2008 Certified
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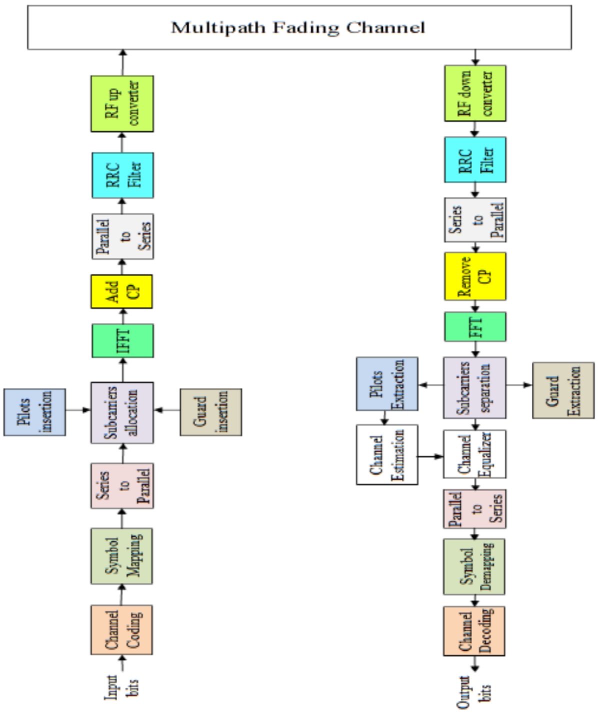
Volume 3, Issue 1, July 2013

matintrlv arrange the symbols for filling a matrix by rows and empty it by columns and matdeintrlv rearrange symbols by filling a matrix by columns and empty by



rows.

Fig 1[5]: Block diagram of OFDM.

The IFFT produce a time domain signal, where the symbols obtained after modulation is used as amplitudes of a certain range of sinusoids. Each of discrete samples having its sub carrier before applying the IFFT algorithm. A cyclic prefix (CP) is added to the time domain samples to make the effect of multipath. Four different interval of CP is available in that standard. At the end point the process is reverse where receives the data by using FFT in which it converts the signal into the frequency domain and then demodulated according to the block diagram. Then cyclic prefix is removed and receive the original signal for further processing of FFT. The FFT transforms is a cyclic time domain signal of its equivalent frequency spectrum. The pilot carrier is removed to use the retrieved signal in parallel form. Now for demodulation these are converted into serial bit stream and passed to the demodulator. The output of demodulator received in the form of symbols. So it is converted into original bits. The interleaved data also regain in its original order and the deinterleaved data is further passed on to Viterbi decoder. Then the received output signal used for computing BER from the simulations and comparing various techniques. The BER is calculating by the received bits are altered due to noise and distortion, divided by the transferred bits during a time interval. The BER for best case in communication systems is 10-6. The BER usually expressed by calculating the carrier-to-noise ratio and Eb/No in noisy channel.

III. RESULTS AND DISCUSSION

The WIMAX model based on simulated using BPSK, QPSK, QAM 16, QAM 64, modulation techniques. The graphs between bit error rate and signal to noise ratio are plotted in each case. The following graph shows the simulated results of WIMAX based OFDM system. The simulation shows the comparison of performance of system corresponding simulated values of signal to noise ratio and there spectral efficiency for each modulation.

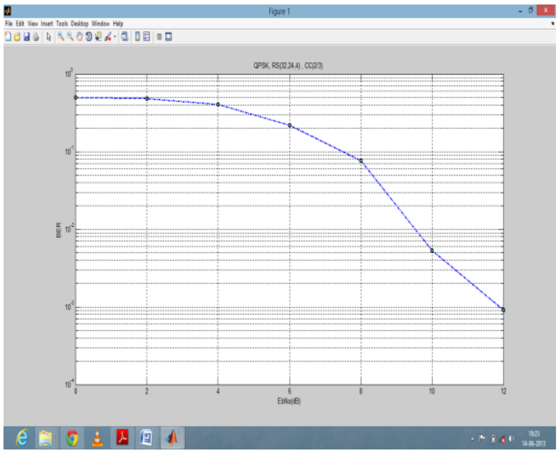


Fig 2: Plot of BER against Eb /No For QPSK-WIMAX.

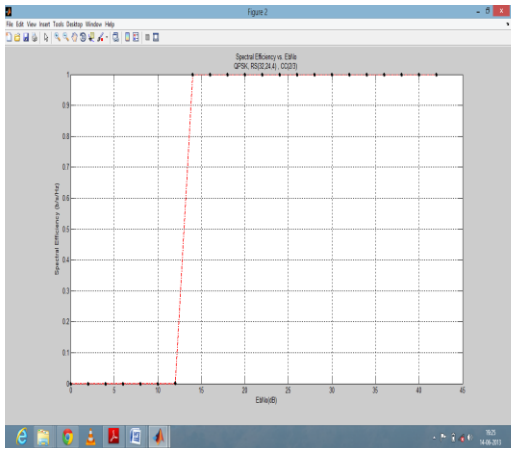


Fig 3: Plot of Spectral Efficiency For QPSK-WIMAX.

Figure 3 shows for QPSK-WIMAX, fixing the BER between 10^{-3} and 10^{-4} the simulated Eb/No (dB) is 12, this indicates that in noisy channel the BER for simulated model is better than theoretical model. Hence, the simulated model works better. Simulated model does not allow the BER between 10^{-1}and10^{-3}, Now Figure 4 shows the spectral efficiency increasing and saturate between 10 -15 db signal to noise ratio.

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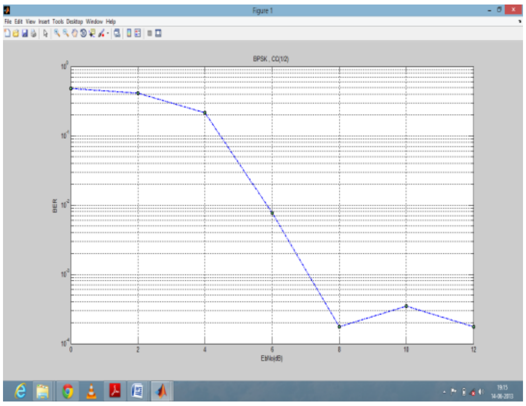

Fig 4: Plot of BER against Eb /No for BPSK-WIMAX.

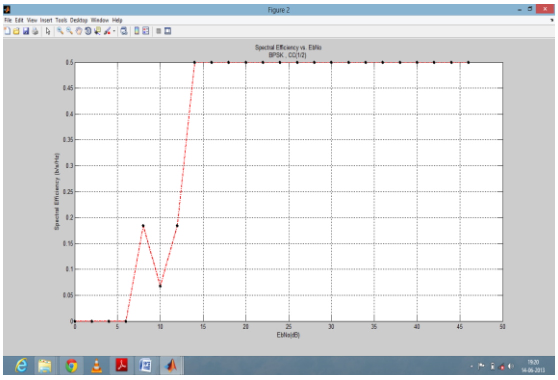

Fig 5: Plot of Spectral Efficiency for BPSK-WIMAX

Figure 5 shows for QPSK-WIMAX, where fixing BER between 10^{-3} and 10^{-4} the simulated Eb/No (dB) is 7-12 db, which indicates the BER for simulated model is better than theoretical model. Hence, the simulated model works better in noisy channel. Simulated model does not allow the BER between 10^{-1}and10^{-3}. Figure 6 shows the spectral efficiency increasing and saturate between 6 -15 db signal to noise ratio.

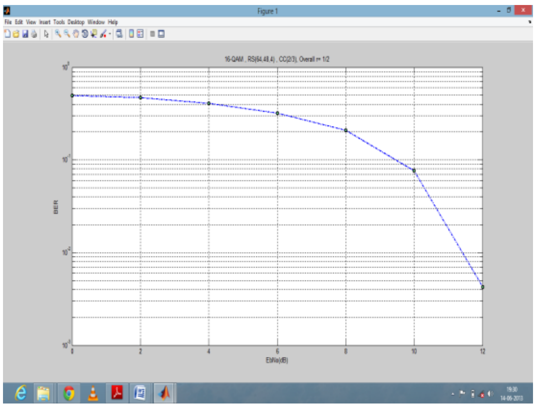

Fig 6: Plot the BER against Eb /No for QAM 16-WIMAX.

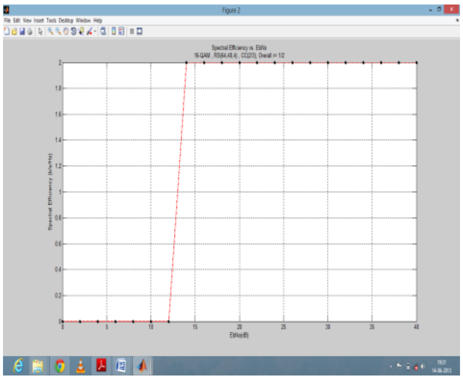

Fig 7: Plot of spectral efficiency for QAM 16-WIMAX

Figure 7 shows for QPSK-WIMAX, for noisy channel fixing the BER between 10^{-3} and 10^{-4} the simulated Eb/No (dB) is 11.5-12 db, indicates the BER for simulated model is better than theoretical model. Hence, the simulated model works better in noisy channel. Simulated model does not allow the BER between 10^{-1}and10^{-3}. Figure 8 shows the spectral efficiency increasing and saturate between 10 -15 db signals to noise ratio.

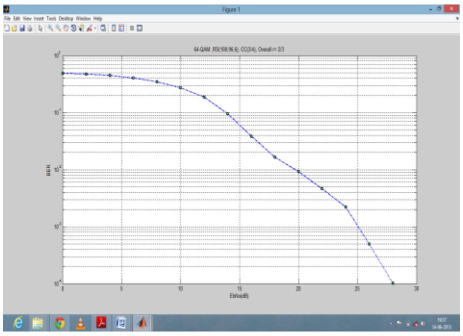

Fig 8: Plot the BER against Eb /No for QAM 64-WIMAX.

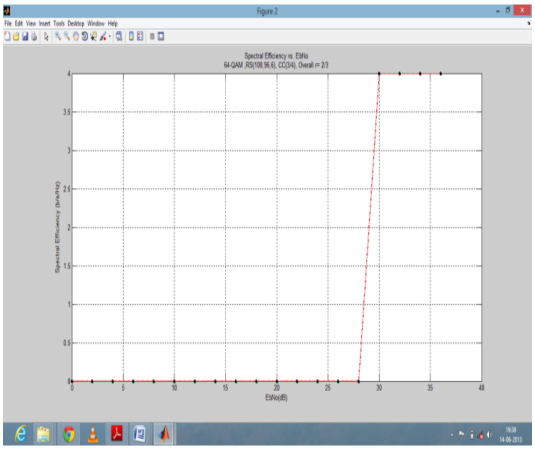

Fig 9. Plot of spectral efficiency for QAM 64-WIMAX

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 1, July 2013

Figure 9 shows that for QPSK-WIMAX, now fixing BER between 10^{-3} and 10^{-4} the simulated Eb/No (dB) is 25-28 db for noisy channel which indicates the BER for simulated model is better than theoretical model. Hence, the simulated model works better in noisy channel. Simulated model does not allow the BER between 10^{-1}and10^{-3}. Figure 10 shows the spectral efficiency increasing and saturate between 28-30 db signals to noise ratio.

Table1: Required Eb /No (dB) to maintain a BER below a given threshold for various modulation techniques.

Modulation Scheme	BER < 10^{-1}	BER <10^{-2}	BER <10^{-3}	BER <10^{-4}
BPSK	4.5	5.8	7	_
QPSK	6.3	8.5	9.5	_
16-QAM	9.3	11.5	_	_
64-QAM	14	20	25	28

Now we can select various modulation technique based on the given Eb/No for various BER. First of all we have to s Select modulation technique at BER <10^{-1}.

Table2: Selection of modulation technique at given Eb/No (dB) at BER <10^{-1}

Eb/No range	Modulation scheme
4.5-6.3	BPSK
6.3-9.3	QPSK
9.3-14	16-QAM

Select modulation technique at BER < 10^{-2}.

Table 3: Selection of modulation technique at given Eb/No (dB) at BER <10^{-2}

Eb/No range	Modulation scheme
5.8-8.5	BPSK
8.5-11.5	QPSK
11.5-20	16-QAM

Select modulation technique at BER <10^{-3}

Table 4: Selection of modulation technique at given Eb/No (dB) at BER <10^{-3}

Eb/No range	Modulation scheme
7-9.5	BPSK
9.5-25	64-QAM

IV. CONCLUSION

The modulation scheme is set based on the Eb/No (dB) of the channel. The Eb/No (dB) must be greater than the threshold value selected from Table 1 for maintaining a maximum BER. When signal to noise ratio exceed results in the BER being lower than the BER threshold. Under the worst channel conditions in this system a fixed modulation scheme is used and the sub carrier modulation designed to provide an acceptable BER. This results in most systems using BPSK or QPSK. These modulation schemes also give better spectral efficiency. Using these figures, we can found that on fixing BER and under good channel conditions QAM with higher mode value gives best spectral efficiency and under worst channel conditions, we can use QPSK, BPSK. Thus, we have to using adaptive modulation depending upon channel conditions. In this simulation we can also used adaptive modulation for effectively control the BER of the transmission.

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