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IMPLEMENTATION AND EFFICIENCY ANALYSIS OF WIMAX COMMUNICATION SYSTEM

Sapna Anand
M. Tech Scholar, Department of ECE, ACET, Amritsar,
Punjab, India
sapnaanand55@gmail.com

Sandeep Kaushal
Associate Prof., Department of ECE, ACET, Amritsar,
Punjab, India
sandeep.laddi@gmail.com

Abstract

The Worldwide Interoperability for Microwave Access (WIMAX) is the new era of communication and is the latest technology. It is approved by IEEE 802.16 group, which is a standard for point to multi-point wireless networking. This paper investigates the performance of WiMAX physical layer based on the IEEE 802.16e standard under different combinations of digital modulation schemes. The effect of varying coding rate and cyclic prefix are also investigated in this paper.

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1. INTRODUCTION

WiMAX stands for Worldwide Interoperability for Microwave Access. WiMAX is one of the latest broadband wireless technologies around today. WiMAX is a standard-based wireless technology that provides high throughput broadband connection services to residential and enterprise customers in an efficient way over long distance [1]. The Institute of Electrical and Electronics Engineers (IEEE) 802 committee, which sets networking standards such as Ethernet (802.3) and Wi-Fi (802.11), has published a set of standards that describe WiMAX. The first 802.16 standard was developed in 2001, to deal with the Line of Sight (LOS) access at spectrum ranges from 10 GHz to 63 GHz. After a number of updates, it was summarized in standard 802.16d-2004, the provision of air interface for fixed broadband wireless Access system, which is also known as the "Fixed WiMAX". In 2005, support for mobile broadband wireless Access was first introduced in 802.16e-2005, the"Mobile WiMAX". Recently, 802.16-2009, called the "Air Interface for Fixed and Mobile Broadband Wireless Access System", was developed to support both fixed and mobile wireless communications [2].

WiMAX is a part of the advancement from voice-only wireless communications systems to ones that offer extra services like web browsing, streaming media, immediate messaging, and additional content. Being able to bring a wide variety of services also requires a delivery system that is flexible and can proficiently distribute system resources. The 802.16 standard offer adjustable data rate to and from each user while maintaining the required quality of service (QoS). Certain applications require higher error flexibility and latency requirements that directly factor into the QoS. The system resources are allocated and planned vigorously by the base station on a frame by frame basis to go on with the need of the users in the environment [3]. WiMAX is expected to offer primarily up to about 40 Mbps bit rate per wireless channel for both fixed and transferable applications, depending on the particular technical configuration selected, sufficient to support hundreds of businesses with T-1 speed connectivity. WiMAX can hold up voice and video as well as Internet data. WiMAX, is an IP-based wireless broadband technology, can be incorporated into both wide-area third-generation (3G) mobile and wireless and wired networks allowing it to become part of a flawless anytime, anywhere broadband access solution. WiMAX could potentially be deployed in a range of spectrum bands: 2.3GHz, 2.5GHz, 3.5GHz, and 5.8GHz.

II. FEATURES OF WiMAX

WiMAX is a wireless broadband with a set of significant features:

- **OFDM-based physical layer:**

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The WiMAX physical layer (PHY) is based on orthogonal frequency division multiplexing, a modulation scheme that offers good quality resistance to multipath, and allows WiMAX to function in NLOS (Non-line-of-sight) conditions.

- **High data rates:**
  WiMAX supports very high peak data rates. The peak PHY data rate can be as high as 74Mbps when operates using a 20MHz wide spectrum.

- ***Scalable bandwidth and data rate support*:**
  WiMAX is capable to support a extensive range of bandwidths. The scalability is implemented by changing the FFT size from 128 to 512, 1024 and 2048 to maintain channel bandwidths of 1.25 MHz, 5MHz, 10MHz and 20 MHz correspondingly [4].

- **Mobility:**
  The mobile WiMAX alternative of the system has mechanisms to support secure flawless handovers for delay-tolerant full-mobility applications and also power-saving mechanisms to increase the battery life of handheld subscriber devices.

- **Resource allocation on demand:**
  Both uplink and downlink resource allocation capacity is shared among several users on a requirement basis, using a burst TDM scheme.

- **Advanced antenna techniques:**
  The WiMAX allows for the utilization of multiple-antenna techniques, such as beam forming, space-time coding, and spatial multiplexing.

- **Quality-of-service:**
  The WiMAX MAC layer has a connection-oriented architecture that is intended to support a variety of applications, including voice and multimedia services each with essential QoS.

- **Security:**
  WiMAX supports strong encryption, by means of Advanced Encryption Standard (AES), and has a robust privacy, key-management protocol, mutual device/user authentication, strong traffic encryption, control and management plane message protection and security protocol optimizations for speedy handovers [5].

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III. SIMULATION MODEL

The function of the PHY layer is to encode the binary digits into signals and to transmit and receive these signals transversely through the communication channel. The WiMAX PHY layer is based on OFDM; which is used to allow high-speed data and multimedia communications and is used by a range of commercial broadband systems. The PHY layer in WiMAX includes different functional stages including; randomizing, forward error correction (FEC), interleaving, and symbol mapping; OFDM symbol in frequency domain, and conversion of the OFDM symbol from the frequency domain to the time domain [6].

IV.RESULTS & DISCUSSION

Figure 2 and figure 3 shows the performance of developed WiMAX model having cyclic prefix of 0.25 (1/4) and 0.5 (1/2) for different modulations under AWGN Channel. The values of BER under different SNR are shown in table 1 and table 2.

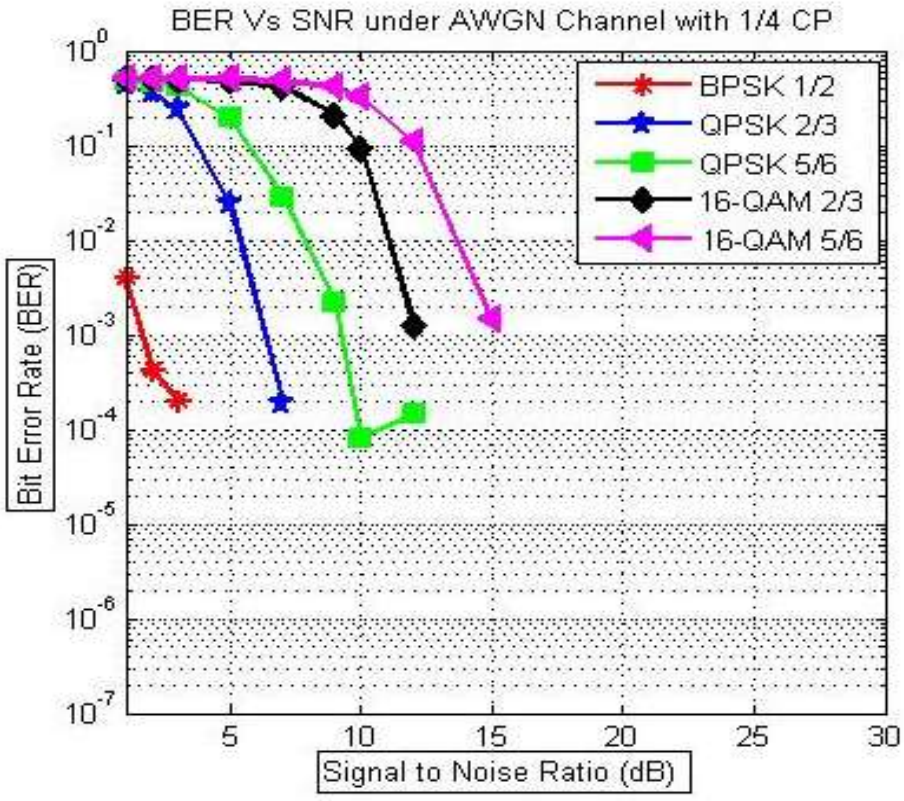

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Figure 2: BER Evaluation under AWGN Channel with CP 1/4, various modulation and rates.

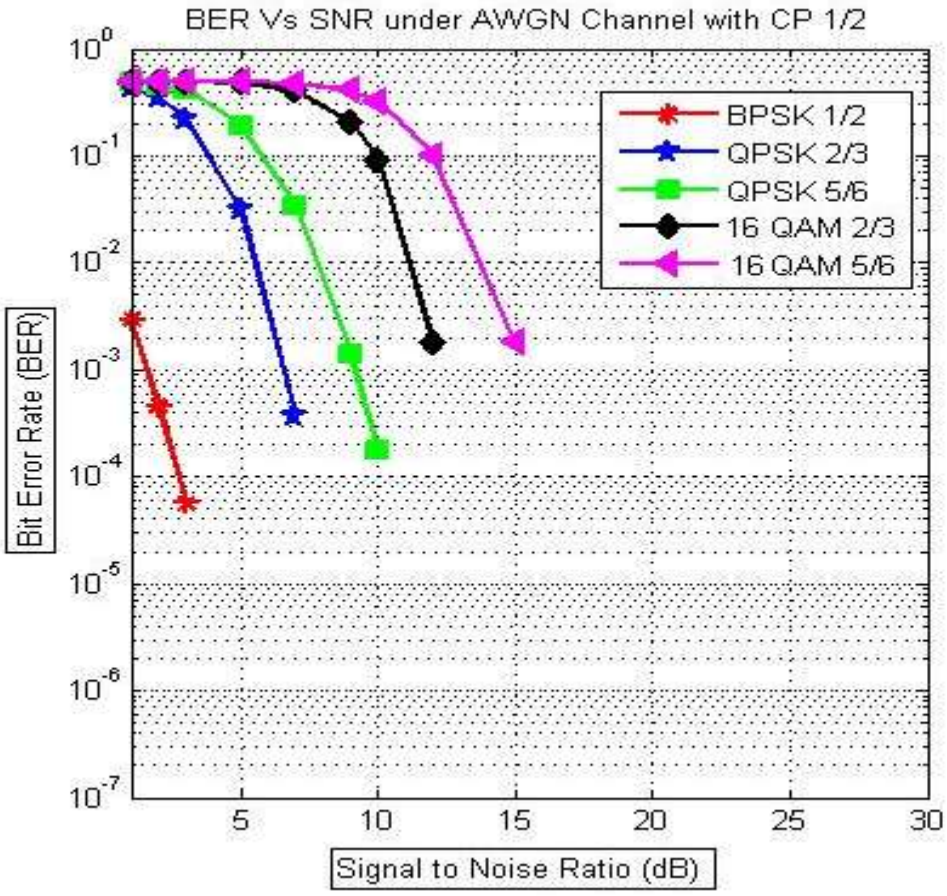

Figure 3: BER Evaluation under AWGN Channel with CP 1/2, various modulation and rates.

The result in figures 2 and 3 reveals that the lower modulation and coding scheme provides better performance with less SNR. This can be easily visualized if we look at their constellation mapping; larger distance between adjacent points can tolerate larger noise (which makes the point shift from the original place) at the cost of coding rate. The performance of WiMAX IEEE

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802.16 standard is evaluated under AWGN Channel with Cyclic Prefix (CP) equal to 1/4 and 1/2. The BER evaluation is done for various modulations that are widely used in literature. Also the code rate is varied to evaluate the performance.

Similarly Table 5.1 and 5.2 shows the values of BER under varying SNR values.

Table 5.1: Bit Error Rate for various SNR values with CP 1/4

SNR(dB)	BPSK – 1/2	QPSK- 2/3	QPSK- 5/6	16-QAM 2/3	16-QAM 5/6
	BER	BER	BER	BER	BER
1	0.0039	0.4292	0.4824	0.4984	0.4981
2	0.0004	0.3543	0.4626	0.4988	0.5008
3	0.0002	0.2359	0.4084	0.4950	0.4994
5	0	0.0240	0.1932	0.4805	0.4970
7	0	0.0002	0.0282	0.4113	0.4778
9	0	0	0.0021	0.2080	0.4137
10	0	0	0.0001	0.0918	0.3240
12	0	0	0.0001	0.0012	0.1054
15	0	0	0	0	0.0015
17	0	0	0	0	0
20	0	0	0	0	0
22	0	0	0	0	0
25	0	0	0	0	0
27	0	0	0	0	0
30	0	0	0	0	0

Table 5.2: Bit Error Rate for various SNR values with CP 1/2

SNR(dB)	BPSK – 1/2	QPSK- 2/3	QPSK- 5/6	16-QAM 2/3	16-QAM 5/6
	BER	BER	BER	BER	BER
1	0.0030	0.4240	0.4812	0.4971	0.5011
2	0.0005	0.3507	0.4540	0.5003	0.4985
3	0.0001	0.2182	0.4206	0.4919	0.5008

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5	0	0.0309	0.1909	0.4808	0.4964
7	0	0.0004	0.0340	0.4059	0.4796
9	0	0	0.0014	0.2056	0.4091
10	0	0	0.0002	0.0920	0.3252
12	0	0	0	0.0018	0.1006
15	0	0	0	0	0.0018
17	0	0	0	0	0
20	0	0	0	0	0
22	0	0	0	0	0
25	0	0	0	0	0
27	0	0	0	0	0
30	0	0	0	0	0

V. CONCLUSION

We evaluate the performance of developed WiMAX model based on IEEE 802.16 for different modulation format, cyclic prefix under AWGN channel. The result reveals that the lower modulation and coding scheme provides better performance with less SNR.

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