วิศวกรรมสาร มข. ปีที่ 33 ฉบับที่ 5 (485 - 493) กันยายน – ตุลาคม 2549 บทความวิจัย
KKU Engineering Journal Vol. 33 No .5 (485 – 493) September – October 2006

การเพิ่มประสิทธิภาพทีซีพีโพรโตคอลบนระบบเครือข่ายไร้สายด้วยการใช้สนูฟแบบปรับปรุงเพื่อชะลอการลดขนาดของหน้าต่างควบคุมความคับคั่งของทีซีพี*

ยุทธพงษ์ มานุษยานนท์[1) มยุรี เลิศเวชกุล[2)

[1) นักศึกษา ภาควิชาวิศวกรรมสารสนเทศ คณะวิศวกรรมศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

[2) ผู้ช่วยศาสตราจารย์ ภาควิชาวิศวกรรมสารสนเทศ คณะวิศวกรรมศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหาร ลาดกระบัง

Email:m_yutthapong@hotmail.com

บทคัดย่อ

บทความฉบับนี้เสนอวิธีการเพิ่มประสิทธิภาพโพรโตคอลทีซีพีบนระบบเครือข่ายแบบไร้สาย โดยปรับปรุงโพรโตคอลสนูป (SNOOP protocol) ที่เป็นโพรโตคอลที่เพิ่มเข้าไปในสถานีฐานเพื่อที่จะคอยเก็บข้อมูลไว้และส่งต่อไปยังสถานีไร้สายเพื่อเป็นการเพิ่มความเร็วในการส่งซ้ำเมื่อเกิดการสูญหายของข้อมูล วัตถุประสงค์ของวิทยานิพนธ์นี้คือปรับปรุงโพรโตคอลสนูปที่มีอยู่ โดยมีแนวคิดที่จะตรวจสอบการเวลาการหมดอายุของแพ็กเกจเพื่อชะลอการลดขนาดของหน้าต่างควบคุมความคับคั่งของโพรโตคอลทีซีพี และให้โพรโตคอลสนูปมีการการตอบกลับสัญญาณยืนยันการได้รับข้อมูลแทนผู้รับไปยังผู้ส่งเพื่อเร่งการเพิ่มขนาดของหน้าต่างควบคุมความคับคั่ง แนวคิดนี้เป็นการเพิ่มประสิทธิภาพของการสื่อสารด้วยโพรโตคอลทีซีพี ในการทดลองนั้นได้ทำการจำลองโพรโตคอลสนูปโดยเปรียบเทียบอัตราการสัมฤทธิผลของการส่งข้อมูลเทียบกันระหว่างโพรโตคอลสนูปที่ได้ปรับปรุงกับโพรโตคอลสนูปที่ยังไม่ได้ปรับปรุงและได้ทำการเปรียบเทียบกับทีซีพีแบบดั้งเดิม พบว่าโพรโตคอลสนูปแบบที่ได้ปรับปรุงขึ้นมานั้นสามารถเพิ่มประสิทธิภาพการทำงานของโพรโตคอลทีซีพีบนระบบเครือข่ายไร้สายได้เป็นอย่างดี

คำสำคัญ : เครือข่ายไร้สาย การปรับปรุงการทำงาน, ทีซีพีโปรโตคอล, สนูปโปรโตคอล

---

* รับต้นฉบับเมื่อวันที่ 16 มีนาคม 2549 และได้รับบทความฉบับแก้ไขเมื่อวันที่ 30 สิงหาคม 2549

Improving TCP Protocol Performance over Wireless Networks with the Modified Snoop Protocol. *

Yutthapong Manutsayanon[1] Mayuree Lertwatechakul[2]

[1] Student, Department of Information Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang
[2] Assistant Professor, Department of Information Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang

Email:m_yutthapong@hotmail.com

ABSTRACT

This paper proposes a modified SNOOP protocol to improve TCP performance for mobile network. The SNOOP protocol utilizes a caching technique implemented in base station to do fast local retransmission in wireless LAN instead of end-to-end TCP retransmission. The paper objective is to modify the existing SNOOP protocol to decrease unnecessary timeout that reduces the congestion window size. The new SNOOP protocol was added with the capability to acknowledge the received TCP segment in manner of the destination host. The idea is to slow down the congestion window size reduction method that decreases the transmission rate of TCP session. As to evaluate the performance of the proposed idea, we implement the protocol into a simulation model and compare the simulation results with the based model. The simulation results show that the proposed protocol gain more performance for TCP mobile node compared to the unmodified SNOOP protocol significantly.

Keywords : Wireless Networks, Improving Performance, TCP protocol, SNOOP protocol

* Original manuscript submitted: March 16, 2006 and Final manuscript received: August 30, 2006

INTRODUCTION

Transport Control Protocol (TCP) (W. R. Stevens. 1984, A. S. Tanenbaum. 1996, J. Postel. 1981, V. Javobson. 1988, W. Stevens. 1997, M. Allen. V. Paxon. W. Stevens. 1999) is a reliable protocol designed to perform well in networks with low bit-error rates, such as wired networks. TCP assumes that all errors are due to network congestion, rather than to loss. When congestion is encountered, TCP adjusts its window size and retransmits the lost packets. In wireless networks, however, packet loss is mainly caused by high bit-error rates over air-links. Thus, TCP window adjustment and retransmission mechanisms result in poor end-to-end performance.

The academic literature contains of solutions for elevating performance over wireless links. Berkeley's SNOOP (J. Border. Performance Enhancing Proxy (PEP). 1999) , (Hari Balakrishnan, Srinivasan Seshan, Elan Amir and Randy H. Katz. 1995) , (H. Balakrishnan. S. Seshan. R. Katz. 1995) , (H. Balakrishnan. V.N. Padmanabhan. S. Seshan. and R.H. Katz. Dec. 1997) , (H. Balakrishnan. S. Seshan. and R. H. Katz. 1995) , M-TCP (K. Brown and S. Singh. 1997), I-TCP (A. Bakre and B. R. Badrinath. 1995) , Freeze-TCP (T. Go . J. Moronski. D. S. Phatak and V. Gupta. 2000), W-TCP (K. Ratnam and I. Matta. 1998) , WTCP (P. Sinha. N. Venkitaraman. R. Sivakumar and V. Bhargavan. 1999) and TCP Westwood (C. Casetti. M. Gerla. S. Mascolo. M. Y. Sanadidi. and R. Wang. 2001) are some of the more important ones. Careful examination of existing schemes suggests four broadly different approaches: link-layer based schemes (both TCP aware and unaware) (e.g. SNOOP), split connection based approaches (e.g. I-TCP, W-TCP), early warning based approaches (e.g. Freeze-TCP) and finally those necessitating end system changes (e.g. WTCP, Freeze-TCP, TCP Westwood).

One of these approaches is the SNOOP protocol. Its main feature is to cache packets at the base station and to perform local retransmissions across the wireless links. The SNOOP protocol based on local retransmission scheme can improve end-to-end performance on networks with wireless links without changing existing TCP implementations at the end hosts and without recompiling or relinking existing applications. The SNOOP protocol introduces a module, called the SNOOP agent, at the Base Station (BS). The agent monitors every packet that passes through the TCP connection in both directions and maintains a cache of TCP segments sent across the link that have not yet been acknowledged by the receiver. A packet loss is detected by the arrival of a small number of duplicate acknowledgments (ACKs) from the receiver or by a local timeout. The SNOOP agent retransmits the lost packet if it has the packet in the SNOOP buffer with suppressing the duplicate ACKs (DUPACKs) to be sent to the sender (E Amir. H Balakrishnan. S Seshan and R. H. Katz. 1995). However, the SNOOP protocol has a problem; if there were no arrivals of DUPACKs, the SNOOP agent does not notice the packet loss until the local retransmission timer is expired. This scheme requires so much time to retransmit the lost packets that TCP throughput performance is degraded as a result.

The SNOOP module has two linked procedures, SNOOP_data() and SNOOP_ACK(). SNOOP_data() processes and caches packets these intending for the MH (Mobile host) while SNOOP_ACK() processes acknowledgments coming from the MH and drives local retransmissions from the base station to the MH.

Modified SNOOP.

The serious problem of TCP performance is due to the reduction of the CWND (congestion window) make the TCP sender get into unnecessary slow start. And the redundant retransmissions also make base station sent and TCP source can consume the original low bandwidth on the wireless link.

We propose a new SNOOP scheme by adding some mechanisms, to make the SNOOP protocol work more efficiently, the idea is to avoid CWND reduction and the mechanism is described as follow:

• The modified SNOOP will acknowledge all received packets in manner of MH. This accelerates sender's CWND size expansion.

• As to avoid the sender's CWND shrink size caused by DUPACK from MH, the modified SNOOP buffers DUPACK that would cause congestion control process. The advantage of this mechanisms is elimination the unnecessary congestion control process because if the packet intended by the DUPACK would come in time. The DUPACK will be discarded or else the DUPACK will be forwarded to FH (fix host) as the normal process.

To solve this problem and make the SNOOP protocol more robust, we generate a control ACK packet to reply all ACK when receives packet from sender and wait DUPACK notify sender on random loss occurred every time. The base station detects the packet from sender then reply ACK all which it will cache packet that in buffer and sent subsequently submit go to still the receiver. This accelerates sender's CWND size expansion and discarded the DUPACK as to avoid the sender's CWND shrink size. The mechanisms are shown in a picture 1, 2, 3 and 4.

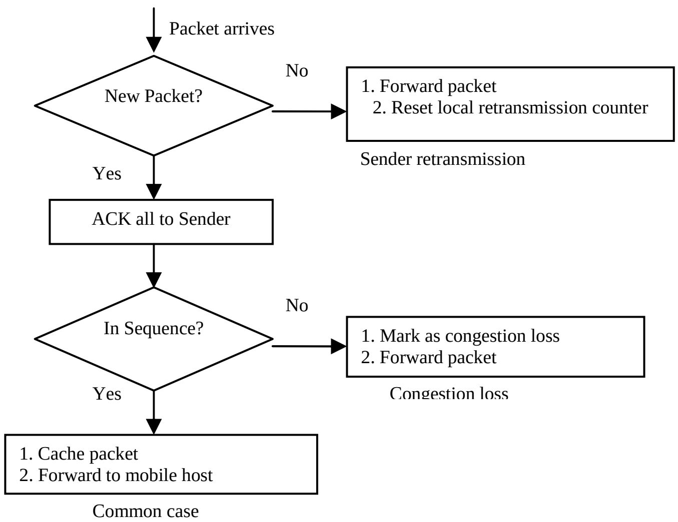

Figure 1 *Flowchart for SNOOP_data().*

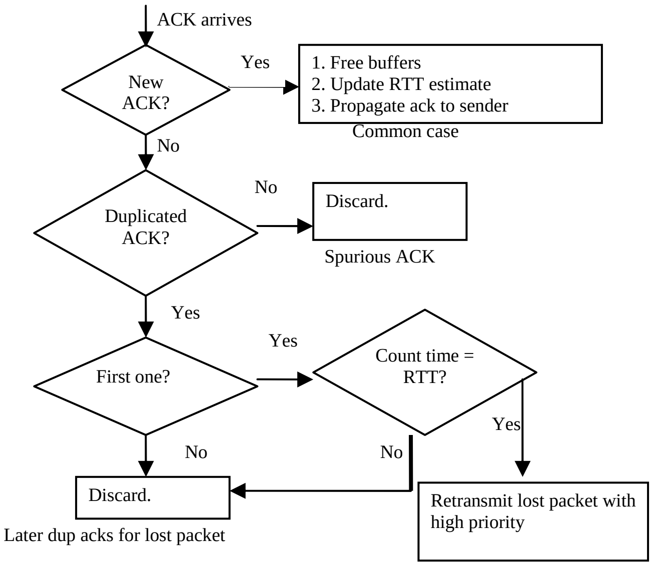

Figure 2 *Flowchart for SNOOP_ACK().*

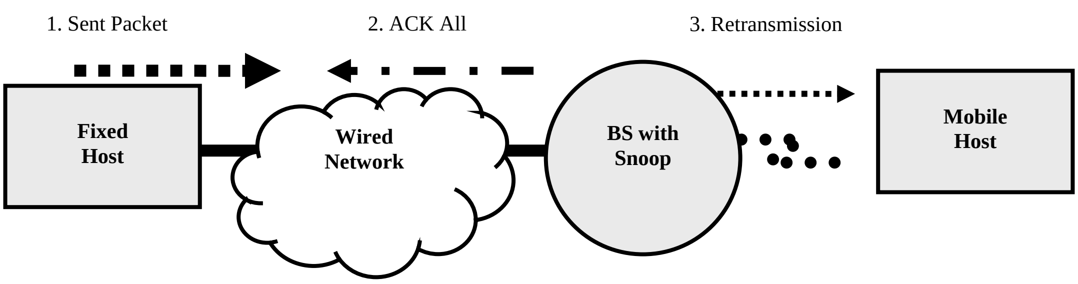

Figure 3 *ACK all to sender.*

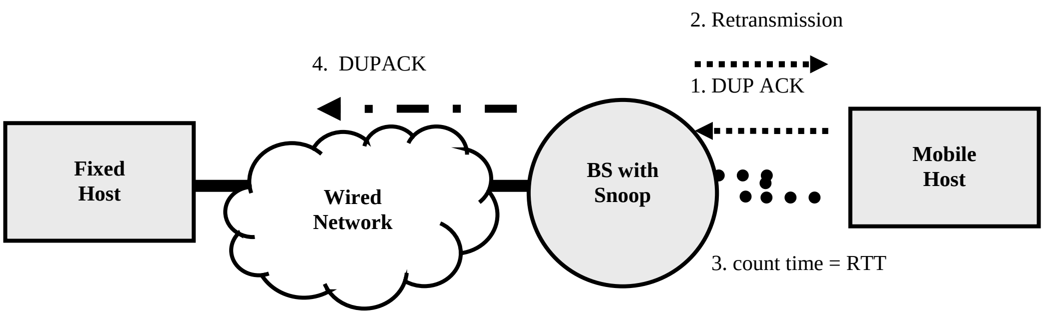

Figure 4 *wait until RTT.*

RESULTS AND DISCUSSION

Our network topology shows in Figure 5. We have implemented modified SNOOP in the NS2 (UCB/LBNL/VINT. 2006) and compared its performance to TCP Reno and the original SNOOP over the network shown in below. The network consists of a wired network segment with some cloud of internet and connected to a base station with an interface to a wireless LAN. Losses are randomly applied to the wireless link with loss rate 10%, and traffic congestions are caused by the simulating infinite source agent FTP Application data transferred on the wire link, packet size 1000 byte. The bandwidth between the fixed host (the TCP source) and the base station is set to 10 Mbps and between the base station and the mobile station (the TCP receiver) is 1 Mbps. we observe variation of the congestion window size to get characteristics of the three scenarios. Also compare the throughputs and the gain of our method.

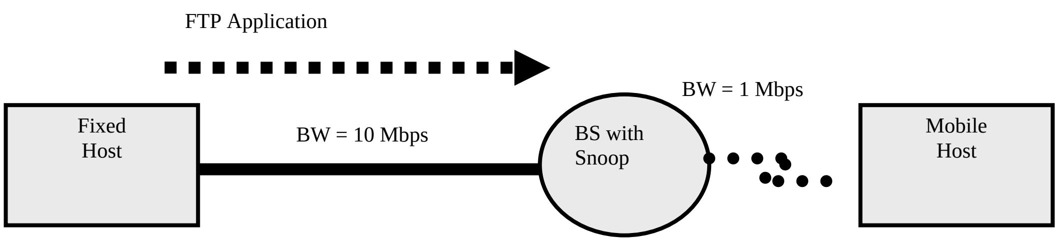

Figure .5 *The topology for simulation.*

Since our effort is to solve the problem of SNOOP, we will focus on comparing of congestion window size and throughput, in figures 6 and Figure 7 shows the comparison three scenarios of TCP-Reno SNOOP and Modified SNOOP. In table 1 show the average congestion window and throughput.

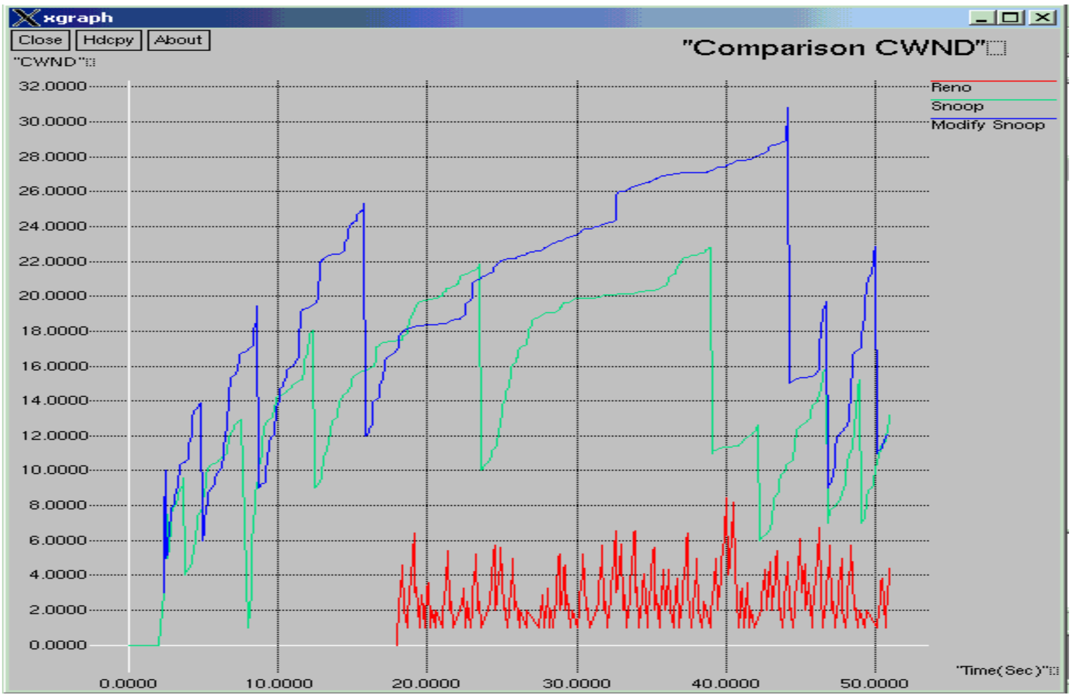

Figure 6. *Comparison three scenarios of the CWND.*

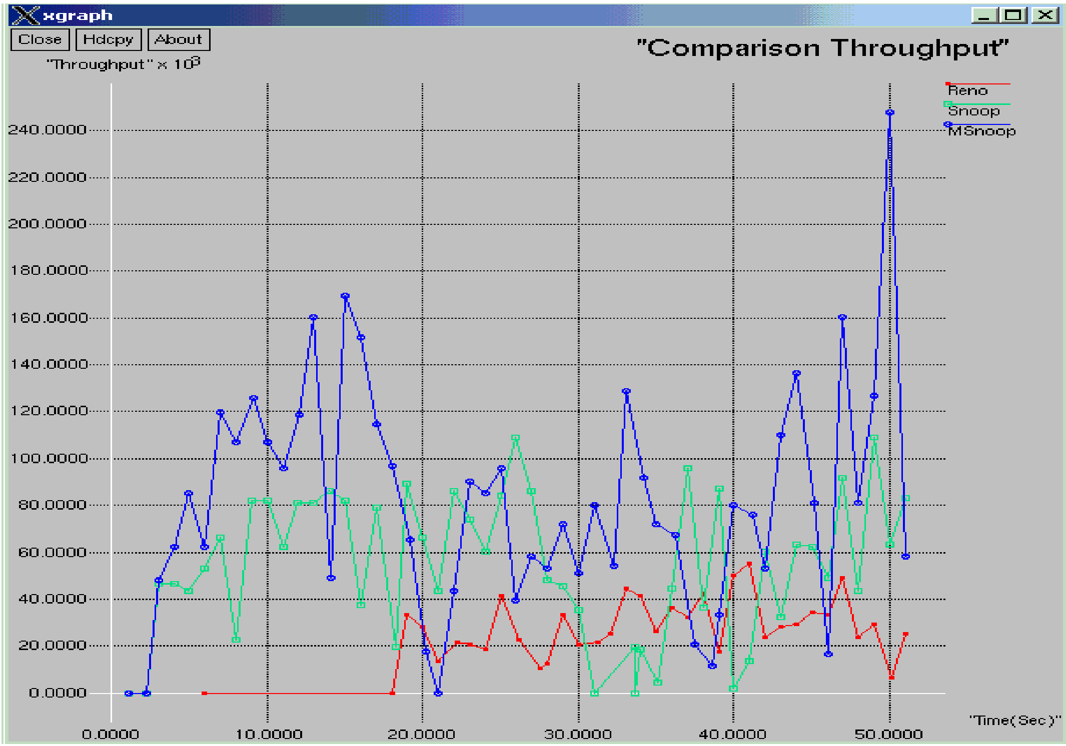

Figure 7. *Comparison three scenarios of throughput.*

	CWND (segment)	Throughput (bps)
Reno	3.8	18680
SNOOP	13.58	54570.2
Modify SNOOP	18.2	81018.8

Table 1 *Comparison CWND and throughput.*

CONCLUSIONS

We modified the SNOOP protocol to ACK to sender and wait the DUPACK to sender method at the base station. The new SNOOP protocol capable of acknowledge the received TCP segment in manner of the destination host. The idea is to slow down the congestion window size reduction process that decreases the transmission rate of TCP session. To solve this problem and make the SNOOP protocol more robust on wireless networks. In our experiment can improve the average throughput about 34 % to SNOOP and 378 % to TCP Reno.

REFERENCES

A. Bakre and B. R. Badrinath. 1995. ``I-TCP: Indirect TCP for mobile hosts". **In Proc. of the 15th IEEE International Conference on Distributed Computing Systems**. pages 136-143.

A. S. Tanenbaum. 1996. Computer Networks. Third Edition. Englewood Cliffs. NJ: **Prentice-Hall Press. IEEE802.11. 1988. Workgroup:http://grouper.ieee.org/groups/802/11/**

C. Casetti. M. Gerla. S. Mascolo. M. Y. Sanadidi. and R. Wang. 2001. ``TCP Westwood: Bandwidth Estimation for Enhanced Transport over Wireless Links". **In Proceedings of ACM Mobicom.**

E Amir. H Balakrishnan. S Seshan and R. H. Katz. 1995. "Efficient TCP over networks with wireless links." **in Proc. of HofOs-V Wwhhop. OrcusIsland. WA**. pp. 35-40

H. Balakrishnan. S. Seshan. R. Katz. 1995. "Improving reliable transport and handoff performance in cellular wireless networks." **ACM wireless networks 1. Page(s): 469-481.**

H. Balakrishnan. V.N. Padmanabhan. S. Seshan. and R.H. Katz. Dec. 1997. "A comparison of mechanisms for improving TCP performance over wireless links." **Networking.IEEE/ACM Transactions on. Volume: 5 Issue: 6..** Page(s): 756 -769

H. Balakrishnan. S. Seshan. and R. H. Katz. 1995. "Improving reliable transport and handoff performance in cellular wireless networks." **ACM Wireless Networks. vol. 1.** no. 4.pp469-481

Hari Balakrishnan, Srinivasan Seshan, Elan Amir and Randy H. Katz. 1995. Improving TCP/IP Performance over Wireless Networks.In **Proc. 1st ACM Int'l Conf. on Mobile Computing and Networking (Mobicom).**

J. Border. Performance Enhancing Proxy (PEP). 1999. Request for Comments: http://www3.ietf.org/proceedings/99jul/I-D/draft-ietf-pilc-pep-00.txt

J. Postel. 1981. "Transmission Control Protocol." **IETF RFC 793.**

K. Brown and S. Singh. 1997. ``M-TCP: TCP for Mobile Cellular Networks ". **ACM Computer Communication Review.**

K. Ratnam and I. Matta. 1998. ``W-TCP: An Efficient Transmission Control Protocol for Networks with Wireless Links". **In Proceedings of Third IEEE Symposium on Computer and Communications (IEEE ISCC).**

M. Allen. V. Paxon. W. Stevens. 1999. "TCP Congestion Control." **IETF. RFC 2581**. : availableonline at http://www.ietf.org/rfc/rfc2581.txt

Prasun Sinha. Narayanan Venkitaraman. Raghupathy Sivakumar and Vaduvur Bharghavan 1999. "WTCP: A Reliable Transport Protocol for Wireless Wide-Area Networks" **ACM Mobicom '99**. pp231-241

P. Sinha. N. Venkitaraman. R. Sivakumar and V. Bhargavan. 1999. ``WTCP: A Reliable Transport Protocol for Wireless Wide-Area Networks". **In Proceedings of ACM MOBICOM**.

T. Go . J. Moronski. D. S. Phatak and V. Gupta. 2000. ``Freeze-TCP: A true end-to-end enhancement mechanism for mobile environments." **In Proceedings of IEEE INFOCOM.**

UCB/LBNL/VINT. 2006. Network Simulator (ns-2) **available on-line** at http://www.isi.edu/nsnam/ns/doc/ns_doc.pdf

V. Javobson. 1988 . "Congestion Avoidance and Control." **ACM SIGCOMM '88**. pp. 273-288.

W. Stevens. 1997. "TCP Slow Start. Congestion Avoidance. Fast Retransmit. and Fast Recovery Algorithms." **IETF. RFC 2001**.:available online at http://www.ietf.org/rfc/rfc2001.txt

W. R. Stevens. 1984. TCP/IP Illustrated. Volume 1. Reading. MA:Addison Wesley. **Professional Computing.**