

Rahul Mangharam

Department of Electrical and Systems Engineering
University of Pennsylvania, Philadelphia, PA, USA 19104

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ACADEMIC EXPERIENCE

Assistant Professor University of Pennsylvania, <i>Philadelphia, PA</i> Department of Electrical and Systems Engineering	March 2008 – present
Stephen J. Angello Chair of Electrical & Systems Engineering University of Pennsylvania, <i>Philadelphia, PA</i> Department of Electrical and Systems Engineering	April 2008 – present
Director, mLAB, Real-Time and Multimedia Laboratory University of Pennsylvania, <i>Philadelphia, PA</i> Department of Electrical and Systems Engineering	May 2008 – present
Assistant Professor (Secondary Appointment) University of Pennsylvania, <i>Philadelphia, PA</i> Department of Computer and Information Science	May 2008 – present

EDUCATION

Ph.D. in Electrical and Computer Engineering Carnegie Mellon University, Pittsburgh, PA <i>Dissertation: "Real-Time Embedded Wireless Networks: Algorithms and Experiences"</i> <i>Advisor: Prof. Rangunathan (Raj) Rajkumar</i>	March 2008
M.S. in Electrical and Computer Engineering Carnegie Mellon University, Pittsburgh, PA <i>Thesis: "Size Matters: Size-based Scheduling for MPEG-4 over Wireless Channels"</i> <i>Advisor: Prof. Rangunathan (Raj) Rajkumar</i>	August 2002
B.S. in Electrical and Computer Engineering Carnegie Mellon University, Pittsburgh, PA	May 2000

RESEARCH INTERESTS

Cyber-Physical Systems, Real-time systems, embedded systems, wireless network control, operating systems, medical devices and automotive networks.

RESEARCH AWARDS and HONORS

- 1st Prize in World Embedded Software Competition, Korea** November 2010
Korean Ministry of Knowledge Economy and Electronics and Telecommunications Research Institute (ETRI)
- Awarded for AutoPlug - Open Automotive Plug-n-Play Architecture project
- Provost's Distinguished International Research Award** January 2010
University of Pennsylvania
- Awarded for continued collaboration with European research institutions
- Wharton Interactive Media Initiative Award** November 2009
University of Pennsylvania
- Awarded for research in Open Architecture for Plug-n-Play Automotive Systems
- University Research Foundation Award** March 2009
University of Pennsylvania
- Awarded for research in Embedded Virtual Machines for Robust Wireless Control Networks
- Stephen J. Angello Term Chair in Electrical & Systems Engineering** Fall 2008
University of Pennsylvania
- Best Paper Award** Summer 2006
IEEE Conference on Sensor, Mesh and Ad hoc Communications and Networks (SECON), Reston, VA
- For "RT-Link: A Time-Synchronized Link Protocol for Energy Constrained Multi-Hop Wireless Networks"
- Sixth Annual Lockheed Martin ECE Project Award** Spring 2006
ECE Department, Carnegie Mellon University
- Awarded for Research in Vehicle-to-Vehicle Wireless Networks
- Sigma Xi Poster Competition Award** Spring 2006
ECE Department, Carnegie Mellon University
- Awarded for Research in Vehicle-to-Vehicle Wireless Networks
- Eta Kappa Nu Research Award** Spring 2002
Meeting of the Minds University Research Award, Carnegie Mellon University
- Awarded for research on Location and Tracking with Wireless Networks

PUBLICATIONS (JOURNALS)

1. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**. "The Wireless Control Network: A New Approach for Control over Networks." *IEEE Transactions in Automatic Control (TAC)*. Accepted. To be published.
2. M. Pajic and **R. Mangharam**. "Robust Architectures for Embedded Wireless Network Control and Actuation." *ACM Transactions of Embedded Computing Systems (TECS)*. Accepted. To be published.

3. M. Pajic and **R. Mangharam**, "Spatio-Temporal Techniques for Anti-Jamming in Embedded Wireless Networks" *EURASIP Journal on Wireless Communications and Networking*, Feb 2010.
4. **R. Mangharam**, A. Rowe and R. Rajkumar, "FireFly: A Cross-Layer Platform for Wireless Sensor Networks", *Real Time Systems Journal, Special Issue on Real-Time Wireless Sensor Networks (RTSJ)*. Nov 2006. [Cited 28]
5. A. Rowe, **R. Mangharam** and R. Rajkumar, "'Global Time-Synchronized Link Protocols for Energy Constrained Multi-hop Wireless Networks" *Elsevier Ad hoc Networks, Special Issue on Energy-efficient Design in Wireless Ad hoc and Sensor Networks*. 2007. **(Invited)**
6. S. Pollin, **R. Mangharam**, B. Bougard, R. Rajkumar, F. Catthoor, L. Van der Perre, I. Moerman "MEERA: Cross-Layer Methodology for Energy-Efficient Resource Allocation for Wireless Networks", *IEEE Transactions in Wireless Communication*. Jan 2008. [Cited 25]
7. S. Pollin, B. Bougard, **R. Mangharam**, F. Catthoor, R. Rajkumar, I. Moerman, L. Van der Perre "Optimizing transmission and shutdown for energy-efficient real-time packet scheduling in clustered ad hoc networks" *EURASIP Journal on Wireless Communications and Networking, Special Issue on Cross-layer Design for Ad Hoc Networks*, vol. 2005, no. 5, pp. 698-711, 2005.

PUBLICATIONS (JOURNALS, SUBMITTED)

1. M. Pajic, **R. Mangharam**, O. Sokolsky, D. Arney, J. M. Goldman and I. Lee "Model-Driven Safety Analysis of Closed-Loop Medical Systems", *IEEE Transactions of Industrial Informatics (TII), Special Section on Cyber-Physical Systems*. 2011 **(Invited)**.
2. Z. Jiang, M. Pajic, and **R. Mangharam**, "Cyber-Physical Modeling of Implantable Cardiac Medical Devices". *IEEE Proceedings, Special Issue on Cyber-Physical Systems*. 2011. (Under review)

PUBLICATIONS (CONFERENCES)

1. Z. Jiang, M. Pajic, and **R. Mangharam**, "Model-based Closed-loop Testing of Implantable Pacemakers". *ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*. April 2011.
2. M. Pajic, S. Sundaram, J. Le Ny, G. J. Pappas and **R. Mangharam**, "The Wireless Control Network: Synthesis and Robustness." *The 49th IEEE Conference on Decision and Control (CDC)*, 2010.
3. S. Sundaram, M. Pajic, C. N. Hadjicostis, **R. Mangharam** and G. J. Pappas, "The Wireless Control Network: Monitoring for Malicious Behavior." *The 49th IEEE Conference on Decision and Control (CDC)*, 2010. **(Invited)**.
4. Z. Jiang, A. T. Connolly and **R. Mangharam**. "Using the Virtual Heart Model to Validate the Mode-Switch Pacemaker Operation. *32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC'10)*.
5. Z. Jiang, M. Pajic, A. T. Connolly, S. Dixit and **R. Mangharam**. "Real-time Heart Model for Implantable Cardiac Device Validation and Verification". *22nd Euromicro Conference on Real-Time Systems, (IEEE ECRTS'10)*. July 2010.
6. D. Arney, M. Pajic, J. M. Goldman, I. Lee, **R. Mangharam** and O. Sokolsky. "Toward Patient Safety in Closed-Loop Medical Device Systems". *ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*. April 2010.

7. M. Pajic and **R. Mangharam**. "Embedded Virtual Machines for Robust Wireless Control and Actuation". *16th IEEE Real-Time and Embedded Technology and Applications Symposium (IEEE RTAS)*. April 2010.
8. M. Pajic and **R. Mangharam**. "Anti-Jamming for Embedded Wireless Networks". *ACM International Conference on Information Processing in Sensor Networks (IPSN'09)*. April 2009. [Cited 6]
9. M. Pajic and **R. Mangharam**. "WisperNet: Anti-Jamming for Wireless Sensor Networks", *2nd Workshop on Embedded Systems Security (WESS'08), IEEE/ACM EMSOFT'2008 and the Embedded Systems Week*.
10. R. Mangharam, R. Rajkumar, M. Hamilton, P. Mudalige and F. Bai, "Bounded-Latency Alerts in Vehicular Networks", *Mobile Networking for Vehicular Environments, IEEE INFOCOM, 2007*. [Cited 7]
11. **R. Mangharam**, A. Rowe and R. Rajkumar, "Voice over Sensor Networks" *27th IEEE Real-Time Systems Symposium (IEEE RTSS)*, Dec 2006. [Cited 43]
12. A. Rowe, **R. Mangharam** and R. Rajkumar, "RT-Link: A Time-Synchronized Link Protocol for Energy Constrained Multi-hop Wireless Networks" *Third IEEE International Conference on Sensors, Mesh and Ad Hoc Communications and Networks (IEEE SECON)*, Sept 2006 (**Best Paper Award**). [Cited 75]
13. **R. Mangharam** and R. Rajkumar, "MAX: A Maximal Transmission Concurrency MAC for Wireless Networks with Regular Structure" *IEEE Third International Conference on Broadband Communications, Networks and Systems (IEEE BROADNETS)*, Oct 2006. [Cited 11]
14. **R. Mangharam**, D. S. Weller, R. Rajkumar, P. Mudalige and F. Bai, "GrooveNet: A Hybrid Simulator for Vehicle-to-Vehicle Networks", *Second International Workshop on Vehicle-to-Vehicle Communications (IEEE V2VCOM)*, July 2006. (**Invited Paper**) [Cited 27]
15. **R. Mangharam**, D. S. Weller, D. D. Stancil, R. Rajkumar, "GrooveSim: A Topography-Accurate Simulator for Geographic Routing in Vehicular Networks" *ACM Mobicom/VANET*, Sept. 2005. [Cited 57]
16. **R. Mangharam**, J. Meyers, R. Rajkumar, D. Stancil, J. Parikh, H. Krishnan, and C. Kellum, "A Multi-hop Mobile Networking Test-bed for Telematics" *Society for Automotive Eng. World Congress*. 2005. [Cited 6]
17. **R. Mangharam**, S. Pollin, B. Bougard, R. Rajkumar, F. Catthoor, L. Van der Perre, "Optimal fixed and scalable energy management for wireless networks" *IEEE INFOCOM*, March 2005. [Cited 35]
18. S. Pollin, B. Bougard, **R. Mangharam**, L. Van der Perre, F. Catthoor, R. Rajkumar, I. Moerman "Optimizing transmission and shutdown for energy-efficient packet scheduling in sensor networks" *European Workshop on Wireless Sensor Networks (EWSN)*. January 2005. [Cited 5]
19. **R. Mangharam**, M. Demirhan, R. Rajkumar, and D. Raychaudhuri, "Size matters: Size-based scheduling for MPEG-4 over wireless channels" *SPIE & ACM Proceedings in Multimedia Computing and Networking (ACM MMCN)*. Vol. 3020 pp. 110-122. San Jose, CA, January 2004. [Cited 35]

PUBLICATIONS (CONFERENCES, SUBMITTED)

1. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**, "Topological Conditions for Wireless Control Networks". *50th IEEE Conference on Decision and Control, CDC 2011*, Submitted.
2. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**, "Closing the Loop: A Simple Decentralized Method for Control over Wireless Networks". *ACM Conference on Embedded Networked Sensor Systems (SenSys 2011)*. Submitted.
3. T. Nghiem, M. Behl, G. J. Pappas and **R. Mangharam**. "Green Scheduling: Scheduling of Control Systems for Peak Power Reduction". *2nd International Green Computing Conference*, 2011. Submitted.
4. T. Nghiem, M. Behl, **R. Mangharam** and G. J. Pappas. "Green Scheduling of Control Systems for Peak Demand Reduction". *50th IEEE Conference on Decision and Control, CDC 2011*, (Invited) Submitted.

5. **R. Mangharam** and **A. A. Saba**, "Anytime Algorithms for GPU Architectures", *IEEE Real-Time Systems Symposium (IEEE RTSS)*. Submitted.
6. **M. Pajic**, **O. Sokolsky**, **I. Lee** and **R. Mangharam**. "Framework for Closed-Loop Testing of Implantable Cardiac Devices: A Pacemaker Case Study". *IEEE Real-Time Systems Symposium (IEEE RTSS)*. Submitted.

PUBLICATIONS (BOOK CHAPTERS)

1. **A. Rowe**, **R. Mangharam** and **R. Rajkumar**, "FireFly: A Time Synchronized Real-Time Sensor Networking Platform." *Wireless Ad Hoc Networking: Personal-Area, Local Area, and Sensor Networks*, CRC Press. 2007. [Cited 12]

PUBLICATIONS (OTHER)

1. **M. Pajic**, **S. Sundaram**, **G. J. Pappas** and **R. Mangharam**, "A Simple Distributed Method for Control over Wireless Networks". *CPS Week Workshop on Real-Time Wireless for Industrial Applications, Real-WIN*. 2011.
2. **W. Etter**, **P. Martin**, and **R. Mangharam**, "Cooperative Flight Guidance of Autonomous Unmanned Aerial Vehicles". *CPS Week Workshop on Networks of Cooperating Objects (CONET)*. 2011.
3. **M. Pajic** and **R. Mangharam**. "Architecture for a Fully Distributed Wireless Control Network". Demo, and Poster at *IEEE/ACM CPSWeek*. April 2011.
4. **Z. Jiang**, **M. Pajic** and **R. Mangharam**. "Closed-loop Testing for Implantable Cardiac Pacemakers". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.
5. **M. Behl**, **M. Aneja**, **H. Jain** and **R. Mangharam**. "EnRoute: An Energy Router for Energy-Efficient Buildings". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.
6. **U. Drolia**, **Z. Wang**, **S. Vemuri**, **M. Behl** and **R. Mangharam**. "AutoPlug - An Automotive Test-bed for ECU Testing, Validation and Verification". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.
7. **P. Martin**, **W. Etter** and **R. Mangharam**, "R.A.V.E.N. - Remote Autonomous Vehicle Explorer Network". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.
8. **R. Mangharam**, "AutoPlug: An Open Experimental Platform for Automotive ECU Testing, Updates and Verification". *NSF/USCAR Automotive CPS Workshop*, Troy, Michigan. March 2011.
9. **A. A. Saba** and **R. Mangharam**, "Anytime Algorithms for GPU Architectures", *Analytic Virtual Integration of Cyber-Physical Systems Workshop*. Co-located with RTSS 2010.
10. **W. H. Bernal** and **R. Mangharam**, "From Control to Scheduling: an Elastic Execution Model" *IEEE Real-Time Systems Symposium (RTSS), Work-in-Progress*. Dec 2010.
11. **M. Behl** and **R. Mangharam**, "Pacer Cars: Real-Time Traffic Shockwave Suppression" *IEEE Real-Time Systems Symposium (RTSS), Work-in-Progress*. Dec 2010.
12. **Z. Jiang**, **M. Pajic**, **A. T. Connolly** and **R. Mangharam**. "A Platform for Implantable Medical Device Validation". Demo and Poster at *Wireless Health Conference*. October 2010.
13. **M. Pajic** and **R. Mangharam**. "Embedded Virtual Machines for Wireless Industrial Automation" *Demo and Poster at IEEE/ACM CPSWeek*. April 2009.
14. **M. Pajic** and **R. Mangharam**. "Runtime Approaches for Embedded Wireless Control-Actuator Networks" at *IEEE Real-Time Systems Symposium (RTSS), PhD Forum*. Dec 2009.

15. M. Pajic, Z. Jiang, A. T. Connolly and **R. Mangharam**. "A Framework for Validation of Implantable Medical Devices". Demo, Poster and Work-in-Progress paper at *IEEE/ACM CPSWeek*. April 2010.
16. A. A. Saba, S. Mohan and **R. Mangharam**. "Anytime Algorithms for Multicore Architectures" in *22nd Euromicro Conference on Real-Time Systems, Work-in-Progress Session, (IEEE ECRTS)*. July 2010.
17. **R. Mangharam** and M. Pajic. "Embedded Virtual Machines for Robust Wireless Control Systems". Proc. of the 29th IEEE International Conference on Distributed Computing Systems Workshops. 2009.
18. **R. Mangharam**. "Real-Time Traffic Congestion Prediction". NSF-NCO/NITRD National Workshop on High Confidence Transportation Cyber-Physical Systems Nov 2008.
19. **R. Mangharam**. "Mixed Reality, Now a Reality - Network Virtualization for Real-Time Automotive-CPS Networks". *NSF-NCO/NITRD National Workshop on High Confidence Automotive Cyber-Physical Systems*. April 2008.
20. **R. Mangharam** and M. Demirhan, "Performance and simulation analysis of 802.15. 3 QoS" IEEE 802.15.3 Standards Meeting, Vancouver, Canada. Feb 2002. [Cited 33]

SOFTWARE ARTIFACTS

1. *AutoPlug*: Open Automotive Architecture for Plug-n-Play Services. Open-source software at <http://www.autoplug.org>. 2011.
2. *AirHacks*: Open Unmanned Aerial Vehicle Platform (Quadrotor) at <http://airhacks.org>. 2011.
3. Penn Virtual Heart Model and Closed-loop Implantable Device Models for medical device software validation and verification. Open-source Matlab/Simulink models. 2011.
4. *AutoMatrix*: Large-scale Traffic Congestion Simulator for estimating and predicting congestion with over 16 million vehicles. 2011
5. *GrooveNet*: Hybrid Network Simulator for Vehicle-to-Vehicle Networking. Both real and simulated vehicles can communicate. Over 45 research institutions have downloaded GrooveNet. 2006.
6. *RT-Link* TDMA protocol for IEEE 802.15.4 sensor networks. Co-developed with Anthony Rowe. Graduate course taught using RT-Link on the FireFly sensor network platform. 2006.
7. IEEE 802.15 Link-layer Scheduling Framework for ns-2 network simulator. Co-developed with Mustafa Demirhan. Over 40 research institutions have downloaded the software. 2003.

TEACHING EXPERIENCE

Course Instructor, Introduction to Embedded Systems (ESE 350)

Spring 2010, 2011

University of Pennsylvania

- New Course. Fully responsible for teaching the junior embedded systems course taken by approximately 32 students from across the College of Engineering.
- Planned and delivered all lectures, developed syllabus, created course notes, designed exams and homework problems, coordinated laboratory and homework teaching assistants

Course Instructor, Real-Time and Embedded Systems (ESE 519)

Fall 2010, 2009

University of Pennsylvania

- New Course. Fully responsible for teaching the graduate real-time systems course taken by approximately 30 students from across the College of Engineering.

- Planned and delivered all lectures, developed syllabus, created course notes, designed exams and homework problems, coordinated laboratory and homework teaching assistants

Course Instructor, Graduate Course on Wireless Embedded Networks (*ESE 680*)

Spring 2009

University of Pennsylvania

- New Course. Fully responsible for teaching the junior embedded systems course taken by approximately 12 students from across the College of Engineering
- Planned and delivered all lectures, developed syllabus, created course notes, designed exams and homework problems, coordinated laboratory and homework teaching assistants

Teaching Assistant, Graduate Embedded Systems (*ECE 18-848*)

Fall 2006

Carnegie Mellon University

- Prof. Rajkumar and I designed this course with Anthony Rowe from ground up. We designed the FireFly 2.0 sensor network platform, nano-RK Sensor RTOS and the hands-on hardware/programming labs. I mentored 16 graduate students with projects ranging from logical topology control, scalable network authentication to middleware for social networking.

Teaching Assistant, *Fundamentals of Electrical Engineering (ECE 18-220)*

Spring 2001

Carnegie Mellon University

- As a teaching assistant for this core undergraduate course by Prof. Ken Gabriel and Prof. Tamal Mukherjee, I helped with recitations, grading and coordinated lab sessions.

Sensor Network Workshop

Nov 2005

Institute for Information Industry, Taipei, Taiwan

- I conducted a workshop on the FireFly Sensor Network Platform at The Institute for Information Industry, Taiwan. A 30-node network was demonstrated in a museum to the Ministry.

RESEARCH EXPERIENCE

Visiting Scholar

Summer 2006

Athens Information Technology, Athens, Greece

Invited to set up a Sensor Network lab with the FireFly platform and help design a course on sensor networks for the resident MS students. An experimental test-bed for tracking, sensing and multi-hop voice streaming was deployed. I conducted a 1-week workshop on network programming, time synchronization, logical topology control and design for predictable lifetime.

International Scholar

Fall 2003

Inter-University Microelectronics Center (IMEC), Leuven, Belgium

I worked with Prof. Francky Catthoor on a cross-layer optimization methodology to improve the energy efficiency of next generation wireless transceivers. The scheme determines the lowest energy configuration, at run-time, of the physical layer, communications layer and link layer while delivering high quality video traffic over a fading wireless link. With actual channel measurements, a real power amplifier and turbo decoder, we were able to reduce the energy consumption by 2-5x, while streaming real MPEG-4 video for multiple users.

Visiting Researcher

Fall & Summer 2002

Intel Labs, Hillsboro, OR

Ultra Wide-Band MAC Protocol: As part of the first design team on UWB, I designed and analyzed a link-layer protocol for multimedia across IEEE 802.15.3. We presented results at IEEE 802 Conference showing a 60% improvement in channel utilization for MPEG-4 streams and non real-time traffic with the addition of just one byte to the draft protocol.

INDUSTRY EXPERIENCE

Hardware Engineer

May – September 2000

Apple Computer Inc., Cupertino, CA

As part of the first Gigabit Ethernet rollout, I developed a performance analysis tool to stress test the Ethernet MAC and PHY across a grid of machines. System programming involved PCI bus, MacOS internals, memory management, TCP/IP stack and the Gigabit Interface.

ASIC Engineer

Marconi Communications (FORE Systems), Warrendale, PA

Spring & Summer 1999

As part of a 5-chip ASIC design team for a 250Gbps ATM/IP network switch, I worked on an ASIC. My work focused on implementing register control, state machine blocks and CRC.

Software Engineer

May – September 1997

National Instruments Corporation, Austin, TX

- Developed GPIB device-driver architecture using COM/DCOM middleware

Current Group

1. Miroslav Pajic (Ph.D. Candidate, ESE) – Network-Controlled Cyber-Physical Systems
2. Aminreza Abrahami Saba (Ph.D. Candidate, CIS) – Anytime Algorithms for Multi-core Architectures
3. Mahdur Behl (Ph.D. Candidate, ESE) – Automotive Cyber-Physical Systems
4. Willy G. Bernal (Ph.D. Candidate, ESE) – Energy-efficient Building Automation
5. Zhihao Jiang (Ph.D. Candidate, CIS) – High-Confidence Medical Device Software & Systems

MS and Undergraduate students active in the lab:

1. Utsav Drolia, MS, ESE
2. Steven Z. Wang, MS, ESE
3. Srinivas Vemuri, MS, ESE
4. Mansimar Aneja, MS, Robotics
5. Harsh Jain, MS, ESE
6. Eric Pinter, MS, ESE
7. Gabe Torres, Senior, CIS. Winner of 1st Prize Senior Design Award, CIS Department 2011.
8. Ross Boczar, Sennior, ESE. Winner of 1st Prize Senior Design Award, CIS Department 2011.
9. Jason Suapengc, CIS. Winner of 1st Prize Senior Design Award, CIS Department 2011.

10. Varun Sampath, Junior, ESE
11. William Etter, Senior, ESE. Awarded Vagelos Undergraduate Research Grant. Winner of Frederick Ketterer Memorial Award for Best Senior Design Project 2011.
12. Paul Martin, Senior, ESE. Awarded Vagelos Undergraduate Research Grant. Winner of Frederick Ketterer Memorial Award for Best Senior Design Project 2011.
13. Theodore Zhang, Junior, ESE
14. Kevin Conley, Junior, ESE. Awarded Rachleff Scholar Scholardhip. Awarded 1st Prize in World Embedded Software Competition, Korea, November 2010.

I mentored the following MS and Undergraduate students for their projects:

1. Anu Sukumaran, MS, ESE. Now at Lutron Electronics.
2. Allison Connolly - Biomedical Engineering. Now pursuing a Ph.D. at U. Minnesota. 2010. Presented research at NSF Engineering Education Awardees Conference, Jan 2010.
3. Danny Lustig, Winner of Harold Berger Senior Design Project Award, 2009. Now pursuing a Ph.D. at Princeton University.
4. Andrew Avrin, Winner of Harold Berger Senior Design Project Award, 2009. Now at Google.
5. Brandon Duick (Boeing), Winner of Harold Berger Senior Design Project Award, 2009. Now at Lockheed Martin.
6. Jason DeLisser, 2010. Now at L3 Communications.
7. Avinash Rajput, 2009. Now at MERK, Automation Division.
8. Sunil Sadasivan (Cisco), 2010. Now at Kno Inc.
9. Uchenna Kevin Anyanwu (Intel), 2009. Now pursuing a Ph.D. at Virginia Tech.
10. RoopKumar Kalimuthu (Penn), 2009
11. Malolan Shantanakrishnan (MathWorks), MS research on *“Dual Radio Platform for Sensor Networks”* in Fall 2006.
12. Mark Hamilton (CMU), BS Honors research on *“Safety Protocols in Vehicular Networks”* in Fall 2006.
13. Dan Weller, BS Honors Thesis on *“Vehicle Network Simulation”* in Spring 2006. Now pursuing a Ph.D. at MIT.
(Winner of Carnegie Institute of Technology Honors Research Competition)
14. Ryohei Suzuki (Tokyo University), Visiting Scholar with focus on *“Topology Discovery and Scheduling for TDMA Sensor Networks”* in Fall 2005.
15. Jalaja Kurubarahalli (Cisco), Masters Thesis on *“GeoRoute: An In-vehicle System for Geographic Routing in Vehicular Networks”* in Spring 2005.
16. Chih-Yuan Liao (Qualcomm), Masters Thesis on *“Network Tiles for Concurrent Transmission in Wireless Mesh Networks”* in Spring 2003.
17. Yoshisato Takeda (Mitsubishi Electric), Masters Thesis on *“PAQ-MAC: Power-Aware MAC Protocol for Wireless Networks with a 2-Packet Buffer”* in Spring 2002.

PROFESSIONAL SERVICE

Program Co-Chair

April 2012

18th IEEE Real-Time and Embedded Technology and Applications Symposium, Beijing, China.

Program Chair April 2011
3rd IEEE Joint Workshop on High-Confidence Medical Devices Software and Systems, Chicago, IL. Co-located with CPSweek

Program Chair Dec 2011
2nd IEEE Analytic Virtual Integration of Cyber-Physical Systems Workshop, Co-located with RTSS

Panelist Dec 2010
1st IEEE Analytic Virtual Integration of Cyber-Physical Systems Workshop, San Diego, CA. Co-located with RTSS

Session Chair April 2010
“Wireless Sensor Networks” IEEE RTAS, *Stockholm, Sweden*

ARPA-E National Workshop Participant
Energy-efficient Building Technology Workshop, *Arlington, VA*

Session Chair June 2009
“Vehicular Ad hoc Networks” IEEE ICDCS, *Montreal, Canada*

Session Chair June 2009
IEEE International Workshop on Cyber-Physical Systems (WCPS), Montreal, Canada

Session Chair April 2008
“Quality of Service” IEEE RTAS, *St. Louis, MO*

Session Chair September 2008
IEEE International Workshop on Mobile Vehicular Networks (MoVeNet), *Atlanta, GA*

Break-out Session Chair Nov 2008
NSF-NCO/NITRD National Workshop on High Confidence Transportation Cyber-Physical Systems, *Arlington, VA*

Break-out Session Chair April 2008
NSF-NCO/NITRD National Workshop on High Confidence Automotive Cyber-Physical Systems. In cooperation with the United States Council for Automotive Research (USCAR), Detroit, MI

NSF-NCO/NITRD National Workshop Participant July 2007
New Research Directions in Composable and Systems Technologies for High Confidence Cyber-Physical Systems, *Arlington, VA*

Break-out Session Chair June 2007
NSF National Workshop on High Confidence Medical Device Software and Safety, *Boston, MA*

Member of Organizing Committee
IEEE HCMDSS (2011), COMSNETS (2009, 2010), IEEE COMSWARE (2008), INFOCOM (2010), INSS (2009)

Member of Program Committee
IEEE Real-Time & Embedded Technology and Applications Symposium, 2011
IEEE RTSS, Work-in-Progress, 2010
IEEE RTSS, Analytical Virtual Integration of CPS Workshop, 2010
IEEE Real-Time & Embedded Technology and Applications Symposium, 2010
ACM INFOCOM, 2009

IEEE Real-Time Systems Symposium (RTSS), 2008
IEEE Real-Time & Embedded Technology and Applications Symposium, 2008
IEEE International Symposium on Wireless Vehicular Communications, 2008
IEEE MoVeNet, 2nd International Workshop on Mobile Vehicular Networks, 2008
IEEE International Symposium on Vehicular Computing Systems, 2008
IEEE Workshop on Mobile Networks for Vehicular Environments, (INFOCOM/MOVE), 2008
IEEE Symposium on Selected Areas of Communication of ICC, 2009

Journal Reviewer

ACM Transactions in Embedded Computing Systems (TECS) , 2010
ACM Computing Surveys Journal, 2010
IEEE Network Special Issue on "Advances in Vehicular Communications Networks", 2009
Elsevier Ad hoc Networks, 2009
ACM Transactions on Sensor Networks, 2008
IEEE Internet Computing, 2008
ACM Transactions on Computers, 2008
ACM Transactions on Mobile Computing, 2008
ACM Transactions on Mobile Computing, 2007
UBIROADS Workshop, 2007
IEEE JSAC Special Issue on Vehicular Networks, 2007

Conference Reviewer

IEEE International Conference on Embedded Software (EMSOFT), 2010
IEEE Intelligent Transportation Systems Magazine, 2010
IEEE Vehicular Networking Conference, 2009
IEEE International Conference on Embedded Software (EMSOFT), 2009
IEEE/IFIP International Conference on Embedded and Ubiquitous Computing, 2009
IEEE International Conference on Computer Communications and Networks, 2009
IEEE ICC Symposium on Selected Areas in Communications, 2009
IEEE Wireless Communication Magazine Special Issue on VANET, 2009
IEEE INFOCOM, 2009
IEEE Wireless Access in Vehicular Environments, 2008
IEEE International Workshop on Mobile Vehicular Networks, 2008
IEEE Communications Magazine, 2008
IEEE Globecom, 2008
IEEE Wireless Vehicular Communications, 2008
IEEE International Symposium on Vehicular Computing Systems, 2008
IEEE INFOCOM MOVE, 2008
ACM SECON, 2008
IEEE Communications Magazine, Automotive Networking Series, 2007
IEEE RTAS 2007

NSF Panel Reviews

NSF CSR-IHCS Panelist, 2010

NSF CSR-CNS Panelist, 2010
NSF CSR-CPS Panelist, 2010
NSF CSR Panelist, 2009

UNIVERSITY SERVICE

Founding Committee Member New Undergraduate Program in Computer Engineering	May 2009 – Present
Founding Committee Member New Masters Program in Embedded Systems	August 2009 – Present
PRECISE Center - Founding Member Penn Research in Embedded Computing and Integrated Systems Engineering (PRECISE) Center	August 2009 – Present
Master Lecture Summer Academy in Applied Science and Technology	July 2010
Faculty Organizer High-School Summer Mentorship Program (SMP)	July 2010
Guide and Lecturer WICS High-school Day	May 2010
Guide and Lecturer Guidance Counselors and Teachers Day	November 2009

SELECTED INVITED TALKS

1. <i>Closing the Loop with Cyber-Physical Modeling</i> University of California, Irvine, ECE Departmental Seminar	April 2011
2. <i>Automotive Cyber-Physical Systems</i> University of Southern California, ECE Departmental Seminar	April 2011
3. <i>Green Scheduling of Buildings for Peak Power Minimization</i> ARPA-Energy	April 2011
4. <i>Medical Cyber-Physical Systems: New Frontiers</i> UIUC, Distinguished Lecture	March 2011
5. <i>Closing the loop with Networked Cyber-Physical Systems</i> UCLA, Center for Embedded Networked Sensing	December 2010
6. <i>Closing the loop with Networked Cyber-Physical Systems</i> University of Pennsylvania, CIS Departmental Seminar	November 2010
7. <i>Networked Cyber-Physical Systems</i> Virginia Tech, Center for Embedded Systems for Critical Applications	November 2010

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| 8. <i>Generic Pacemaker Project: Closed-loop Software Testing, Validation and Verification</i>
US. Food and Drug Administration (FDA) | November 2010 |
| 9. <i>Closing the loop with Networked Cyber-Physical Systems</i>
University of Pittsburgh, ECE Departmental Seminar | November 2010 |
| 10. <i>Closing the loop with Networked Cyber-Physical Systems</i>
Cornell University, ECE Departmental Seminar | October 2010 |
| 11. <i>Robust Architectures for Wireless Actuation and Control</i>
Honeywell Technical Fellows Seminar | October 2010 |
| 12. <i>Cyber-Physical Systems Research at Penn</i>
UT Austin, ECE Seminar | October 2010 |
| 13. <i>Medial Cyber-Physical Systems</i>
Temple University, ECE Departmental Seminar | October 2010 |
| 14. <i>Recent Research in Cyber-Physical Systems at mLAB-UPenn</i>
IMEC, Leuven, Belgium | July 2010 |
| 15. <i>Recent Research in Cyber-Physical Systems at mLAB-UPenn</i>
Embedded Systems Institute, Eindhoven, Netherlands | July 2010 |
| 16. <i>High-Confidence Medical Device Software and Systems</i>
IMEC-NL, Holst Center, Eindhoven, Netherlands | July 2010 |
| 17. <i>Medical Cyber-physical Systems</i>
IMEC, Leuven, Belgium | August 2009 |
| 18. <i>Automotive Cyber-Physical Systems</i>
University of Waterloo, Ontario, Canada | June 2009 |
| 19. <i>Distributed Wireless Control Grids</i>
Honeywell Technical Symposium, Arizona | May 2009 |
| 20. <i>Networked Cyber-Physical Systems</i>
Indian Institute of Technology Bombay (IIT-B), Mumbai | March 2009 |
| 21. <i>Networked Cyber-Physical Systems</i>
Indian Institute of Technology Madras (IIT-M), Chennai | March 2009 |
| 22. <i>Networked Cyber-Physical Systems</i>
Veermata Jijabai Technological Institute (VJTI), Mumbai | March 2009 |
| 23. <i>Research Activities at mLAB-UPenn</i>
Infosys SET Labs, Bangalore | March 2009 |
| 24. <i>Vehicular Wireless Networks for Safety and Congestion Prediction</i> | Jan 2009 |

Arada Systems, Bangalore

25. *Networked Automotive Cyber-Physical Systems* Dec 2008
Keynote Speaker, Conference on Wireless Access in Vehicular Environments, U Michigan
26. *Vehicle to Vehicle Wireless Networks* Nov 2008
WINLAB, Rutgers University. New Jersey
27. *Vehicle to Vehicle Wireless Networks* Nov 2008
University of Delaware, Delaware
28. *FireFly: Real-Time Sensor Networking Platform* Oct 2006
Cornell University, New York
29. *Scalable Time Synchronization for Multi-hop Networks* Sept 2006
Microsoft Research – Silicon Valley Center
30. *Scalable Time Synchronization for Multi-hop Networks* Sept 2006
Intel Labs, Santa Clara
31. *GrooveNet: Hybrid Network Simulation for Vehicular Networks* June 2006
Imperial College, London
32. *MAX: Maximal Transmission Concurrency for Wireless Mesh Networks* Jan 2005
Microsoft Research, Redmond
33. *RT-Link: Predictable Lifetime in Embedded Wireless Networks* Dec 2005
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Cambridge University, U.K.
35. *Tiling for Maximal Concurrency in Regular Wireless Networks'* Aug 2005
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36. *Real-Time Services for Multi-hop Wireless Networks* Mar 2005
University of York, U.K.
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Intel Labs, Oregon
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Philips Research, New York

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