Performance Analysis of Wi-MAX Networking Modulation Scheme

Gaurav Sethi, Sweta Shaw, B. Jyothi and Chandrani Chakravorty

Abstract--- Wi-MAX stands for the Worldwide Interoperability for Microwave Access and is also known as the IEEE 802.16 wireless metropolitan area network. IEEE 802.16e WIMAX (Worldwide interoperable Microwave Access) is the upcoming wireless system which can offer high speed voice, video and data service up to the customer end. In 1998, a working group named 802.16 was formed by the Institute of Electrical and Electronics Engineers (IEEE), and their responsibility is to develop the specifications of broadband wireless access technology. IEEE specifies the different modulation techniques which should be used in WIMAX namely QPSK, 8-QAM, 16QAM and 64 QAM.

Keywords--- QPSK, 8-QAM, 16-QAM, 32-QAM, 64-QAM, IEEE 802.16d

I. INTRODUCTION

IEEE 802.16 is the standard for WiMAX. WiMAX is also known as wireless broadband. WiMAX, the cronym of Worldwide Interoperability for Microwave Access, is a technology created in 2004 corresponding to the standard 802.16 of IEEE. The aim of this new technology is to provide business and consumer broadband access on the scale of MAN (Metropolitan Area Network).It can be considered the evolution of the Wi-Fi, since it offers higher data rates with coverage of up to 50 kilometers.

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The IEEE 802.16-2004 standard specified OFDM as the transmission method for NLOS connection. The OFDM signal is made up of many orthogonal carrier and each individual carrier is digitally modulated with the relatively slow symbol rate. This method is distinct advantages in multipath propagation because, in comparison with the single carrier method at the same transmission rate, more time is needed to transmit the symbol. The QPSK, 8-QAM, 16-QAM, and 32- QAM modulation modes are used, and the modulation is adapted to the specific transmission requirements. Transmission rate up to 75Mbit/sec are possible. Unlike WiMAX "little brother" WLAN, the bandwidth is not constant and can vary between 1.25MHz and 28 MHz The principles of orthogonal frequency division multiplexing (OFDM) modulation have been in existence for over forty years but the concept has only become popular in the last decade. The first proposal for OFDM was made in the early 1950's and during the 1960s its theory was fully developed. Since then it has received tremendous attention from researchers and today, OFDM is a household name in the field of communication. The modulation used can be OFDM with a number of subcarriers between 128 and 2048 which are modulated with QPSK, 8QAM, 16QAM or 64QAM. The band widths used vary between 1.25 and 20 MHz per channel, achieving data rates of up to 100Mbit/s. The idea of OFDM is to split the total transmission bandwidth into a number of orthogonal sub carriers in order to transmit the symbols using these sub carriers in parallel [4]. Each smaller data stream is then mapped to individual data sub-carrier and modulated using some sorts of Phase Shift Keying (PSK) or Quadrature Amplitude Modulation (QAM) such as QPSK, 16-QAM, 64-QAM and 8- QAM.

Different types of QAM are available for WiMAX networks depending on throughput and range. 64 QAM has higher throughput but the lower range whereas 16 QAM has lower throughput but higher range to cover from the BS. WiMAX has the freedom to select Quadrature Phase Shift Keying (QPSK) and QAM as its modulation techniques depending on the situation.

II. IEEE 802.16 WI-MAX STANDARD

WiMAX (Worldwide interoperability for Microwave Access) is one of the most emerging technologies for Broadband Wireless Access (BWA) in metropolitan areas by providing an exciting addition to the current broadband techniques for the last-mile access. It is demonstrated that WiMAX is a viable alternative to the cable modem and DSL technologies due to its high resource utilization, easy implementation and low cost. Furthermore, WiMAX not only enhances the existing features of the competitive cabled access networks, but provides high data rate applications with a variety of Quality of Service (QoS) requirements.

III. SIMULATION MODEL

Figure (1) corresponds to the physical layer of WiMAX/IEEE 802.16d wireless MAN –OFDM air interface. The system is modeled or defined as per the IEEE 802.16d standard and is there after analyzed. The definition of the model means to construct the model from basic elements constructed previously, as, mathematical operators, signals, connectors, visualizes and others. The analysis of the model means to realize the simulation, linearization and to determine the point of balance of a model as was defined.

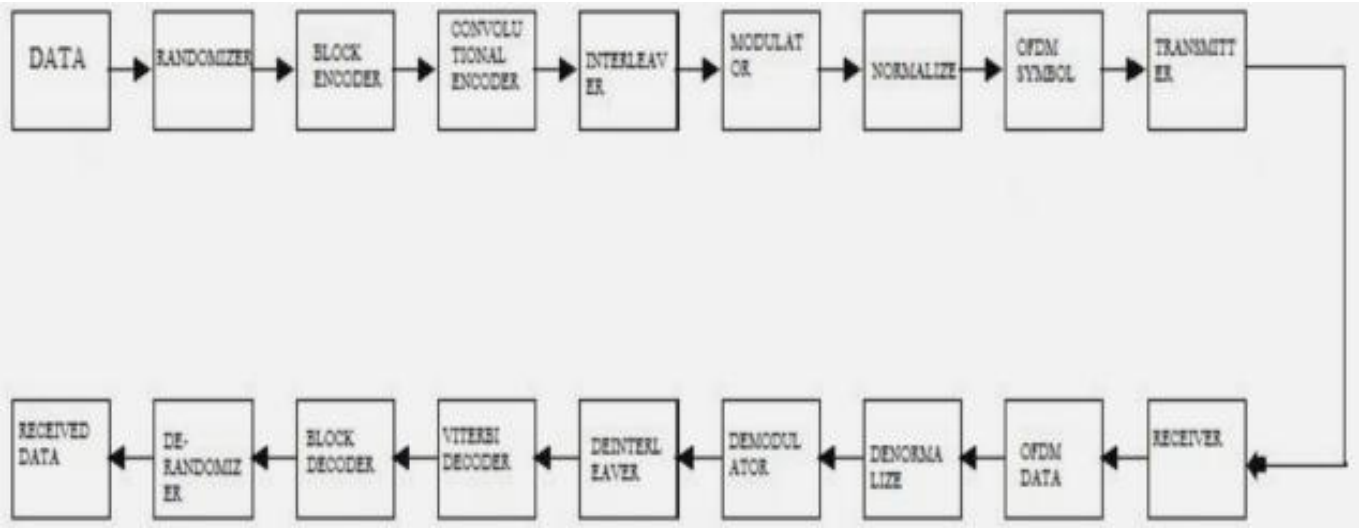


Fig .1: Simulation Model

Figure shows simulation model of the physical layer of the network WiMAX that is used for different modulations techniques namely QPSK, 16- QAM and 64-QAM. This model consists of two parts: the transmission and the reception. A random data (test data as provided by IEEE 802.16d standard) is modulated and is transmitted by employing Orthogonal Frequency Division Multiplexing (OFDM) technique. The reverse processes goes at the receiver end and same data is retrieved at the output. The different errors in transmitted data and received data were compared.

Simulation can be done in any software but the procedure remains same. For simulation some parameters are taken from the standard and some parameters are varied to get the appropriate results. Modulation parameters used in the simulation are listed in the Table - 1

TABLE 1.
MODULATION PARAMETER

Modulation	Code rate for convolution coding
QPSK	1/2 , 3/4
8 QAM	1/2 , 3/4
16 QAM	1/2 , 3/4
32 QAM	1/2 , 3/4
64 QAM	2/3 , 3/4

A. *Randomizer*

The Randomizer performs randomization of input data on each burst on each allocation to avoid long sequence of continuous ones and zeroes. This is implemented with a Pseudo Random Binary Sequence (PRBS) generator which uses a 15stage shift register with a generator polynomial of with XOR gates.

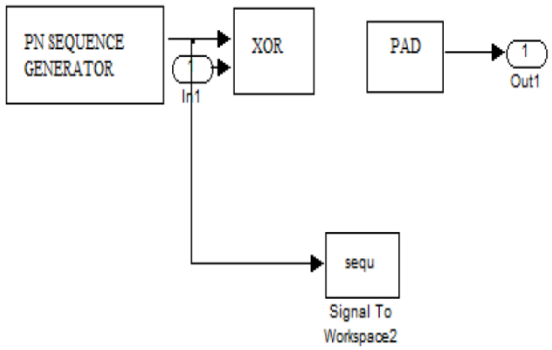


Fig. 2: Randomizer

B. *Encoder*

The encoding process consists of a concatenation of an Reed-Solomon (RS) code and an inner convolution code (CC) as a FEC scheme. That means that first data passes through the RS encoder, and then, it goes across the convolution encoder. It is a flexible coding process due to the puncturing of the signal, and allows different coding rates. The last part of the encoder is a process of interleaving to avoid long error bursts is designed to offer optimal error protection levels to the users.

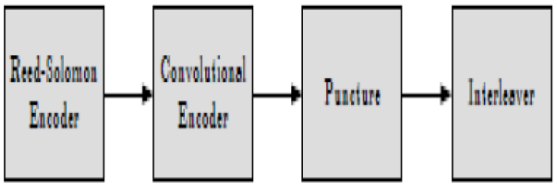


Fig. 3: Encoder

C. *Interleaver*

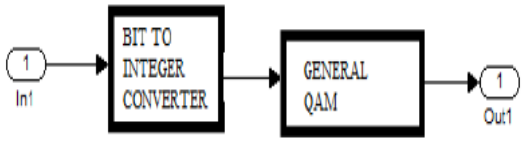
When the data goes from the puncture code which punctures the encoded code then the bits are fed to General Block Inter-leaver which allows placing of transmitted bits in a vector to be accepted by the modulator. Before feeding to a modulator the bits should be converted into Integers.

Table 2. Normalizer gain

TYPE	GAIN
QPSK	$1/\sqrt{2}$
16 QAM	$1/\sqrt{10}$
64 QAM	$1/\sqrt{42}$

D. *Normalizer*

The output of modulator should be normalized into Order to send it over the channel after employing OFDM modulation technique. The gain of the normalizer Block as per the standard is.



E. *Modulator*

Modulation depending their size and on the basis of different modulation schemes like BPSK,, Gray mapped QPSK The modulation has done on the basis of incoming bits by dividing among the groups of i. The total number of bits represented according to constellation mapped of different modulation techniques. The size for BPSK, QPSK, and 16 QAM is 1, 2, 4 and 16 respectively.

IV. CONCLUSION

By above experiment and observation we conclude that QAM is better modulation provider than QPSK. Hence QAM is preferable over other types of modulation due to its lower SNR and BER.

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