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Performance Analysis of WiMAX with Different Modulation Techniques

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Abstract: Worldwide Interoperability for Microwave Access (WiMAX) is one of the most developing technology in modern wireless communication system for providing voice, data, video and multimedia services on mobile phones at high speeds, cheap rate & unwired transmission. The physical layer of WiMax emphasis on Orthogonal Frequency Division Multiplexing (OFDM) signals. OFDM is a parallel transmission scheme, where a high – rate serial data stream is split up into a set of low – rate sub streams, each of which is modulated on a separate subcarrier. Increasing the number of parallel transmission reduces the data rate that each individual carrier must convey and that lengthens the symbol period. However, in OFDM, no frequency diversity is exploited to improve Bit Error Rate (BER) performance. Today's OFDM systems attempt to overcome this limitation by application of channel coding and interleaving, which requires a reduction in throughput. OFDM uses different type of modulation and encoding schemes to improve BER performance. In this paper we study WiMax with OFDM transmission system and compared WiMax system by using different modulation schemes such as QAM and QPSK modulation over multi-path fading channels at the cost of small increase in complexity.

Keywords: WiMAX, OFDM, BER

I. INTRODUCTION OF WIMAX

WiMAX, or 802.16, is a fast-emerging wide-area wireless broadband technology that provides high-speed Internet access into homes and businesses and covers wider, metropolitan or rural areas [1]. It can provide data rates up to 75 Megabits Per Second (Mbps) per base station. The IEEE 802.16a standard provides wireless broadband access over the frequency bands between 2 and 11 GHz, a range that enables non-line-of-sight performance. This makes the IEEE 802.16a standard the appropriate technology for last-mile applications where obstacles like trees and buildings are present, or where base stations must be mounted on homes and buildings rather than towers and mountains [2].

To support a profitable business model, operators and service providers need to sustain a mix of high-revenue business customers and high-volume residential subscribers. 802.16a systems can help meet this requirement by supporting differentiated service levels [3]. This can be achieved by proper use of frequency band of WiMax. For this purpose, OFDM is used as a frequency division multiplexing scheme in WiMax. The basic principle of OFDM is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of sub carriers. The relative amount of dispersion in time caused by multipath delay spread is decreased because the symbol duration increases for lower rate parallel sub carriers.

The other problem to solve is the intersymbol interference, which is eliminated almost completely by introducing a guard time in every OFDM symbol [4]. This means that in the guard time, the OFDM symbol is cyclically extended to avoid intercarrier interference. An OFDM signal is a sum of sub carriers that are individually modulated by using Quadrature Phase Shift Keying (QPSK) or Quadrature Amplitude Modulation (QAM). The OFDM is Frequency-Division Multiplexing (FDM) scheme utilized as a digital multi – carrier modulation method. This greatly simplifies the design of both the transmitter and receiver, unlike conventional Frequency-Division Multiplexing (FDM), a separate filter for each sub channel is not required [5]. So, by using the OFDM in WiMax the data transmission rate increases and the interference of the system also reduces.

II. SYSTEM MODEL OF WIMAX

This system is concerned with the calculation of the bit error rate of a WiMax in a multipath fading and additive white Gaussian noise channels that is modeled by a discrete set of Rayleigh faded paths. Figure 1 shows a WiMax transmitter. It consists of a Forward Error Correction (FEC) block encoder with convolutional encoder, interleaver, modulator, OFDM baseband modulator which produces OFDM symbols. Forward error correction that is block coding is required to protect the transmitted data against channel errors [6]. The encoded data is mapped with the help of modulator. In modulator different modulation schemes are used such as 4 – QAM and QPSK modulation. Then this

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ampped signal is passed through the OFDM baseband modulator, where this data is divided into number of low rate data streams and each data stream is spreaded with the PN sequence code over a much wider bandwidth than the bandwidth of the information signal [7]. As the power of the modulated signal is distributed over a wide bandwidth, the power density of the modulated signal is much lower than that of the input signal. Note that the multiplication process is done with a spreading sequence with no DC component. The wider the bandwidth, the better the resolution in multipath detection. Since the total transmission bandwidth is limited, a pulse shaping filtering is employed so that the frequency spectrum is used efficiently.

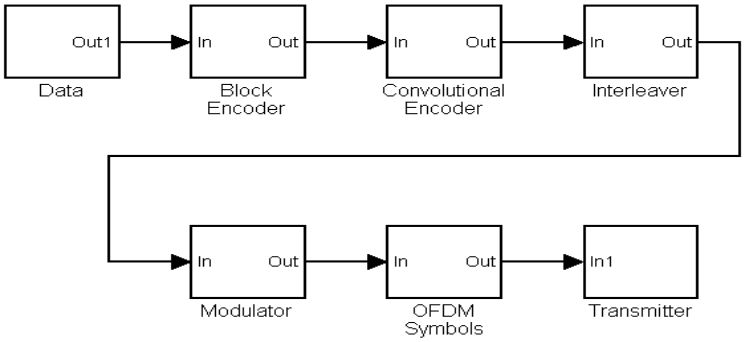

Figure 1: WiMax Transmitter.

In Figure 2, the receiver block-diagram of a WiMax signal is plotted. The received signal is first filtered and then digitally converted into original form by passing it through OFDM baseband demodulator. Then the received signal is passed through for viterbi decoder and block decoder for error detection and correction purpose. Then by comparing the received data and transmitted data one can calculate the bit error rate of the system.

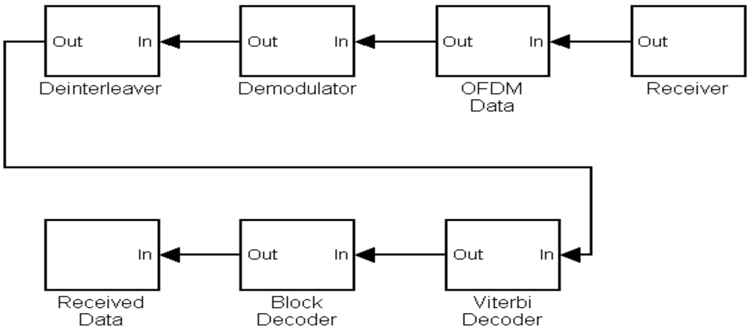

Figure 2: WiMax Receiver.

Viterbi decoding is one of two types of decoding algorithms used with convolutional encoding. The other type is sequential decoding. Sequential decoding has the advantage that it can perform very well with long constraint length convolutional codes, but it has a variable decoding time. Viterbi decoding has the advantage that it has a fixed decoding time. It is well suited to hardware decoder implementation. But its computational requirements grow exponentially as a function of the constraint length. Viterbi decoding is essentially performing the maximum likelihood decoding. It reduces the computational load by taking advantage of special structure in code trellis [8]. The Viterbi decoder examines an entire received sequence of a given length. The decoder computes a metric for each path and makes a decision based on this metric. All paths are followed until two paths converge on one node. Then the path with the higher metric is kept and the one with lower metric is discarded. The paths selected are called the survivors.

III. WIMAX PERFORMANCE ANALYSIS

Wimax performance analysis presented in this section is based on computer simulations. The basic scenario of our simulation is represented by the Wimax transmission system performing through multipath fading and AWGN transmission channel, at sample time (16e-5)/35 and 35 samples per frame. As the spreading sequences, Walsh codes with period of 64 chips is used. The simulation results of WiMax system is shown below:

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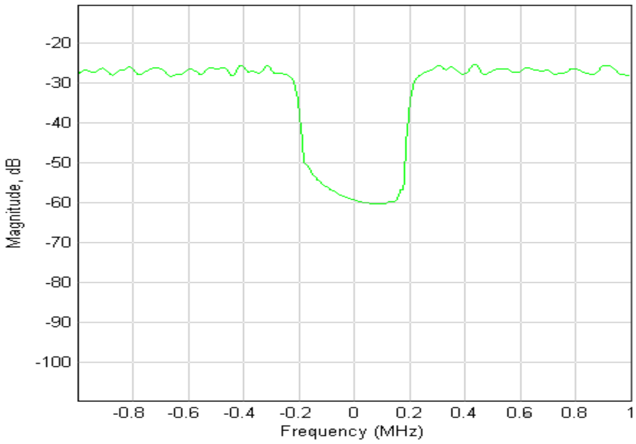

Figure 3: WiMax Transmitted Signal.

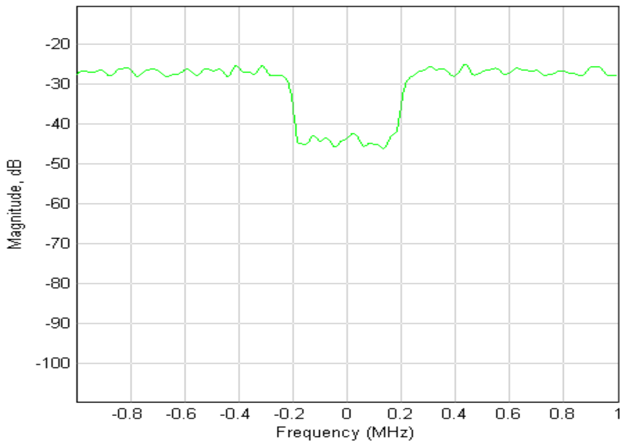

Figure 4: WiMax Received Signal.

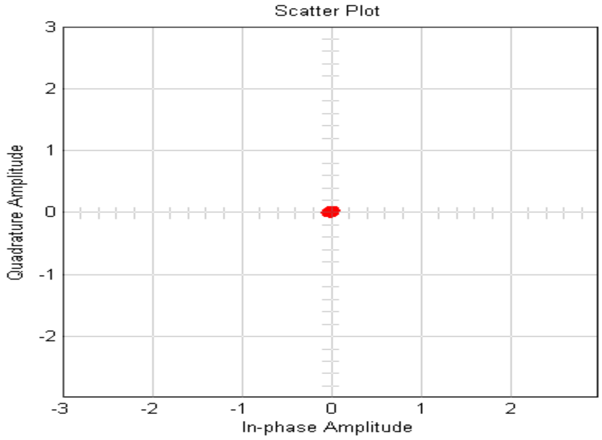

Figure 5: Scatter Plot of WiMax Signal.

Figure 3 shows the WIMAX transmitted signal to the channel. This signal is passed through the multipath fading and additive white Gaussian noise channel. After passing this signal from channel we get the WIMAX received signal as shown in Figure 4 which is full of distortions. Figure 5 shows the scatter plot of signal of WIMAX system. The scatter plot is used to reveal the modulation characteristics, such as pulse shaping or channel distortions of the signal. The scatter plot illustrates the effect of fading on the signal constellation.

The different modulation scheme has been used such as 4 – QAM and QPSK modulation and their bit error rates are calculated as shown in following Table 1.

Table 1. BER of Modulation Schemes.

Sr. No.	Modulation Schemes	Total Bits	Error Bits	Bit Error Rate
1.	4 – QAM	28260	14110	0.4995
2.	QPSK	28260	14220	0.5033

So, we get that from these QAM modulation scheme is very suitable for WiMax system because the transmission rate is very high and the BER is very low then other modulation schemes at same bandwidth usage. So a large number of users can efficiently use WiMax system by QAM modulation.

IV. CONCLUSION

The transmission bandwidth of the WiMax system by using different modulation is approximately same but the number of user in QAM WiMax system is more than other modulation schemes. Because each user uses a very small portion of available bandwidth. But in a transmission system main concern is on efficient transmission i.e. number of error or distortion is less. So QAM modulated WIMAX system is more efficient because it has less BER and less multipath fading effects as compare to other modulation schemes in WIMAX system. We conclude that QAM modulated WIMAX system achieves better BER results for the same bandwidth efficiency.

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