

**Venkatesh Rajendran**

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**Professional Objective**

To pursue a research career in wireless communication system design. Currently looking for summer internship/Co-op position in wireless communications research.

**Education****Ph.D in Computer Engineering**, June 2005

University of California, Santa Cruz.

*Overall GPA:* 3.91 out of 4.00

**Master's in Computer Engineering**, June 2003

University of California, Santa Cruz.

*Overall GPA:* 3.89 out of 4.00

**B.E in Electronics and Communication Engineering**, June 2001

College of Engineering, Anna University, India.

*Overall GPA:* 8.9 out of 10.0

*Master's Thesis:* *Reliable Multicasting in Ad Hoc Networks.*

*B.E. Thesis:* *Energy Allocation and Multiple Access for Multi-carrier communication.*

**Awards and Honors**

- **Jack Baskin School of Engineering's Outstanding Teaching Assistant Award, 2002-2003.**
- **Regents Fellowship, UC Santa Cruz, for the year 2001-2002.**
- **Rotary Club Award for Project Work for the year 2000-2001, Alumni Association, College of Engineering, Guindy, Anna University.**
- **The Engineering College Co-Operative Society Common Good Fund Endowment Prize for the year 1998-1999.**

**Research Interests**

Wireless communication system design, protocols and services for mobile ad hoc wireless networks, smart MAC protocols for WLANs, IEEE WLAN standards, energy-aware media access control protocols for smart sensor networks, reliable multicasting in MANETs, OFDM/multi-carrier communications for multiuser systems, digital signal processing, adaptive modulation, and MIMO / smart antenna systems.

**Computer Skills**

Experience in Linux, FreeBSD, Windows XP/9x/NT, and Solaris. Experience in network programming in UNIX environment using sockets and POSIX threads. Network administration experience in Linux and FreeBSD. Experience in implementing network protocols in Qualnet (contributed protocols to the development team), Glomosim, CSIM and NS2. Programming knowledge in C, C++, PERL scripting, assembly, and Matlab. Experience in programming TMS320C5x series and ADSP21xx series fixed-point DSP and TMS320C3x series floating point DSP.

**Employment History****Graduate Student Researcher**

*Internetworking Research Group (I-NRG) headed by Prof. Katia Obraczka*  
*Spring 2002 –Present*

Design, implement and evaluate network protocols for wireless ad hoc networks, and maintain lab web pages.

*Projects:*

- **Flow-based Multi-channel Media Access Protocol for Sensor Networks**

This project involves design and implementation of a flow-based multi-channel media access protocol for CC1000 radio used in Mica2 Motes. CC1000 is a FSK-based radio with selectable power states and tunable channels. Current media access protocols implemented for CC1000 radio does not take into advantage of the frequency diversity. We propose a distributed, energy-aware, collision-free scheduling for electing flows to improve the channel utilization.

- **Traffic-Adaptive Medium Access Protocol (TRAMA)**

Sensor networks are generally power-anemic and energy-efficient channel access is important to enhance the lifetime of the network. The main sources of energy inefficiency are: idle listening, hidden-terminal collisions and transmissions to sleeping node. We propose TRAMA, a novel distributed scheduling scheme to regulate channel access. Channel access is time-slotted and neighborhood-aware contention resolution is used to schedule transmissions. Schedules are adapted based on the traffic rate and an analytical model is developed to evaluate the performance and is verified using Qualnet simulations. TRAMA significantly outperforms other contention-based channel access schemes. A simplified version of TRAMA for MOTES platform is being implemented to test the real-world performance of TRAMA. This project is under the supervision of Dr.Katia Obraczka and in collaboration with Dr.J.J.Garcia-Luna-Aceves.

- **Reliable Broadcast/Multicast MAC Protocols for Wireless Ad hoc Networks**

IEEE 802.11 DCF (CSMA/CA) has become a default standard for media-access in wireless ad hoc networks. For broadcast/multicast transmissions the standard does not provide any reliability and is done by plain carrier-sensing. Hence, the performance is severely affected due to hidden terminal collisions. The goal of this work is to develop a novel approach to broadcasting/multicasting using two-hop neighborhood information. Unlike unicast transmissions, broadcast and multicast transmissions have much larger contention region and hence, more susceptible to collisions. We propose a hybrid contention resolution scheme based on collision avoidance and neighbor information. We are also studying the impact of multicast reliability at MAC level on higher layer protocols.

- **Reliable Multicasting in MANETs**

This work focuses on design and analysis of reliable multicast transport protocols for mobile ad-hoc networks. Unlike wired environments, wireless environments have the inherent unreliability. Each of the members can experience time-varying losses depending on its channel contention and link quality. We propose ReACT: Reliable, Adaptive, Congestion-Controlled Ad hoc Multicast Transport Protocol (ReACT) aimed to improve reliability using local recovery and source-based congestion control. ReACT classifies packet losses into local and global contention and generates appropriate feedback to initiate recovery and congestion-control. Losses due to local factors like collision, link quality etc., are recovered locally from nearest member, while losses due to congestion trigger source-based congestion control. ReACT is designed work both on top of tree- and mesh-based multicast routing fabrics. ReACT improves the reliable delivery ratio significantly when compared to plain UDP or Gossip-based approaches. This project is under supervision of Dr. Katia Obraczka and in collaboration with Dr. Mario Gerla, UCLA, Dr. S.J. Lee, HP Research Labs and Dr.Ken Tang, Scalable Networks.

### **Teaching Assistant**

*University of California*

Teaching assistant for the following graduate and undergraduate level courses  
CMPE252a Computer Networks, Fall 2003.

CMPE150 Introduction to Computer Networks, Spring 2003.

CMPE151 Network Administration, Winter 2003.

CMPE080N Introduction to Internet and Computer Networks, Winter 2002.

### **Summer Research Fellow**

*AU-KBC Research Center, India*

*1 June 2001–1 September 2001*

Worked as a Summer Research Fellow at AU-KBC Research Center, India. Work involved developing an energy allocation algorithm for multi-carrier communication and a patent has been filed for the algorithm developed.

*Projects:*

- **Multiple Access and Resource Allocation for Multi-carrier Communication**

We propose a new Adaptive Allocation Algorithm for Multiuser OFDM (MOAAA), which outperforms existing multiple access schemes like OFDM-TDMA and OFDM-FDMA. The experiments have been conducted with reference to the powerline environment with multipath fading, exponential noise spectrum and narrow-band interference. We have presented the results obtained by Monte-Carlo simulation using Matlab under different channel and noise conditions. We have quantified the improvement in terms of overall transmit power and BER. Our new algorithm achieves a significant gain of 3 to 5 dB in SNR over OFDM-FDMA and TDMA. Hence, the proposed algorithm can be

used for efficient multiple access for broadband multimedia communications over frequency selective fading environments.

### **Industrial training in testing and servicing wireless equipments**

*Electronics Corporation of Tamil Nadu (ELCOT)*

*28 December 1998–4 January 1999*

### **Patents**

Multi-user Indoor Wireless Access Systems based on the OFDM Transmission Technique - under submission for Indian Patent.

### **Other Selected Projects**

**Multihop Networking with Lego Mindstorms:** Lego Mindstorms are tiny robots with an embedded micro-controller, motion controllers, sensors and an IR port for downloading firm-wares. LegOS is an embedded operating system for the Mindstorms based on Linux. This is an implementation project and a lightweight communication stack (MAC and routing support) was implemented in the Linux kernel to enable multi-hop communication between the robots through the IR port. To communicate with host PC, the stack was also implemented in host PC (as a daemon). Sample applications involving multi-hop communication were demonstrated over the stack developed.

**Indoor Location Estimation based on Wireless Signal Strength:** Relative location information is needed for developing location-aware application. In this project, a location estimation system that estimates the location of a mobile user relative to the location servers was implemented and demonstrated. The main advantage of the system is it is developed with off the shelf components: laptops and 802.11 based wireless cards. The location servers are laptops fixed in known locations and a user roams around with a laptop. All the laptops are equipped with wireless cards and the distances of the mobile user to the location servers are measured using the signal strength of the packet received from the servers. A triangulation algorithm is used to find the exact location based on the distance information. This was done in Linux platform. An adaptive learning algorithm is used to reduce the estimation errors caused due to the highly varying signal strength in indoor environment.

**Dynamic Power Management Schemes for Sensor Networks:** In this project various system level power management schemes are analyzed. The power management model was developed in CSIM and analyzed extensively by simulation.

**Survey of interconnection networks for M-SIMD architecture and its applications.**

### **Publications**

- Venkatesh Rajendran, Katia Obraczka, J.J. Garcia-Luna-Aceves. "Energy-Efficient, Collision-Free Medium Access Control for Wireless Sensor Networks". *ACM/Kluwer Wireless Networks (WINET)*. 2004.
- Venkatesh Rajendran, Katia Obraczka, Yunjung Yi, Sung-Ju Lee, Ken Tang, Mario Gerla. "Combining Source- and Localized Recovery to Achieve Reliable Multicast in Multi-Hop Ad Hoc Networks". *Proceedings of the Networking'04*. May 2004.
- Venkatesh Rajendran, Katia Obraczka, J.J. Garcia-Luna-Aceves. "Energy-Efficient, Collision-Free Medium Access Control for Wireless Sensor Networks ". *ACM SenSys 03*. November 2003. .
- Venkatesh Rajendran, J.J. Garcia-Luna-Aceves, Katia Obraczka. "An Energy-Efficient Channel Access Scheduling for Sensor Networks ". *Proc. The Fifth International Symposium on Wireless Personal Multimedia Communication (WPMC)*. October 2002.
- Venkatesh Rajendran, Yunjung Yi, Katia Obraczka, Sung-Ju Lee, Ken Tang, Mario Gerla. "Reliable, Adaptive, Congestion-Controlled Ad hoc Multicast Transport Protocol: Combining Source-based and Local Recovery". *UCSC Technical Report*. 2003.
- Venkatesh Rajendran, Karthikeyan Sundaresan , Srikanth Subramanian. "Performance of an OFDM based downlink multiple access system for indoor wireless communications ". *Wireless Personal Communications*. April 2003.
- Venkatesh Rajendran, Karthikeyan Sundaresan , Srikanth Subramanian. "A Power-Efficient Resource Allocation Scheme for Multiuser OFDM ". *International Conference on Personal Wireless Communications(ICPWC)*. December 2002.
- Arun Pachai, Venkatesh Rajendran, Karthikeyan Sundaresan , Srikanth Subramanian. "Multiple Access Schemes for OFDM based Indoor Wireless Systems ". *Proc. The 8th National Conference on Communications (NCC)*. 2002.

### **Related Course Work**

Wireless and Mobile Networks, Advanced Wireless Communications, Computer Networks, Software Engineering, Advanced Operating Systems, Computer Architecture and Computer Performance Evaluation.

### **Other Activities**

Reviewed Papers for MONET Journal, WCNC 2004, and IEEE Consumer Communications and Networking 2004.  
Student Volunteer for IPSN 2003, and Infocom 2003.  
Judge for Santa Cruz County Science Fair 2003.  
Guest Lecture on Debugging Techniques in C for SWE ANSI-C workshop 2003.

## References

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