A Comparison of Performance Between TFRC and UDP over a Mobile IP Network

Malek Mohammed Saleh AL-Zoubi

UNIVERSITI UTARA MALAYSIA

2010

A Comparison of Performance Between TFRC and UDP over a Mobile IP Network

This thesis is presented to the Graduate School

In fulfillment of the requirements for

Master of Science (Information Technology)

Universiti Utara Malaysia

By

Malek Mohammed Saleh AL-Zoubi

(801965)

PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor(s) or, in their absence by the Dean of the Graduate School. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall 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 which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part should be addressed to:

Dean of Graduate School

Universiti Utara Malaysia

06010 UUM Sintok

Kedah Darulaman

Abstract

In this project we will study three performance metrics (packet loss, packet delay and jitter) of two different transport layer protocols over a Mobile IP Network. The researcher will be implementing TFRC and UDP in the Mobile IP Network, to identify which protocols could support mobility. Network Simulation NS-2 was proposed for implementing previous items and to present and interpret the results.

Acknowledgments

First, I would like to express my appreciation to Allah, the Most Merciful and, the Most Compassionate who has granted me the ability and willingness to start and complete this study. I do pray to His Greatness to inspire and enable me to continue the work for the benefits of humanity.

I dedicate this humble work to my father and mother; the spring of loyalty, affection, and dedication. They raised me on the principles of virtue, to my dear brothers and sisters; who spared no effort helping me during my school years.

I dedicate this work also for my uncles, my grandfather and my grandmother's souls.

Moreover, my special thanks to my supervisor Khuzairi bin Mohd Zaini for all the advice, encouragement and supervision.

And my appreciation to all my friends who supported me.

TABLE OF CONTENTS

Permission To Use..... *i*
Abstract ..... *ii*
Aknowledgments..... *iii*
Table of Contents.....*iv*
List of Figures ..... *vii*
List Of Tables ..... *viii*
List of Abbreviations .....*ix*

CHAPTER 1

INTRODUCTION

1.1INTRODUCTION ……..……1
1.2BACKGROUND..... 1
1.3Problem statement ……..……4
1.4Research Question ……..……5
1.5Research objectives 5
1.6Scope of the study 5
1.7Significance of the study ……..……...6
1.8Summary 6

CHAPTER 2

LITERATURE REVIEW

2.1INTRODUCTION ……..….7
2.2MOBILE IP NETWORK …….7
2.2.1 Devices required for a mobile IP ……...8
2.3WIRELESS NETWORK ……..……...11
2.3.1 Wireless network and networking benefits ……....11
2.4MULTIMEDIA STREAMING ……..……....13
2.4.1 Types of Streaming ……..……13
2.5USER DATAGRAM PROTOCOL (UDP) ……..…. 15
2.6TFRC ……....17

2.6.1 Challenges of TFRC in a Wireless Environment ……...18
2.7RELATED WORK ……..... 19
2.7.1 Performance of UDP over IP-Based Wire Lines and Wireless Networks …….....19
2.7.1.1 Throughput/Packet failure …….....20
2.7.1.2 Throughput/Bandwidth ..... …..21
2.7.2 Jitter Ratio-Based TFRC Scheme in Wireless-Wired Hybrid Network 22
2.7.3 Analysis of Mobile IP for NS-2 ……..…..……. 25
2.8PERFORMANCE METRICS 28
2.8.1 Packet loss ……..……28
2.8.2 Delay ……..…..…..…29
2.8.3 Jitter ……..…..…..30
2.9SUMMARY ……...….30

CHAPTER 3

METHODOLOGY

3.1INTRODUCTION ……..31
3.2SIMULATION DESCRIPTIO ……...31
3.3RESEARCH METHODOLOGY ……...32
3.3.1 Pre-software stage ……..33
3.3.2 Software stage ……....35
3.4Network simulator 2 (ns-2) ……..….36
3.5Summary ……..….38

CHAPTER 4

SIMULATION RESULTS

4.1INTRODUCTION ……....39
4.2SIMULATION SCENARIO ……..39
4.3SIMULATION EXECUTION ……..…40
4.4PERFORMANCE METRICS RESULT ANALYSIS ……..…43
4.4.1 Packet Loss ……..…...44
4.4.2 Delay: ……..…….... 46
4.4.3 Jitter ……...47
4.5ITU RECOMMENDATION ……..…..49

4.6SUMMARY ……..……..…..…….50

CHAPTER 5

CONCLUSIONS AND RECOMMENDED FURTHER STUDY

5.1INTRODUCTION ……...51
5.2DISCUSSION of FINDINGS …… 51
5.3LIMITATIONS ……..……...……..... 53
5.4CONTRIBUTION ……..53
5.5FUTURE WORK …… 54
REFERENCES 55

List of Figures

Figure 1.1: Wireless Home Network 2
Figure 2.1: Mobile IP 8
Figure 2.2: Mobile IP devices 10
Figure 2.3: UDP Header 16
Figure 2.4: A form of Two LANs having a Wireless Link 20
Figure 2.5: Throughput adjacent to Packet Drop over Wired and Wireless Network 21
Figure 2.6: Throughput next to Bandwidth over Wired and Wireless network 22
Figure 2.7: WAN+WLAN+3G cellular system 23
Figure 2.8: Wired-wireless hybrid network topology with N flows 24
Figure 2.9: Contrast of TCP and TFRC-Jr in wireless-wired network with different wireless connection error rates 25
Figure 2.10: Handover scenario 27
Figure 3.1: Simulation steps 33
Figure 3.2 Experiment Topology 34
Figure 3.3: The duality of ns 37
Figure 3.4: The basic simulator objects in NS and their interconnections 37
Figure 4.1: Simulation scenario 40
Figure 4.2: Simulation execution 41
Figure 4.3: Sum of numbers of send TFRC packets 42
Figure 4.4: Sum of numbers of UDP send packets 43
Figure 4.5: Sum of drop packets for TFRC session 44
Figure 4.6: Sum of drop packets for UDP session 45
Figure 4.7: Delay of TFRC session. 46
Figure 4.8: Delay of UDP session. 47
Figure 4.9: Jitter of TFRC session. 48
Figure 4.10: Jitter of UDP session. 49

List of Tables

Table 4.1: ITU Performance Metrics Recommendation.....50

List of Abbreviations

APs	Access Points
BS	Base Station
CBR	Constant Bit Rate
CD	Compact Disk
CoA	Care of Address
DES	Discrete Event-based Simulation
DRM	Digital Rights Management
DVRs	Digital Video Recorders
FA	Foreign Agent
HA	Home Agent
HTTP	Hyper Text Transfer Protocol
IP	Internet Protocol
ISP	Internet Service Provider
ITU	International Telecommunication Union
LAN	Local Area Network
MH	Mobile Host
NAM	Network Animator
Ns-2	Network Simulator 2
OTCL	Object-oriented Tool Command Language
PC	Personal Computer
PLR	Packet Loss Ratio
RH	Remote Host
RTSP	Real Time Streaming Protocol

RTP	Real-time Transport Protocol
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol over Internet Protocol
TFRC	TCP Friendly Rate Protocol
UDP	User Datagram Protocol
UDP/IP	User Datagram Protocol over Internet Protocol
VOIP	Voice Over IP
WAN	Wide Area Network
WLAN	Wireless Local Area Network
3G	Third Generation

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter provides an overview of the entire study. It contains a general overview for each section through this report structure. In Section 1.2 we present the background of this study, in Section 1.3 the problem statement, then in Section 1.4 the research question, followed by the objectives in Section 1.5, the scope and significance of the study in Section 1.6 and 1.7. Finally, in Section 1.8 we end this chapter with a small summary**.**

1.2 BACKGROUND

Recently the number of Internet users and Internet access are increasing over the world. Looking at the Internet, the world stats website has shown the number of Internet users in the world has grown by **1,668,870,408** persons as of June 30, 2009; this represents a 24.7 % yearly increase with regard to the number of estimated users that existed one year ago at year end 2008 [1].

According to [2] and [3], a Wireless Local Area Network (WLAN) connects two or more computers or devices (nodes) without using wires; it uses electronic waves such as radio wave technology to enable communication between devices

The contents of the thesis is for internal user only

REFERENCES

[1] Internet world statistics, available at http://www.internetworldstats.com/stats.htm, July 22, 2009.

[2] October 14, 2009). Wireless LAN. Available: http://en.wikipedia.org/wiki/Wireless_LAN

[3] A. Goldsmith, Wireless Communications: Cambridge University Press, 2005.

[4] R. MacManus (September 5, 2007, 10), Future Web Trends, http://www.readwriteweb.com/archives/10_future_web_trends.php (July 22, 2009).

[5] M. Handley, et al., "RFC3448 - TCP Friendly Rate Control (TFRC): Protocol Specification," The Internet Society, pp. 1-24, January 2003.

[6] J. Postel, "RFC768 - User Datagram Protocol," USC/Information Sciences Institute, 28 August 1980.

[7] October 18, 2009). What are the advantages of UDP over TCP? Available: http://wiki.answers.com/Q/What_are_the_advantages_of_UDP_over_TCP.

[8] H. ElAarag and A. Moedinger, "IFTP-W: A TCP-Friendly Protocol for Multimedia Applications over Wireless Networks," presented at the 43rd ACM Southeast Conference, 2005.

[9] Q. Li, et al., "Jitter Ratio-Based TFRC Scheme in Wireless-Wired Hybrid Network," Digital Telecommunications, 2006. ICDT '06. International Conference, 2006.

[10] N. Venkataraman, "Inside Mobile IP", available at: http://www.ddj.com/mobile/184406240 July 23, 2009.

[11] M. Hassan and R. Jain, "High Performance TCP/IP Networking: Concepts, Issues, and Solutions," Prentice-Hall, 2003.

[12] C. T. Bhunia. (February 2009) Internet with Mobile IP. *Electronics for you*. 108-114.

[13] B. Mitchell. (November 9, 2009, What Are the Benefits of Networking? Available: http://compnetworking.about.com/cs/wireless/f/whywirelesslan.htm

[14] D. Tse and P. Viswanath, Fundamentals of Wireless Communication: Cambridge University Press, 2005.

[15] S. McEvoy, Microsoft Windows Media Player for Windows XP handbook: Microsoft Press, 2001.

[16] A. i. Research. (February 16, 2006, Accustream Research: Internet video up by 50% in '05 to over 17.9 billion streams served. Available: http://www.accustreamrearch.com/news/feb-16-06.html.

[17] A. E. Grant and J. H. Meadows, Communication Technology Update: Focal Press is an imprint of Elsevier, 2006.

[18] J. Kristoff, "The Trouble with UDP scanning" presented at the 14th Annual Computer Security Incident Handling Conference, Hawaii, USA, March 11, 2002.

[19] S. Floyd and K. Fall, "Promoting the use of end-to-end congestion control in the Internet," IEEE/ACM Transactions on Networking, vol. 7, no. 4, pp. 458-472, August 1999.

[20] H. ElAarag and M. Bassiouni, “An Internet Friendly Transport Protocol for continuous media over best effort networks,” Int. J. of Communication Systems, John Wiley and Sons, 2002, 15:881-898.

[21] J. Widmer, R. Denda, and M. Mauve., “A survey on TCP Friendly congestion control,” IEEE Network, vol. 15, pp. 28-37, May 2001.

[22] Gu, Y., Hong, X., Mazzuco, M, and Grossman, R. (2005). SABUL: A high performance data transfer protocol. Available at: http://www.rgrossman.com/pdf/sabul-hpdtp-11-02.pdf.

[23] He, J. and Gary-Chan, S. H. (2004). TCP and UDP performance for Internet over optical packet-switched networks. Journal of Computer Networks, 45, 505-521.

[24] A. A. Akintola, et al., "Performance Modeling of UDP over IP-Based Wireline and Wireless Networks," Informing Science and Information Technology, vol. 3, 2006.

[25] Song Cen, Pamela C. Cosman and Geoffrey M. Voelker, "End-to-End Differentiation of Congestion", IEEE/ACM Transactions on Networking(TON), Volume 11 Issue 5, October 2003 Page(s):703- 717

[26] Wu E.H, Mei-Zhen Chen; "JTCP: Jitter-based TCP for heterogeneous wireless networks", Selected Areas in Communications, IEEE Journal on What? Volume 22, Issue 4, May 2004, Page(s):757- 766

[27] T. Janevski and I. Petrov, "Analysis of Mobile IP for NS-2," presented at the 16th Telecommunications forum TELFOR Serbia, Belgrade 2008.

[28] http://www.isi.edu/nsnam/ns/, last accessed in October 2009.

[29] C. Perkins, “IP Mobility Support for IPv4”, IETF RFC 3344, August 2002. Claudio.

[30] E. Palazzi et al., “High Mobility in a Realistic Wireless Environment: a Mobile IP Handoff Model for NS-2”, Trident Com 2007.

[31] J. F.Kurose, et al., Computer Networking: A Top-Down Approach. Greg Tobin, 2008.

[32] G. Almes, et al., "RFC2680-A One-way Packet Loss Metric for IPPM," Network Working Group, September 1999.

[33] "Monitoring Your IP Telephony," NetworkNEC Unified Solutions, 2004.

[34] G. Almes, et al., "RFC2681-A Round-trip Delay Metric for IPPM," Network Working Group, September 1999.

[35] C. Demichelis and P. Chimento, "RFC3393-IP Packet Delay Variation Metric for IP Performance Metrics (IPPM)," Network Working Group, November 2002.

[36] E. Weingartner, et al., "A performance comparison of recent network simulators," presented at the Communications, 2009. ICC '09. IEEE International Conference on, 14-18 June 2009.

[37] A. Varga and R. Hornig. An overview of the OMNeT++ simulation environment. In Proceedings of the First International Conference on Simulation Tools and Techniques for Communications, Networks and Systems (SIMUTools 2008’), March 2008.

[38] R. Barr, Z. J. Haas, and R. van Renesse. JiST: an efficient approach to simulation using virtual machines. Softw. Pract. Exper, 35(6):539–576, 2005.

[39] P. Levis, N. Lee, M. Welsh, and D. Culler. TOSSIM: accurate and scalable simulation of entire TinyOS applications. In Proceedings of the

1st ACM Conference on Embedded Networked Sensor Systems (SenSys 2003), 2003.

[40] Mattsson and Nils-Erik, A DCCP module for ns-2, 2004-05-05.

[41] M. Greis. (2009). Tutorial for the Network Simulator "ns". Available: http://www.isi.edu/nsnam/ns/tutorial/ns.html

[42] T. Issariyakul and E. Hossain, Introduction to Network Simulator NS2: Springer, 2009.

[43] Malek. J., 2004. Trace graph. Wroclaw University of Technology, Poland. http://www.geocities.comtracegraph.html (accessed on Sept. 2009)

[44] E. Kamen and B. Heck. (November 23, 2009). Fundamentals of Signals and Systems Using Matlab. Available: http://users.ece.gatech.edu/bonnie/book/TUTORIAL/tutorial.html

[45] Lysis. November 23, 2009). Calculate Packet Loss Ratio. Available: http://www.ehow.com/how_5108799_calculate-packet-loss-ratio.html

[46] November 23, 2009). ITU-T Recommendations. Available: http://www.itu.int/ITU-T/publications/recs.html

[47] (2007-11, November 23, 2009). Y.1540: Internet protocol data communication service - IP packet transfer and availability performance parameters. Available: http://www.itu.int/rec/T-REC-Y.1540-200711-I/en