Performance Analysis of Wimax with Different Modulation

G.P.G.Rasagna
B.Tech,
Dept of ECE,
Anurag Engineering College, Kodad.

D.Muthilingam
M.Tech,
Dept of ECE,
Anurag Engineering College, Kodad.

Abstract:

The advancements in broadband and mobile communication has given many privileges to the subscribers for instance high speed data connectivity, voice and video applications in economical rates with good quality of services. WiMAX is an eminent technology that provides broadband and IP connectivity on "lastmile" scenario. It offers both line of sight and non-line of sight wireless communication. Orthogonal frequency division multiple accesses is used by WiMAX on its physical layer. Orthogonal frequency division multiple access uses adaptive modulation technique on the physical layer of WiMAX and it uses the concept of cyclic prefix that adds additional bits at the transmitter end. The signal is transmitted through the channel and it is received at the receiver end. Then the receiver removes these additional bits in order to minimize the inter symbol interference, to improve the bit error rate and to reduce the power spectrum .In our research work,we investigated the physical layer performance on the basis of bit error rate, signal to noise ratio, power spectral density and error probability. These parameters are discussed in two different models. The first model is as simple OFDM communication model without the cyclic prefix, while the second model with CP.

INTRODUCTION TO WIMAX:

1.1 History of Broadband Communication:

Marconi presented the idea of wireless communication in 1895. Today it is used in satellite transmission, broadcasting of radio and television channels and cellular networks. There has been tremendous advancement in the transmission and reception of voice and data through wireless communication.

1.2 Generations of Mobile Phone:

Before 1977, wireless communication was only used in military applications and for research purposes in satellite communication. The evolution of Advanced Mobile Phone System (AMPS) was the starting and turning point in wireless communication by offering at way communication(i.e.Full Duplex Mode). It uses analog technology and also supports data streams up to 19.2Kbps. AMPS is an example of first generation of wire less phones.

| Generation	Standard	Multiple Access	Frequency Band	Throughput
2 G	GSM	TDMA/FDMA	890-960 (MHz) 1710-1880 (MHz)	9.6 Kbps
2.5 G	GPRS	TDMA/FDMA	890-960 (MHz) 1710-1880 (MHz)	171 Kbps
2.75 G	EDGE	TDMA/FDMA	890-960 (MHz) 1710-1880 (MHz)	384 Kbps
3G	UMTS	W-CDMA	1885-2025 (MHz) 2110-2200 (MHz)	2 Mbps

Table 1: Mobile Phone Generations

The 4th Generation of mobile phone system is under research with an objective of fully Internet Protocol (IP) based integrated system. The only difference with 3G is that it provides an IP based solution for data, voice and multimedia services to subscribers on the basis of two concepts i.e. "Anywhere" and "Anytime" .In this scenario, the users are always connected to the network with good and reliabled at a connectivity, where ever they go and what ever the time is. The generations that came after the 2.5th generation are also referred as the broad band generations because these generations have high data rates and provide multimedia services to their subscribers.

1.3 Broadband:

The term Broadband has no specific definition because every country has different characteristics of a

broadband connection but normally broad band is defined as the high speed, reliable and on-demand internet connectivity. Broadband access not only gives the access to download files more quickly and provides faster web surfing but also enables multimedia applications like real-time audio, video streaming, multimedia conferencing and interactive gaming. The broadband connection is also used as voice telephony by using the Voice over Internet Protocol (VoIP) technology. Different rganizations such as International Telecommunication Union(ITU) or other international regulators specified that if the downloading speed is in the range of 256Kbps to 2Mbps or higher then it fall in the category of Broadband connections. By considering these points they formed the formal definition as: "As an always – on the data connection side that is able to support various interactive services and that has the capability of a minimum download speed of 256 Kbps." In recent years, are markable growth in wireless and broadband technologies has been found and these technologies enjoyed rapid market adoption. The graph in Figure1 indicates the growth rate of the broadband and wireless technologies throughout the world in recent years.
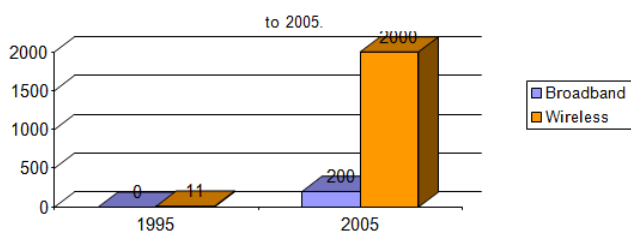
IncreaseintheNo.ofSubscribersinMillionfromyear1995 to2005.

Cable Mode:

Cable Modem is a type of modem that provides broadband connectivity to subscribers over cable television coaxial cables. It isused to deliver sound and pictures to the subscriber's TV set. Cable modem enables the users to connect their PC to a local cable TV line and enjoy transmission speeds of 1.5Mbps or more. Cable modem is an external device with two connections; one for the TV cable wall outlets while the other one is for the PC.

Optical Fiber:

Fiber or Optical Fiber uses either transparent glass or plastic or a combination of these two materials. It is a newer technology that permits transmission at much higher data rates as compared to other sources of communication along long distances. This technology converts the electrical signal that carries data to a light source and sends it through transparent glass fiber. The optical fiber cable diameter is the same as the diameter of the human hair. The optical fiber connection not only provides broad band connectivity but at the same time It also delivers voice and video services such as VoIP and Video on Demand. The optical fiber cable can be classified in to single mode fiber and multi mode fiber cables.The single mode fiber is used for transmission over longer distances, while the multimode fiber is used for shorter distances (up to 500 meter). The transmitting speed in optical fiber communication is much higher than current DSL and cable modem speed. It is typically in the range of tens or even hundreds of Mbps.

Broadband over Power line (BPL):

It is also called Power Digital Subscriber Line (PDSL) and uses Power Line Carrier (PLC) for sending and receiving radio signals over the existing electric power distribution network. The PLC modems can transmit data in medium and high frequencies,i.e.,in the range of 1.6MHz to 80MHz electrical carriers. The modem has a speed range of 256Kbps to 2.7 Mbps, whereas the use of repeaters speeds up the data rates to 45 Mbps. BPL is an emerging and an new technology and so far it has been deployed in very limited areas but it is an evolving technology because power distribution networks are installed everywhere and thus this is the only technique that perfectly provides broadband facilities to every customer.

Wireless Broadband Technologies:

The wireless broadband technologies are bringing the broadband experience closes to a wireless context to their subscribers by providing certain features,

convenience and unique benefits. These broadband services can be categorized into two types; Fixed Wireless Broadband and Mobile Broadband. The fixed wireless broadband provides services that are similar to the services offered by the fixed line broadband. But wireless medium isused for fixed wireless broadband and that is the only difference. The mobile broadband offers broadband services with an addition namely the concept of mobility and nomadicity. The term nomadicity can be defined as "Ability to establish the connection with the network from different locations via different base stations "while mobility is "the ability to keep on going connection sengaged and active while moving at vehicular speeds". Examples of wireless broadband technologies are Satellite communication, Wireless LAN and WiMAX.

Satellite Broadband:

Satellite Communication is also used to provide broadband services for those locations where fixed broadband infrastructure is not available and for those subscribers who live in remote areas. Thesedays satellite broadband services are used in ships and land vehicles. Satellite Broadband has two types which are as follows:

1. One Way Satellite Broadband
2. Two Way Satellite Broadband

Wireless LAN:

Wireless Local Area Network (WLAN) is a wireless technique that has replaced wired networks. It connects number of devices or computers through radio waves. WLAN gives more flexibility and provides mobility to subscribers with in a campus or workplace. WLAN not only gives mobility but it also ensures provides ease of installation, affordability and scalability as compared to the wired networks .The basic WLAN structure comprises an Access Point (AP) or transceivers placed on fixed locations which are connected to the wired network through ordinary LAN or Ethernet cables. The devices which have

wireless Network Interface Card (NIC) communicate with AP's for transmission and reception of data. There are two types of modes in WLAN; Infrastructure Mode and Ad-Hoc mode. Infrastructure mode is comprised on Aps connected with the wired network and these Aps are communicating with the devices that have Wireless NIC's. It is also referred as Basic Service Set (BSS). In Ad-Hoc mode, devices are communicating directly with each other and they are not using any wired network. It is also termed as Peer to Peer network or Independent Basic Service Set (IBSS). The Infrastructure and Ad-Hoc network sare shown in Figure2&3.
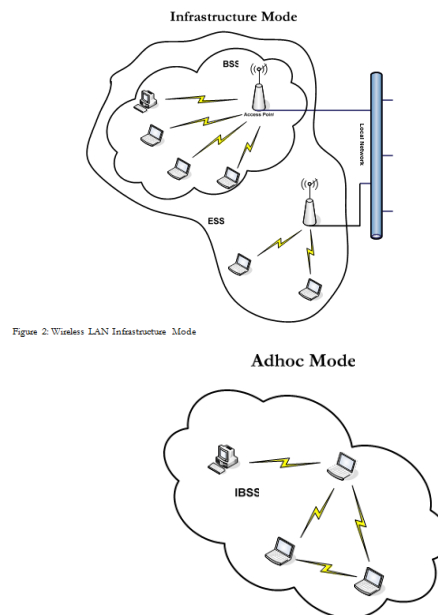

Figure 2: Wireless LAN Infrastructure Mode

Figure3: WirelessLAN AdhocMode

WiMAX is the abbreviation of Worldwide Inter operability for Microwave Access and is based on Wireless Metropolitan Area Networking (WMAN). The WMAN standard has been developed by the IEEE 802.16 group which is also adopted by European elecommunication Standard Institute (ETSI) in High Performance Radio Metropolitan Area Network, i.e., the Hiper MAN group. The main purpose of WiMAX is to provide broadband facilities by using wireless communication. WiMAX is also known as "Last Mile" broadband wireless access

technology. WiMAX gives analternate and better solution compared to cable, DSL and Wi-Fi technologies as depicted in Figure 4.
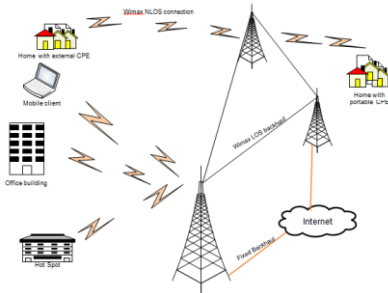

Figure4: WiMAXOverview

Evolution of WiMAX IEEE 802.16 Working Group:

In 1998, the IEEE 802.16 working group focused to develop WMAN solution for Line of Sight (LOS) based point to point and point to multi point wireless broadband systems. It was also decided that the frequency range for IEEE802.16 will be 10GHz to 66GHz. The first standard of WiMAX was completed in December 2001 which employs single carrier physical (PHY) layer with burst Time Division Multiplexed (TDM) on MAC layer.

WiMAXObjectives:

WiMAX has been standardized with different goals as depicted in Figure5.

Figure5: WiMAXObjectives

Inter operability:

Main objective of WiMAX is inter operability. Based on international standards, interoperability make it easier for users to move and use their subscriber module with different operators.

All operators can select equipment from different vendors because of the standardized adoption. Wide Coverage: WiMAX can adopt techniques that support several modulation levels, i.e., QPSK, 16 –QAM and 64 – QAM and thus WiMAX systems are capable of covering large area.

High Capacity:

WiMAX provides higher bandwidths as compared to Global System for Mobile communication (GSM) and Universal Mobile Telecommunication System (UMTS). It uses64-QAM modulation technique which gives channel bandwidth up to 10 MHz. WiMAX supports latest encryption standards like AES and Triple-DES. It encrypts the links between the base station and the subscriber module, ensuring users confidentiality, integrity, and authentication.

Flexible Architecture:

WiMAX supports several system architectures including:

• Point-to-Point
• Point-to-Multipoint
• Ubiquitous coverage

Quality of Service (QoS):

For ensuring QoS, WiMAX can be optimized for different types of traffic:

• VoIP
• Multimedia applications
• Data

Network ArchitectureofWiMAX:

The network architecture of WiMAX has been developed by a WiMAX Forum Network Group (WiMAX NWG) to ensure inter operability among different vendors and their equipments. The network architecture is based on the IP network service model and supports fixed, nomadicand mobile standards of WiMAX as shown in Figure6.

The network architecture of WiMAX is logically

divided among three parts:

- Mobile Stations (MS) is the device which is used by the subscribers to access the network.
- Access Service Network (ASN) consists of Base Stations (BS) or a group of base stations through ASN gate ways that connects with the core network.
- Connectivity Service Network (CSN) provides the IP connectivity and responsible for the entire core IP network functions.

Access Service Network:

The ASN comprises of BS and the Access Service Network gateways (ASN-GW), while the CSN consists of a number of network functions and provides IP connectivity to the mobile stations. The details of these entities are discussed below.

Mobile Stations (MS):

Devices used by the subscribers to use different services provided by the WiMAX operators. The subscriber unit is either a fixed terminal or a portable, mobile terminal.

Base Stations (BS):

The base station is responsible for providing the air interface to the subscriber units. It is also responsible for hand off decisions, Quality of Service (QoS) policies enforcements, DHCP proxy, session managements and radio resource management.

Access Service Network Gateway (ASN-GW):

Access Service Network Gateway (ASN-GW) acts as layer 2 traffic aggregation point and works within the Access Service Network (ASN). The ASN-GW is also responsible for intra-ASN location management and paging, radio resource management, admission control, encryption, security issues like AAA, mobility management, QOS and routing to CSN.

Connectivity Service Network (CSN):

The CSN comprises the Network Service Provider (NSP) that provides IP connectivity to ASN, Application Service Provider (ASP) which offers value added services like multimedia applications using IP Multimedia Subsystem (IMS), the Authentication Authorization and Accounting (AAA) servers for users, devices and specific services. CSN also contains the mobile IP home agent that carries the subscriber database. The other networks are interconnected with CSN through gateways (the other network may be PSTN or 3G GPetc). CSN is also responsible for IP address management, mobility and roaming betweendifferent CoreIPNetworknetwork service providers.
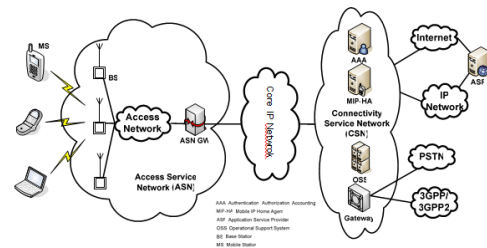

Figure6: WiMAXNetwork IPbasedArchitecture

Silent Features of WiMAX:

WiMAX is a wireless broadband technology that offes silent features and flexibility in terms of deployment and services as compared to other broadband technologies. Some silent features offered by WiMAX are:

OFDM-based Physical layer:

OFDM is a technique that isused by the PHY of WiMAX. This technique provides good resistance to multipath interference and offers WiMAX to operate in NLOS environment.

Extremely High Data Rate:

WiMAX can support extremely high data rates which can be high as 75Mbps. This extreme data rate can be achieved when the system is operating at 20MHz widespread spectrum. Also, 10MHz spectrum uses TDD scheme with downlink-to-uplink ratio of 3:1 means that at the PHY layer the data rate is 25 Mbps for Downlink and 6.7Mbps for uplink.

Scalable band width and data rate support:

The subscribers can get different data rates depending solely on how wide is the spread spectrum. Bandwidth is directly proportional to data rates and the channel bandwidth in WiMAX is scalable. We can vary the channel bandwidth and hence the data rates increases. The OFDM mode supports scalability by using the Fast Fourier Transform (FFT). WiMAX system uses 128,512 and 1048bits FFT for 1.25,5 and 10MHz's of channel bandwidths respectively. WiMAX supports numeral modulation and Forward Error Correction (FEC) coding schemes. Modulation schemes are continuously changing on the basis of channel conditions. Adaptive modulation and coding scheme is an effective mechanism to maximize the through put in a time varying channel. This algorithm calls different modulation and coding schemes on the basis of signal-to-noise and interference ratio at the receiver end in such a way that each user is provided with the highest possible data rate according to theirrespective links.

Link Layer Retransmission:

WiMAX supports the Automatic Repeat request (ARQ) algorithm at the link layer for reliability of the enhanced connection. Due to this, each transmitted packet must be acknowledged by the receiver and if any packet is lost and no acknowledgement is received then the packet is retransmitted.WiMAX optionally supports the hybrid-ARQ.

TDD and FDD Support:

WiMAX standards, IEEE802.16-2004 and IEEE802.16e-2005 use both Time Division Duplexing (TDD) and Frequency Division Duplexing (FDD). But in most of the cases TDD is used for implementation because it offers flexible ratios for uplink to downlink data,the ability to utilize channel reciprocity. TDD has less complicated transceiver design.

Orthogonal Frequency Division Multiple Accesses (OFDMA):

IEEE802.16e-2005 uses OFDMA as a multiple-access technique in which different subsets of the OFDM tones are allocated to different users. OFDMA improves the capacity of the system significantly by facilitating the exploitation of frequency diversity and multi user diversity.

User on Demand Resource Allocation:

Resource allocation for both uplink and downlink are controlled by a scheduler in the base station. Capacity is distributed among different users on demand basis while using a burst TDM scheme. In case, when OFDM-PHY mode used is then additionally multiplexing is done on basis of frequency dimension by allocating different subsets of OFDM sub carrier among different users. Resources are allocated not only in the spatial domain but also when using the advanced optimal antenna systems. The standard has a flexible mechanism to convey the resource allocation information on a frame-by-frame basis but it also allows for bandwidth resources to be allocated in time, frequency and space.

II. OFDMA SYSTEM MODEL:

LTE (Long Term Evolution) uses OFDMA and SC-FDMA at downstream and upstream for downlink and uplink transmission. The OFDMA system model is shown in Figure I. A brief description of the model is provided below. At first, S symbols/second data are transmitted to the transmitter and the data symbols are pass through a serial to parallel converter and the data rate on every X line is SIX symbols [3].The input data stream on each carrier is then mapped by using different types of modulation scheme such as QPSK, 16-QAM, 64QAM etc. Then Inverse fast Fourier Transform is used to find the corresponding Time wave form, which means that M symbols are sent to an Inverse Fast Fourier Transform that performs N-point IFFT operation. The output is N time sample [4]. The Guard interval is then introduced at the start of each sample which is known as addition of cyclic extension in the prefix. Then the length of the output sample is N+LP.

The cyclically extended symbols are passed through a parallel to serial converter and then transmitted through a channel [5]. A channel model is then applied to the transmitted signal. The model allows for the signal to noise ratio, channel to be controlled. The signal to noise ratio is set by adding a known amount of white noise to the transmitted signal which is known as A WGN Additive white Gaussian noise [lO].The Receiver basically does the reverse operation of the transmitter. The transmitted signals which pass through the channel are then converted by using Serial to parallel converter and cyclic extension is also removed. The signals pass through an N-point Fast Fourier Transform which converted time domain signal into frequency domain. Then the signal is de-mapped and performs parallel to serial conversion using Parallel to serial convert block and the resultant signal is a M sample output [3].
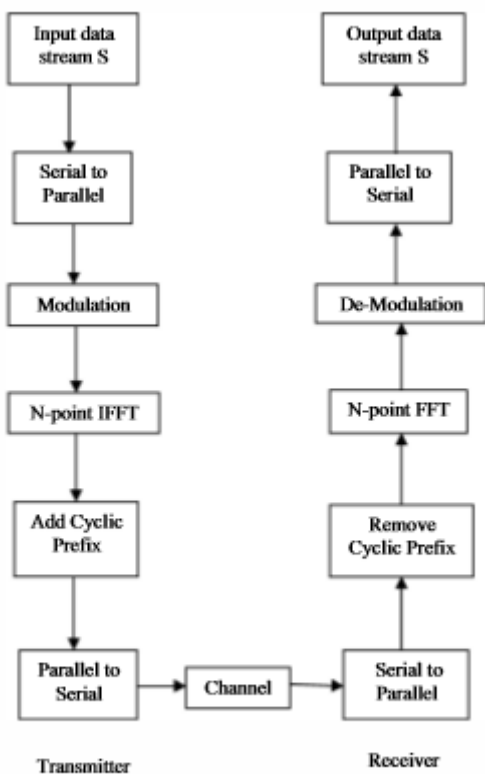

Figure 1: OFDMA System Model

SIMULATION DESION AND RESULTS:

In 30PP L TE design, BER performance with various subcarrier modulations under A WON and fading channels are simulated using a bandwidth of 10MHZ in A WGN channel and 3MHZ in fading channel. This design contains signal source, Noise, Receiver and BER performance. A QPSK and 16 QAM symbol constellation is considered.
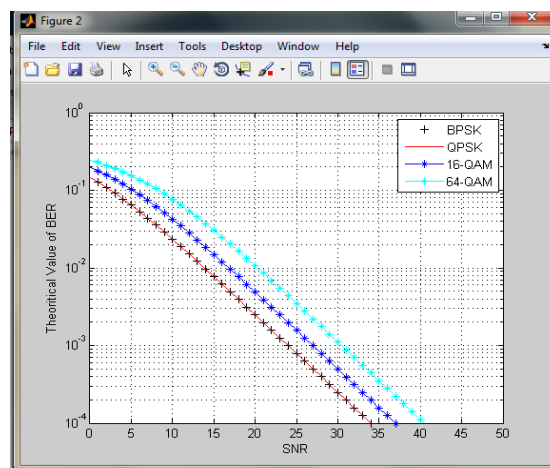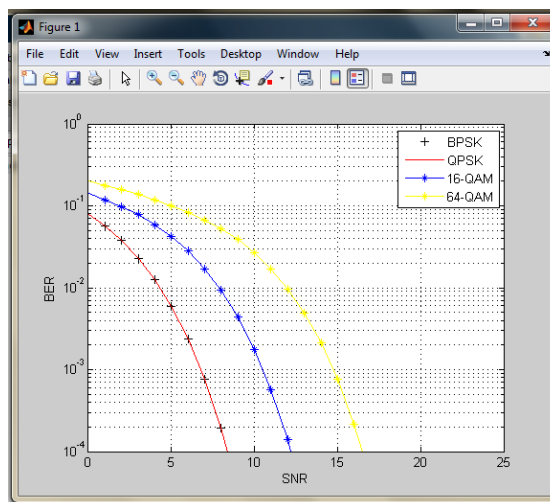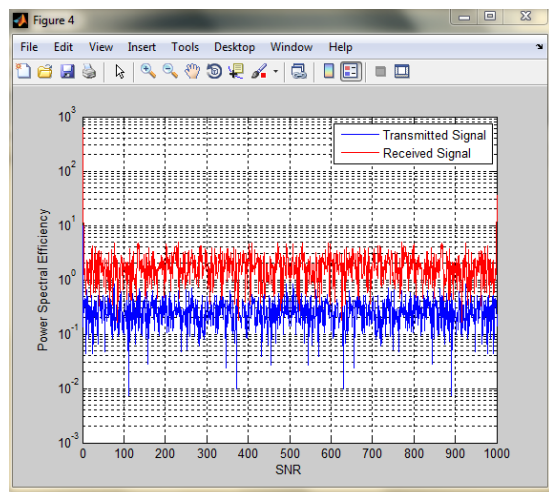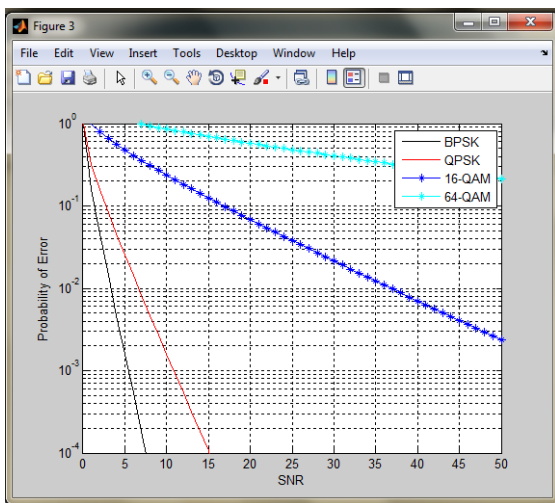
CONCLUSION:

In this paper, we compare the various subcarrier modulation of 3G LTE downlink of OFDMA. In A WGN channel, QPSK error rate is less has compared to 16QAM and 64QAM. 16 QAM has lower error rate has compared to 64 QAM in A WGN channel. From the graph for BER vs EblNo in a WG channel for higher order modulation schemes like 16QAM and 64QAM in terms of energy consumption remains the same as referred in table 6. From the graph, BER vs BblNo for A WGN channel performance as compared to fading channel.