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Study of Physical Layer in IEEE 802.16e Standards

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***Abstract*— Worldwide Interoperability for Microwave Access, known as WIMAX, is a wireless networking standard which aim at addressing interoperability across IEEE802.16 standard based products WIMAX defines a WMAN ,a kind of huge hotspot network that provide interoperable broadband wireless connectivity to fixed, portable and nomadic users. Mobile WIMAX or IEEE 802.16e is able to provide radio converge up to 50 kilometres and data rate up to 70 Mbps over broad range of frequency bands ensuring a flexible and cost effective solution for the last mile applications. The data throughput should achieve 20Mbps both for uplink and downlink.**

***Index Terms*- OFDM, OFDMA, WIMAX, IEEE, PHY, MAC, BS, MS, SS, ASN, CSN, CSNGW, QOS, AES, VoIP, SOFDMA.**

I. INTRODUCTION

As currently defined through IEEE Standard 802.16, a wireless MAN provides network access to buildings through exterior antennas communicating with central radio base stations. WirelessMAN technology bringing the network to a building, users inside the building will connect to it with conventional in-building networks such as, for data, Ethernet (IEEE Standard 802.3) or wireless LANs (IEEE Standard 802.11). IEEE Standard 802.16 was designed to evolve as a set of air interfaces based on a common MAC protocol but with physical layer specifications dependent on the spectrum of use and the associated regulations.[1] 802.16a and 802.16d for fixed users, 802.16e for mobile subscribers. 802.16a: The original version, released Jan. 2003.

 Three versions: SC, OFDM, OFDMA
 2-11 GHz spectrum range
 Focus on fixed broadband wireless

• 802.16d: The "current" version, released June 2004.

 Also known as 802.16-2004, very similar to 802.16a
 Various performance enhancement features in the uplink
 Provide support for indoor CPE

• 802.16e: The "new" version, released Any Day Now

 Based on OFDMA concept
 Supports Mobility
 Modest performance enhancements expected [2]

Our aim is to provide a single chip solution for 802.16e PHY baseband processing, based on general IT platform with multicore. Processing capability, cost and power consumption are three important factors for system design.[3]

IEEE Std 802.16 to allow for mobile as well as fixed (stationary) subscriber stations.[4]

The MAC is structured to support multiple physical layer(PHY) specifications, each suited to a particular operational environment. For operational frequencies from 10-66 GHz, the wirelessMAN-SC PHY, based on single-carrier modulation, is specified. For frequencies below 11 GHz, where propagation without a direct line of sight must be accommodated, three alternatives are provided: wirelessMAN-OFDM, wirelessMAN-OFDMA and wirelessMAN-SCa.[5]

II. WIMAX NETWORK ARCHITECTURE

WiMAX architecture comprises of several components but the basic two components are BS and SS. Other components are MS, ASN, CSN and CSNGW. 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 Base Station (BS) 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.

•*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.

•*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.

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.

WiMAX comprises of two main parts:

1.WiMAX base station

2.WiMAX receiver

1.*Wimax Base Station*

It is often called WiMAX tower or booster. The base station broadcasts radio frequencies to the receiver end.

•*Responsible for*: Providing air interface to the MS and it performs in MAC and PHY.

•*Additional functions*: Frequency reuse, handoff, tunnel establishment, QoS & classification of traffic etc.

•*Management*: Session management, bandwidth management for uplink and downlink and multicast group management etc.

•*Practical Face*: Tower in outdoor environment and electronic equipment in indoor environment.

2.WiMAX

•*Receiver :* WiMAX receiver receives the radio frequency from the WiMAX base station and makes sure the connectivity of WiMAX network is in range.

• *Responsible for:* Providing connectivity between subscriber equipment (such as mobile phone or laptop) and a WiMAX base station.

•*Additional function:* Packet priority, network interoperability and QoS.

•*Connection:* Backhaul, high speed microwave link which is also referred to a connection between core network and WiMAX system.

•*Provides User*: VoIP, multimedia and Internet access and many mobile applications.

•*Practical face:* Customer Premises Equipment (CPE) for indoor and outdoor purposes.[6]

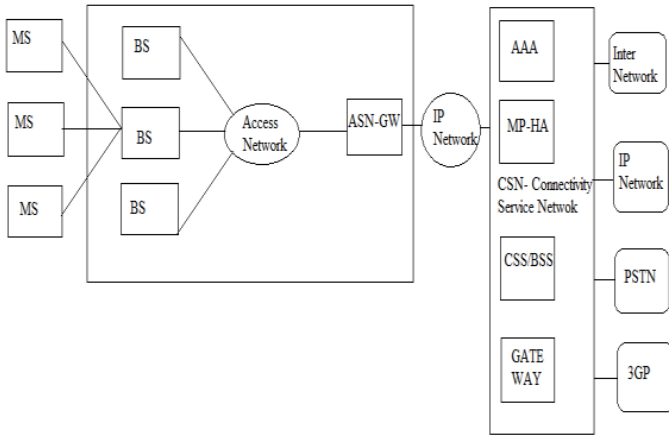

Figure 1:-WiMAX Network Architecture

III. FEATURES OF WIMAX

WiMAX has a set of salient features: (i) OFDM based physical layer: WiMAX is based on orthogonal frequency division multiplexing that offers multipath resistance and allow NLoS communication; (ii) High data rate: WiMAX can support very high peak data rate which is as high as 74 mbps; (iii) Quality of service (QoS): WiMAX MAC layer is responsible for QoS. WiMAX MAC layer support real time, non real time and best effort data traffic and its high data rate, sub channelization, and flexible scheduling improve the QoS; (iv) Flexible architecture: WiMAX architecture is very flexible. It can support point to point and point to multipoint connection according to its requirements. It also supports IP-based architecture that is easily converge with other networks and takes advantage of application development from the existing IP based application; (v) Mobility support: WiMAX offer optimized handover which support full mobility application such as voice over internet protocol (VoIP). It has also the power saving mechanism which increases the battery life of handheld devices; (vi) Scalability: WiMAX offer scalable network architecture that support user roaming indifferent networks. It also enhances the broadband access capability, and (vii) Strong Security: WiMAX support extensible security feature for reliable data exchange. It use Advanced Encryption Standard (AES) encryption for secure transmission and for data integrity, it use data authentication mechanism [10]

WIMAX 802.16/D/E AND RELATED STANDARDS

TABLE 1 : WIMAX STANDARDS

Parameters	**802.16**	**802.16d/HiperMAN**	**802.16e**
Completed	December 2001	Jan- 2004	2005
Spectrum	10-66 GHz	<11 GHz	<6GHz
Channel Conditions	Line-of-sight service	Nonline-of-sight Service	Nonline-of-sight Service
Bit Rate	32-134 Mbps in 28MHz channel bandwidth	Up to 75 Mbps in 20MHz channel bandwidth	Up to 15 Mbps in 20MHz channel bandwidth
Modulation	QPSK, 16QAM and 64	OFDM256FFT, QPSK, 16QAM and 64 QAM	Scalable OFDMA, QPSK,

	QAM		16QAM and 64QAM
Mobility	Fixed	Fixed	Nomadic/mobile
Bandwidths	20, 25 and 28 MHz	1.75-20MHz	1.75-20 MHz

ADVANTAGESOF 802.16e

Mobile WiMAXphysical layer is based on Scalable OFDMA technology.

The new technologies employed for Mobile WiMAXresult in lower equipment complexity and simpler mobility management due to the all-IP core network and provide Mobile WiMAXsystems with many other advantages over CDMA-based 3G systems

Tolerance to Multipathand Self-Interference

Scalable Channel Bandwidth

Orthogonal Uplink Multiple Access

Support for Spectrally-Efficient TDD

Frequency-Selective Scheduling

Fractional Frequency Reuse

Fine Quality of Service (QoS)

Advanced Antenna Technology

PHYSICAL LAYER DESCRIPTION

The Mobile WiMAXAir Interface adopts Orthogonal Frequency Division Multiple Access (OFDMA) for improved multi-path performance in non-line-of-sight environments.

Scalable OFDMA (SOFDMA) is introduced in the IEEE 802.16e Amendment to support scalable channel bandwidths from 1.25 to 20 MHz.

The scalability is supported by adjusting the FFT size while fixing the sub-carrier frequency spacing at 10.94 kHz.

Since the resource unit sub-carrier bandwidth and symbol duration is fixed, the impact to higher layers is minimal when scaling the bandwidth.

802.16e systems offer scalability in both radio access technology and network architecture, thus providing a great deal of flexibility in network deployment options and service offerings.

802.16e supports TDD and Full and Half-Duplex FDD operation.[7]

COMPARE IEEE802.11 AND IEEE802.16

TABLE 2 : Comparison between IEEE 802.11 and IEEE 802.16[8]

	802.11 (Wi-Fi)	802.16 (WiMAX)
Primary Application	Wireless LAN	Wireless MAN mainly designed for broadband wireless
Range and Coverage	Mainly designed for indoor Optimized for 100 meters No mesh topology is supported	Designed for outdoor NLOS performance Optimized for 50 km Mesh topology is supported
Scalability	MAC designed to support tens of user	MAC designed to support thousands of users
Frequency Band	Unlicensed Band 2.4 GHz to 5 GHz	Licensed and Unlicensed Band 2 GHz to 11 GHz
Channel Bandwidth	On the range from 20-25 MHz	Adjustable range from 1.25 to 20 MHz
Bandwidth Efficiency	0.44 to 2.7 bps/Hz	<=5 bps/Hz
Radio Technique	OFDM 64 channels and Direct Sequence Spread Spectrum	OFDM 256 Channels
Security	Security is optional here. Better encryption technique like WPA and WEP available now	3 DES (128 bit)
Mobility	In Development phase now	Mobile WiMAX build in to 802.16e
QoS	Contention Based MAC (CSMA/CA) QoS is proposed in IEEE 802.11e	Grant Request MAC Mainly designed to support voice and video

WiMAX Model for Physical Layer (802.16)

An Inverse Fast Fourier transform converts the input data stream from frequency domain to time domain representing OFDM Subcarrier as the channel is basically in time domain. IFFT is useful for OFDM system as it generates samples of a waveform with frequency components satisfying the orthogonality condition such that no interference occurs in the subcarriers.

Similarly FFT converts the time domain to frequency domain as basically we have to work in frequency domain. By calculating the outputs simultaneously and taking advantage of the cyclic properties of the multipliers FFT techniques reduce the number of computations to the order of $N \log N$. The FFT is most efficient when N is a power of two.[9]

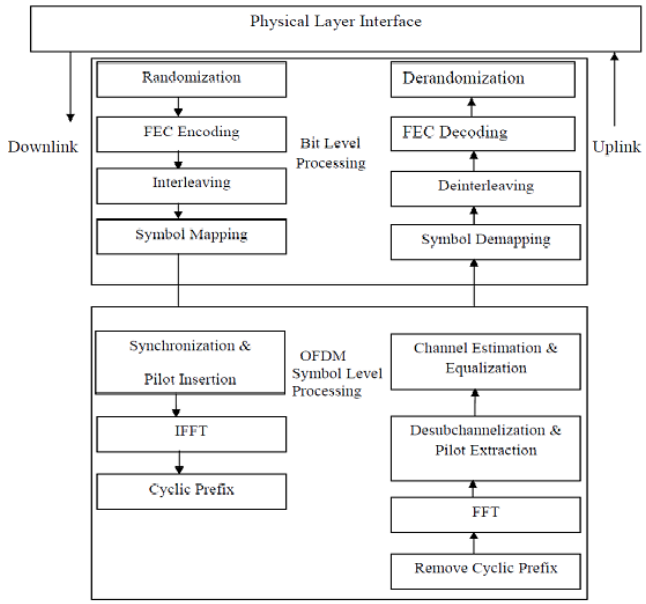

Fig. 2. WiMAX Model for Physical Layer (802.16)

IV. CONCLUSION

The major contribution of this work is the study of the IEEE 802.16e OFDM PHY layer system model using MATLAB in order to evaluate the PHY layer performance. The system model has been developed to obtain numerical results.

REFERENCES

[1] C.Eklund," IEEE Standard 802.16: A Technical Overview of the WirelessMAN™ Air Interface for Broadband Wireless Access", IEEE commun. Mag,PP.98-107,june 2002

[2] Ghosh,A.;Wolter,D.R; Andrew S,J.G; Chen,R," Wireless Broadband with 802.16/WiMax: Current Performance and Future Potential"communication magazine ,IEEE, Vol. 43, Issue 2,Feb 2005,pp.129-136

[3] Da Fan.Q.Wang,Y.Lin and Z.Zhu, "Design Of Bs Transceiver For Ieee 802.16e Ofdma Mode" , IEEE,ICASSP 2008,pp.1513-1516

[4] IEEE Std 802.16e-2005 "Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands", Feb 2006

[5] IEEE Std 802.16-2004 "Air Interface for Fixed Broadband Wireless Access Systems",Oct 2004

[6] Ruby Verma & Pankaj Garg "Interpretation of IEEE 802.16e (Wimax)", Volume 13 Issue 10 Version 1.0 , 2013

[7] Mikko and Petri Järvelä," 802.16e Mobile WiMAX",2006

[8] A.F.M Sultanul Kabir,Md.Razib Hayat Khan," WiMAX or Wi-Fi: The Best Suited Candidate
Technology for Building Wireless Access Infrastructure

[9] Pavani Sanghoi and Lavish Kansal , "Analysis of WiMAX Physical Layer Using Spatial Multiplexing",2012

[10] M.A. Mohamed, F.W. Zaki, R.H. Mosbeh "Simulation of WiMAX Physical Layer: IEEE 802.16e" VOL.10 No.11, November 2010