

MUKUNDAN SRIDHARAN

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INTERESTS

- ◇ *Networked and distributed systems*: Mobile networks, mobility modeling, connectivity, social networks, scalable network protocols, wireless networks, sensor networks and ubiquitous computing.
- ◇ *Software Systems*: Architectures, services and tools for design of testbeds and rule-based autonomic systems.

EDUCATION

- ◇ Ph.D, Computer Science and Engineering
The Ohio State University, June 2009 (Expected)
Adviser: Dr. Anish Arora
Major: Networking
Minors: Distributed Computing, Software Systems, High Performance Computing
GPA: 3.50/4.0
- ◇ M.S., Computer Science and Engineering
The Ohio State University, March 2003
Adviser: Dr. Arjan Durresi
Major: Networking
GPA: 3.48/4.0
- ◇ B.E., Electronics and Communication Engineering
University of Madras, India, June 2000
First Class with Hons.

WORK EXPERIENCE

- ◇ Graduate Research Associate and Network Administrator, Dependable and Distributed Networked Systems Lab, CSE, The Ohio State University (Jan 2005 - Present)
- ◇ Research Intern, Robert Bosch Research Technology Center, Palo Alto, CA (Jun - Sept 2008). I designed and implemented a wireless reprogramming service for the a industrial security sensor network.
- ◇ Research Associate, Third Frontier Network Measurement Project, Oarnet, OSC (Sept 2003 - Dec 2004)
- ◇ Graduate Research Associate and Network Administrator, Networking and Telecommunications Lab, CSE, The Ohio State University (Jan 2001 - June 2003)
- ◇ Graduate Teaching Associate, CSE, The Ohio State University (Oct 2000 - June 2001)
- ◇ Intern, HTL Limited (Telecommunication Switch Manufacturers), Chennai, India. (July 1999 - Sept 1999)

TECHNICAL SKILLS

- ◇ Experience in systems development
 - * Designed and implemented an end-to-end wireless reprogramming service for msp430/CC1020 based nodes, using C/IAR WorkBench, MATLAB, Perl.

- * Designed and implemented a *locality-specific* application suite for (linux based) mobile phone in-building network using Java/EzX platform.
- * Designed and implemented routing and network services for wireless/mobile sensor networks for mote platforms (MICA, MICA2, XSM, TELOS, Imote2), Stargates, IEEE 802.11b radios, Chipcon radios, TinyOS, nesC and Emstar
- * Developed networking and monitoring software for testbeds using TCP/UDP sockets, Perl etc.
- * Designed and developed web-based scheduling interface for wireless experimentation using, MySQL, Python, PHP, Perl etc
- * Developed a wireless simulator for mobile networks in MATLAB
- ◇ Research Tools
 - * Formal Methods: I/O Automata, Guarded Commands
 - * Others: TOSSIM, Emstar, NS2, MATLAB, Prowler, LATEX,
- ◇ Networking standards and protocols
 - * Wireless networks: IEEE 802.15.4, IEEE 802.11, AODV, DSR etc.
 - * Others: TCP, UDP, OSPF, BGP, ECN, MPLS, RTP/RTCP etc.
- ◇ Programming
 - * Languages: C, nesC, C++, Perl, Java, MPI, JavaScript, Python, Tcl/Tk, PHP, SQL
 - * Operating systems: TinyOS, Linux, UNIX, Windows

COURSE WORK

Introduction to Computer Networks, Telecommunication Networks, Internetworking with TCP/IP, Communication Networks, Multimedia Networking, Wireless and Mobile Computing, Principles of Programming Language, Operating Systems, Comparative Operating Systems, Advanced Operating Systems, Operating Systems Lab, Advanced Operating Systems Lab, Advanced Computer Architecture, Computability And Unsolvability, Distributed Computing, Analysis of Algorithms, Data Structures, Introduction to Database Systems, Neural Networks, Induction to High Performance Computing, Introduction to Parallel Computing, Computer Aided Design and Analysis of VLSI Circuits.

DETAILS OF SELECTED PROJECTS

- ◇ *GENIfying and Federating Autonomous Kansei Wireless Sensor Networks*
The Ohio State University, USA

The project aims to adapt the large-scale prototype wireless sensor network Kansei to provide GENI-compliant interfaces and principles, to provide publically available support for programmability, virtualization, and slice-based experimentation, and to deploy three geographically dispersed sites in a federated arrangement. Also, provide periodic demonstrations, code releases and installation packages. As the designer of Kansei software architecture, I am responsible for re-designing Kansei modules to make it GENI complaint.

- ◇ *WISP: Wireless In-field Sensor Programmer*
Robert Bosch Research Technology Center, Palo Alto, CA, USA

The Wireless In-field Sensor Programmer(WISP) is a framework that lets application developer of Wireless sensor networks programs/update their applications in-field after they have been deployed. The framework currently supports MSP430/CC1020 based sensor nodes, but can be easily extended to CC2420 based nodes. The framework consist of four parts, namely, a Matlab/perl based PC side tools, a base-station mote application, a reprogramming kernel module for every network node and a small reprogramming library that has to be built into every application that needs to be downloaded to the network nodes. One or more nodes can be selected for reprogramming using a nodes MAC address. I developed the WISP framework as part of my internship in Bosch RTC.

- ◇ *PeopleNet: A Testbed for Real World Mobility Experiments*

The Ohio State University, USA

PeopleNet is a persistent real world mobility testbed, currently under development at OSU. (Details of this project can be found at <http://kansei.netlab.ohio-state.edu/peoplenet>). The testbed consist of 35 (linux based) mobile phone integrated with a PSImote (uses TI MSP430 CPU and Chipcon CC2420 radio). The mobile phones are used as the primary mobile phones by the faculty and students in the Computer Science department building at OSU, who form an ad hoc mobile network (using their 15.4 radios) from 8 am to 5 pm, when they are in the building. A separate static sensor network deployed in the building monitors the mobile network and helps in the localization of the mobile nodes for studying the real world human mobility patterns. The static sensor network also monitors various common resources used in the building (like conference rooms and elevators) and the status of these resources can be queried using the cellphones. I lead the overall design and development of the PeopleNet project. My contribution to the project include design and implementation of reliable fault-tolerent scheduler for deploying applications on the cellphones, a mobility driven multiparent routing, a transport protocol for end-to-end reliable messaging and congestion control, and java based locality-specific applications for the phone.

- ◇ *Kansei: Wireless Sensor Network Testbed*
The Ohio State University, USA

Kansei is currently the largest wireless testbed consisting of 432 Telosb, 112 Extreme Scale Motes (XSM), 112 Imote2 and 112 Stargates. A SunSpot array has been planned for the near future. (Details of this project can be found at <http://www.cse.ohio-state.edu/kansei>). Kansei provides a easy and convenient web interface to conduct experiments with 5 different hardware layers. We are currently working to expose Kansei services as a web-service layer to enable automatic machine-to-machine scheduling and GENI compliance. I am one of the main designers and developers of the testbed and also the administrator of the testbed, since Jan 2005. My contribution to Kansei development are (a) designing a scalable and autonomic manager which can manage 1000 hardware devices, (b) designing a web interface for virtualization of resources and simplifying access to the testbed (c) designing a tool for logging experiment data and retrieval of the same, (d) packaging the Kansei software for release, to enable cloning of the testbed at various institutions and (e) supporting the software of Kansei clones at other institutions.

- ◇ *Robust routing and tracking in constrained mobility scenarios*
Demonstrated at ACM Sensys 2006

This project was the fore runner of the PeopleNet project. The goals of this project were (a) Online tracking of mobile objects at base station using noisy RSSI measurements (b) Proactive maintenance of connectivity of mobile nodes to/from base station, for convergecast, broadcast, and unicast (c) Experimental study of impact of mobility on quality of structure. The system was designed for a constrained mobility model, i.e., a small percentage of the nodes move with low speeds at a given time. This system was demonstrated at Sensys 2006, in the context of an application that tracks the number of visitors (tagged with a TELOS mote) for each poster, in a poster presentation area and uses the visitors (i.e. the mobile nodes) to exfiltrate this information to a base station (laptop). I developed the robust routing for exfiltration and was in charge of the overall integration.

- ◇ *Catch Me If You Can, A Distributed pursuer evader tracking application*
DARPA Field Demonstration at Richmond Field Station, Berkeley and Kansei, The Ohio State University, USA, August 2005

In this project, a multiple pursuer multiple evader tracking application was demonstrated using a wireless sensor network at Richmond Field Station, Berkeley and the Kansei testbed at OSU. A sensor network barrier is laid to protect a valuable asset. The system is modeled as a differential pursuer evader game. Traces of real objects moving in the sensor network, deployed at Berkeley, was collected and injected into the Kansei testbed as virtual evaders, while the pursuers are real Garcia Robots, moving on top of the static XSM array in Kansei. The goal of the pursuers is to maximize the distance of evaders from the asset while the evaders' goal is to minimize the distance. For this project, I implemented a network services, Trail, for distributed object tracking in a reliable and

energy efficient manner. The service was implemented on XSMs (Extreme Scale Motes) using the TinyOS platform. The tracking services were experimentally validated in a network of 105 nodes in the Kansei testbed. I was also in charge of overall integration for the project, including streaming of the data collected at Berkeley into the indoor testbed at Ohio State.

- ◇ *ExScal: Extreme Scale Wireless Sensor Networking*
DARPA Field Demonstration, Florida, December 2004

ExScal is the largest sensor network built till date with 935 XSMs, 203 MICA2 motes and 203 Stargates, deployed over 1.2 Km by 200 m. (Details on this project can be found at <http://www.cse.ohio-state.edu/exscal>). I designed and implemented a reliable structure less initialization service for a 200 node Stargate (linux device) network, which uses 802.11b radios for communication. The challenge is to send a message to all the nodes in the network and get a confirmation from the nodes to a base station within a few seconds with 100% reliability.

- ◇ *TFN Measurement/ActiveMon Project*
Oarnet, Ohio Supercomputer Center, USA

ActiveMon is an extensible and customizable software framework for generation and analysis of active measurements that can be used for routine network health monitoring. (Details of the project can be found at <http://sourceforge.net/projects/activemon/>). It supports various tools that measure network health metrics such as: route changes, delay, jitter, loss, bandwidth and MOS. I co-designed and implemented the framework and the tool-kit for the project. The project also involved building a number of ActiveMon Servers and deploying them close to the router switches of the Third Frontier Network.

- ◇ *H323 Beacon Project*
Oarnet, Ohio Supercomputer Center, USA

I was part of a 3-person team that developed the H.323 Beacon, a open source software, widely used in industry and academia, to troubleshoot H.323 videoconferencing applications. (The details of the project can be found at <http://sourceforge.net/projects/h323beacon/>). I was especially responsible for the server version of the software, which enabled automating the testing. Version 1.5 of the server and client software was released in June 2005.

JOURNAL PUBLICATIONS

- ◇ A. Durresi, P. Kandikuppa, M. Sridharan, S.Chellappan, R. Jain, and L. Barolli, "LED: Load Early Detection: A Congestion Control Algorithm based on Router Traffic Load", *Journal of IPSJ*, 2005
- ◇ A. Durresi, L. Barolli, M. Sridharan, S.Chellappan, R. Jain, and Hitai Ozbai, "Control Theoretical Optimization of TCP/IP Traffic Management in Satellite Networks", *International Journal of Wireless and Mobile Computing (IJWMC)*, 2005
- ◇ M. Sridharan, A. Durresi and R.Jain, "Congestion Control using Adaptive Multilevel Early Congestion Notification", *International Journal of High Performance Computing and Networking (IJHPCN)*, 2005

CONFERENCE PUBLICATIONS

- ◇ V. Kulathumani and M. Sridharan and R. Ramnath and A. Arora, "Weave: An Architecture for Tailoring Urban Sensing Applications across Multiple Sensor Fabrics", *MODUS, International Workshop on Mobile Devices and Urban Sensing*, 2008.
- ◇ M. Sridharan, S. Bapat, R. Ramnath and A. Arora, "Designing an Autonomic Architecture for Fault-Tolerance in a Wireless Sensor Network Testbed for At-Scale Experimentation", *ACM Symposium on Applied Computing, Autonomic Computing Track, SAC08*, 2008.
- ◇ V. Kulathumani, M. Demirbas, A. Arora, and M. Sridharan, "Trail: A Distance Sensitive Network Service for Distributed Object Tracking", *European Conference on Wireless Sensor Networks (EWSN)*, 2007 (Acceptance rate = 13%)

- ◇ M. Sridharan, E. Ertin, R. Ramnath and A. Arora, “Mobility Centric Campus Area Sensor Network for Locality Specific Applications”, *demonstration at ACM Sensys*, 2006
- ◇ H. Cao, E. Ertin, V. Kulathumani, M. Sridharan and A. Arora, “Differential Games in Large Scale Sensor Actuator Networks”, *International Conference on Information Processing in Sensor Networks, IPSN*, 2006
- ◇ E. Ertin, A. Arora, R. Ramnath, M. Nestkerenko, S. Bapat, M. Sridharan, V. Naik, V. Kulathumani, H. Zhang and H. Cao, “Kansei: A Testbed for Sensing at Scale”, *International Conference on Information Processing in Sensor Networks, Special Track on Platform Tools and Design Methods for Network Embedded Sensors (IPSN/SPOTS)*, 2006
- ◇ A. Arora, E. Ertin, R. Ramnath, P. Sinha, S. Bapat, V. Naik, M.Sridharan, et al., “ExScal: Elements of an Extreme Scale Wireless Sensor Network”, *11th IEEE International Conference on Embedded and Real time Computing Systems and Applications, (RTCSA)*, 2005
- ◇ P. Calyam, M.Sridharan, D. Krymskiy and P. Schopis, “TBI: End-to-end Network Performance Measurement Testbed for Empirical Bottleneck Detection”, *IEEE TridentCom*, 2005
- ◇ A. Durresi, L. Barolli, M. Sridharan, S.Chellappan, R. Jain, and Hitai Ozbai, “Control Theory optimization of MECN in Satellite Networks”, *Proceedings of ICDCS-MNSA*, Columbus, Ohio, June, 2005
- ◇ P. Calyam, M.Sridharan, W. Mandrawa and P. Schopis, “Performance Measurement and Analysis of H.323 Traffic”, *Passive and Active Measurements, PAM2004*, France, April 19-20, 2004
- ◇ P. Calyam, W. Mandrawa, M.Sridharan, A. Khan and P. Schopis, “H.323 Beacon: An H.323 Application Related End-to-end Performance Troubleshooting Tool”, *ACM SIGCOMM Workshop on Network Troubleshooting*, 2004
- ◇ M. Sridharan, A. Durresi and R. Jain, “Adaptive Multi-level Explicit Congestion Notification”, *Proceedings of Symposium on Performance Evaluation of Computer and Telecommunication Systems*, San Jose, CA, 2004
- ◇ M. Sridharan, A. Durresi, C. Liu and R. Jain, “Wireless TCP Enhancements using Multi-level ECN”, *Proceedings of Internet Quality of Service*, SPIE Vol. 5245, Florida, 2003
- ◇ M. Sridharan, S.Chellappan, A. Durresi, Hitai Ozbai and R. Jain, “Tuning RED in Satellite Networks Using Control Theory”, *Proceedings of Internet Quality of Service*, SPIE Vol. 5245, Florida, 2003
- ◇ P. Quet, M. Sridharan, S.Chellappan, A. Durresi, R. Jain, and Hitai Ozbai, “Guidelines for Optimizing Multi-level ECN, using Fluid Flow based TCP model”, *Proceedings of ITCOM02 Quality of Service over Next Generation Internet*, Boston, 2002
- ◇ A. Durresi, M. Sridharan, C. Liu, M. Goyal and R. Jain, “Congestion Control using Multilevel Explicit Congestion Notification in Satellite Networks”, *Proceedings of 10th IEEE International Conference on Computer Communications and Networks*, Phoenix, Arizona, 2001.
- ◇ A. Durresi, M. Sridharan, C. Liu, M. Goyal and R. Jain, “Traffic Management Using Multilevel Early Congestion Notification”, *Proceedings of the 5th World Multiconference on Systemics, Cybernetics and Informatics (SCI01)*, Orlando, Florida, 2001. *Winner of one of the best paper awards*

POSTERS

- ◇ M. Sridharan, E. Ertin, V. Kulathumani and A. Arora, “Robust Routing and Tracking in Constrained Mobility Scenarios”, *ACM Sensys*, Demonstration and poster, 2006
- ◇ M. Sridharan, V. Kulathumani and A. Arora, “Locality Specific and Mobility Centric Sensor Network Applications”, *ACM Sensys*, Demonstration and Poster, 2006