Qos Analysis using Different FFT Size for Wimax Network

Anurag Sharma
Department of Electronics & Communication Engineering, Sobhasaria Group of Institutions, Sikar, Rajasthan

Rakesh Kumar
Department of Electronics & Communication Engineering, Sobhasaria Group of Institutions, Sikar, Rajasthan

Anita Garhwal
Amity School of Engineering & Technology, Amity University, Rajasthan, India

ABSTRACT
Worldwide interoperability for Microwave Access (WiMAX) standard is based on the IEEE 802.16-2005. It provides wireless broadband for fixed and mobile terminals. The demand for broadband wireless services is increasing day by day. In this paper performance analysis of physical layer of WiMAX system are evaluated by using different modulation techniques like QPSK ½, 16 QAM ½ and 64 QAM. By using different modulation techniques we compare the results of downlink BER, downlink SNR and uplink SNR on the behalf of different FFT size like 128, 512, 1024 and 2048. In this paper we considered the effects of varying the FFT size were observed on the downlink BER, downlink SNR and uplink SNR.

Keywords
WiMAX, OFDM, OPNET, BER, FFT, QOS

1. INTRODUCTION
Wimax stands for Worldwide Interoperability for Microwave Access formed by WiMAX forum in 2001. It provides wireless broadband to fixed and mobile terminals in a large geographical area. The 2005 version of WiMAX provides data rate up to 40Mbits/s and 2011 version can support data rate up to 1 Gbit/s for fixed stations [1]. WiMAX system uses OFDM in the physical layer. OFDM is based on the adaptive modulation technique in non-line-of-sight (NLOS) environments. Base stations of WiMAX can provide communication without the need of line-of-sight (LOS) connection. WiMAX base station has enough available bandwidth so at a time it can serve number of subscribers and also cover large area range. WiMAX standard have two versions: IEEE 802.16-2004 and IEEE 802.16d. It supports Orthogonal Frequency Division Multiplexing (OFDM) in physical layer. It provides wireless DSL technology where broadband cables are not available. WiMAX standard 802.16e uses (Orthogonal Frequency Division Multiple Access) OFDMA technique. It provides support for nomadic and mobility services so it also known as mobile WiMAX [2].

This WiMAX is a wireless broadband technology it has several improvement then Wi-Fi and UMTS (Universal Mobile Telecommunication Services) / HSDPA (High Speed Downlink Packet Acess). Wi-Fi (Wireless Fidelity) provides wireless high speed internet and network connections [3]. UMTS is based on 3G GSM standard. HSDPA is an enhanced 3G (Third Generation) communication protocol that supports high data transfer speed and capacity [4], [5].

WiMAX is based on Wireless Metropolitan Area Network (WMAN). IEEE 802.16 group developed WMAN and it is adopted by ETSI (European Telecommunication Standard Institute) in HiperMAN group i.e. High Performance Radio Metropolitan Area Network [2]. Although the work on IEEE standard started in 1999, it was only during 2003 that the standard received wide attention when the IEEE 802.16a standard was ratified in January.WiMAX can be classified into Fixed WiMAX [6] and Mobile WiMAX. Fixed WiMAX is based upon Line Of Sight (LOS) condition in the frequency range of 10-66GHz whereas Mobile WiMAX is based upon Non-Line of Sight (NLOS) condition that works in 2-11 GHz frequency range [7]. For 802.16e standard, MAC layer & PHY layer has been defined, but in this paper, emphasis is given only on the PHY layer. PHY layer for mobile WiMAX which is IEEE-802.16e standard [8] has scalable FFT size i.e. 128-2048 point FFT with OFDMA, Range varies from 1.6 to 5 Km at 5Mbps in 5MHz channel BW, supporting 100Km/hr speed.

Multi-Input Multi-Output (MIMO) technology has also been renowned as an important technique for achieving an increase in the overall capacity of wireless communication systems. In this multiple antennas are employed at the transmitter side as well as the receiver side [8]. One can achieve spatial multiplexing gain in MIMO systems realized by transmitting independent information from the individual antennas, and interference reduction. The enormous values of the spatial multiplexing or capacity gain achieved by MIMO spatial multiplexing technique had a major impact on the introduction of MIMO technology in wireless communication systems [9]. This paper is organized as follows. Simulation model of network using OPNET modeler is given in section II. Section III gives the simulation results. Conclusion is given in section IV.

2. SIMULATION MODEL
The Network consists of three WiMAX cell i.e. single BS (base station) and three SS (subscriber station) per cell. The parameters of SS and BS are given in Table I and Table II. Each BS is connected to the IP backbone. The channel was configured to vary according to ITU Pedestrian a multipath fading model. For traffic configuration, all SS nodes had an uplink application load of 20 Kbps for a total of 0.4 Mbps. All SS nodes were configured to use QPSK, 16 QAM and 64 QAM for both uplink and downlink applications to measure the characteristics. The cell used an SOFDMA frame with 512 subcarriers and frame duration of 5 milliseconds. Simulation time is taken as 400 seconds. We have used OPNET modeler 14.5 for simulation [10]. We have analyzed firstly delay, load and throughput of the network. Then performance of physical layer on the basis of uplink and downlink‘s BER and SNR is evaluated [11].

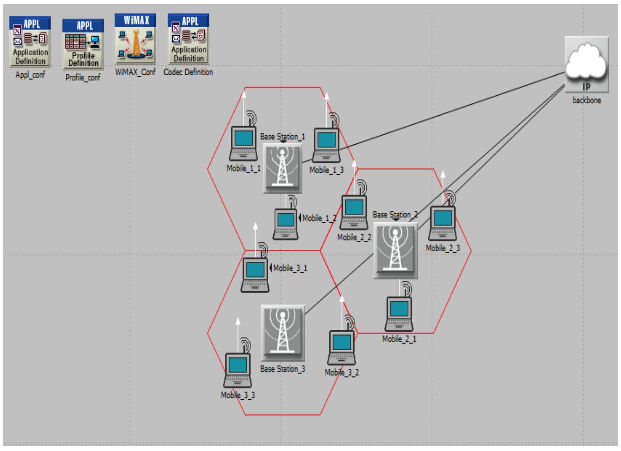

Figure 1. Network Model of WiMEX

Following are the necessary steps for WiMAX network to simulate over OPNET modeler.

- Create the initial technology
- Create the wireless development scenario
- Add traffic to wireless network mod
- Configure BS, SS and WiMAX parameters.
- Running and analyzing simulation results

Table: 1. Subscribe Station Parameters

Antenna Gain (dBi)	-1 dBi
Max Power Transfer (W)	0.5
PHY Profile	Wireless OFDMA 20 MHz
PHY Profile Type	OFDM
Modulation and coding	QPSK, QAM 16, QAM 64
Pathloss Model	Free Space
Buffer Size	64 KB
Terrain Type	Terrain Type A

•

Table: 2. Base Station Parameters

Antenna Gain (dBi)	15 dBi
Maximum Number of SS nodes	100
Maximum Power density (dBm/subchannel)	-110
Ranging Backoff Start	2
Ranging Backoff End	4
PHY Profile	Wireless OFDM 20MHz
PHY Profile Type	OFDM
Antenna Gain (dBi)	15 dBi
Maximum Number of SS nodes	100
Maximum Power density (dBm/subchannel)	-110
Ranging Backoff Start	2
Ranging Backoff End	4
PHY Profile	Wireless OFDM 20MHz
PHY Profile Type	OFDM

Application profile used audio application and video applications. WiMAX configuration attributes are shown in figure 3. [10].

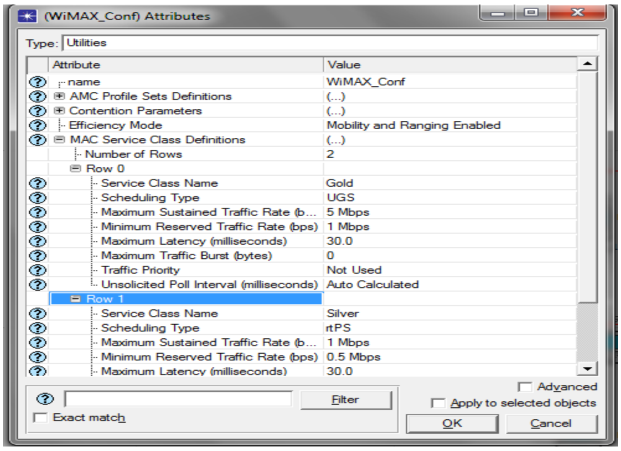

Fig: 2. WiMAX Configuration Attributes

IEEE 802.16 standard supports UGS, rtPS, nrtPS and BE (best effort) services [10].

UGS (Unsolicited Grant Service)

It supports VoIP (Voice over Internet Protocol) and streaming applications. When this service is used then wastage of bandwidth during the off period of voice calls.

rtPS (Real-Time Polling Service)

When rtPS service is used, in every polling interval, BS polls a mobile and the polled mobile transmits Bw-request (bandwidth request) if it has data to transmit. The BS grants the data burst using UL-MAP-IE upon its reception.

3. SIMULATION RESULTS

After configuring all the BS, SS and WiMAX profile, application attributes. Then individual DES statistics for SS and BS are defined like downlink BER, uplink BER and uplink SNR (dB). Then network model is simulated.

All the figures abovefrom 3 to 11 are showing the results of downlink bler, downlink snr and uplink snr for different FFT size like 128, 512, 1024 and 2048 bytes using different modulation techniques.

3.1 Case –I when modulation technique is QPSK ½

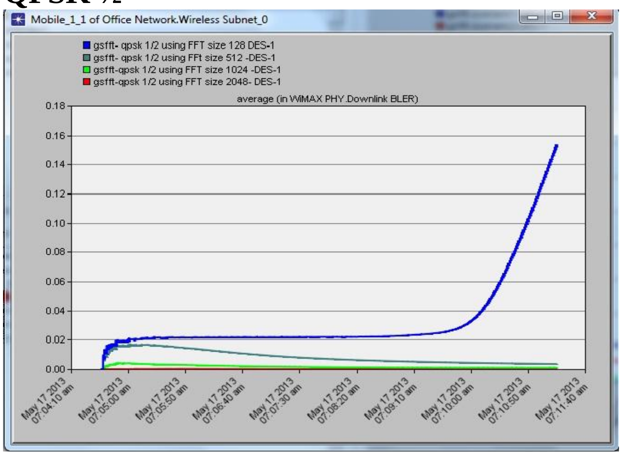

Fig: 3. Comparison of WiMAX PHY downlink BLER

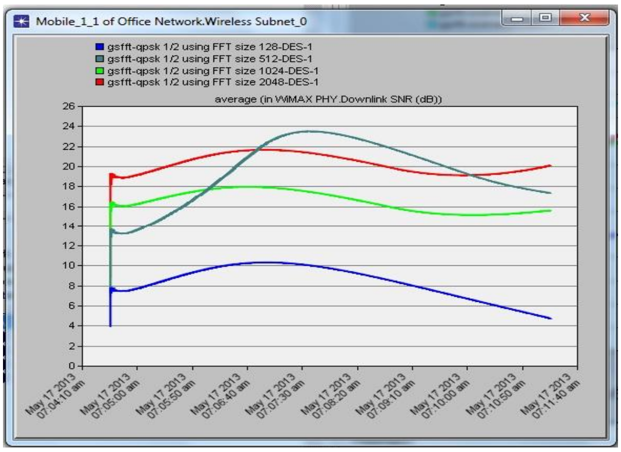

Fig: 4. Comparison of WiMAX PHY downlink SNR (dB)

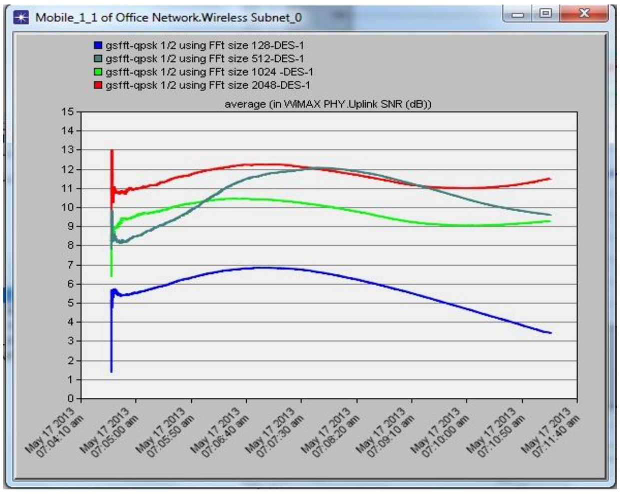

Fig: 5. Comparison of WiMAX PHY uplink SNR (dB)

Figure 3 shows the downlink BER for modulation technique QPSK ½. It is clear from the figure that when FFT size is 128 then it have highest value around 0.15. Comparison for downlink SNR (dB) is shown in figure 4. Here for 128 FFT size it has lowest value. Figure 5 shows the uplink SNR value. When FFT size is 2048 bytes then it achieves highest value of 13 dB.

Table: 3. QPSK ½ Comparison on different FFT size

	FFT SIZE 128	FFT SIZE 512	FFT SIZE1024	FFT SIZE 2048
Downlink BER	0.15	0.015	0.005	0.0
Downlink SNR	10.5	23	18	22
Uplink SNR	7	12	10.5	13

3.2 Case –II when modulation technique is 16QAM 1/2

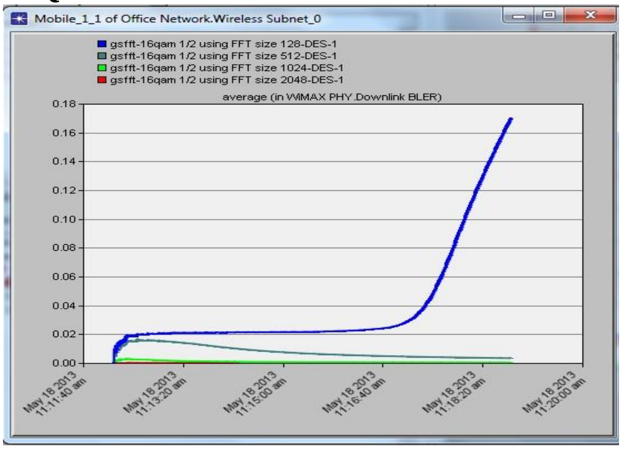

Fig: 6. Comparison of WiMAX PHY downlink BLER

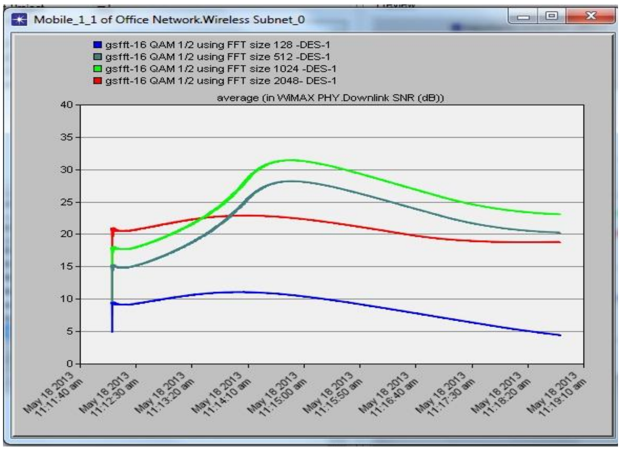

Fig: 7. Comparison of WiMAX PHY downlink SNR (dB)

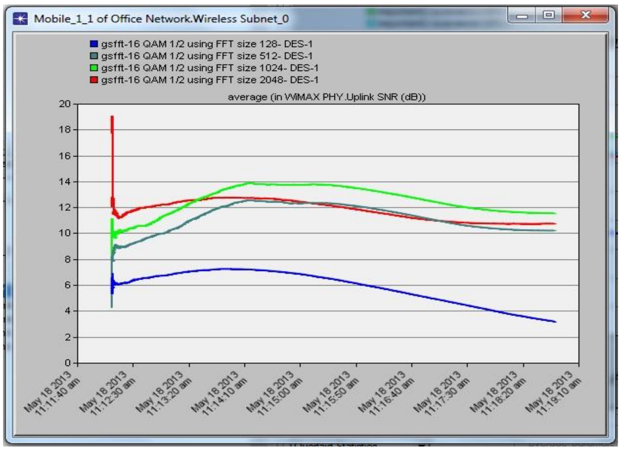

Fig: 8. Comparison of WiMAX PHY uplink SNR (dB)

Table: 4. 16 QAM ½ Comparison on different FFT size

	FFT SIZE 128	FFT SIZE 512	FFT SIZE1024	FFT SIZE 2048
Downlink BER	0.15	0.015	0.04	0.0
Downlink SNR	11	28	32	23
Uplink SNR	7	12.5	14	13

3.3 Case III- when modulation technique is 64 QAM

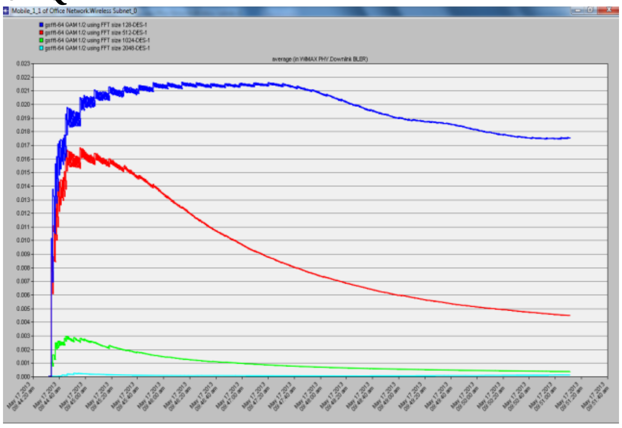

Fig: 9. Comparison of WiMAX PHY downlink SNR (dB)

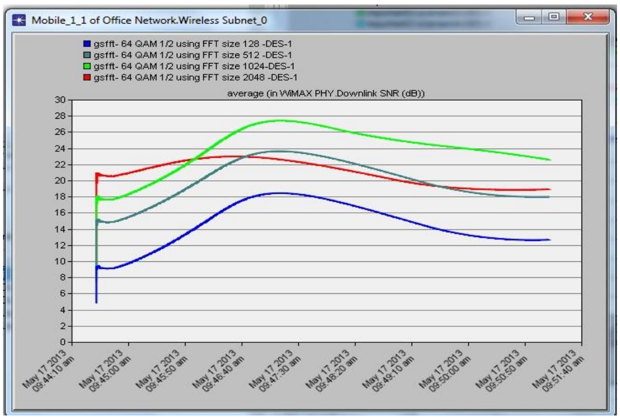

Fig: 10. Comparison of WiMAX PHY downlink SNR (dB)

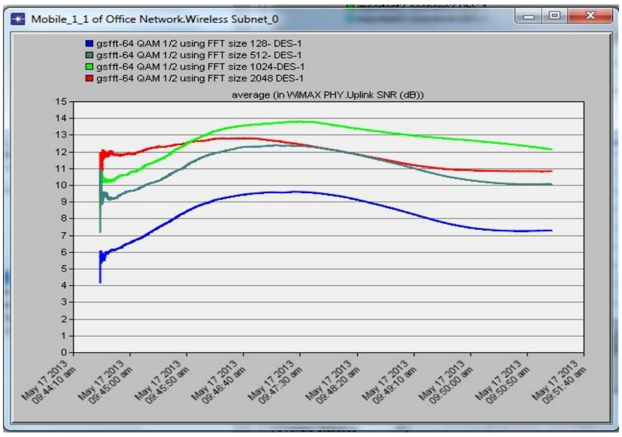

Fig: 11. Comparison of WiMAX PHY uplink SNR (dB)

Table: 5. 64 QAM Comparison on different FFT size.

	FFT SIZE 128	FFT SIZE 512	FFT SIZE1024	FFT SIZE 2048
Downlink BER	0.0215	0.017	0.003	0.00025
Downlink SNR	18.5	24	27.5	23
Uplink SNR	9.5	12.5	14	13

4. CONCLUSION

In this paper performance analysis of physical layer of WiMAX system using OPNET modeler 14.5 is done. Firstly, performance of physical layer of WiMAX system is evaluated on the basis of uplink SNR, downlink BER and downlink SNR for adaptive modulation techniques like QPSK ½, 16 QAM ½ and 64 QAM using different FFT sizes like 128, 512, 1024 and 2048 bytes.

In modulation technique QPSK ½ the downlink BER is maximum at FFT size 128 and minimum at FFT size 2048, downlink SNR is maximum at FFT size 512 and minimum at FFT size 128, the uplink SNR is maximum at FFT size 2048 and minimum at FFT size 128.

In modulation technique 16 QAM ½ the downlink BER is maximum at FFT size 128 and minimum at FFT size 2048, downlink SNR is maximum at FFT size 512 and minimum at FFT size 128, the uplink SNR is maximum at FFT size 2048 and minimum at FFT size 128.

Finally In modulation technique 64 QAM the downlink BER is maximum at FFT size 128 and minimum at FFT size 2048, downlink SNR is maximum at FFT size 1024 and minimum at FFT size 128, the uplink SNR is maximum at FFT size 1024 and minimum at FFT size 128.

5. REFERENCES

[1] Mai Tran, George Zaggoulos, Andrew Nix and Angela Doufexi,"Mobile WiMAX: Performance Analysis And Comparison with Experimental Results", in proceeding *68th IEEE Vehicular Technology Conference*, 21-24 September, 2008.

[2] Jeffery G. Andrews, Arunabha Ghosh, RiasMuhamed, "Fundamentals of WiMAX: Understanding Broadband Wireless Networking", *Prentice Hall*, 2007.

[3] Theodore S. Rappaport, "Wireless Communications: Principles & Practice", 2nd ed., *Prentice Hall*, 2001.

[4] Kobayashi, H. Fukuhara, Hao Yuan, Takeuchi Y," Proposal of single carrier OFDM technique with adaptive modulation technique", in proc. *IEEE conference on Vehicular technology*, 2003.

[5] J.El-Naijar, B.Jaumard, C.Assi, "Minimizing Inter-ference in WiMAX/802.16 basded networks with Centralized scheduling", in proc. *Global Telecommunications Conference*, pp 1-6,2008.

[6] IEEE standard 802.16-2005, IEEE standard for Local and Metropolitan Area Networks-Part16: Air Interface for Fixed and Mobile Broadband wireless Access system, Feb 2006.

[7] IEEE 802.16 WG,"IEEE Standard for Local and Metropolitan Area Network Part 16: Air Interface for Fixed Broadband Wireless Access Systems", *IEEE std.* 802.16-2004 p.851 - p.857.

[8] IEEE 802.16WG,"IEEE standard for local and metropolitan area networks part 16: Air interface for fixed and mobile broadband wireless access systems, Amendment 2", *IEEE 802.16 Standard*, December 2005.

[9] Anurag Sharma, Anita Garhwal, "Performnce Analysis of Physical Layer of WiMAX System using Simulink", *International Journal of Computer and Electronics Research (IJCER)*, volume2, issue2, April 2013.

[10] Rakesh Kumar Jha, Idris Z. Bholebawa, Upena D. Dalal , "Location Based Performance of WiMAX Network for QoS with Optimal Base Stations (BS)" , *Wireless Engineering and Technology*, volume 2, 135-145,2011.

[11] NarendraBagoria, Anita Garhwal, Anurag Sharma, "Simulation of Physical layer of WiMAX Network using OPNET Modeller", *International Journal of P2P Network Trends and Technology (IJPTT)*, volume 2, Issue 3, May-June 2013.

[12] Vinit Grewal, Ajay K Sharma, "On Performance Evaluation of Different QoS Mechanisms and AMC Scheme for an IEEE 802.16 based WiMAX Network", *International Journal of Computer Applications(0975-8887)*, Volume 6-No. 7, pp. 12-17, September 2010.