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Wireless Information Network Laboratory (WINLAB)
Rutgers University, 671 Route 1 South,
North Brunswick, NJ 08902-3390

OBJECTIVE — A faculty/research position in Electrical And Computer Engineering.

RESEARCH AREA — LARGE Mobile Wireless Networks, Intelligent Transportation Systems, Medium Access Control techniques, Wireless Channel Modeling, Emulation Testbeds.

EDUCATION

Rutgers University, NJ PhD. in Electrical and Computer Engineering (**GPA: 3.867**)	Sep 2004 – Present **(Expected May 2011)**
Birla Institute of Technology, Ranchi, India BE in Electrical and Computer Engineering	May 2000

EMPLOYMENT

Wireless Information Network Laboratory (WINLAB), Rutgers University, NJ **Graduate Assistant**	Sep 2005 – Present
InterDigital Communications, Farmingdale, NY **Summer Intern**	July 2005 – Sep 2005
WINLAB, Rutgers University, NJ **Staff**	Sep 2004 – Sep 2005
Ubinetics India Private Ltd. (now CSR), Bangalore, India **Senior Engineer**	Sep 2003 – Aug 2004
Hughes Software Systems (now Aricent), Gurgaon, India **Senior Software Engineer**	Oct 2002 – Sep 2003
Hughes Software Systems (now Aricent), Gurgaon, India **Software Engineer**	Jan 2001 – Oct 2002
Tata Consultancy Services, Calcutta, India **Assistant Software Engineer, Trainee**	July 2000 – Jan 2001

PROJECTS

Delay Optimal State Dissemination with Piggybacking *Analyze the problem of reliable and timely broadcast of state information in large vehicular networks and design optimal schemes.* We consider the problem of periodic dissemination of time-varying state among nodes in a wireless network, with minimum average delay. We assume packets have large overheads such that node transmissions can piggyback other nodes' state information with negligible increase in their packet transmission times. The optimization problem is finding round robin schedules that minimize the system delay.	2009 – Present *At WINLAB, in collaboration with Toyota InfoTechnology Center.*
Minimizing Age of Information in Vehicular Networks using Rate Control *Design and implement a rate control algorithm that minimizes the age of system information in vehicular networks.* Even in congested networks, when applications may not be able to achieve very high messaging rates, on-road vehicles must be able to converge to the best possible messaging rate, a rate that minimizes the average age (delay) of vehicles' information at any vehicle in the network. We design a rate control algorithm that achieves the best rate. The algorithm is distributed in nature and adapts to varying number of cars in the network.	2009 – Present *At WINLAB, in collaboration with Toyota InfoTechnology Center.*
Vehicle-to-Vehicle channel modeling *Model the channel between two vehicles in presence of other vehicles in proximity.*	2009 – Present

We measure and model the narrowband channel between two cars, separated by up to 50m in distance, while up to five other cars drive in their vicinity. The measurement scenarios are designed to emulate typical on-road multi-lane scenarios. All measurements were carried out in an empty parking lot, which provided a controlled and repeatable environment.	*WINLAB.*
Exploiting Spatio-Temporal Similarity in Vehicle Movements for Reducing Messaging Loads in Vehicular Networks *Empirically study prediction and compression schemes to reduce messaging in vehicular networks.* Many vehicular safety applications rely on vehicles periodically broadcasting their position information and location trace. In very dense networks, such safety messaging can lead to offered traffic loads that saturate the shared wireless medium. One approach to address this problem is to reduce the frequency of location update messages when the movements of a vehicle can be predicted by nearby vehicles. We study the predictability of vehicular locations, given a Global Positioning System trace of a vehicles recent path.	2009 *WINLAB, in collaboration with Toyota InfoTechnology Center.*
GeoMAC: Geo-Backoff based Co-operative MAC for V2V networks *Design and implement a location based MAC to disseminate safety information in sparse vehicular networks.* On-road vehicles talk to each other via messages. We tackle the communications challenge at the medium access control (MAC) layer, which is to achieve low bounded latency and high delivery reliability, goals that are intrinsic to the success of many envisioned vehicular safety applications. GeoMAC is a MAC protocol that exploits spatial diversity in highly mobile wireless networks. GeoMAC exploits spatial diversity by allowing other nearby nodes to opportunistically forward and retransmit messages. Through a geo-backoff mechanism it uses geographic distance to the destination as a heuristic to select the forwarder most likely to succeed.	2008 *WINLAB, in collaboration with Toyota InfoTechnology Center*
Effects of antenna placement and vehicle (car) geometry *Empirically evaluate the effect of antenna placement at different positions in a vehicle under varied propagation environments.* We examine the effects of antenna placement and vehicle (car) geometry on a vehicle-to-vehicle link in the 5 GHz band, which is of interest for planned inter-vehicle communication standards. The measurements were made at three different parking lots and a freeway. Propagation environments varied from strong line of sight to no line of sight. Off the shelf 802.11a cards were used for the measurements.	2006 – 2007 *WINLAB.*
Topology creation on wireless testbeds using noise injection *Design algorithms that allow users of the ORBIT testbed to map a real-world wireless topology to nodes on the grid, such that the topologies are throughput equivalent.* We design and implement an algorithm that takes as input the number of nodes in a topology and the link RSSI(s). The algorithm maps the nodes in the topology onto the grid and returns the interference (noise) power that needs to be injected into the grid to emulate the required topology.	2005 – 2006 *WINLAB.*
Mobility Emulation on wireless testbeds *Provide users of the ORBIT testbed with a framework that can emulate one or more mobile nodes on the grid.* Develop a framework to emulate mobility of a wireless node in the real world on a testbed (ORBIT, 400 nodes in an area of 400 square meters). Combined with interference injection the framework is useful to emulate mobile ad-hoc networks where nodes may experience	2004 – 2005 *WINLAB.*

variable connectivity.	
Radio Resource Management in WLANs Modify and test existent algorithms to allow channel selection and access point selection in an infrastructure WLAN network with multiple access points and clients so as to distribute load over all access points and avoid channels with high traffic or interference (for e.g., microwave) on them.	2005 *Internship at InterDigital Communications, NY.*
Radio Resource Control for the User Equipment (UE) in UTRAN *The project involved design and implementation of the RRC layer for the UE.* Was involved in: 1) Handling of SIB5 and storage of the same in the database. 2) Development of Inter RAT Measurements handling. 3) Fixing of any observations raised during customer testing or otherwise.	2003 – 2004 *Ubinetics*
Porting SAAL/ALCAP/NBAP *The project involved porting of SAAL/ALCAP/NBAP stacks onto OSE-SFK. The stacks were available for Solaris and Linux Platforms. After porting on OSE-SFK, the stacks were compiled using GHS Multi IDE and run on a PPC simulator.* Was involved in: 1) Porting of the SAAL and ALCAP stacks. 2) Integration of SAAL with NBAP.	2003 *HSS, India.*
Radio Resource Control layer for a Radio Network Controller in UTRAN *The project involved design and implementation of the layer 3 of the Radio Network Controller. The design included various service blocks that implement functionalities of mobile call control, handover control, and resource management amongst others.* Was involved in design and development of the Node B RRC functionality. Worked on RAB setup, modification and release and I_u relocation.	2003 *HSS, India.*
Geographical Redundancy Solution for a WCDMA Home Location Register (HLR) *The project involved designing and implementing N:1 geographical redundancy for HLR. The solution provided for movement of network operations from one location to another with minimum data loss and down time in case of a Catastrophic Disaster. All Operational HLRs replicate data to a geographically separated site called Non-Operational HLR. On failure of any Operational HLR, Non-Operational site takes up operations of failed HLR. Data Replication was implemented on various sub-systems of HLR, including the BPM (Backend Processing Module), SM (Subscriber Manager) and EM (Element Manager).* Was involved in: 1) Requirement analysis and Design of the Geographical Redundancy solution. 2) Design and development of Remote Replication Manager/ Agent for SM. 3) Design and development of Remote Replication Manager for BPM.	2002 – 2003 *HSS, India.*
Subscriber Management for a WCDMA HLR *Subscriber management involved providing a means of provision and query of Subscriber, AUC and EIR Data stored in the HLR Database.* My responsibilities included: 1) Design and development of the system which provided an interface to provision and query the data stored in the HLR Database. Other functionality included an interface to import and export the database. UML/OOAD methodology was used for design. 2) Development of a wrapper library to access the Oracle Database via OCI APIs. 3) Reviewing and coordinating the team work.	2001 – 2002 *HSS, India.*
Malaysian railway reservation system *The project involved providing a web based railway reservation system for Malaysia. The graphical user interface was created using Oracle D-2K. The backend was Oracle 8i.* Was involved in: Maintenance of the existing release which involved writing stored	2000 – 2001 *Tata Consultancy Services.*

procedures, and make fixes in the user interface as and when encountered.

PUBLICATIONS

[*Preparing for Submission*] **S. K. Kaul**, L. Greenstein, and M. Gruteser, "Vehicle-to-Vehicle channel modeling with cars in vicinity," 2011.

[*Preparing for Submission*] **S. K. Kaul**, R. Yates, M. Gruteser, "Delay optimal state dissemination with piggybacking," 2011.

[*Submitted*] **S. K. Kaul**, R. Yates, M. Gruteser, "On Piggybacking in Vehicular Networks," in Globecom, 2011.

[*Accepted for Publication*] **S. K. Kaul**, M. Gruteser, V. Rai, and J. Kenney, "Minimizing age of information in congested vehicular networks," in IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), 2011.

S. Kaul, M. Gruteser, V. Rai, and J. Kenney, "On Predicting and Compressing Vehicular GPS Traces," in Communications Workshops (ICC), 2010 IEEE International Conference on, pp. 1-5, 2010.

Sangho Oh, **Sanjit Kaul**, Marco Gruteser, "Exploiting Vertical Diversity in Vehicular Networks Channel Environments," Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), 2009.

Suhas Mathur, **Sanjit Kaul**, Marco Gruteser, Wade Trappe. ParkNet: Harvesting Real-Time Vehicular Parking Information Using a Mobile Sensor Network. The S3 Workshop at the 10th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc), 2009.

S. Kaul, M. Gruteser, R. Onishi, R. Vuyyuru, and T.I.T. Center, "GeoMAC: Geo-Backoff based Co-operative MAC for V2V networks," IEEE International Conference on Vehicular Electronics and Safety, 2008. ICVES 2008, 2008, pp. 334-339.

S. Kaul, K. Ramachandran, P. Shankar, S. Oh, M. Gruteser, I. Seskar and T. Nadeem. "Effect of Antenna Placement and Diversity on Vehicular Network Communications", Proceedings of IEEE Sensor, Mesh, and Ad Hoc Communications and Networks (SECON), June 2007 [AR 20%].

Sanjit Kaul, Marco Gruteser, and Ivan Seskar. "Creating Wireless Multi-hop Topologies on Space-Constrained Indoor Testbeds Through Noise Injection", 2nd International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (Tridentcom), Barcelona, Spain 2006.

K. Ramachandran, **S. Kaul**, S. Mathur, and M. Gruteser. "Towards Mobility Emulation Through Spatial Switching on a Wireless Grid", Proceedings of ACM E-WIND Workshop (held with ACM SIGCOMM), Philadelphia, PA, 2005.

K. Ramachandran, **S. Kaul**, S. Mathur, and M. Gruteser. "Mobility Emulation Through Spatial Switching on a Wireless Grid (Demo)", ACM/USENIX Intl. Conference on Mobile Systems, Applications and Services (MOBISYS), Seattle, WA, June 2005.

TALKS AND POSTERS

On Predicting and Compressing Vehicular GPS Trace
Talk at Communications Workshops, IEEE International Conference (ICC), 2010, Cape Town, South Africa.

On Predicting and Compressing Vehicular GPS Trace
Poster at WINLAB IAB, Dec 2009.

GeoMAC: Geo-backoff based Co-operative MAC for V2V networks.
Talk at IEEE International Conference on Vehicular Electronics and Safety, Sep 2008, Ohio.

Geo-Cooperative MAC Protocol (LocMAC) for Vehicular Networks

Poster at WINLAB IAB, June 2008.

Effect of Antenna Placement and Diversity on Vehicular Network Communications
Talk at WINLAB IAB, Dec 2007.

Effect of Antenna Placement and Diversity on Vehicular Network Communications
Talk at IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks, June 2007, San Diego.

Creating Wireless Multi-hop Topologies on Space-Constrained Indoor Testbeds Through Noise Injection
Talk at WINLAB IAB, Nov 2006.

Creating Wireless Multi-hop Topologies on Space-Constrained Indoor Testbeds Through Noise Injection
Talk at International Conference on Testbeds and Research Infrastructures for the Development of Networks and Communities (Tridentcom), March 2006.

PROFESSIONAL ACTIVITIES

Reviewer for ACM/IEEE conferences and journals: Infocom, Mobisys, IEEE Wireless Communications Magazine, IEEE JSAC Vehicular Networks, IEEE MASS, IEEE ITS, IEEE VNC, MobiOpp, nivi09, Oakland09, Winmee, Hotmobile, Wivec, V2VCOM 2008, Data & Knowledge Engineering Journal, GLOBECOM-ISET, Wowmom.

IEEE student member.

Student volunteer at IEEE SECON 2007.

AWARDS

IEEE ICC 2010 travel grant.

PLATFORMS/SOFTWARE/TOOLS/LANGUAGES

Sun Solaris, Linux, Windows NT, OSE, VxWorks, ARM.
Rational Rose, Rational Purify, Rational Clearcase, Rational Quantify, MSVC, GHS Multi, gdb, dbx, GNU Make, Atheros Madwifi Driver. C, C++, Perl, Java, Unix shell scripting.

REFERENCES

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