Shravan Rayanchu

1210 W. Dayton St, Madison, WI 53706.
(608) 320-5639 • shravan@cs.wisc.edu • http://cs.wisc.edu/~shravan

Education

Ph.D., Computer Sciences,
Thesis: *Models and systems for understanding wireless interference*
Awarded the 2012 Outstanding Graduate Student Research Award
Advisor: Dr. Suman Banerjee
Doctoral Minor: *Business (Wisconsin school of Business)*
University of Wisconsin Madison, August 2012.

M.S., Computer Sciences,
Thesis: *Network coding for wireless unicast sessions: design, implementation and perf. evaluation*
University of Wisconsin Madison, August 2010.
GPA: 4.0/4.0

B.Tech., Computer Science and Engineering,
Indian Institute of Technology Guwahati, May 2004.
GPA: 9.21/10.0, Rank: 3^{rd} in the department

Research Interests

(i) Mobile networking systems — design and development of applications, algorithms, and networked systems, (ii) Machine learning — applications of machine learning algorithms in the context of mobile systems

Systems Skills

- *Languages*: C, C++, Java, Perl, Python, Shell Scripting
- *Systems Programming*: Assembly Programming, Sockets Programming, Libpcap, ioctls, Windows/Linux driver-level programming experience (Softap, Madwifi)
- *Embedded Platforms and software*: Soekris boards, ARM (Ipaq 336X, 45XX).

Honors and Awards

- Outstanding Graduate Student Research Award 2012 (awarded for best PhD thesis research at Computer Sciences, University of Wisconsin Madison)
- Microsoft Research Ph.D. Fellowship Recipient (2009-2011)
- Best paper nominee at ACM MobiCom 2011 (one of the top 3 papers, fast tracked to IEEE TMC)
- Author on award poster (first place in student research competition) at ACM MobiCom 2011
- Best paper award at ACM MobiCom 2009
- ACM MobiCom student travel award (2009)
- Student research competition winner at ACM MobiCom 2007

Media coverage of my work

- **Airshark**: Slashdot ("WiFi cards can now detect microwave ovens"), Network World ("Software upgrades could produce self-tuning wireless access points, researchers say"), PC Magazine ("Researchers Combat Wi-Fi RF Interference"), CRA (research highlight of the week), Wall Street Journal, The Register, BoingBoing, ... (20+ blogs)

- **NAPman**: CNN ("New ways to double phone battery life"), MIT Technology Review ("How Wi-Fi Drains Your Cell Phone"), Technology Today, Enterprise Mobile Blog, ... (10+ blogs)
- **Delusional Boot**: ZDNet ("Microsoft mulls improving hypervisor security for the cloud with Bunker-V"), Virtualization Info ("Microsoft is working on a more secure architecture for Hyper-V"), Ars Technica, Business Insider, ... (10+ blogs)

Publications

Journal articles

[1] FLUID: Improving Throughputs in Enterprise Wireless LANs through Flexible Channelization. Shravan Rayanchu, Vivek Shrivastava, Suman Banerjee, Ranveer Chandra. Invited for fast-track publication in **IEEE Transactions on Mobile Computing, 2011**.

[2] Network Coding Aware Routing in Wireless Networks. Sudipta Sengupta, Shravan Rayanchu, Suman Banerjee. In Proc. of **IEEE/ACM Transactions on Networking, August 2010**.

Conference and workshop papers

[3] The Anatomy of a Large Mobile Massively Multiplayer Online Game. Ashish Patro, Shravan Rayanchu, Michael Griepentrog, Yadi Ma, Suman Banerjee. In Proc. of **Workshop on Mobile Gaming (MobiGames), ACM SIGCOMM 2012** (*Awarded best paper*).

[4] Catching Whales and Minnows using WiFiNet: Deconstructing Non-WiFi Interference using WiFi Hardware. Shravan Rayanchu, Ashish Patro, Suman Banerjee. In Proc. of **ACM/USENIX NSDI 2012**.

[5] Delusional Boot: Securing Cloud Hypervisors without Massive Re-engineering. Anh Nguyen, Himanshu Raj, Shravan Rayanchu, Stefan Saroiu, Alec Wolman. In Proc. of **ACM EuroSys 2012**.

[6] Airshark: Detecting Non-WiFi RF Devices using Commodity WiFi Hardware. Shravan Rayanchu, Ashish Patro, Suman Banerjee. In Proc. of **ACM/USENIX IMC 2011**.

[7] AirTrack: Locating Non-WiFi Interferers using Commodity WiFi Hardware. Ashish Patro, Shravan Rayanchu, Suman Banerjee. **ACM MobiCom 2011 (***First place in ACM student research competition***)** and In Proc. of **ACM SIGMOBILE Mobile Computing and Communications Review 2011**.

[8] FLUID: Improving Throughputs in Enterprise Wireless LANs through Flexible Channelization. Shravan Rayanchu, Vivek Shrivastava, Suman Banerjee, Ranveer Chandra. In Proc. of **ACM MobiCom 2011 (Best paper nominee; one of the top 3 papers)**.

[9] PIE in the Sky: Online Passive Interference Estimation for Enterprise WLANs. Vivek Shrivastava, Shravan Rayanchu, Suman Banerjee, Dina Papagiannaki. In Proc. of **ACM/USENIX NSDI 2011**.

[10] NAPMan: Network-Assisted Power Management for WiFi Devices. Eric Rozner, Vishnu Navda, Ramachandran Ramjee, Shravan Rayanchu. In Proc. of **ACM MobiSys 2010**.

[11] CENTAUR: Realizing the Full Potential of Centralized WLANs through a Hybrid Data Path. Vivek Shrivastava, Nabeel Ahmed, Shravan Rayanchu, Suman Banerjee, Dina Papagiannaki, Srinivasan Keshav, Arunesh Mishra. In Proc. of **ACM MobiCom 2009 (Best paper award winner)**.

[12] A Measurement Study of a Commercial-grade Urban WiFi Mesh. Vladimir Brik, Shravan Rayanchu, Sharad Saha, Sayandeep Sen, Vivek Shrivastava, Suman Banerjee. In Proc. of **ACM/USENIX IMC 2008**.

[13] 802.11n Under the Microscope. Vivek Shrivastava, Shravan Rayanchu, Jongwon Yoon, Suman Banerjee. In Proc. of **ACM/USENIX IMC 2008**.

[14] Loss-Aware Network Coding for Unicast Wireless Sessions: Design, Implementation, and Performance Evaluation. Shravan Rayanchu, Sayandeep Sen, Suman Banerjee, Sudipta Sengupta. In Proc. of **ACM Sigmetrics 2008**.

[15] Diagnosing Wireless Packet Losses in 802.11: Separating Collision from Weak Signal. Shravan Rayanchu, Arunesh Mishra, Dheeraj Agrawal, Sharad Saha, Suman Banerjee. In Proc. of **IEEE Infocom 2008**.

[16] Supporting Continuous Mobility through Multi-rate Wireless Packetization. Arunesh Mishra, Shravan Rayanchu, Dheeraj Agrawal, Suman Banerjee. In Proc. of **IEEE HotMobile 2008**.

[17] Deconstructing Wireless Errors: Collision or 'Bad' Channel? Shravan Rayanchu, Arunesh Mishra, Dheeraj Agrawal, Suman Banerjee. **ACM MobiCom 2007 (***First place in ACM student research competition***)** and In Proc. of **ACM SIGMOBILE Mobile Computing and Communications Review 2008**.

[18] An Analysis of Wireless Network Coding for Unicast Sessions: The Case for Coding-Aware Routing. Sudipta Sengupta, Shravan Rayanchu, Suman Banerjee. In Proc. of **IEEE Infocom 2007**.

[19] Towards Robust Localization Using Wireless Congruity. Arunesh Mishra, Shravan Rayanchu, Ashutosh Shukla, Suman Banerjee. In Proc. of **IEEE HotMobile 2007**.

[20] TRAC: An Architecture for Real-Time Dissemination of Vehicular Traffic Information. Shravan Rayanchu, Sulabh Agarwal, Arunesh Mishra, Suman Banerjee, Samrat Ganguly. **ACM MobiCom 2006** (*student poster*) and In Proc. of **ACM SIGMOBILE Mobile Computing and Communications Review 2007**.

[21] Defending Against Slave and Reflector Attacks with Deterministic Edge Router Marking. Shravan Rayanchu, Gautam Barua. In Proc. of **National Conference on Communications, 2005**.

[22] Tracing Attackers with Deterministic Edge Router Marking. Shravan Rayanchu, Gautam Barua. In Proc. of **ICDCIT, LNCS 3347, Springer-Verlag, 2004**.

[23] Location Management by Movement Prediction Using Mobility Patterns and Regional Route Maps. Ratan K. Ghosh, Shravan Rayanchu, Hrushikesha Mohanty. In Proc. of **IWDC, LNCS 2918, Springer-Verlag, 2003**.

Patents

[1] System and Method for Interference Mitigation in Wireless Networks. (Filed with UW Madison. Granted Jul 10, 2012. Application number: 12/555,452 Publication number: US 2010/0080183 A1).

[2] Network Assisted Power Management. (Filed with Microsoft. Application number: 12/363,450. Publication number: US 2010/0195548 A1).

[3] Attestation Protocol for Securely Booting a Guest Operating System. (Filed with Microsoft. Application number: 13/222,379)

Work Experience

Aug 2012 - present,
Software Engineer

Google Inc., USA

Working on improving the quality of mobile ads.

Jan 2006 - Aug 2012,
Research Assistant, (with Suman Banerjee)

WiNGS Research Group, UW-Madison, USA

My work has focused on developing practical solutions to the research problems in the broad area of mobile and wireless networking. All of my work has been implemented using off-the-shelf hardware and has focused on developing easily deployable solutions in today's networks. Projects include:

1. Techniques to diagnose performance issues in WLANs.

• Designed **Airshark (IMC'11)**, a technique that uses only off-the-shelf WiFi cards to detect the presence of various non-WiFi sources (e.g., Bluetooth devices, cordless phones, microwave ovens etc). Airshark uses spectral samples from emerging WiFi cards, builds device-specific signatures and identifies these devices using decision-tree classifiers.

• Developed **WiFiNet (NSDI'12)**, a system that uses feedback from multiple WiFi nodes to provide a deeper analysis of non-WiFi transmitters: (a) WiFiNet uses fine-grained timing analysis to estimate the exact interference impact of each non-WiFi transmitter on every WiFi link in the WLAN, even in the presence of multiple simultaneously operating devices of the same type (b) It can physically locate the non-WiFi transmitter using WiFi-only hardware.

• Designed the first experimental approach, **COLLIE (Infocom'08)**, for diagnosing the cause of a packet loss — is the loss due to a collision or weak signal? COLLIE works on a single wireless node uses empirical analysis of wireless error patterns to identify the cause.

• Designed **PIE (NSDI'11)** uses feedback from multiple wireless nodes to estimate the interference impact of different wireless sources in real-time. PIE recognizes the changes in interference due to various environmental (e.g., user mobility) and communication parameters (e.g., transmit power, PHY rates, packet sizes) and updates its estimates seamlessly.

2. Techniques to improve WiFi performance.

• Designed **FLUID (MobiCom'11)** a technique to model the interference from wireless transmitters operating on various channel widths and PHY rates. We then implemented a system that uses the modeled interference estimates to employ "flexible channelization" (i.e., links can use arbitrary channel widths of 5, 10, 20, 40 MHz) and significantly improve WLAN throughput.

• Designed **CENTAUR (MobiCom'09)** a system that employs a hybrid approach of using centralized, data packet scheduling mechanisms along with decentralized, randomized channel access methods to improve performance in an enterprise WLAN.

• Designed efficient rate adaptation mechanisms for WiFi networks using concepts such as (a) distinguishing between collisions and channel errors (COLLIE) and (b) using multiple PHY rates within a single packet **(Multi-rate, HotMobile'08)**

• Implemented practical network coding algorithms for mesh networks that take into account the lossy nature of wireless links **(CLONE, Sigmetrics'08)**, and demonstrated the benefits of making routing protocols aware of coding opportunities **(Infocom'07)**.

3. Techniques to improve WiFi battery consumption.

• Designed energy efficient protocol stacks for mobile clients that improve battery (a) using network-assisted techniques that enable a WiFi card to "sleep" more **(NAPMan, MobiSys'10)**, and (b) using efficient rate adaptation (COLLIE) and header compression techniques (Woice) to minimize the energy spent in transmitting data packets.

4. Measurement and analysis of WiFi Networks.

• Benchmarked the performance of 802.11n in realistic wireless settings and designed an empirical model for 802.11n interference using variable widths of 20 and 40 MHz **(IMC'08)**.

• We worked with Madcity Networks Inc., that has deployed a city-wide mesh network consisting of 250 wireless access points in Madison, to monitor the network using active and passive measurements, and to analyze the performance bottlenecks **(IMC'08)**.

5. Mobile application analytics.

• Developed **Insight**, a framework that uses the vast and diverse application user base on popular mobile platforms (iOS, Android) to enable capturing application analytics and crowd-sourcing mobile network measurements. Insight is deployed two applications, and one of them is popular multiplayer game, Parallel Kingdom, that has over 600,000 unique users across 118 countries.

June 2009 - Aug 2009,
Research Intern, (with Stefan Saroiu, Alec Wolman)
Microsoft Research, Redmond

Delusional Boot / Mobile application security. Designed and implemented a secure runtime environment for mobile applications. Work involved hacking Microsoft's Hyper-V virtualization platform and crippling Windows Vista to create a restricted I/O environment with minimal devices and drivers. Also implemented an authentication framework using Windows Live Id and worked on using TPMs, Microsoft BitLocker to create a secure boot environment.

May 2008 - July 2008,
Research Intern, (with Ram Ramjee, Vishnu Navda, Venkat Padmanabhan)

Microsoft Research, India

NAPMan / Energy efficiency of smart phones. Work consisted of: (1) Profiling experiments – Measurement of per-packet RX/TX power profiles (wireless interface and host) of iPAQ 6965/Samsung i780 under a variety of scenarios. Evaluation of the effect of dynamic frequency/voltage scaling and packet-compression techniques on energy consumption. (2) Network-Assisted Power Management – developed schemes for smart management of "sleep" durations of wireless interfaces using network support. Implementation of proposed schemes on Windows SoftAP wireless driver.

June 2006 - Aug 2006,
Research Intern, (with Sudipta Sengupta)

Bell Laboratories, Alcatel-Lucent, USA

Network coding for wireless mesh networks. Developed a framework for computing the throughput of network coding on any wireless network topology and any pattern of concurrent unicast traffic sessions. Proposed coding-aware routing which gave a performance improvement of 40% compared to opportunistic coding and 70% when compared to traditional routing.

Aug 2005 - Dec 2005,
Research Assistant

CyLab, Carnegie Mellon University, USA

Mining router configurations. Worked on the development of a router configuration checker for Juniper routers as a member of Project M3 (Mining, Modeling & Monitoring of Core Routers). Worked on Transparent Switching (TS) Network Architecture, to provide a unified control plane to TDM & packet networks and QoS to real time applications.

July 2004 - July 2005,
Research Engineer, Ultra Wideband MAC Team

Samsung Software, Telecom & Network Division, India

Implementing Ultra wideband MAC. Involved in the design & implementation of the evolving MBOA (Multi Band OFDM Alliance) Medium Access Control standard. Developed MAC Libraries, Layer Management Entity, Beacon, Test & Power Control kernel modules.

Aug 2003 - Apr 2004,
Research Assistant (with Prof. Gautam Barua and Prof. Ratan Ghosh)

Computer Sciences, Indian Institute of Technology Guwahati

IP traceback and location management. Designed a novel approach to IP Traceback, for tracing attackers using spoofed source addresses. The proposed scheme is scalable to thousands of attackers, is very simple to implement at the routers, has no bandwidth overhead and needs minimal processing & storage requirements at the victim. Also, designed a Location Management scheme making use of mobility patterns of a mobile host to optimize routing. A hunt algorithm making use of regional route maps was proposed to tackle transient deviations from mobility pattern.

May 2003 - July 2003,
Summer Intern, Database Management Systems Group

University of Duisburg-Essen, Germany

Aspect-oriented programming. Worked on the encapsulation of extended observer pattern using aspect-oriented techniques - AspectJ, JAC (Java Aspect Components), PROSE (PROgrammable Service Extenstions).

Professional Activities

- **Program Committee Member:** IEEE DySPAN Demo Panel 2012, MobiSys 2011 PhD forum
- **Technical Reviewer:**
  1. Conferences: ACM/USENIX NSDI 2011, ACM MobiCom 2010, IEEE Infocom (2009, 2010, 2011), IEEE Globecom (2006, 2008, 2010), IEEE ICC 2010, IEEE ICNP 2007, COMSWARE 2007
  2. Journals: IEEE Transactions on Networking, IEEE Transactions on Wireless Communications, IEEE Transactions on Mobile Computing, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Multimedia, IEEE Transactions on Vehicular Technology, Wireless Personal Communications, EURASIP Journal of Communications and Networks
  3. Magazines: Mobile Computing and Communications Review, Wireless Networks
- **Miscellaneous Activities:** Scribe for MobiCom 2010 PC Meeting, compiled MobiCom 2010 conference program report, interviewer for MC2R (expert testimony series)

References

Available upon request.