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PERFORMANCE EVALUATION OF BIT ERROR RATE IN WIMAX USING DIFFERENT MODULATION TECHNIQUES

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Abstract: Wireless network offer various benefits over wired network such as rapid deployment, low installation cost, mobility etc. To satisfy user requirements and overcome the problems of existing wireless technology, researchers come up with efficient technology. This paper presents the simulation of IEEE802.16 WIMAX (Worldwide Interoperability for Microwave Access). WIMAX based on OFDM (Orthogonal Frequency Division Multiplexing). WIMAX is a broadband wireless technology which offers higher range and bandwidth as compared to other wireless technologies such as Wi-Fi (Wireless Fidelity). In this paper we have analyzed Bit Error Rate (BER) performance of WIMAX physical layer according to parameters established by standard. The Modulation techniques used are BPSK (Binary Phase Shift Keying), QPSK (Quadrature Phase Shift Keying) and QAM (Quadrature amplitude Modulation). Convolution coding is also used to improve the performance of system. The cyclic prefix is added at transmitter end which improve the bit error rate and minimize the inter symbol interference (ISI).The MATLAB software is used to analysis the performance of WIMAX system. The analysis based on BER, SNR (signal to noise).
Keywords: WIMAX, OFDM, BER, SNR, modulation techniques.

I. INTRODUCTION

Worldwide Interoperability for Microwave Access (WiMAX) is a technology that enables anywhere, anytime access to information and applications at low cost and with a small investment [1]. WiMAX (World Wide Interoperability for Microwave Access) is an IEEE standard (IEEE 802.16) that promises high bandwidth solution with long range for metropolitan area networks. IEEE 802.16 is able to cover large geographical area since the distance between the Base Station (BS) and the Subscriber Station (SS) can extend up to 50km (30 miles) for fixed stations and 5-15km for mobile stations [4]. WIMAX provides data rate up to 70mbps [2]. There are two parts of WIMAX system are:

1. Base Station (BS): Base Station is place where WiMAX signals are Broadcasted and it basically consists of electronic devices and WiMAX towers. BS is transmitter/receiver that serve as a hub. BS manages one or more SS.
2. Subscriber Station (SS): Receive signals from base station and connects to the WiMAX networks. SS can indoor or outdoor depending on the distance to the nearest WiMAX base station tower. The WIMAX defined two layers: Physical layer and MAC layer(Medium access control)Physical layer of WIMAX based on OFDM. In OFDM, instead of using a single wide-band carrier to transmit information, a large number of parallel narrow-band sub-carriers are used [5].In OFDM serial-to-parallel transmitter converts the incoming high-rate data stream into low-rate streams, then transmits each low-rate data stream over a unique orthogonal carrier [5]. The MAC layer functions of IEEE 802.16e are described Internet Protocol (IP) and Asynchronous Transfer Mode (ATM) traffic are supported by convergence sublayer. This layer converts the traffic into MAC data units [4]. The convolution coding is applied to improve BER performance of OFDM system. WiMAX supports a number of modulations and forward error correction (FEC) coding schemes [2]. WiMAX supports LOS (line of sight) and NLOS (non line of sight) connections. WiMAX can be classified into Fixed WiMAX [7] and Mobile WiMAX. Fixed WiMAX is based upon Line Of Sight (LOS) condition in the frequency range of 10-66GHz whereas Mobile WiMAX is based upon Non-Line of Sight (NLOS) condition that works in 2-11 GHz frequency range [7]. The aim of this paper is to transmit the data at lower bit error rate and higher efficient data with noisy area using forward error correction (FEC) as Reed Solomon and Convolution coding. To increase the efficiency of coding techniques cyclic prefix and interleaving techniques are used [3]. This paper presents analysis of WIMAX using different modulation techniques such as BPSK, QPSK, QAM and also analysis efficiency of modulation techniques.

Features of WiMAX

1)Interoperability: The IEEE 802.16 standard is internationally accepted and the standard is maintained and certified WiMAX forum covers fixed, portable and mobile deployments and giving the user the freedom to choose their product from different certified vendors and use it in different fixed, portable or mobile networks.

2) Long Range: It covers up to 30 miles but in practice, it covers only 6 miles. Mobile WiMAX, can support both LOS and NLOS connections. For that, it must meet the condition of the range for LOS, 50 kilometers and for NLOS, 10 kilometers.

3) QoS(Quality of services): QoS of WiMAX media access control (MAC) is designed to support a large number of users, with multiple connections per terminal, each with its own QoS requirement.

4) Mobility: WiMAX offers immense mobility especially IEEE 802.16e-2005 as it adopted SOFDMA (Scalable Orthogonal Frequency Division Multiple Access) as a modulation technique and MIMO (Multiple Input Multiple

Output) in its physical layer. The mobile WiMAX variant of the system has mechanisms to support secure seamless handovers and also power-saving mechanisms that extend the battery life of handheld subscriber devices.

5) Security: WiMAX have a robust privacy and key management protocol as it uses Advanced Encryption Standard (AES) which provides robust encryption policy. It also supports flexible authentication architecture which is based on Extensible Authentication Protocol (EAP) which allows variety of subscriber credentials including subscriber's username and password, digital certificates and cards.

II. BLOCK DIAGRAM OF OFDM

To implement the OFDM transmission scheme MATLAB software is used and design is divided into three sections: Transmitter, channel and Receiver.

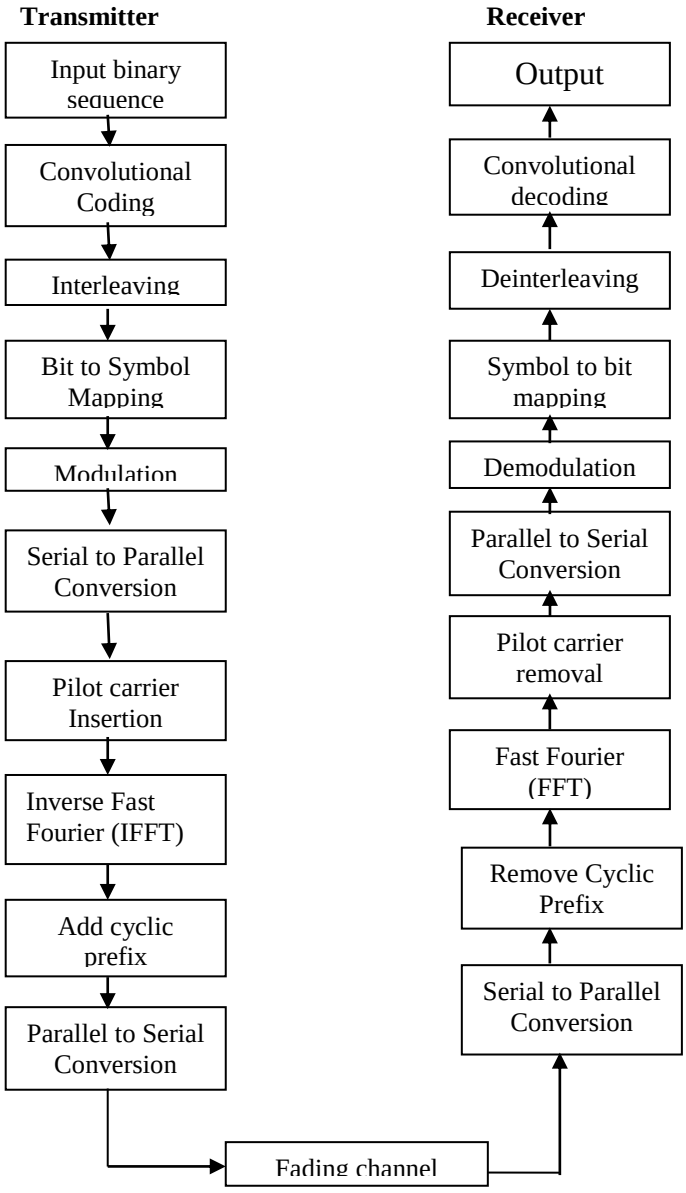

Fig.1 Block Diagram of OFDM

In the transmitter input data is taken. Forward Error-Correction Coding (FEC) and interleaving is done to provide frequency diversity [5]. Then Interleaving is applied to randomize the occurrence of bit errors prior to increase performance. After interleaving, the binary values are converted to symbol values, on which digital modulation scheme is applied [5]. The resulting modulated signals are then multiplexed before their transmission by applying the Inverse Fast Fourier Transform (IFFT) [1]. The output is converted to serial and cyclic prefix that adds additional bits at the transmitter end and then the receiver removes these additional bits in order to minimize the inter symbol interference, improve the bit error rate and reduce the power spectrum [1]. Thus the multiplexed signal passes through the AWGN (additive white Gaussian noise) channel. After removing the cyclic extension, the signal can be applied to a Fast Fourier transform to recover the modulated values of all subcarriers. The modulated values are then demapped into binary values, and finally deinterleaving and Viterbi decoder decodes the information bits [5].

III. BER(BIT ERROR RATE) AND SNR(SIGNAL TO NOISE RATIO)

The BER is calculated from the number of bits received with error divided by the total number of bits transmitted. BER= (Bits with Error) / (Total bits transmitted). The performance of BER is often expressed by percentage. BER performance is affected by noise and quantization errors [2].

SNR is the ratio of the received signal strength over the noise strength in the frequency range of the operation. It is an important parameter of the physical layer of WiMAX. BER is inversely related to SNR, that is high BER causes low SNR. Signal to noise ratio (SNR) is an indicator commonly used to evaluate the quality of a communication link and measured in decibels and represented by equation [2].

SNR = 10 log10 (Signal Power / Noise Power) dB.

IV. CODING TECHNIQUES

A. Reed Solomon (RS) Code

Due to the fading nature of the wireless channel, the errors usually occur in bursty manner. Most of the errors in real time traffic in wireless network are burst in nature and RS (Reed Solomon) codes are found to be most efficient in correcting burst errors. RS codes are able to recover from errors more quickly. The use of RS codes will significantly reduce the number of retransmissions [2]. Reed-Solomon codes are block based error correcting codes with a wide range of applications in digital communications and storage [2]. In RS encoder block the redundant bits are added to the block of data. Errors occur during transmission or storage for a number of reasons (for e.g. noise, scratches on a CD, etc). The RS decoder processes each block and attempts to correct errors and recover the original data. The characteristics of the RS code affect the number and type of errors that can be corrected [2].

B. Convolution Coding

The convolution coding technique is designed to reduce the

probability of error transmission over noisy communication channels. The decoding algorithm for convolution coding is the Viterbi algorithm. The Viterbi algorithm suffers from a high decoding complexity for convolution codes with long constraint lengths [2]. While the attainable decoding failure probability of convolution codes generally decays exponentially with the code constraint length, the high complexity of the Viterbi decoder for codes with a long constraint length to some extent limits the achievable system performance [2].

V. CONCLUSION

The WiMAX system based on OFDM model using adaptive modulation schemes was successfully developed using MATLAB software. Adaptive modulation techniques allow to adjust the signal modulation scheme depending on the SNR condition of the channels which give freedom to the WiMAX system to choose either PSK or QAM. BER for different addative modulation techniques are evaluated using AWGN channel. For poor channel conditions BPSK and QPSK is best and for good channel conditions QAM is best. It means that for a particular value of Bit error rate SNR value for BPSK and QPSK is lower as compared to 16QAM and 64QAM. So 64QAM has highest SNR value.

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