Tara Small

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Education

2004 to 2005: Ph.D. in Applied Mathematics from Cornell University, USA.
Advisor: Prof. Zygmunt Haas
Thesis title: "Modeling Tradeoffs in Intermittent-Connectivity Networks"

2000 to 2004: Masters of Science in Applied Mathematics from Cornell University, USA.
Advisor: Prof. Zygmunt Haas
Cumulative GPA 3.8

1996 to 2000: Bachelor of Science with Honours in Mathematics and Physics from the University of New Brunswick, Canada.
Cumulative GPA 4.3

Work Experience

August 2005 to present:
Postdoctoral Fellow, University of Toronto. Full-time work. Used mathematical background to devise methods of improving efficiency in overlay networks; Designed methods for media-content providers to serve high-quality streaming to network nodes without overwhelming provider cost using techniques from randomized algorithms and optimization.

December 2001 to present:
Networking Article TPC Chair/Reviewer, Cornell University and University of Toronto. Part-time work. TPC Chair: MASS 2006. Revier for ad hoc networking articles for conferences and journals such as WINET, IEEE Communications Magazine, AdHoc Networks Journal, Mobihoc, MONET, Transactions on Mobile Computing, Transactions on Parallel and Distributed Systems, among others.

May to August 2002, January to April 2003, September 2003 to August 2005:
Electrical and Computer Engineering Research Assistant, Cornell University. Full-time work with Prof. Zygmunt Haas. Developing analytical solutions for a bioengineering project involving the communication of devices on whales to transmit biological information to land more quickly and reliably than is currently possible; Creating a simulation in C++ strongly supporting these analytical results.

September 2003 to May 2005:
Peer Mentor, Cornell University. Part-time work. Advising first year Applied Mathematics

PhD students one-on-one; Accompanying the students to organized events.

September 2001 to May 2004:
Colloquium Coordinator, Cornell University. Part-time work. Organizing seminar series for Applied Mathematics graduate students to discuss the work in progress of their theses, and to give opportunities to practice presentations for conferences and exams, and for first year Applied Math graduate students to assist in finding a faculty advisor.

May to August 2001:
LabVIEW Software Designer, Nortel Networks. Full-time work. Developing an interface between a PC running LabVIEW software and a Transport Control System card on amplifier and MUX/DeMUX circuit packs to create an automated testing environment for hardware/software interface commands; Producing documentation for use and further development of the software; Configuring test cards for optical modules and mother boards.

Teaching Experience

September to December 2002, July to August 2003:
Teaching Assistant, Cornell University. Part-time work. Teaching recitations twice a week for discrete mathematics freshman-level students; Assisting in laboratories for computer programming courses twice per week; Grading preliminary and final examinations.

September 2001 to May 2002:
Calculus Instructor, Cornell University. Part-time work. Teaching freshman-level Calculus 4 days each week; Grading and helping to develop midterm and final examinations.

September 1997 - May 1999:
Middle School Mathematics Teacher, Self-Employed. Part-time work. Home-schooling a student in grades six, seven and eight mathematics, who won first place on a provincial Junior High Mathematics Competition; Serving as a mathematical enrichment instructor for junior high school, in which I presented six weekly workshops for gifted students.

Scholarly publications and presentations

Journal articles and book chapters:

- **Small, T.** and Haas, Z.J., "Quality of Service and Capacity in Constrained Intermittent-Connectivity Networks," to appear in IEEE Transactions on Transactions on Mobile Computing.
- **Small, T.**, Li, B., and Liang, B., "Outreach: Peer-to-Peer Topology Construction towards Minimized Server Bandwidth Costs," to appear in IEEE JSAC's special issue on Peer-to-Peer Communications and Applications.
- Haas, Z.J. and **Small, T.**, "A New Networking Model for Biological Applications of Ad Hoc Sensor Networks," IEEE/ACM Transactions on Networking, February 2006. [1 citation]

- **Small, T.**, Haas, Z.J., Purgue, A., and Fristup, K., "A Sensor Network for Biological Data Acquisition," Chapter 11 in "Handbook of Sensor Networks editor Mohammad Ilyas," CRC Press: **11**-1-**11**-17 (July 2004). [1 citation]

Conference and workshop papers, Internet drafts:

- **Small, T.**, Liang, B., and Li, B., "Fundamental Scaling Laws of Peer-to-Peer Live Multimedia Streaming," to appear in ACM Multimedia Systems Track, 2006. [17.1% acceptance rate]
- Haas, Z.J. and **Small, T.**, "Evaluating the Capacity of Resource-Constrained DTNs," International Wireless Communications and Mobile Computing Conference: 545-550 (July 2006). [48.1% acceptance rate]
- **Small, T.**, Li, B., and Liang, B., "On Optimal Peer-to-Peer Topology Construction with Maximum Peer Bandwidth Contributions," 23rd Biennial Symposium on Communications: 157-160 (May 2006). [66% acceptance rate]
- **Small, T.** and Haas, Z.J., "Resource Tradeoffs in Delay-Tolerant Wireless Networks," ACM SIGCOMM'05, Workshop on Delay-Tolerant Networking: 260-267 (August 2005). [22.8% acceptance rate, 5 citations]
- **Small, T.** and Haas, Z.J., "Designing Markov Models for Mobile Sensor Systems," 1st IEEE Upstate NY Workshop on Communications and Networking: 172-176 (November 2004).
- Arpacioglu, O., **Small, T.**, Haas, Z.J., "Notes on Scalability of Wireless Ad Hoc Networks," IEEE ANS WG Internet draft http://wnl.ece.cornell.edu/Publications/draft-irtf-ans-scalability-definition-01.txt (August 2003, updated October 2003).
- **Small, T.** and Haas, Z.J., "The Shared Wireless Infostation Model – A New Ad Hoc Networking Paradigm (or Where there is a Whale, there is a Way)," ACM MOBIHOC '03: 233-244 (June 2003). [15.3% acceptance rate, 56 citations]

Distinctions and Awards

O'Brien Foundation Fellowship	July 2004 to July 2005
NSERC Postgraduate Scholarship A	September 2000 to August 2002
(declined - due to decision to study outside Canada)	
Cornell University Graduate Fellowship	August 2000 to May 2001
Governor General's Silver Medal	Graduation 2000
(for highest academic standing for entire university)	
Lieutenant Governor's Silver Medal - Science	Graduation 2000
(for highest academic standing in Science)	
Regional Finalist for the Rhodes Scholarship	Fall 1999

Research Statement

"Sorry, the webcam servers are currently too busy to handle your request. Try again later." is a common message issued by the Yahoo! Messenger service when attempting to connect in a video conference session. Although many of today's communication technologies have been implemented and are in commercial use, they have problems scaling to large numbers of users. I am interested in developing mathematical models to better understand and analyze current networking protocols and to design efficient algorithms to optimize their performance.

In my PhD thesis, I introduced the Shared Wireless Infostation Model (SWIM)[1]. This mathematical model represents the propagation of packets in a mobile wireless network with frequent partitions (delay-tolerant networks), where the entire path from a message source to a destination almost never exists in the system at the same time. Epidemic routing[2] is a solution that can deliver messages to their destinations in these networks, but uses considerable resources. I derived analytical Markov chains to represent the transient behaviour of packets in the system propagating to their destinations taking into account Quality of Service constraints. Furthermore, I quantified and improved tradeoffs between the network resources (such as storage and energy at the nodes) and non-critical performance (such as delay in packet reception). Most importantly, SWIM provides network designers control over resource usage in intermittent-connectivity systems. Before running simulations or making any network measurements, the designer experiments with the mathematical models to allocate resources in the system that optimize cost while providing the performance described by the Quality of Service agreement.

My postdoctoral work involves mathematical modeling for wired multimedia streaming networks. While CoolStreaming[3] is a functional implementation of this technology over today's Internet, it does not optimize system resources. Again, I model the network to observe the system and design algorithms to approach the optimal efficiency, which in turn allows me to scale networks to very large numbers of nodes with limited resources.

I would like to further my research to delay-tolerant networks in wired, wireless or heterogeneous settings. There are many practical scenarios today that would benefit from the creation and optimization of delay-tolerant networking. Some of these applications include deep space communications, sensor networks and terrestrial "hole" regions where it is costly to provide ubiquitous Internet coverage. My goal is to design abstract mathematical models that can be approximated in ways that are practical and durable enough to be used in products in this fast-growing field. I believe that my strong applied mathematics background has been and will continue to be invaluable in supporting this line of research.

[1] T. Small and Z. J. Haas, "The Shared Wireless Infostation Model – A New Ad Hoc Networking Paradigm (or Where there is a Whale, there is a Way)," *ACM MOBIHOC'03*, June 2003.

[2] A. Vahdat and D. Becker, "Epidemic routing for partially-connected ad hoc networks," Duke Technical Report CS-2000-06, July 2000.

[3] X. Zhang, J. Liu, B. Li, and T.-S. P. Yum, "CoolStreaming/DONet: A Data-Driven Overlay Network for Efficient Live Media Streaming," *INFOCOM 2005*, March 2005.