Sumit Singh

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Profile

Ph.D. in Electrical and Computer Engineering with research experience in communication network protocol design, modeling and performance analysis, resource allocation, and quality of service for multimedia applications.

Education

Nov., 2009 **Ph.D., Electrical and Computer Engineering**
University of California, Santa Barbara, CA, USA
Thesis title Medium Access Control and Bandwidth Allocation in Millimeter Wave and WiFi Networks
Advisors Prof. Upamanyu Madhow and Prof. Elizabeth Belding

Mar., 2006 **M.S., Electrical and Computer Engineering**
University of California, Santa Barbara, CA, USA
Advisors Prof. Upamanyu Madhow and Prof. Elizabeth Belding

Mar., 2008 **Graduate Certificate, Graduate Program in Management Practice**
University of California, Santa Barbara, CA, USA

Aug., 2002 **B.Tech., Electrical Engineering**
Indian Institute of Technology Bombay, Mumbai, India
Thesis title Virtual Topology Optimization and Multi-Period Design in Wavelength Routed Optical Networks
Advisor Prof. D. Manjunath

Professional Experience

07/2008-09/2008 **Graduate Intern,** *Intel Communication Technologies Lab,* Hillsboro, OR
Manager/Mentor: Dr. Lily L. Yang, Dr. Guoqing C. Li
Project: High definition compressed/uncompressed video support over 60 GHz wireless personal area networks.

07/2007-09/2007 **Summer Intern,** *Alcatel-Lucent Bell Laboratories,* Murray Hill, NJ
Manager/Mentor: Dr. T. V. Lakshman, Dr. Murali Kodialam
Project: A game theoretic approach to characterize the throughput achieved by wireless systems comprising autonomous users.

06/2002-08/2004 **Software Engineer,** *Samsung India Software Operations,* Bangalore, India
Project: Multi-Protocol Label Switching (MPLS) implementation for an IP router, focusing on two MPLS applications: traffic engineering and layer-2 tunneling support.

05/2001-07/2001 **Summer Intern,** *Cypress Semiconductors,* Bangalore, India
Project: A study of the Resilient Packet Ring (RPR) Technology and its implementations.

09/2004-12/2005 **Teaching Assistant,** *ECE Dept., UCSB*
Courses: ECE-2A: Circuits, Devices and Systems (Fall 2004, Winter 2005), ECE-155A: Computer Networks (Spring, 2005), ECE-139: Random Processes for Engineering (Fall 2005)
Responsibilities: conducting lab sessions, discussion sections, grading assignments and exams, conducting office hours to help students with course-related difficulties.

Student Mentor, *ECE Dept., UCSB*

09/2006-06/2007 Federico Ziliotto (masters)
03/2009-06/2009 Nathan Radke (undergraduate)

Research Interests and Experience

Networking: networked systems, next generation wireless networks: architectures, resource allocation and protocol design

Nov., 2009 – **Postdoctoral Researcher,** *with Prof. U. Madhow and Prof. E. Belding, UCSB*

- Network modeling, protocol design, and experimentation for multi-gigabit outdoor and indoor wireless networks operating in the unlicensed 60 GHz "millimeter (mm) wave" band.
- Design, analysis and experimentation for cooperative pico-cellular communication strategies for increased capacity in next generation cellular/WiMAX networks.
- Responsibilities include assisting with research proposals and mentoring Ph.D. students.

2005-2009 **Graduate Research Assistant,** *with Prof. U. Madhow and Prof. E. Belding, UCSB*

- *60 GHz millimeter (mm) wave outdoor mesh networks*
  This research investigates an architecture for multi-gigabit mm wave outdoor mesh networks. Given the high directionality essential to combat high atmospheric path loss, we showed that interference is drastically reduced in such networks. However, the high link directionality renders carrier sensing-based medium access approaches infeasible. Armed with these design insights, we defined a distributed medium access control (MAC) protocol that exploits the pseudo-wired characteristic of mm wave links, and employs memory and learning to achieve implicit transmit coordination in the network.
- *60 GHz millimeter wave wireless personal area networks (WPANs)*
  We proposed a cross-layer modeling methodology and designed a directional multihop WPAN architecture for efficient utilization of the unlicensed 60 GHz band, taking into account the unique physical characteristics of mm waves, such as larger propagation losses and reduced diffraction around obstacles. We developed a diffraction-based model to determine link losses as a function of stationary and moving obstacles in a given indoor setting, and defined a directional MAC protocol that employs multihop relay to maintain consistent network connectivity.
- *A resource biasing framework for shaping throughput profiles in multihop wireless networks*
  In this research, we investigated bandwidth allocation for competing flows in multihop wireless networks, and proposed a rich class of "mixed-bias" strategies that achieve a desired tradeoff between throughputs achieved by flows and their resource usage (i.e., flow throughput profiles), while ensuring efficient network utilization.
- *Sticky CSMA/CA: Implicit synchronization and real-time QoS over mesh networks*
  The goal of this research was to rethink MAC for real-time quality of service (QoS) support over mesh networks operating in the 2.4 and 5.8 GHz WiFi bands. We proposed Sticky CSMA/CA, a MAC framework that exploits application layer regularities along with learning and memory at each node to achieve decentralized transmit coordination. The large gains relative to the conventional CSMA/CA MAC protocols (IEEE 802.11b/e) over voice/data networks demonstrated the promise of yet-underutilized tools of learning and memory in network protocol design.
- *MAC framework for opportunistic use of the TV spectrum*
  MAC design for prediction-based opportunistic utilization of the broadcast TV spectrum by the unlicensed secondary users while proactively avoiding interference to the primary users.

2000 - 2002 **Undergraduate Researcher,** *with Prof. D. Manjunath, IIT Bombay, India*

- *Virtual topology optimization and multi-period design in wavelength-routed optical networks*
  Formulation of network topology design problems as mixed integer linear programming (MILP) problems, which can be solved using software tools for optimization. We proposed two algorithms for multiperiod topology design.
- *Quality of service in packet switching networks*
  A survey of different components of QoS-capable network architectures such as IntServ and DiffServ, various packet scheduling disciplines, resource allocation and QoS routing.

Publications

Journals

- S. Singh, F. Ziliotto, U. Madhow, E. M. Belding, and M. Rodwell. **Blockage and Directivity in 60 GHz Wireless Personal Area Networks: From Cross-Layer Model to Multihop MAC Design.** IEEE Journal on Selected Areas in Communication (JSAC): Special Issue on Realizing Gbps Wireless Personal Area Networks, vol 27, no. 8, pp. 1400-1413, Oct. 2009.

- S. Singh, P. Acharya, U. Madhow, and E. M. Belding. **Sticky CSMA/CA: Implicit Synchronization and Real-time QoS in Mesh Networks.** Ad hoc Networks Journal, vol.5, no. 6, pp. 744-768, Aug. 2007.
- S. Singh, U. Madhow, and E. M. Belding. **Shaping Throughput Profiles in Multihop Wireless Networks: A Resource Biasing Approach.** Submitted for publication in IEEE Trans. Mob. Comput., 2009.
- S. Singh, R. Mudumbai, and U. Madhow. **Interference analysis for highly directional 60 GHz mesh networks: the case for rethinking medium access control.** In preparation.
- P. Manohar, A. Padmanath, S. Singh, and D. Manjunath. **Multiperiod Virtual Topology Design in Wavelength Routed Optical Networks.** IEE Proc. - Circuits, Devices and Systems, vol 150, no. 6, pp. 516-520, Dec. 2003.

Conferences

- S. Singh, R. Mudumbai, and U. Madhow. **Distributed Coordination with Deaf Neighbors: Efficient Medium Access for 60 GHz Mesh Networks.** in Proc. IEEE INFOCOM 2010, San Diego, CA, Mar. 2010.
- R. Mudumbai, S. Singh, and U. Madhow. **Medium Access Control for 60 GHz Outdoor Mesh Networks with Highly Directional Links.** in Proc. IEEE INFOCOM 2009, Mini Conference, Rio de Janeiro, Brazil, Apr. 2009.
- S. Singh, U. Madhow, and E. M. Belding. **Beyond Proportional Fairness: A Resource Biasing Framework for Shaping Throughput Profiles in Multihop Wireless Networks.** in Proc. IEEE INFOCOM 2008, Mini Conference, Phoenix, AZ, Apr. 2008.
- S. Singh, F. Ziliotto, U. Madhow, E. Belding, and M. Rodwell. **Millimeter Wave WPAN: Cross-Layer Modeling and Multihop Architecture.** in Proc. IEEE INFOCOM 2007, Minisymposium, Anchorage, AL, May 2007.
- P. Acharya, S. Singh, and H. Zheng. **Reliable Open Spectrum Communications Through Proactive Spectrum Access.** in Proc. International Workshop on Technology and Policy for Accessing Spectrum (TAPAS), Boston, MA, Aug. 2006.
- P. Manohar, A. Padmanath, S. Singh, and D. Manjunath. **Multiperiod Virtual Topology Design in Wavelength Routed Optical Networks.** Sixth International Conference on Optoelectronics, Fiber Optics and Photonics (PHOTONICS 2002), Mumbai, India, 2002.

Patents

- K. Han, G. C. Li and S. Singh. **Display update for a wireless display device.** U.S. patent application serial number 12/489,746 (Intel patent application).

Computer Skills

- *Programming Languages: C, Perl; Data processing: awk, shell script*
- *Software Tools: Network simulators: QualNet, OPNET and NS-2; MATLAB; Optimization tools: GLPK, AMPL Optimization Language, MathProg*

Professional Service and Extracurricular Activities

- **Member,** *ACM, IEEE and IEEE Communications Society*
- **Technical Program Commitees:** *TPC member and web-chair: mmCom 2010 (A MobiCom/MobiHoc 2010 workshop)*
- **Journal reviews:** *IEEE Trans. on Mobile Computing, IEEE Trans. on Information Theory, IEEE Trans. on Communications, IEEE Trans. on Wireless Communications, Elsevier Ad Hoc Networks Journal, ACM/Springer MONET Journal*
- **Conference reviews:** *ACM MOBICOM '07, '08, ACM MOBISYS '07, IEEE INFOCOM '06, IEEE ICC '09, IEEE VTC '06, '10, IEEE PIMRC '08, '10, IWCMC '08, WiOpt '09, SECON '10*
- *President (2005-2006), India Association of Santa Barbara, UCSB*

References

Available on request.