

RESUME

Teunis J. Ott

Research Interests

Modeling of Internet Protocols. TCP, ECN, Differentiated Services. The implementation of Networking Protocols, in particular in the linux Kernel. Stability of the Internet and Design of Internet Protocols. Routing in the Internet, in particular MPLS. Source Models and Traffic Characteristics for Data Traffic. Internet Telephony and its effect on the stability of the Internet, mainly in the context of RTP and RTCP. Network Security and Firewalls.

Employment History

Rutgers Univ Winlab, Jan 2007 - Dec 2007, Visiting Professor.

New Jersey Institute of Technology, 2001 - 2006, Professor, Computer Science.

Bellcore/Telcordia, 1983-1994, Director of Research Group, 1994 - 2001, Senior Scientist.

ATT-Bell Labs, 1978-'83, MTS, later Supervisor, Performance Analysis.

Univ. of Texas at Dallas, 1976-'78, Assistant Professor, Operations Research.

Case Western Reserve Univ., 1974-'76, Assistant Professor, Operations Research.

Recent Activities

Started the "Internet Laboratory" at NJIT. In the lab, supervised projects on Linux Routing, Linux Firewalls, Traceback, Implementation of "Split TCP" in the Linux Kernel, etc, see website.

Was instrumental in greatly improving the Networking Curriculum in the College of Computing Sciences at NJIT.

In Bellcore / Telcordia, started and led research on optimal load balancing in IP networks using MPLS. Started and participated in research projects on Stability of the Internet, design of IP Protocols, IP Routing. Among other items, this led to the invention of SRED (Stabilized RED, two patents) and work on IP transport protocols suitable for satellite links and for use with Explicit Congestion Notification. Led internal Telcordia project on "IP Traffic Characterization" (leading up to models for customer behavior). Did research on "Stability of Internet" with Matt Mathis and Joop Kemperman and obtained (1998) NSF grant for this research (see the draft "Stationary Behavior of ideal TCP Congestion Avoidance). Started and led a research project on the interaction between the end-to-end TCP flow control scheme and the ATM based ABR flowcontrol scheme in TCP/IP over ATM. Started and led research project on TCP over ATM with ABR and obtained (1997) Air Force Grant to implement priorities in ABR (two patents).

(Less recent:) Started the measurements of Ethernet traffic that led to later research on fractal behavior (with Will Leland and Dan Wilson). Participated in research on smoothing of Time-Constrained traffic (one patent). Started a research project on simulation with importance sampling of markov chains (with Sigrun Andradottir and Dan Heyman). This work was aimed at simulating an ATM switch with very low cell loss probabilities, and led to 4 publications. Started a research project on "TCP over ATM" (with T.V. Lakshman and Arnold Neidhardt). This led to the patent "the Drop from Front of Buffer Policy in Feedback Networks".

Education

Ph.D., Operations Research, Univ of Rochester, 1974.

Drs., Mathematics, Univ of Amsterdam, 1970 (cum laude).

B.Sc., Physics, Mathematics, and Chemistry, Univ of Amsterdam, 1965.

Nationality, Immigration Status, Languages

Citizen of The Netherlands, immigrant in USA, Green Card since 1976.

Fluent in Dutch and English, competent in French, reading German.

Professional Activities

Member, IFIP WG. 7.3.

Member, INFORMS (was ORSA and TIMS), IEEE, ACM.

NSF Panel member (Networking) July 2002, July 2003.

Speaker, NSF IPAM meeting at UCLA, March 2002.

Council member, INFORMS Telecommunications College (2002-2004). Member, Organizing/Program Committees of: HPSR 2008, Sigmetrics 2007, HPSR2007, Globecom2006 NG Networks, Sarnoff 2006 Symposium, INFORMS Telecommunications Conference 2004, Milcom 2002, ACM Sigmetrics '01 / Performance '01 (June '01, Cambridge, MA), ITC Specialist Seminar on IP Traffic Measurements (Sept 2000, Monterey, CA), Sigmetrics'98/Performance'98, Fourth INFORMS Telecomm '98, Sigmetrics'97, Infocom'97 (Kobe, Japan), Performance'96 (Lausanne, 1996), Third INFORMS (was ORSA) Telecommunications Conference (Boca Raton, Fla., 1995); PADS'94 (Workshop on Parallel and Distributed Simulation, Edinburgh, 1994); Performance'93 (Rome, 1993); Performance'92 (Newport, RI, 1992); Performance of Distributed Systems and Integrated Communications Networks (Kyoto, 1991); Performance'90 (Edinburgh, Scotland, 1990); etc.

Member, INFORMS Nicholson Prize Committee, 1995; ORSA Lanchester Prize Committee, 1990.

Occasional participant in IETF meetings.

Program Chairman, "Computer Science - Applied Probability, the Interface" Boca Raton, Jan '81.

Chairman, College in Applied Probability of ORSA/TIMS, 1981-'83. Also council member for a couple of years.

Dissertation Supervision

Archan Misra, Electrical Engineering, University of Maryland.

"Dynamics of TCP Congestion Avoidance with Random Drop and Random Marking Queues". Defense February 2000.

Jingxuan Liu, Computer Science, NJIT.

"Control Architecture and Performance Analysis for WDM Burst-Switched Long haul and Metropolitan Area networks". Defense spring 2004.

Rahul B. Jain, Computer Science, NJIT.

"Design and Implementation of Split TCP in the Linux Kernel". Defense August 2007.

Teaching

Taught Courses in Computer Networking at NJIT (Graduate and Undergraduate) 2000 - 2006.

Initiated and taught new courses in “Quality of Service in the Internet”, “Advanced Networking” (includes Loadable Kernel Modules, use of Netfilter Hooks, Linux Kernel Function Hijacking).

Publications

(includes refereed conference proceedings)

The Covariance Function of the Virtual waiting Time Process in an M/G/1 Queue, *Adv. Appl. Prob. 9*, pp 158-168 (1977).

The Stable M/G/1 Queue in Heavy Traffic and its Covariance Function, *Adv. Appl. Prob. 9*, pp 169-186 (1977).

Some more results for the Stable M/G/1 Queue in Heavy Traffic, *J. Appl. Prob. 16*, pp 187 - 197 (1979).

Applied Probability - Computer Science, the Interface (Conference Proceedings), ed Ralph Disney and Teunis J. Ott, *Birkhauser*, Boston, Vol I & II (Jan 1981).

Clocked Operating Systems, Queues, and Power Series, *Proceedings of ITC Seminar “Fundamentals of Traffic Theory”*, Moscow, June’84.

On the M/G/1 Queue with Additional Inputs, *J. Appl. Prob. 21* pp 129-142 (1984).

The Sojourn Time Distribution in the M/G/1 Queue with Processor Sharing, *J. Appl. Prob. 21* pp 360-378 (1984).

(with K.R. Krishnan) State Dependent Routing of Telephone Traffic and the use of Separable Routing Schemes, Proceedings, *ITC - Kyoto*, pp A-5, Sept 1985.

(with W.E. Leland*) Load Balancing Heuristics and Process Behavior, *Perf. Eval. Rev. 14* pp 53-69 (1986) (also presented at Perf’86, Raleigh, NC).

(with W.E. Leland) Unix Processor Behavior and Load Balancing among Loosely Coupled Computers, in *Teletraffic Analysis and Computer Performance Evaluation*, O.J.Boxma, J.W. Cohen, H.C.Tijms, eds. pp 191-208, Elsevier (1986)

On the Stationary Waiting Time Distribution in the GI/G/1 Queue, I: Transform Methods and Almost Phase Type Distributions, *Adv. Appl. Prob. 19*, pp 240-265 (1987).

Simple Inequalities for the D/G/1 Queue, *Operations Research 35*, pp 589-597 (1987).

The Single Server Queue with Independent GI/G and M/G Input Streams. *Adv. Appl. Prob., 19*, pp 266-286 (1987).

(with K.R. Krishnan*) Forward Looking Routing: A new State Dependent Routing Scheme, *Proceedings of ITC-12*, Torino, Italy, pp 3.4A.4.1-3.4A.4.7 (1988).

(with M.L. Honig) On Waiting for Simultaneous Access to two Resources, *Math of OR 14*, pp 664-687, (1989).

Timescales for Packet Streams and Spectral Analysis of Point Processes, *Proceedings of ITC Seminar “Traffic Theories for New Services”*, Adelaide, Australia, Sept 1989.

- (with J.G. Shanthikumar) On Maxima and Minima of Partial Sums of Strongly Interchangeable Random Variables, *PEIS* 3, pp 319-332, (1990).
- (with J.G. Shanthikumar) On a Buffer Problem for Packetized Voice with an N-Periodic Strongly Interchangeable Input Process, *JAP* 28, pp 630-646, (1991).
- (with J.G. Shanthikumar) Structural Properties and Stochastic Bounds for a Buffer Problem in Packetized Voice Transmission, *QUESTA* 8, pp 225-236 (1991).
- (with N. Alon and K. Dewdney) Efficient Simulation of Finite Automata by Neural Nets, *JACM* 38, pp 495-514, (1991).
- (with K.R. Krishnan) A scheme for State Dependent Routing of Circuit Switched Telephone Traffic, *Ann. OR* 35, pp 43-68, (1992).
- (with G. Brightwell and P. Winkler*) Target Shooting with Programmed Random Variables, *Proceedings, ACM STOC'92* pp 691-698 (1992).
- (with T.V. Lakshman and A. Tabatabai) A scheme for Smoothing Delay-Sensitive Traffic offered to ATM Networks, *Proceedings, IEEE Infocom'92*.
- (with S. Andradottir* and D.P. Heyman) Smoothing Methods for Variance Reduction in Simulation of Markov Chains, *Proceedings, WSC'92*, pp 453-457, 1992.
- A Versatile Packet Arrival Process and its Second Order Properties, *PEIS* 7, pp 495-513 (1993).
- A Queueing System with a Branching Process Arrival Stream, the case of Short- Range Dependence, *PEIS* 7, pp 515-528 (1993).
- (with S. Andradottir and D.P. Heyman) Variance Reduction through Smoothing and Control Variates for Markov Chain Simulations, *ACM TOMACS* 3, pp 167-189 (1993).
- (with J.H.B Kemperman) Complementary Permutations for Abelian Groups, *Aequationes Mathematicae* 48 pp 262-282 (1994).
- (with S. Andradottir and D.P. Heyman) On the choice of alternative measure in importance sampling with Markov Chains, *OR* 43 pp 509 - 519 (1995).
- (with G. Brightwell and P. Winkler) Target Shooting with Programmed Random Variables, *Ann. of Appl. Prob.* 3 #5 pp 834 - 853 (Aug. 1995).
- (with S. Andradottir) Time-Segmentation Parallel Simulation of Networks of Queues with Loss or Communication Blocking, *ACM TOMACS* 5 no 4 pp 269 - 305, (Oct 1995).
- (with S. Andradottir and D.P. Heyman) Potentially unlimited Variance Reduction in Importance Sampling with Markov Chains, *Adv. Appl. Prob.* 28 no 1, pp 166 - 188, (March 1996).
- (with T.V. Lakshman and A. Neidhardt) The Drop from Front Strategy in TCP and TCP over ATM. *Proceedings of Infocom'96* pp 1242 - 1250, Los Angeles, (March 1996).
- (with N. Aggarwal) TCP over ATM: ABR or UBR? *Proceedings of Sigmetrics 1997*, pp 52-63 (1997) Seattle, WA (June 1997), also *Performance Evaluation Review* 25 (1) pp 52 - 63 (June 1997).

(with Matthew Mathis, Jeffrey Semke, and Jamshid Mahdavi) The Macroscopic Behavior of the TCP Congestion Avoidance Algorithm. *Computer Communications Review* 27 (3), pp 67 - 82 (July 1997).

This paper received the 2008 SigComm “Test of Time” award.

(with T.V. Lakshman and Larry H. Wong) SRED: Stabilized RED *Proceedings Infocom’99* pp 1346–1355. New York, NY (March 1999).

(with Archan Misra*) The Window Distribution of Idealized TCP Congestion Avoidance with Variable Packet Loss *Proceedings Infocom’99* pp 1564–1572. New York, NY (March 1999).

(with George Shanthikumar) Random Matrices, and the number of $\{0, 1\}$ matrices with given Row and Column sums. (1999). Chapter 12 in *Applied Probability and Stochastic Processes*, tribute to Julian Keilson, edited by J.G. Shanthikumar and Ushio Sumita, Kluwers 1999.

(with Archan Misra* and John Baras) The Window Distribution of Multiple TCPs with Random Loss Queues. *Globecomm’99*. Rio de Janeiro, Dec 1999.

(with Archan Misra* and John Baras) Using Drop-Biasing to Stabilize the Occupancy of Random Drop Queues with TCP Traffic. *Proceedings ICCS*, Singapore, Nov 2000.

(with Archan Misra* and John Baras) Generalized TCP Congestion Avoidance and its effect on Bandwidth Sharing and Variability. *Proceedings Globecomm 2000*. San Francisco, Dec 2000.

(with Archan Misra) Effect of Exponential Averaging on the Variability of a RED Queue. *Proceedings, ICC’01*. Helsinki, June 2001.

(with J. E. Burns, J. M. de Kock, A. E. Krzesinski*) Path selection and bandwidth allocation in MPLS networks: a non-linear programming approach. *Proceedings of ITCOM 2001*, August 2001, paper 4523-02.

A rewritten version with different set of authors appeared in PEVA 2002, see below.

(with Archan Misra) Jointly Coordinating ECN and TCP for Rapid Adaptation to varying Bandwidth. *Proceedings of MILCOM 2001*, Nov 2001. (Best unclassified MILCOM 2001 paper award).

(with Archan Misra) Performance Sensitivity and Fairness of ECN-Aware ‘Modified TCP’, *Proceedings of Networking 2002*, Pisa, May 2002.

Also published in PEVA 2003, see below.

Also published as Lecture Notes in Computer Science (LNCS), no. 2345, edited by Enrico Gregori, Marco Conti, Andrew T. Campbell, Guy Omidyar, Moshe Zukerman.

(with Burns, J.E., Krzesinski, A.E., Müller, K.E.) Path Selection and Bandwidth Allocation in MPLS Networks. *Performance Evaluation*. July 2002, 52/2-3 pp 133 - 152. Elsevier.

(with Archan Misra and John Baras) Predicting bottleneck bandwidth sharing by generalized TCP flows. *Computer Networks*. 40/4 pp 557 - 576 Nov 2002.

(with Archan Misra) Performance Sensitivity and Fairness of ECN-Aware ‘Modified TCP’, *Journal of Performance Evaluation (PEVA)*, 53/3, pp 255 - 272, August 2003.

(with Jinxuan Liu and Nirwan Ansari) FRR for Latency Reduction and QoS Provisioning in OBS Networks. *IEEE Journal on Selected Areas in Communications*, Sept 2003, 21/7 pp 1210 - 1219.

(with Lichuan Liu* and Hongya Ge) Differential STBC Scheme for Cooperative Relays in Multi-Hop Sensor Networks, *MILCOM 2005* Atlantic City, Oct 2005.

Transport Protocols in the TCP Paradigm and their Performance.
Telecommunication Systems **30**:4 pp 351-385, Springer 2005.
Also available in www.teunisott.com/Papers.

(with Rahul Jain) Design and Implementation of Split TCP in the Linux Kernel.
Proceedings Globecom 2006, Nov 2006, San Francisco, paper NXG-03-6.
Also available at www.teunisott.com/Papers.

(with Jason Swanson) Stationarity of some processes in Transport Protocols.
Under submission.

Some of this material was presented at the IFIP WG 7.3 MAMA workshop, June 2006. A shortened version appeared in *Perf.Eval.Rev.* **34**(3) (Dec 2006) pp 30 - 32.
Also available at www.teunisott.com/Papers.

Rate of Convergence for the “Square Root Formula” in the Internet transmission control protocol.
Advances in Applied Probability **38**(4) (Dec 2006) pp 1132-1154.
Also available at www.teunisott.com/Papers.

(With Jason Swanson) Asymptotic Behavior of a Generalized TCP Congestion Avoidance Algorithm.
J Appl Prob. **44**, pp 618 - 635 (Sept 2007)
Also available at www.teunisott.com/Papers.

(With Joop Kemperman) The Transient Behavior of processes in the TCP Paradigm.
Probability in the Engineering and Informational Sciences **22**(3) pp 431 - 471 (July 2008)
Also available at www.teunisott.com/Papers.

Current Working Papers

(With Matt Mathis and Joop Kemperman) The stationary behavior of ideal TCP congestion avoidance.
Available at www.teunisott.com/Papers.

This is the paper that predicts and analyzes the “Square-Root” behavior of stationary TCP under ideal Reno.

(With Abdel Es-Saghouani and Michel Mandjes) The Covariance Structure of Left Skip-Free Lévy Processes.

(With J.S.H. van Leeuwen and A.H. Löpker) TCP and Iso-Stationary Transformations.

(With Cristian Borcea and Josiane Nzouonta) Effect of Queue Discipline on Delay in Congested Wireless Ad Hoc Networks.

On the Ornstein-Uhlenbeck process with Delayed Feedback.

Among other things, this paper shows under what circumstances delay in the feedback loop makes the Ornstein-Uhlenbeck process unstable. The purpose of this paper is to study possible oscillatory behavior in TCP/IP, for example with Random Early Detection (RED) and in the situation of the “TCP Paradigm”.

See website for a copy.

Other current working paper: Cache Management.

Recent Talks

(non-refereed, all but a few invited, * indicates presenting co-author).

Rate of Convergence for the “Square Root Law for TCP”. Keynote speaker, Third ARC TCP Workshop, INRIA, Sophia-Antipolis, France. Oct 2004.

Path Selection and Bandwidth Assignment in MPLS. Presentation at “MPLS-2000”, workshop at UUNET and George Mason University, Oct 2000. Based on work with Tony Bogovic, Jim Burns, Tami Carpenter, K.R. Krishnan, and David Shallcross.

(with Larry Wong) “Link Level Boosters for TCP over Noisy Links” *Conference Proceedings, Advanced Telecommunication & Information Distribution Research Program (ATIRP) 3rd Annual FEDLAB Symposium*, pp 207–210, February 1999.

ECN Protocols and the TCP Paradigm.

Workshop on Modeling of Flow and Congestion Control Mechanisms, Ecole Normale Supérieure, Paris, Sept 1999.

(with T.V. Lakshman and Larry Wong) “BRED (Biased RED)” Fourth INFORMS Telecommunication Conference, Boca Raton, Fla, March 1998.

Organized hot-topics session for Performance’96: “TCP over ATM with ABR”. Oct ’96, Lausanne, Switzerland.

Organized hot-topics session for Sigmetrics ’95: “The Internet in Evolution, and TCP over ATM”. Also co-author of talk (with T.V. Lakshman and A. Neidhardt) in this session. May ’95, Ottawa.

Patents

USA Patent 4,704,724 (with K.R. Krishnan)

Routing of Network Traffic.

(This is the “Separable Routing” patent.)

Nov. 3, 1987.

USA Patent 4,788,721 (with K.R. Krishnan)

Routing of Network Traffic.

(This is the “Forward Looking Routing” patent.)

Nov. 29, 1988.

USA Patent 5,537,446 (with T.V. Lakshman and A. Tabatabai)

Smoothing of Delay Sensitive Traffic.

(Mostly aimed at smoothing video traffic.)

July 16 1996.

USA Patent 5,650,993 (with T.V. Lakshman and A. Neidhardt)
The Drop from Front of Buffer Policy in Feedback Networks.
July 22 1997.

USA Patent 6,434,116
Method and system for stabilized random early detection using connection sampling.
August 13 2002.

USA Patent 6,449,253
Method and system for dynamic allocation of bandwidth in asynchronous transfer mode
(ATM) switching systems.
Sept. 10, 2002.

USA Patent 6,560,198 (with T.V. Lakshman)
Method and system for stabilized random early detection using packet sampling.
May 6, 2003.

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