Interpretation of IEEE 802.16e (Wimax)

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Abstract

The development of 802.16 standards for Broadband Wireless Access technologies was motivated by the rapidly growing need for high-speed, ubiquitous and cost-effective access. The limitations of conventional Broadband wireless access have been overcome with the scalable features of WiMAX. The aim of this paper is to analyse all compulsory features of the WiMAX OFDM physical layer specified in IEEE 802.16e. This paper gives an overview about the WiMAX standard and studies the performance of a WiMAX transmitter and receiver. This is done in order to study the WiMAX network practically. WiMAX network is implemented and analysed in great detail with the help of simulation results. Simulation is performed in the Matlab simulink.

Index terms— WIMAX, OFDM, 4G, WLAN.

1 Introduction

ccompanying the explosive growth of the Internet during the last decades, the current expansion of wireless technology promises a greater impact on how people communicate, interact and enjoy their entertainment. With the demand for greater range of services, such as video conferences, or applications with multimedia contents, the telecommunication industry is changing. The increased dependence on computer networking and the Internet has resulted in a wider demand for connectivity to be provided "any where, any time", which leads to the rise in the requirement for higher capacity and high reliability in broadband wireless telecommunication systems. Wireless networks have become increasingly interoperable with each other and this reflects a paradigm shift towards new generations of mobile networks where seamless mobility across heterogeneous networks becomes fundamental. This generation is referred to as fourth generation (4G). Future users will be connected through different available access networks when they move from one place to another (at home, in the office, on the bus, on the train or in the shopping mall) [1]. For example, a video teleconference can transparently switch from an enterprise Wireless Local Area Network (WLAN) to the traditional cellular environment when driving home and to the fixed home network when arrived. This shows that the users can access and maintain a seamless connectivity anywhere, anytime through any access technology owned by any operator to use any available service.

2 a) WiMAX Technology

WiMAX (also known as IEEE 802.16) is a wireless digital communication system that is intended for wireless "metropolitan area networks" (WMAN). It can provide broadband wireless access (BWA) up to 30 miles (50 km) for fixed stations, and 3 -10 miles (5 -15 km) for mobile stations. In 2005, when IEEE introduced first Mobile WiMAX standard 802.16e, and some of the added features of 802.16e were:

Enhanced mobility and portability capabilities, improved NLOS coverage by using adaptive antenna system (AAS) with multiple inputs multiple output (MIMO) technology, increased system gain and improved indoor penetration by adopting denser sub channelization and handovers for portable and mobile access. WiMAX architecture comprises of several components but the basic two components are BS and SS. Other components are MS, ASN, CSN and CSN-GW. The WiMAX Forum's Network Working Group has developed a network reference model according to the IEEE 802.16e air interface to make sure the objectives of WiMAX are achieved.

To support fixed, nomadic and mobile WiMAX network, the reference model (Figure 1) can be logically divided into four parts [5]. The BS provides connection between operator networks and wireless subscriber devices. To enable wireless communications consists of antennas, transceivers, and other electromagnetic wave transmitting equipments.

? Subscriber Station (SS) Also called Mobile Station (MS). The SS is the user that needs to use services while in motion at vehicular speed. These SS are battery operated compared to the fixed station. Generally mobiles and laptops are used as SS.

3 ? Access Service Network (ASN)

It is owned by NAP, formed with one or several base stations and ASN gateways (ASN-GW) which creates radio access network. It provides all the access services with full mobility and efficient scalability. Its ASN-GW controls the access in the network and coordinates between data and networking elements.ASN-GW performs traffic management function within the ASN.

4 ? Connectivity Service Network (CSN)

Provides IP connectivity to the Internet or other public or corporate networks. It also applies per user policy management, address management, location management between ASN, ensures QoS, roaming and security.

5 i. Design Details

As any other communication system, WiMAX has three basic elements, a transmitter, a receiver, and a channel over which the information is sent. ii. WiMAX Simulation Model

The Simulink model of WiMAX PHY developed for the study is as shown in Figure 2, the model consists of transmitter and receiver section linked by the Channel sub systems. Randomization is the first process carried out in the physical layer after the data packet is received from the higher layers. Each burst in Downlink and Uplink is randomized. Randomizer operates on a bit by bit basis. The purpose of the scrambled data is to convert long sequences of 0'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. The generator defined for the randomizer is given by Equation 1:

1 + x 14 + x 15 (1)

b. Reed Solomon Encoding

The purpose of using Reed-Solomon code to the data is to add redundancy to the data sequence. The encoding process for RS encoder is based on Galois Field Computations to do the calculations of the redundant bits. Galois Field is widely used to represent data in error control coding and is denoted by GF (2m). WiMAX uses a fixed RS Encoding technique based on GF(28) which is denoted as: RS (N = 255, K = 239, T =8)

Where: N = Number of Bytes after encoding K = Data Bytes before encoding T = Number of bytes that can be corrected Eight tail bits are added to the data just before it is presented to the Reed Solomon Encoder stage. This stage requires two polynomials for its operation called code generator polynomial g(x) and field generator polynomial p(x). The code generator polynomial is used for generating the Galois Field Array whereas the field generator polynomial is used to calculate the redundant information bits which are appended at the start of the output data. These polynomials are defined by the standard as below:

Code Generator Polynomial: 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 ensures that adjacent bits are mapped onto nonadjacent 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.

6 d. 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. In the modulation phase the coded bits are mapped to the IQ constellation, starting with carrier number -100 on up to carrier number + 100. To simplify transmitter and receiver designs, all symbols in the FCH and DL data bursts are transmitted with equal power by using a normalization factor. The constellation-mapped data is subsequently modulated onto all allocated data carriers in order of increasing frequency offset index.

7 Conclusion

As foreseen by many researchers, the next generation wireless mobile communications (4G) will be based on the heterogeneous underlying infrastructure integrating different wireless access technologies in a complementary manner. By using the simulation tool, I have analyzed the various waveforms after each block of the signal transmitted and received over the channel in a WiMAX network.

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Figure 1: Figure 1 :

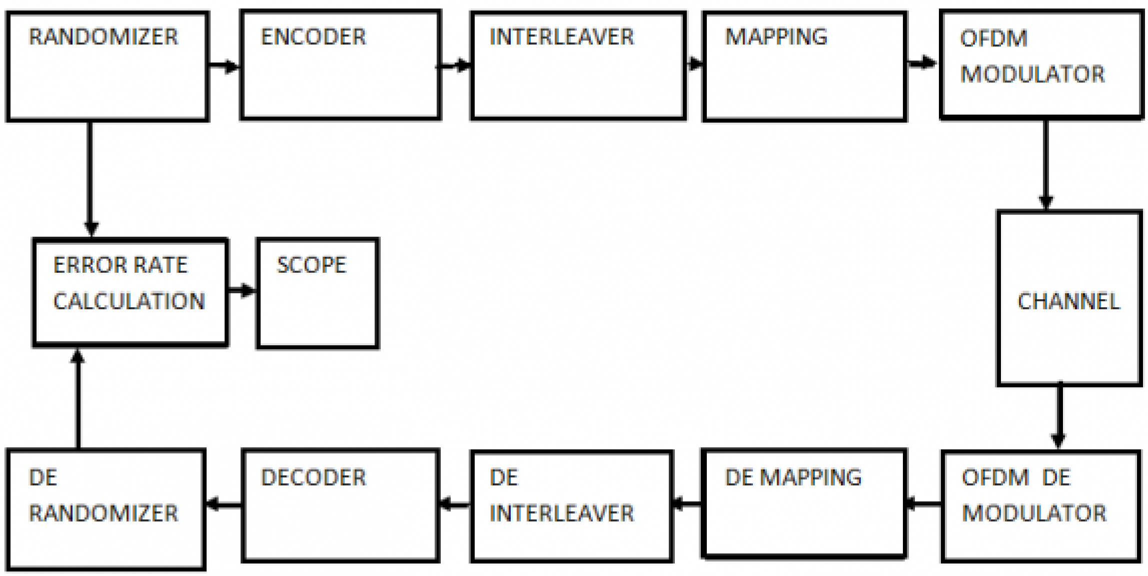

Figure 2:

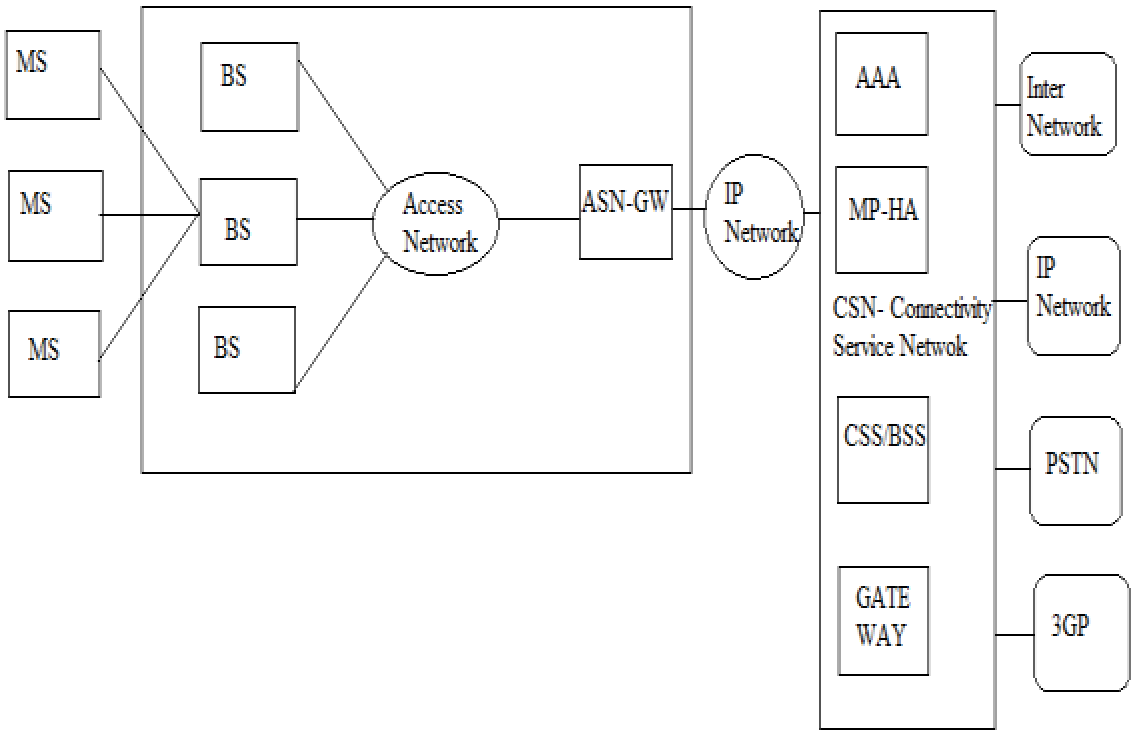

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Figure 3: Figure 2 :

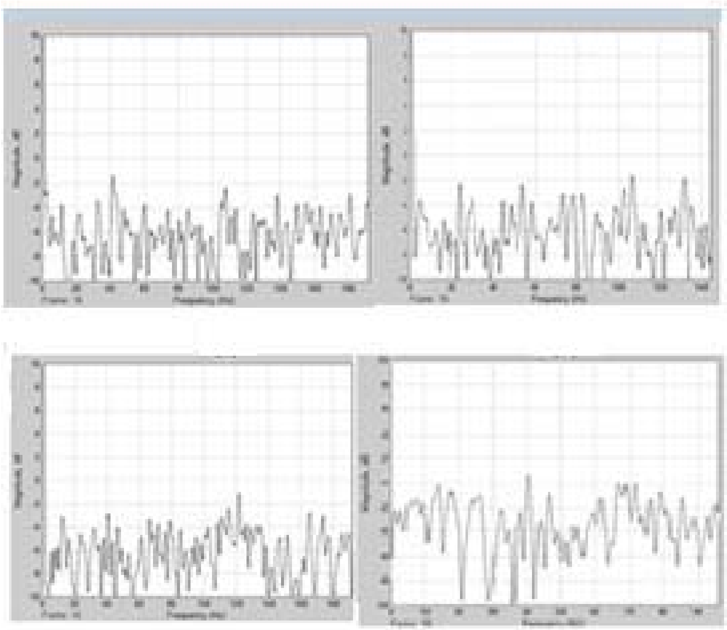

Figure 4:

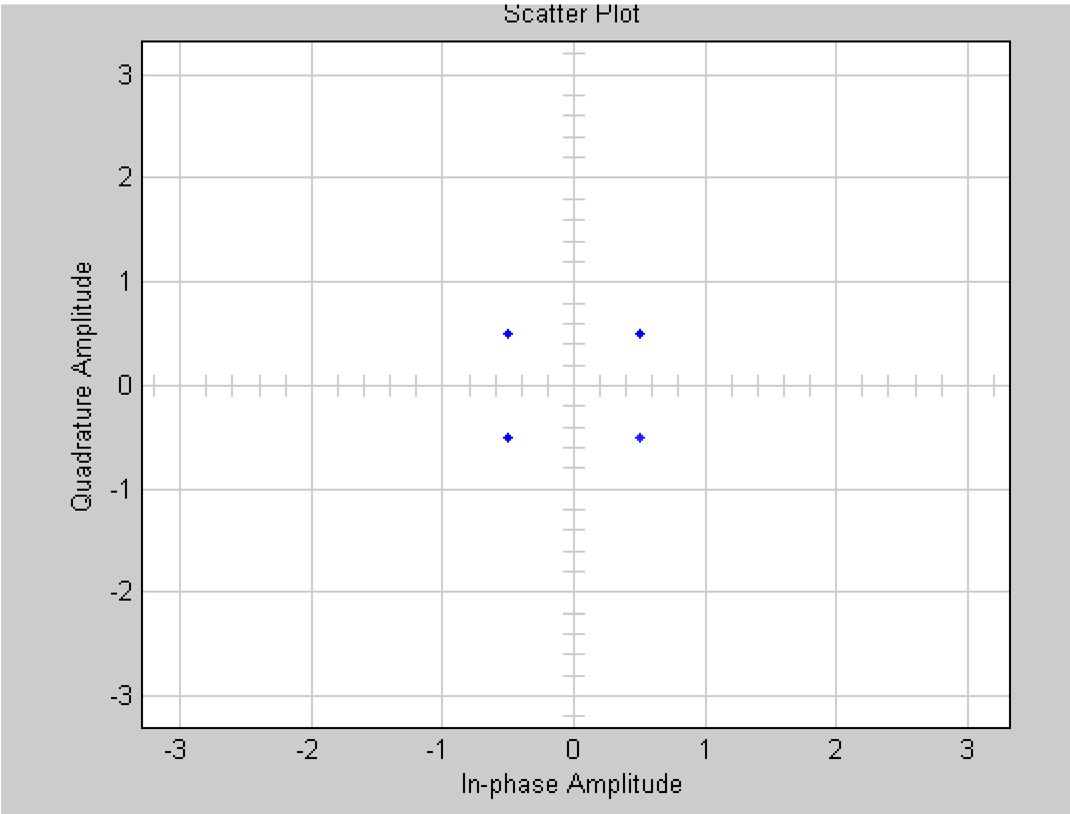

Figure 5:

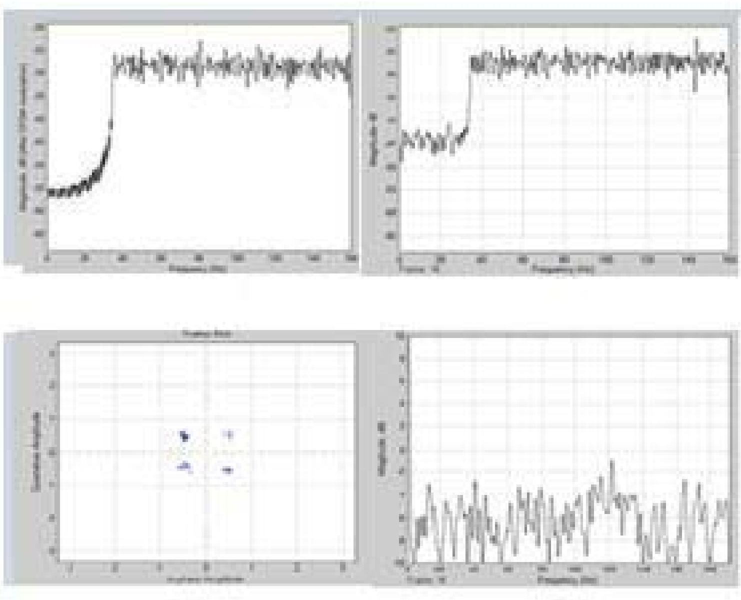

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Figure 6: Figure 3 :AFigure 4 :

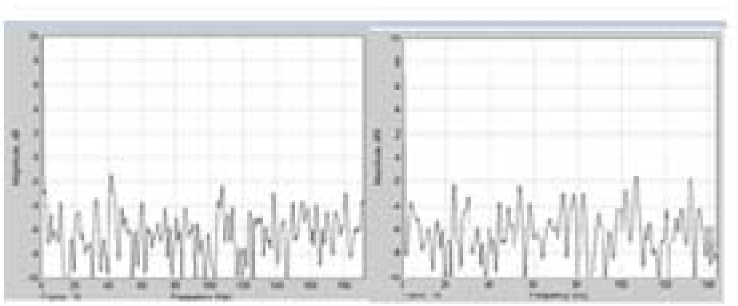

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Figure 7: Figure 5 :

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