Simulation Of WiMax Model Using AWGN Channel

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Abstract— WiMax(Worldwide Interoperability for Microwaves Access) is a promising technology which can offer high speed voice, video and data service up to the customer end. The development of 802.16 standards for BWA (Broadband Wireless Access) technologies was motivated by the rapidly growing need for high-speed, ubiquitous and cost effective access. The WiMAX can also be considered to be the main technology in the implementation of other networks like wireless sensor networks. Developing an understanding of the WiMAX system can be best achieved by looking at a model of the WiMAX system. This paper discusses the model building of the WiMAX System using simulink in Matlab R2013a version. This model is a useful tool for BER (Bit Error Rate) performance evaluation. . In this paper, transmitter and receiver model are simulated to evaluate the performance.

Keywords— WiMAX, OFDM, QAM, AWGN, Matlab, RS Decoder, BWA.

INTRODUCTION

The growth in the use of the information networks lead to the need for new communication networks with higher data rates. The telecommunication industry is also change, with a demand for a greater range of services, such as video conferences, or applications with multimedia contents, wireless communication has permeated nearly all facts of human life. Example home, offices, car etc. WiMAX (Worldwide Interoperability for Microwaves Access) is a 4G technology. [1]

The increased reliance on computer networking and the Internet has resulted in a wider demand for connectivity to be provided "anywhere, anytime", leading to a rise in the requirements for higher capacity and high reliability broadband wireless telecommunication systems. WiMAX is one of the most promising techology which has changed the scenario of the industry completely. WiMAX is considered today the most interesting opportunity, able to provide radio coverage distances of almost 50 kilometers and data throughput up to 70 Mbps, and to complete wired network architectures, ensuring a cheap and flexible solution for the last-mile. WiMAX may be seen as the fourth generation (4G) of mobile communications systems. WiMAX is an IEEE 802.16 standard based technology responsible for bringing the Broadband Wireless Access (BWA) to the world as an alternative to wired broadband. WiMAX is expected to have an explosive growth, as well as the WiFi, but compared with the Wi-Fi WiMAX provides broadband connections in greater areas, measured in several kilometers, even with links not in line of sight. For these reasons WiMAX is a MAN, highlighting that “metropolitan” is referred to the extension of the areas and not to the density of population. [1]

DESIGN OF WIMAX SYSTEM MODEL USING AWGN CHANNEL

The main objective behind designing this model was to build up the real time model for the WiMAX system along with the suitable wireless channels compatible to various atmospheric conditions for the signal propagation. The model discussed here is built on QAM modulation scheme and OFDM technique based on the platform of Matlab R2009a, running on Windows XP SP2. Matlab Simulink includes all the mandatory function blocks as specified by the standard documents. The model shown in fig.1 comprises of transmitter, receiver and channel which is AWGN channel in the first case.

First of all, 256 x 256 image input with 96 samples per frame for image and 30138 samples with 1/35 sample time for the process of frame based speech output are taken. Once the data is received in terms of either speech or image, the randomization would be performed which will be applied for encoding. The encoder of the WiMAX system is the combination of Reed-Solomn (RS) code as an outer code and Convolution code (CC) as an inner code. The encoded baseband data is modulated by means of QAM which is applied for OFDM process as the physical layer of WiMAX system is made up of OFDM. In OFDM process, the in phase and quadrature phase components of the symbols will undergo through the process of IFFT so that requirement of effective bandwidth can

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be made approximately half without any inter symbol interference. For the simulation purpose, the communication medium is considered to be suitable for long distance system wherein average fading is assumed to be constant throughout the path. To characterize the above system, the channel has been modeled as an additive white Gaussian noise (AWGN) channel. This is the simplest type of channel that is having the noise distribution with a constant power spectral density with Gaussian nature of PDF over the entire channel bandwidth. [2]

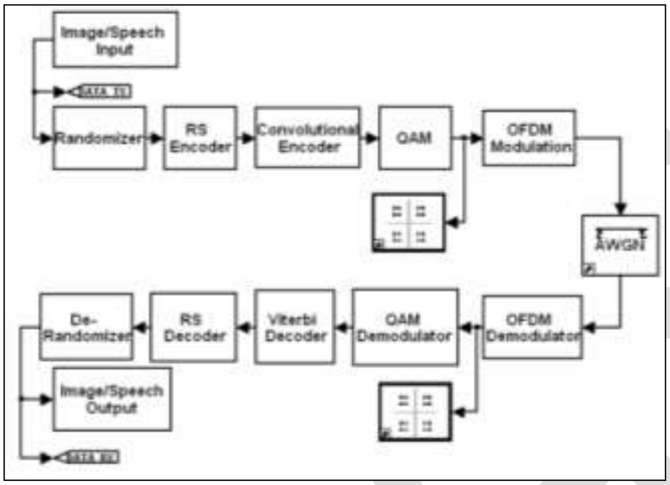

Fig 1 : Block diagram of WiMax System using AWGN Channel.

PROPOSED MODEL

The proposed model for the WiMax system is given in fig 2. The model discussed in the research paper is based on the platform of Matab R2013a. Simulink includes all the mandatory function blocks as specified by the standard documents.

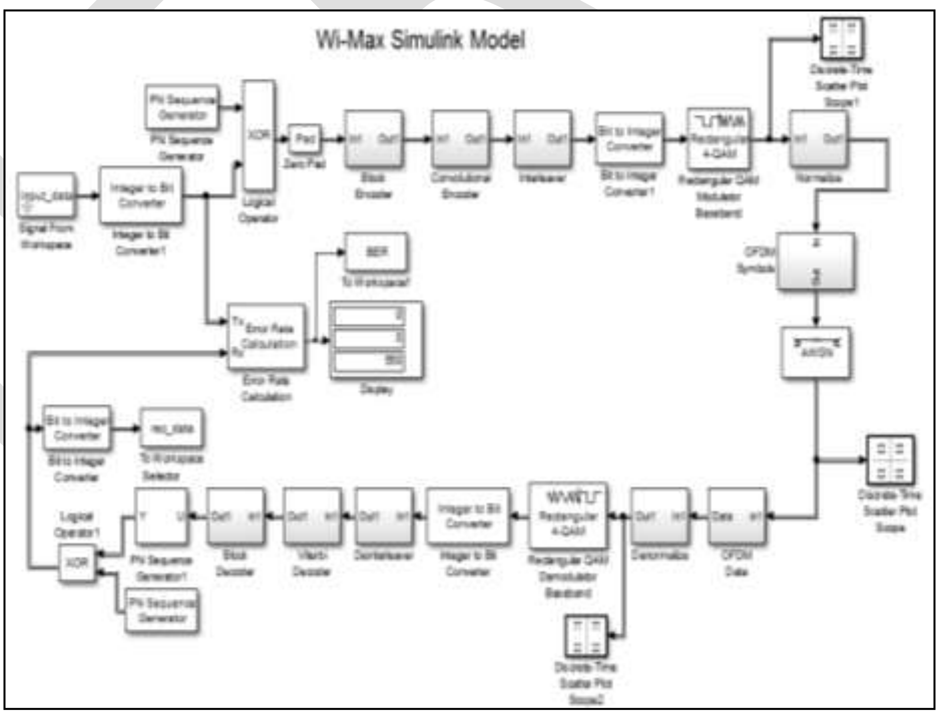

Fig.2: Proposed WiMax Simulink Model

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SYSTEM IMPLEMENTATION

1. RANDOMIZER.

Randomization is the first process carried out in the physical layer after the data packet is received from the higher layers. Each error burst in Downlink and Uplink is randomized.

Randomizer operates on a bit by bit basis. The purpose of the randmizer is to convert long sequences of O's or 1 's in a random sequence to improve the coding performance.

The main component of the data randomization is a Pseudo Random Binary Sequence generator which is implemented using Linear Feedback Shift Register.[5]

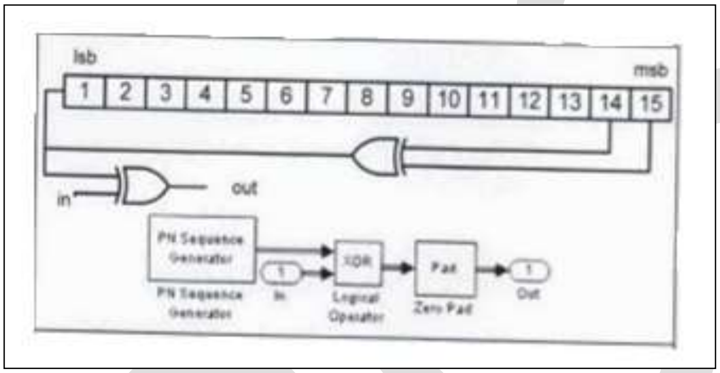

Fig 3 : Channel Encoding – Data Randomizer

2. BLOCK ENCODER

The use of Reed-Solomon code to the data is to add redundancy to the data sequence. This addition of redundancy helps in correcting block errors that occur during transmission of the signal. After randomizer the data is passed onto the Reed Solomon Encoder. The encoding process for RS encoder is based on Galois Field Computations for the calculations of the redundant bits. Galois Field is widely used to represent data in error control coding. [2]

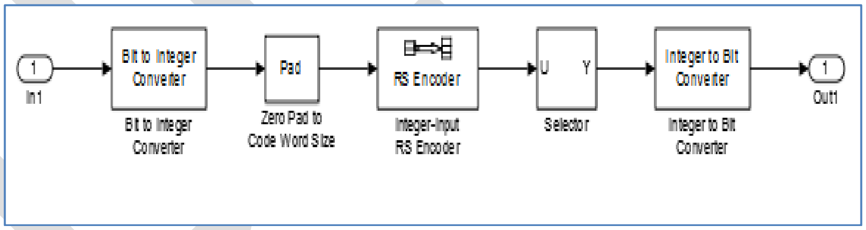

Fig 4 : Channel Cding – FEC Reed Solomon Encoder

3. CONVOLUTIONAL ENCODER

Convolutional codes are used to correct the random errors in the data transmission. A convolutional code is a type of FEC code that is specified by CC(m, n, k), in which each in-bit information symbol to be encoded is transformed into an n-bit symbol, where m/n is the code rate (n > m) and the transformation is a function of the last k information symbols, where k is the constraint length of the code. In WiMAX Physical Layer each RS block is encoded by the binary convolutional encoder, which has a code rate of 7/2 and a constraint length equal to 7.
The output of the convolutional encoder is then punctured to remove the additional bits from the encoded stream. The number of bits removed is dependent on the code rate used.[3]

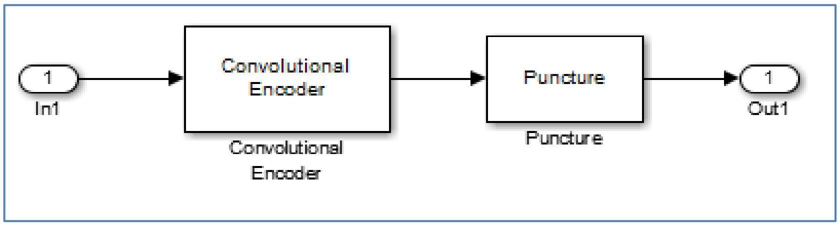

Fig 5 : Convolutional Encoder.

4. PUNCTURING PROCESS

Puncturing is the process of systematically deleting bits from the output stream of a low-rate encoder in order to reduce the amount of data to be transmitted, thus forming a high-rate code. The bits are deleted according to a perforation matrix, where a "zero" means a discarded bit. [3]

5. INTERLEAVER.

Interleaver in its most basic form can be described as a randomizer but it is quite different from the randomizer in the sense that it does not change the state of the bits but it works on the position of bits.

Interleaving is done by spreading the coded symbols in time before transmission. The incoming data into the interleaver is randomized in two permutations. First permutation makes sure that adjacent bits are mapped onto non-adjacent subcarriers. The second permutation maps the adjacent coded bits onto less or more significant bits of constellation thus avoiding long runs of less reliable bits.[3]

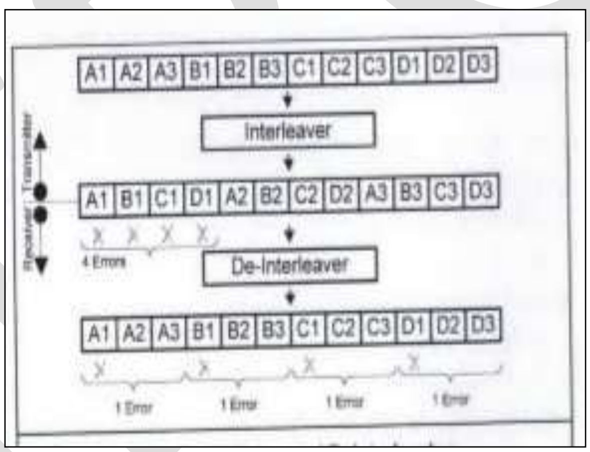

Fig 6 : Channel Coding – Interleaving and Deinterleaving

The first permutation is defined by the formula:

mk =(Ncbps/ 12) * mod(k, 12) + floor(k/ 12)

The second permutation is defined by the formula:

s = ceil(Ncpc/2)

jk = s x floor(mk / s)+ (ink + Ncbps - floor(2 xmk / Ncbps))mod(s)

where:

Ncpc = Number of coded bits per carrier

Ncbp s= Number of coded bits per symbol

k = index of coded bits before first permutation

jk=Index of coded bits after first permutation

mk= Index of coded bits after second permutation

Same permutation is done on the receiver side to rearrange the data bits into the correct sequence. Index of bits represented by jk is used during the modulation process.

6. Quadrature Amplitude Modulation

The interleaver reorders the data and sends the data frame to the IQ mapper. The function of the IQ mapper is to map the incoming bits of data from interleaver onto a constellation.

7. OFDM MODULATOR

The OFDM (Orthogonal Frequency Division Multiplexing) is a wideband wireless digital communication technique that is based on block modulation, with the wireless multimedia application becoming more and more popular, the required bit rate are achieved due to OFDM multicarrier transmission for video communication, very high bit rate/high-speed communication is required. To satisfy this, we must have the modulation scheme that can read more number of bits at a time and send it with considerably of the reception must be good enough. The OFDM is a digital modulation scheme that can support high-speed video communication along with audio with elimination of ISI and ICI. At the same time, it can accommodate more number of users showing the spectral efficiency. It is a multiplexing/multiple access scheme that has many favorable features required for the 4th generation wireless communication schemes. [4]

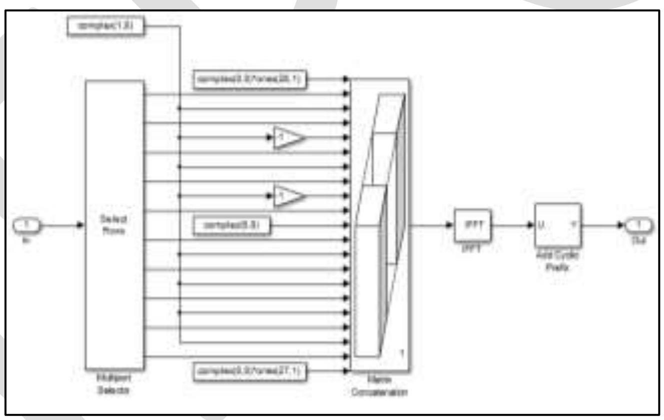

Fig 7 : OFDM Symbols

8. AWGN (Additive white Gaussian noise) Channel

The AWGN channel block adds white Gaussian noise to real or complex input signal. When the input signal is real, this block add real Gaussian noise and produces a real output signal. Additive white Gaussian noise is a channel model in which the only impairment to communication is a linear addition of wideband or white noise with a constant spectral density (expressed as watts per hertz of bandwidth) and a Gaussian distribution of amplitude. The AWGN channel is a good model for many satellite and deep space communication links.

9. OFDM DEMODULATOR

The OFDM Demodulator object demodulates using the orthogonal frequency division demodulation method. The output is a baseband representation of the modulated signal, which was input into the OFDM Modulator companion object. The Orthogonal Frequency

Division Modulation (OFDM) Demodulator System object demodulates an OFDM input signal by using an FFT operation that results in *N* parallel data streams [15].

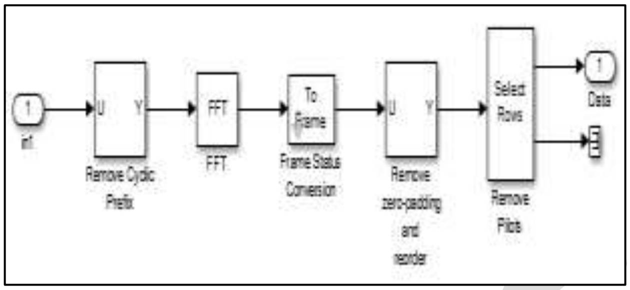

Fig 8 : OFDM Data.

10. VITERBI DEODER

TheViterbi algorithm reduces the computational load by taking advantage of the special structure of the trellis code. Another advantage is its complexity, which is not a function of the number of symbols that compose the codeword sequence. The Viterbi algorithm performs approximate maximum likelihood decoding. It involves calculating a measure of similarity or distance between the received signal at time ti, and all the trellis paths entering each state at the same time. [5]

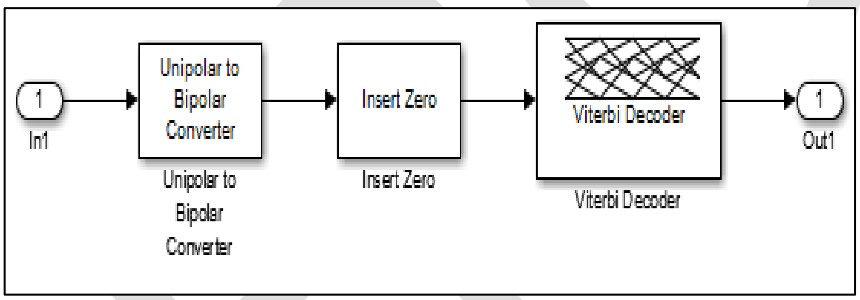

Fig 9 : Viterbi Decoder

11. RS DECODER

It performs the necessary operations to decode the signal, and get, at the end, the original message sent by the source. As in all the receiver blocks, the RS decoder reverses the different steps performed by its corresponding encoding block. [5]

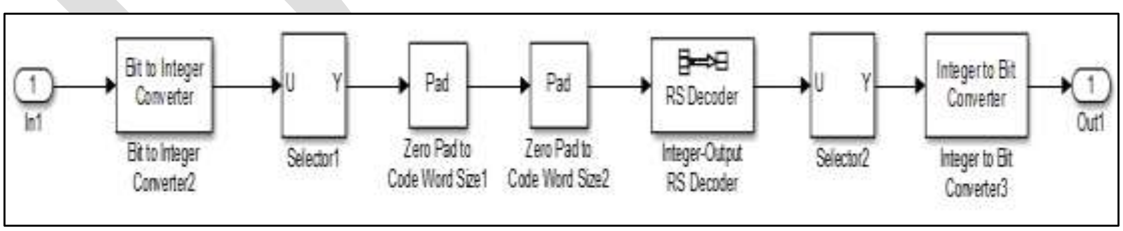

Fig 10 : RS Encoder

CONCLUSION

This paper represents the complete Simulink block diagram of the WiMax System. The blocks used in designing the WiMax model are explained in detail. The BER can be calculated by varying the SNR in the AWGN Channel. This model provides Zero BER from 15 SNR Onwards.

REFERENCES

[1] Mukesh Patidar, Rupesh dubey, Nitin kumar Jain, Sarita kulpariya, "Performance Analysis of WiMAX 802.16e Physical Layer " , IEEE International Conference on 20-22 Sept. 2012.

[2] Bhavin S. Sedani, Nirali A.Kotak, Komal R. Borisagar, G. R. Kulkarni., "Implementation and Performance Analysis of Efficient Wireless Channels in WiMAX using Image and Speech Transmission" International Conference on Communication Systems and Network Technologies ,Issue 11-13 May 2012.

[3] Priyanka. R. Banswani, Vaishali Tehre , "*Design of WiMAX Transmitter Model Using AWGN Channel* " National Conference on Recent Trends In Information And Telecommunication (TTITC-2014), Issue 23-24 December 2014

[4] Muhammad Nadeem Khan, Sabir Ghauri "The WiMAX 802.16e Physical Layer Model ", University of the West of England, United Kingdom.

[5] Diplomarbeit "Implementation Of A WiMax Simulator in Simulink".

[6] Bijoy Kumar Upadhyaya, Iti Saha Misra and Salil Kumar Sanyal "Novel Design of Address Generator for WiMAX Multimode Interleaver using FPGA based Finite State Machine" Proceedings of 13th International Conference on Computer and Information Technology (ICCIT 2010) 23-25 December, 2010, Dhaka, Bangladesh

[7] Onsy Abdel Alim, Hiba S. Abdallah, Azza M. Elaskary, "Simulation of WiMAX Systems", IEEE International Conference on 31-31 May 2008.

[8] Abdulrahman Yarali, Bwanga Mbula, Ajay Tumula, "WiMAX: A Key to Bridging the Digital Divide", IEEE International Conference on22-25 March 2007.

[9] Ming Wu Fei Wu* Changsheng Xie "The Design and Implementation of WiMAX Base Station MAC based on Intel Network Processor", The 2008 International Conference on Embedded Software and Systems Symposia (ICESS2008).

[10] Ming Wu Fei Wu* Changsheng Xie "WiMAX Performance at 4.9 GHz", 2010 IEEE International Conference.

[11] Perumalraja Rengaraju, Chung-Horng Lung, Anand Srinivasan "Measuring Analyzing WiMAX Security and QoS in Testbed Experiments",IEEE Communications Society subject matter experts for publication in the IEEE ICC 2011.

[12] Anita Marzuki, Mohd Dani Baba "Downlink Performance Evaluation of Multi mode Devices in WiMAX and WiFi Environment", 2011 IEEE Control and System Graduate Research Colloquium.

[13] Mona Shokair and Hifzalla Sakran, "PAPR Reduction in WiMAX System".

[14] Deepak Sharma, Praveen Srivastava, "OFDM Simulator Using MATLAB", International Journal of Emerging Technology and Advanced Engineering

[15] Andrews, J. G., A. Ghosh, and R. Muhamed, *Fundamentals of WiMAX*, Upper Saddle River, NJ: Prentice Hall, 2007