

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

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

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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.

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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
P.
- [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.accustreamresearch.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-hpdtcp-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.com/tracegraph.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>