A SIMULATION STUDY ON AMPLIFIED WiMAX AND WiFi SIGNAL OF TIKRIT UNIVERSITY

IHAB AHMED NAJM

UNIVERSITY UTARA MALAYSIA

2012

KOLEJ SASTERA DAN SAINS
(College of Arts and Sciences)
Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK
(Certificate of Project Paper)

Saya, yang bertandatangan, memperakukan bahawa
(I, the undersigned, certifies that)

IHAB AHMED NAJM
(808196)

calon untuk Ijazah
(candidate for the degree of) **MSc. (Information Technology)**

telah mengemukakan kertas projek yang bertajuk
(has presented his/her project of the following title)

A SIMULATION STUDY ON AMPLIFIED WIMAX AND WIFI SIGNAL OF TIKRIT UNIVERSITY

seperti yang tercatat di muka surat tajuk dan kulit kertas projek
(as it appears on the title page and front cover of project)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan.
(that this project is in acceptable form and content, and that a satisfactory knowledge of the field is covered by the project).

Nama Penyelia Utama:
(Main Supervisor) : **DR. MASSUDI MAHMUDDIN**

Tandatangan
(Signature) : _____ Tarikh (Date) : 2/2/2012

DR. MASSUDI BIN MAHMUDDIN
Senior Lecturer
School of Computing
UUM College of Arts and Science
Universiti Utara Malaysia

Nama Penyelia Kedua:
(Co-Supervisor) : **DR. MOHD HASBULLAH OMAR**

Tandatangan
(Signature) : _____ Tarikh (Date) : 2/2/2012

MOHD. HASBULLAH BIN OMAR
Lecturer
School of Computing
UUM College of Arts and Sciences
Universiti Utara Malaysia

Nama Penilai
(Name of Evaluator) : **DR. ANGELA AMPHAWAN**

Tandatangan
(Signature) : _____ Tarikh (Date) : 2/2/2012

PERMISSION TO USE

In presenting this project in partial fulfillment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the Universiti Utara Malaysia the Library may make it freely available for inspection. I further agree that permission for copying of this project in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor or, in her absence by the dean of the Faculty of Information Technology. It is understood that any copying or publication or use of this project or parts thereof for financial gain should not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use may be made of any material from my project.

Request for permission to copy or to make use of material in this project, in whole or in part should be addressed to:

Dean of the Awang Had Salleh Graduate School

College of Arts and Sciences

University Utara Malaysia

06010 UUM Sintok

Kedah Darul Aman

ACKNOWLEDGEMENTS

"In The Name Of Allah the Most Gracious and Most Merciful"

First and foremost, all praises go to Almighty Allah (SWT), the Most Gracious and Most Merciful. Peace upon the prophet Muhammad S.A.W. Alhamdulillah, a foremost praise and thankful to Allah for His blessing, giving me opportunity, perseverance, wisdom to have this work done on time and strength in completing this study.

No volume of words is enough to express my gratitude towards my guides, Dr. Masuddi Bin Mahmuddin and Dr. Mohd. Hasbullah Omar, who have been very concerned and have aided for all the material essential for the preparation of this thesis report. They have helped me explore this vast topic in an organized manner and provided me with all the ideas on how to work towards a research-oriented venture.

I am also thankful to Dr.Angela, Dr. Mohammed M. Kadhum, and PhD (Student) Naseer Ali Husieen, for the motivation and inspiration that triggered me for this thesis work.

I would also like to thank the staff members and my colleagues especially Niyef Mohammad who were always there at the need of the hour and provided with all the help and facilities, which I required, for the completion of my thesis work. I extend thanks for all Sultanah Bahiyah Librarys' staffs in UUM for great and wonderful attitudes, help, respect, kindness and patience.

Most importantly, I would like to thank my whole beloved family and the almighty for showing me the right direction out of the blue, in order to help me stay calm in the oddest of the times and keep moving even when there was no hope.

Ihab

Table of Contents

PERMISSION TO USE ..... **I**

ACKNOWLEDGEMENTS ..... **II**

List of Figures ..... **VI**

List of Tables ..... **VIII**

List of Appendixes ..... **IX**

List of Abbreviations ..... **X**

ABSTRACT ..... **XIV**

CHAPTER 1

INTRODUCTION 1

1.1 Background 1

1.2 ProblemStatement 6

1.3 ResearchQuestion 7

1.4 Objectives 7

1.5 Contribution 7

1.6 Summary 8

CHAPTER 2

LITERATURE REVIEW 9

2.1 Background 9

2.2 Wireless Technology 9

2.2.1 Modulation 12

2.2.2 The Electromagnetic Spectrum 16

2.3 WiFi Architectures 20

2.3.1 BSS 20

2.3.2 ESS 21

2.3.3 IBSS 22

2.3.4 Direct-sequence spread spectrum (DSSS) 24

2.3.5 OFDM 25

2.3.6 Orthogonal Frequency Division Multiple Accesses (OFDMA) 27

2.4 WiMAX Architectures 28
2.4.1 Vision of WiMAX 29
2.4.2 Building a WiMAX network 30
2.4.3 WiMAX protocol stack 31
2.4.4 Physical Layer 32
2.4.5 Convergence at The Service Layer 33
2.4.6 MAC Layer 34
2.4.7 Managing The Demand from Subscriber Station 36
2.4.8 Authentication a Client SS in a WiMAX Network 37
2.4.9 Classes of Service 39
2.4.10 Uses of WiMAX and NLOS operation 40
2.5 Issues of Wireless in Tikrit University 42
2.6 Network Simulator 46
2.6.1 Why Simulation 48
2.6.2 C++ and TCL 50
2.7 Conclusion 51

CHAPTER 3

RESEARCH METHODOLOGY 53
3.1 Research Methodology 53
3.2 Network Phase Implementation 55
3.3 Evaluation Phase 64
3.4 Simulation Settings 65
3.4.1 WiFi Scenario 66
3.4.1.1 Scene 1: WiFi Scenario 68
3.4.1.1 Scene 2: WiFi Scenario 72
3.4.2 WiMAX Scenario 72
3.5 Performance Metric: 77

CHAPTER 4

FINDING **78**
4.1 Wifi Result 78
4.2 WiMAX Result 85
4.3 Comparison between WiFi and WiMAX 89
4.4 NS2 Challenging 92
4.5. Summary 96

CHAPTER 5

CONCLUSION 97
5.1 Summary 97
5.2 Future work 99

List of Figures

Figure 1.1: WiFi varoius useing 3
Figure 1.2 : Wireless networks classification. 4
Figure 1.3: differences point to point or light of sight LOS from NLOS 5
Figure 1.4 : Point to Point and Point to multi point paradigm 6
Figure 2.1 Amplitude 12
Figure 2.2 Amplitude modulation 13
Figure 2.3 Frequency modulation (FM). 13
Figure 2.4 Phase modulation (PM) 14
Figure 2.5 Amplitude Shift Keying (ASK) 15
Figure 2.6 Frequency shift keying (FSK). 16
Figure 2.7 Phase shift keying (PSK) 16
Figure 2.8 The electromagnetic spectrum 17
Figure 2.9 Gain 18
Figure 2.10 Loss 19
Figure 2.11 data link sub layers. 23
Figure 2.13 difference of OFDM and OFDMA 27
Figure 2.14 WiMAX overcome 29
Figure 2.15WiMAX protocol stack 31
Figure 2.16 different modulations as explained 32
Figure 2.17 MAC layer frame 34
Figure 2.18 TDD. 36
Figure 2.19 RF chain. 41
Figure 2.20 OFDM symbol structure in WiMAX 41
Figure 2.21 OFDMA in WiMAX. 42
Figure 2.22 WiFi system equipment's. 44
Figure 2.23 grid anntena 44
Figure 2.24 POE devices 45
Figure 2.25 Simulation class 47
Figure 2.26 NS representation 48
Figure 2.27 Differentials between real and simulation environments. 50
Figure 2.28 NS process and result generation 51
Figure 2.29 NS objects 51

Figure 3.1 phases of methodology. 54
Figure 3.2: WiFi client with WiMAX backhaul 56
Figure 3.3: The supposed topology 57
Figure 3.4: Non-Overlap channels 58
Figure 3.5: Schematic nodes under CMU type in Wireless 68
Figure 3.6: Structure of SS 73
Figure 3.7: Structure of BS inside NS2 74
Figure 3.8: Default synchronization in WiMAX 76
Figure 4.1 Throughput direct proportion with packet size. 82
Figure 4.2 total throughput 802.16 versus simulation time 87
Figure 4.3 total throughput at base station in WiMAX 88
Figure 4.4 total throughput per subscriber station in WiMAX 89
Figure 4.5 Users of opreating systems arounf the world 92

List of Tables

Table 2.1Radio frequency bands 10
Table 3.1: Parameters inside 802.11 packages. 67
Table 3.2: Keys parameters of Scenarios 1 of WiFi. 69
Table 3.3: Parameters of MAC layer wit WiMAX. 76
Table 3.4: PHY WiMAX parameters. 74
Table 3.5: System parameters WiMAX. 75
Table 4.1:Scenes 1: WiFi Scenario result 78
Table 4.2:Scenes 2: WiFi Scenario result 80
Table 4.3:WiMAX result. 85
Table 4.4:List most significant differences between WiFi and WiMAX 89
Table 4.5 Percentage of users for the operating systems in last five years 93

List of Appendixes

Appendix A WiFi 100
Appendix B WiMAX 105

List of Abbreviations

3GGP: 3rd Generation Partnership Project.

AAA: Authentication, Authorization and Accounting Administrations.

AM: Amplitude Modulation.

ASK: Amplitude Shift Keying.

ASN: Access Service Network.

ASP: Application Service Provider.

AWGN: Additive White Gaussian Noise.

BER: Bit Error Rate.

BPSK: Binary Phase Shift Keying.

BS: Base Station.

CC: Convolution Code.

CEPT: European Conference of Postal and Telecommunications.

CSN: Connectivity Service Network.

DAA: Detect and Avoid.

DL: Downlink.

DoS: Denial of Service.

DPSK: Differential Phase Shift Keying.

DSL: Digital Subscriber Line.

DSSS: Direct sequence Spread Spectrum.

DUR: Downlink to Uplink Ratio.

ECC: Electronic Communications Committee.

FCC: Federal Communications Commission.

FDM: Frequency Division Multiplexing.

FDMA: Frequency Division Multiple Access.

FEC: Forward Error Correction.

FFT: Fast Fourier Transform.

FHSS: Frequency-hopping spread spectrum.

FM: Frequency Modulation.

FSK: Frequency Shift Keying.

GW: Gateway.

HAP: High Altitude Platform.

IEEE: Institute of Electrical and Electronic Engineers.

IFFT: Inverse Fast Fourier Transform.

IMS: IP Multimedia Subsystem.

IP: Internet Protocol.

ISI: Inter Symbol Interference.

ISP: Internet service provider.

ITU: International Telecommunication Union.

ITU: International Telecommunication Union.

LAN: Local Area Network.

LOS: Line of Sight.

LTE: Long Term Evaluation.

MAC: Media Access Control.

MB-OFDM: Multiband OFDM.

Mbps: Mega bit per second.

MBWA: Mobile Broadband Wireless Access.

MFSK: Multiple Frequency Shift Keying.

MGF: Moment Generating Function.

MPSK: Multilevel Phase Shift Keying.

MS: Mobile Station.

MTRNG: Mersenne Twister Random Number Generator.

NLOS: None-Line of Sight.

NS: Network Simulator.

NSP: Network Service Provider.

NWG: Network Group.

OECD: Organization for Economic Co-operation and Development.

OFDM: Orthogonal Frequency Division Multiplexing.

OFDMA: Orthogonal Frequency Division Multiple Access.

PAPR: Peak-to-Average Power Ratio.

PE: Probability of Error.

PHY: Physical layer.

PSD: Power Spectral Density.

PSK: Phase Shift Keying.

PSTN: Public Switched Telephone Network.

PUSC: Partially Used Sub-Carrier.

QAM: Quadrature Amplitude Modulation.

QoS: Quality of Service.

QPSK: Quadrature Phase Shift Keying

RNG: Random Number Generator.

RS: Reed-Solomon.

SNR: Signal to Noise Ratio.

SS: Subscriber station.

TDMA: Time Division Multiple Access.

UP: Uplink.

WiFi: Wireless Fidelity.

WiMAX: Worldwide Interoperability for Microwave Access.

WLAN: Wireless Local Area Network.

WLAN: Wireless Local Area Network.

WMAN: Wireless Metropolitan Area Network.

ABSTRACT

The limitation of WiFi coverage and free frequency create problems as well as weaken security and degrade quality of services. Therefore, a complementary wireless technology, WiMAX, is required. WiMAX and WiFi are chosen as both technology are the most highly popular by wireless network protocols usage in Iraq. Simulation on both of the network environments will be used to imitate the real situation in Tikrit University. This study provides a comprehensive field survey on wireless networking in Tikrit University of Iraq. Suitable wireless protocol, expanding coverage, performance of network will be included after the application of this study. The major benefits that have achieved as the outcome of this study are packet delivery ratio and throughput. Both WiFi scenarios achieved packet delivery ratios of 97.2% and 96.012% respectively, while WiMAX scenario scored 98.0% on packet delivery ratio. On the other hand, the throughput was found to produce interesting results and increased with packet size. WiMAX throughput had been discovered to be increasing linearly to the throughput. The maximum throughput achieved by WiMAX was 22.12 Mbps while the WiFi obtained throughputs of 22.46 Kbps and 11.61 Kbps for the different scenarios.

CHAPTER 1

INTRODUCTION

In this chapter, wireless implementation is discussed in order to improve communication performance. This chapter highlights sections that cover the concepts of both WiFi and WiMAX in term of standards and protocols. The attempt is to reduce the challenges facing the Wi-Fi performance and therefore presents WiMAX technology base on the one that convenient to the real work. The research problem, objectives and research questions together with significance of the study are included in this chapter.

1.1 Background

Iraq is one of the Arab countries in the western Asia, situated on top of the Arabian Peninsula and consists of 18 provinces, which lies on borders with Turkey, Iran, Kuwait, Saudi Arabia, Jordan and Syria. Population of Iraq is about 30,399,572 million people with varying density distribution. Iraq is regarded as one of the richest countries in the world because of its natural resources, such as petroleum, gas, sulfur and agricultural products.

The weather condition of Iraq is harsh with hot and dusty in the summer and almost devoid of rain with dry cold in the winter. Iraq has more than 54 universities which cut across all the provinces and control by private organizations and government. Wireless network works proper within a short period of time [1, 4, 5] to integrate infrastructures. It's recommendation depends on verity networks resources so that when Wireless networks are augmented with (Ethernets and Fiber optics) networks, there will be increase in reliability and performance,

The contents of the thesis is for internal user only

REFERENCES

[1] M. Hassan and R. Jain, *High performance TCP/IP networking*: Pearson Prentice Hall, 2004.

[2] V. K. Garg, *Wireless communications and networking*: Morgan Kaufmann, 2007.

[3] D. Niyato and E. Hossain, "Wireless broadband access: Wimax and beyond-integration of wimax and wifi: Optimal pricing for bandwidth sharing," *Communications Magazine, IEEE,* vol. 45, pp. 140-146, 2007.

[4] Y. KAWASUMI, "Deployment of WiFi for Rural Communities in Japan and ITU's Initiative for Pilot Projects," *IEEE,* 2004.

[5] A. Kumar, *et al.*, *Wireless networking*: Morgan Kaufmann, 2008.

[6] M. Ciampa, *CWNA guide to wireless LANs*: Course Technology Ptr, 2005.

[7] T. Cooklev, "Wireless Communication Standards: A Study of IEEE 802.11, 802.15, and 802.16," *IEEE,* 2004.

[8] D. M. Anurag Kumar, Joy Kuri, *Wireless networking* 2009.

[9] B. S. C. Choi and M. Gerla, "Wireless Interrupt: Inter-Device Signaling in Next Generation Wireless Networks," in *INFOCOM IEEE Conference on Computer Communications Workshops , 2010*, 2010, pp. 1-5.

[10] M. Hassan and R. Jain, *High Performance TCP/IP Networking*, 2004.

[11] Price, "fundamentals of wireless networking " 2008.

[12] J. Feng, *Wireless networks* 2011.

[13] Y. Miyahara, "Next-generation wireless technologies trends for ultra low energy," in *Low Power Electronics and Design (ISLPED) 2011 International Symposium on*, 2011, pp. 345-345.

[14] S. Ahson and M. Ilyas, *The WiMAX handbook*: CRC Press, 2008.

[15] J. G. Andrews, *et al.*, *Fundamentals of WiMAX: understanding broadband wireless networking*: Prentice Hall PTR, 2007.

[16] F. A. Ibikunle, "Security Issues in Mobile WiMAX (802.16 e)," 2009, pp. 117-122.

[17] F. Ohrtman, *WiMAX handbook*: McGraw-Hill, 2005.

[18] J. G. Andrews, *et al.*, *Fundamentals of WIMAX*: Prentice Hall, 2007.

[19] K. X. Miao, "Enterprise WiMAX building the next generation enterprise wireless infrastructure with WiMAX," 2010, pp. 1-5.

[20] F. A. Ibikunle, "Notice of Violation of IEEE Publication Principles
Security Issues in Mobile WiMAX (802.16e)," in *Mobile WiMAX Symposium, 2009. MWS '09. IEEE*, 2009, pp. 117-122.

[21] F. Ohrtman, *WiMAX handbook*, 2010.

[22] A. Durresi and M. Denko, "Advances in wireless networks," *Mobile Information Systems*, vol. 5, pp. 1-3, 2009.

[23] T. Cornelsen, "WiFi- implementation Fundamentals and piloting," PHD, Computer science University for Applied Science of Regensburg, 2010.

[24] R. Price, *Fundamentals of wireless networking*: McGraw-Hill, Inc., 2006.

[25] Alberto Escudero P. Sebastian Buettrich, "Basic Wireless Infrastructure and Topologies," 2009.

[26] P. Rengaraju, *et al.*, "Measuring and Analyzing WiMAX Security and QoS in Testbed Experiments," 2011, pp. 1-5.

[27] C. S. Tsai and C. Y. He, "A Novel Group Communication for Disaster Positioning in Mobile Ad Hoc Network," 2010.

[28] Z. Zheng, *et al.*, "ONU placement in fiber-wireless (FiWi) networks considering peer-to-peer communications," 2009, pp. 1-7.

[29] B. S. C. Choi and M. Gerla, "Wireless Interrupt: Inter-Device Signaling in Next Generation Wireless Networks," 2010, pp. 1-5.

[30] C.-a. b. M. a. Intel, "WiMAX and WiFi Together:Deployment Models and User Scenarios," ed, 2011.

[31] E. Kartsakli, *et al.*, "Multiuser MAC protocols for 802.11 n wireless networks," 2009, pp. 1-5.

[32] A. Khan and N. Zaman, "Comparative analysis of broadband wireless access from Wi-Fi to WiMax," 2009, pp. 8-14.

[33] Y. M. Li and J. H. Jhang-Li, "Integration of WiMAX and WiFi Services: Bandwidth Sharing and Channel Collaboration," 2010.

[34] Z. Zeyu, *et al.*, "ONU Placement in Fiber-Wireless (FiWi) Networks Considering Peer-to-Peer Communications," in *Global Telecommunications Conference, 2009. GLOBECOM 2009. IEEE*, 2009, pp. 1-7.

[35] M. Fahad, *et al.*, "Broadcasting in cognitive wireless mesh networks with dynamic channel conditions," 2010, pp. 400-404.

[36] V. K. GARG, *Wireless communications and networking* Morgan Kaufmann, 2009.

[37] Y. P. GEYONG Ming , Pingzhi Fan, *Advances in Wireless Networks*, 2010.

[38] W. fourm. (2011). *WiMAX 2 Collaboration Initiative*.

[39] Z. Abate, *WiMax RF systems engineering*: Artech House Publishers, 2009.

[40] J. Hu, *et al.*, "A Distributed QoS Provision Scheme in IEEE802. 16 Mesh Networks with Directional Antennas," 2010, pp. 1-6.

[41] N. Frangiadakis and N. Roussopoulos, "A Pegasus over WiFi and WiMax Demo: Connectivity at high speeds," 2009, pp. 1-3.

[42] Y. Miyahara, "Next-generation wireless technologies trends for ultra low energy," 2011, pp. 345-346.

[43] S. Dhawan, "Analogy of promising wireless technologies on different frequencies: Bluetooth, wifi, and wimax," 2007, pp. 14-14.

[44] M. Gracias, *et al.*, "Interoperability between WiMAX and WiFi in a testbed environment," 2011, pp. 001144-001148.

[45] I. A. O. Ganan "Performance Evaluation of OFDM and Modulation Techniques in Mobile WiMAX (IEEE 802.16e)" Master, IT faculty -CAS Universiti Utara Malaysia., 2010.

[46] Y. C. Lai and Y. H. Chen, "Designing and Implementing an IEEE 802.16 Network Simulator for Performance Evaluation of Bandwidth Allocation Algorithms," 2009, pp. 432-437.

[47] A. (Sandy), *et al.*, "DakNet: Rethinking Connectivity in Developing Nations," *IEEE*, 2004.

[48] S. R. Ibanez, *et al.*, "Hybrid wifi-wimax network routing protocol," 2008, pp. 87-92.

[49] Y.-Y. L. Hui-Tang Lin, Wang-Rong Chang, and Rung-Shiang Cheng, "An Integrated WiMAX/WiFi Architecture with QoS Consistency over Broadband Wireless Networks " *IEEE*, 2009.

[50] S. Castillo and L. Ahumada, "On the simulation of fixed wireless users in NS-2," 2010, pp. 16-20.

[51] M. C. Ng, *et al.*, "From WiFi to WiMAX: Techniques for high-level IP reuse across Different OFDM protocols," 2007, pp. 71-80.

[52] A. Sayenko, *et al.*, "Winse: Wimax ns-2 extension," 2009, p. 46.

[53] R. K. Bansal, "PERFORMANCE ANALYSIS OF CLUSTER BASED ROUTING PROTOCOL IN MANETs, COMPUTER SCIENCE AND ENGINEERING DEPARTMENT THAPAR INSTITUTE OF ENGINEERING AND TECHNOLOGY, DEEMED UNIVERSITY, 2011.

[54] E. H. Teerawat Issariyakul, "Introduction to Network Simulator NS2," 2009.

[55] R. Rauf, " Simulation Study of Throughput Performance of Wi-Fi and WiMAX Systems ", Department of Electric & Electronic Engineering, University College London 2008.

[56] C.-H. Liao, "Integration of WiMAX and WiFi:Optimal Pricing for Bandwidth Sharing," *IEEE Communications magazine* 2008.