

Aaron Schulman

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Research Interests

Embedded systems, Networking, Wireless communication, Visualization of measurements

Education

2007–2013 **Ph.D. Computer Science**, *University of Maryland*, College Park.

Dissertation: Observing and Improving The Reliability of Internet Last-mile Links

- **ACM SIGCOMM Doctoral Dissertation Award**
- **Larry S. Davis Doctoral Dissertation Award, University of Maryland**

Advisor: Neil Spring

2007 - 2010 **M.S. Computer Science**, *University of Maryland*, College Park.

2003 - 2007 **B.S. Computer Science**, *University of Maryland*, College Park.

Awards and Grants

- **\$99,000 - Google Faculty Research Award** – “Scalable and Precise Smartphone Power Monitoring”
- **Outstanding graduate student**–UMD College of Computer Mathematical & Natural Sciences
Awarded by the CMNS Board of Visitors to one student out of the ten departments in the college.
- **Best of team projects**–Intel International Science and Engineering Fair 2003

Publications

Conferences

Y. Liu, W. Tome, L. Zhang, D. Choffnes, D. Levin, B. Maggs, A. Mislove, **A. Schulman**, and C. Wilson. An end-to-end measurement of certificate revocation in the web’s PKI. In *ACM IMC (Internet Measurement Conference)*, 2015. 33% acceptance.

R. Padmanabhan, P. Owen, **A. Schulman**, and N. Spring. Timeouts: Beware surprisingly high delay. In *ACM IMC (Internet Measurement Conference)*, 2015. 33% acceptance.

Y. Michalevsky, G. Nakibly, **A. Schulman**, and D. Boneh. PowerSpy: Location tracking using mobile device power analysis. In *USENIX Security*, 2015. 15% acceptance.

M. Bansal, **A. Schulman**, and S. Katti. Atomix: A framework for deploying signal processing applications on wireless infrastructure. In *USENIX NSDI (Networked Systems Design and Implementation)*, 2015. 20% acceptance.

A. Schulman, D. Levin, and N. Spring. RevCast: Fast, private certificate revocation over FM radio. In *ACM CCS (Conference on Computer and Communication Security)*, 2014. 20% acceptance.

L. Zhang, D. Choffnes, T. Dumitras, D. Levin, A. Mislove, **A. Schulman**, and C. Wilson. Analysis of SSL certificate reissues and revocations in the wake of Heartbleed. In *ACM IMC (Internet Measurement Conference)*, 2014. 23% acceptance.

Selected to appear as CACM Research Highlight.

A. Schulman and N. Spring. Pingin' in the rain. In *ACM IMC (Internet Measurement Conference) - Short Paper*, 2011. 13% acceptance.

A. Schulman, N. Spring, V. Navda, R. Ramjee, P. Deshpande, C. Grunewald, V. N. Padmanabhan, and K. Jain. Bartendr: A practical approach to energy-aware cellular data scheduling. In *ACM MobiCom (Conference on Mobile Computing and Networking)*, 2010. 14% acceptance.

B. Han, **A. Schulman**, N. Spring, B. Bhattacharjee, F. Gringoli, L. Nava, L. Ji, S. Lee, and R. Miller. Maranello: Practical partial packet recovery for 802.11. In *USENIX NSDI (Networked Systems Design and Implementation)*, 2010. 17% acceptance.

A. Schulman, D. Levin, and N. Spring. On the fidelity of 802.11 packet traces. In *PAM (Passive and Active Measurement Conference)*, 2008. 32% acceptance.

Journals

Z. Foo, D. Devescery, M. Ghaed, I. Lee, A. Madhavan, Y. Park, A. Rao, Z. Renner, N. Roberts, **A. Schulman**, V. Vinay, M. Wieckowski, D. Yoon, C. Schmidt, T. Schmid, P. Dutta, P. Chen, and D. Blaauw. A low-cost audio computer for information dissemination among illiterate people groups. *IEEE Transactions on Circuits and Systems I: Regular Papers*, 2013.

Workshops

D. Levin, **A. Schulman**, K. Lacurts, N. Spring, and B. Bhattacharjee. Making currency inexpensive with iOwe. In *NetEcon (Workshop on the Economics of Networks, Systems, and Computation)*, 2011. 35% acceptance.

R. Blue, C. Dunne, A. Fuchs, K. King, and **A. Schulman**. Visualizing real-time network resource usage (NetGrok). In *VizSEC (Workshop on Visualization for Cyber Security)*, 2008. 72% acceptance.

Demos

A. Schulman, T. Schmid, P. Dutta, and N. Spring. Phone power monitoring with BattOr. In *ACM MobiCom (Conference on Mobile Computing and Networking)*, 2011.

B. Aggarwal, P. Chitnis, A. Dey, K. Jain, V. Navda, V. Padmanabhan, R. Ramjee, **A. Schulman**, and N. Spring. Stratus: Energy-efficient mobile communication using cloud support. In *ACM SIGCOMM*, 2010. 33% Acceptance.

■ Talks

- SIGCOMM 2015: *SIGCOMM Preview Session – Wireless*
- CCS 2014: *Fast, Private Certificate Revocation over FM Radio*
- CAIDA AIMS-5: *Pingin' II: Now We're Analyzin'*
- CAIDA AIMS-4: *Pingin' in the Rain*
- NANOG 54 Lightning Talk: *Pingin' in the Rain*
- IMC 2011: *Pingin' in the Rain*

- MobiCom 2010: *Bartendr: A Practical Approach to Energy-aware Cellular Data Scheduling*
- NSDI 2010: *Maranello: Practical Partial Packet Recovery for 802.11*
- PAM 2008: *On the Fidelity of 802.11 Packet Traces*

Research Experience

- 2013–Present **Postdoctoral Scholar**, *Stanford University*, Mentor: Sachin Katti.
Leading a research agenda that addresses the growing concern that we are reaching the limits of the efficiency of software developed for abstract computing hardware.
- 2007–2013 **Research Assistant**, *University of Maryland*, Advisor: Neil Spring.
Designed, implemented, and evaluated systems to defend the following thesis: By building on existing infrastructure, it is possible to (1) observe the reliability of Internet last-mile links across different weather conditions and link types; (2) improve the energy efficiency of cellular Internet last-mile links; and (3) provide an incrementally deployable, energy-efficient Internet last-mile downlink that is highly resilient to weather-related failures.
- 2010–2012 **Visiting Research Student**, *University of Michigan*, Mentor: Prabal Dutta.
Learned about various aspects of embedded systems development, including: circuit design, analog circuit design, and firmware programming. These skills enabled me to (1) create BattOr—the first portable smartphone power monitor, (2) create the FM RDS receiver hardware that I used to evaluate the reliability of revoking certificates over FM broadcasts, (3) teach the embedded systems courses at Stanford and Maryland.
- 2009 **Research Intern**, *Microsoft Research India*, Mentors: Navda, Ramjee, and Padmanabhan.
Researched and designed a system for energy-aware cellular data scheduling. My work from this internship was published in MobiCom and patented by Microsoft.
- 2008 **Research Intern**, *Microsoft Research*, Mentor: Galen Hunt.
Researched and implemented a system that removes the need for synchronizing application data between PCs and mobile devices; without modifying existing PC and mobile applications.

Service

- **Program committee chair:** ACM S3 2012
- **Program committee member:** HotMobile 2016, INFOCOM 2015, SIGCOMM 2014 Posters, TMA 2014, ACM S3 2011, MobiSys PhD Forum 2011
- **Corporate sponsorship chair:** MobiCom 2014
- **External reviewer:** ACM SIGCOMM 2013, ACM MC2R 2009, IEEE ToN 2009, IEEE Communications Letters 2009, SP&E 2010, IMC 2011
- **Judge:** Intel ISEF 2014
- **Organizer:** Syschat weekly paper discussions 2009-2010
- **Data set collector:** 802.11 traces collected at SIGCOMM 2008

Press

- Heartbleed revocation study featured in:
 - "Sysadmins disposed of Heartbleed certs, but forgot to flush" *The Register*, Nov. 2014
 - "UMD Cyber Experts Discover Lapses in Heartbleed Bug Fix" *UMD Now*, Nov. 2014
- PowerSpy featured in:
 - "Battery power alone can be used to track Android phones" *BBC*, Feb. 2015

- "Cell Phone Surveillance, What Androids Reveal, Silicon Valley Gender Discrimination" *KQED TV Interview*, Feb. 2015
- Several radio interviews: *BBC World Service* and *KSL Broadcasting*
- o NetGrok featured in: McRee, Russ "Security Visualization Tools" *Linux Magazine*, Sep. 2009
- o ThunderPing featured in: "Tracking Internet Outages in Sandy's Wake" *IEEE Spectrum*, Nov. 2012

Teaching Experience

Fall Quarter 2015 **Co-Instructor**, *EE107: Networked Embedded Systems*, Stanford University.

I designed the first embedded systems course for EE undergraduates at Stanford. I also co-taught twice-weekly classes with Sachin Katti. The topics covered included: MMIO, GPIO, timers, interrupts, clocks, serial busses, ADC, power management, and wireless networking. The course project entailed assembling and programming a smartphone power monitor. For the final project, the students used the power monitors that they created to compare the power consumption of popular Android applications.

Spring Quarter 2014 **Co-Instructor**, *ENGR40C: Engineering Wireless Networks*, Stanford University.

I co-taught various classes on wireless communications, including compression, modulation, and demodulation. I also created live in-class demonstrations of wireless communication concepts using audio signals, including: modulation, multipath, angle-of-arrival, channel linearity, and error models.

Fall 2012 **Co-Instructor and Course Designer**, *CMSC498A Introduction to Embedded Systems*, University of Maryland.

I designed and taught the first embedded systems course for CS undergraduates at Maryland. I co-taught twice weekly, 75 minute classes with Bobby Bhattacharjee. The topics covered included: MMIO, GPIO, clocks, interrupts, ADC and DAC, filtering, DMA, busses, amplifiers, energy efficiency, and circuit boards. The course projects consisted of building the following systems around an ARM microcontroller: a binary clock, a sound recorder, and an audio modem.

Fall 2008 **Graduate Teaching Assistant**, *CMSC412 Operating Systems*, University of Maryland.

Taught twice-weekly, hour-long discussions sections. Administered a semester long course project. Graded homework, projects, and the final exam. The projects consisted of adding the following features to an open source educational kernel: process listing, signals, scheduling, synchronization, paging, virtual memory, and an inodes-based file system.

Spring 2006 **Undergraduate Teaching Assistant**, *CMSC420 Data Structures*, University of Maryland.

Revised and improved the specification for a semester long project. Answered students' questions regarding the project.

Professional Experience

2015– **Co-Founder and Chief Scientist**, *Mellow Research, LLC*, Redwood City, CA.
Commercializing the BattOr power monitor hardware.

2015– **Software Engineer**, *Contractor for Google*, Mountain View, CA.

Tech transfer of the BattOr power monitor research into Telemetry, Google Chrome's automated performance testing framework.

2008–2013 **Software Engineer**, *KEYW Corporation*, Annapolis Junction, MD.

Advising the development of quick reaction software applications.

2007–2008 **Software Engineer**, *Northrop Grumman Mission Systems: Essex Windermere*, Annapolis, MD.

Designed and implemented software and hardware for a wireless signal capture system.

2005–2007 **Research Fellow**, *Consortium Research Fellows Program: National Defense University*, Fort McNair, DC.

Assisted in the design, implementation and presentation of an Information Assurance Laboratory used in executive briefings, presentations to foreign dignitaries and masters level coursework.

Patents

- o US8345616: Scheduling Communications in a Mobile Device
Vishnu Navda, Ramachandran Ramjee, *Aaron Schulman*, Venkata N. Padmanabhan, Kamal Jain