Matthew J. Miller

Curriculum Vitae

Contact

Apex, NC

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Employment

7/2020–present
Principal Engineer
NetApp
Research Triangle Park, NC

12/2011–7/2020
Senior Software Engineer
NetApp
Research Triangle Park, NC

1/2007–12/2011
Senior Software Engineer
Cisco Systems
Research Triangle Park, NC

1/2003–9/2005
Research Assistant
Coordinated Science Laboratory, University of Illinois at Urbana-Champaign
Urbana, IL

Education

Ph.D., Computer Science, December 2006
University of Illinois at Urbana-Champaign
Urbana, IL

Thesis: *Energy Efficiency and Security for Multihop Wireless Networks*
Adviser: Prof. Nitin H. Vaidya
Committee: Prof. Klara Nahrstedt, Prof. Jennifer Hou, and Prof. Indranil Gupta
GPA: 3.94/4.0

M.S., Computer Science, December 2003
University of Illinois at Urbana-Champaign
Urbana, IL

Thesis: *Minimizing Energy Consumption in Sensor Networks Using a Wakeup Radio*
Adviser: Prof. Nitin H. Vaidya

B.S., Computer Engineering, May 2001
Clemson University
Clemson, SC

GPA: 4.0/4.0
Minors: *Computer Science* and *Mathematics*

Industry Experience

NetApp

- Data ONTAP Scale-Out Networking Team (2011 to present)
  - Co-lead for project to convert Data ONTAP's network data plane from NetApp's proprietary kernel to FreeBSD.
    - Designed and implemented network threading model to reduce lock contention. The design integrates with RSS capabilities in NICs and FreeBSD's connection groups.
    - Designed and implemented the APIs for packet processing and manipulation to integrate FreeBSD's mbufs with existing ONTAP semantics. Unified several existing different representations of network packets.
  - Lead networking-related projects to adapt ONTAP to run in user-space, containerized environments.
    - Designed and implemented the networking related adapter APIs needed for the code to seamlessly use both kernel and POSIX sockets as well as the packet and network threading APIs. In particular, this involved adapting the kernel socket upcall model to a user-space epoll() model that worked seamlessly with existing kernel code.
    - Integrated Protocol Buffers and gRPC into NetApp's proprietary build system and implemented a plug-in to generate code to provide APIs that avoided conflict with kernel headers.
    - Designed and implemented a gRPC-based etcd client in containerized ONTAP to provide persistence of some data in cloud/k8s environments
    - Ported ONTAP custom RPC implementation (CSM) to environment and adapted to:
      - Use a pluggable database backend for endpoint lookups.
      - Input configuration from REST and container library.
      - TLS to use certificates for mutual authentication instead of existing pre-shared key scheme.
    - Designed and implemented an IPC framework build on top of gRPC and Unix Domain Sockets to allow synchronous, asynchronous, and pub-sub IPC APIs to be added. The framework abstracted gRPC details/knowledge required for API implementations.
  - Designed and implemented a RDMA-based transport layer for ONTAP's proprietary node-to-node data transfer protocol to replace the existing TCP socket-based transport layer. This consisted of adding an adapter layer to interface with the existing APIs and converting packet data to be sent and received via OFED APIs.
  - Created the infrastructure to support Linux user-space unit testing of FreeBSD kernel code using CxxTest. This consisted of implementing mocks of widely used FreeBSD kernel APIs using Linux system calls. This infrastructure was then adopted across all of ONTAP and used by many teams for unit testing of kernel code.
  - Implemented several widely used GDB functions using Python to display and search networking objects such as sockets, threads, and packets. For example, a function to take in search criteria from user input and walk through FreeBSD UMA zones to display matching sockets in memory.
  - Developed several Python and Bash productivitiy tools used by others, including diff/patch utilities to move/save unsubmitted changes, a script to parse clang-generated ASTs and find unused functions, and a command-line smoketest submission tool.
  - Provided TCP sustaining and supportability improvements for Data ONTAP's network stacks (FreeBSD and a proprietary kernel).
  - Served as a mentor for a Hackathon project to investigate some locking changes.
  - Served as a judge for the 2022 AMIE Design Challenge for Historically Black Colleges and Universities (HBCU).

Cisco Systems

- IOS-XE Operating System on the ASR-1000 Router (2008 to 2011)
  - Lead designer and developer for implementing the entire NAT64 control plane from scratch to support IPv6 to IPv4 translation. Responsible for both the platform independent and platform dependent portions. Improved the scalability compared to previous NAT implementations. Developed algorithm to split an IP address range into the minimum number of subnets for efficient route table programming.
  - Lead designer and developer for enhancing and maintaining existing NAT44 (Network Address Translation) control plane (both platform independent and platform dependent). In one instance, based on profiling, was able to improve the boot-up performance of a scaled configuration by $\sim$90%.
  - Implemented several, smaller NAT-related projects for the multi-threaded data plane to enhance functionality.
  - Lead developer for the data plane client code for the ASR-1000's hardware implementation of Cisco's Performance Routing (PfR) to allow latency and throughput-based routing (vs. strictly shortest path). Managed all external memory allocation and configuration set-up (linked lists, hash tables, and prefix lookups) for the data plane. Assisted in data plane design to improve sorting performance.
  - Participated in effort to make platform endian-neutral to run on multiple processors.
  - Designed several command line user interfaces for NAT and NAT64.
  - Worked in multiple environments including the IOS daemon, platform dependent code in Linux, and both the control plane and multi-threaded data plane on the network processor.
- IOS Operating System on the 7600 Router (2007 to 2008)
  - Worked on several small projects for the SIP-400 linecard and IP routing platform code.
- Cisco Research
  - Reviewer for external proposals for Cisco Research.
  - Served multiple times as a Cisco judge for Duke University's graduate networking project class.

Honors

US National Science Foundation Fellowship
Awarded in 2001
Acceptance Percentage: 16.2% (903/5560)

ASEE National Defense Science and Engineering Graduate Fellowship
Awarded in 2001
Acceptance Percentage: 21.3% (285/1339)

Publications

Journal Papers

Cigdem Sengul, **Matthew J. Miller**, and Indranil Gupta. Adaptive Probability-Based Broadcast Forwarding in Energy-Saving Sensor Networks. *ACM Transactions on Sensor Networks*, 4(2):1–32, March 2008.

Matthew J. Miller and Nitin H. Vaidya. Ad hoc Routing for Multilevel Power Save Protocols. *Elsevier Ad Hoc Networks*, 6(2):210–225, April 2008.

Matthew J. Miller and Nitin H. Vaidya. A MAC Protocol to Reduce Sensor Network Energy Consumption Using a Wakeup Radio. *IEEE Transactions on Mobile Computing*, 4(3):228–242, May/June 2005.
Acceptance rate $\approx$ 25%.

Conference Papers

Matthew J. Miller and Indranil Gupta. Practical Exploitation of the Energy-Latency Tradeoff for Sensor Network Broadcast. In *IEEE Workshop on Sensor Networks and Systems for Pervasive Computing (PerSeNS) 2007*, March 2007.
Acceptance rate = 28.9% (13/45).

Matthew J. Miller and Nitin H. Vaidya. Leveraging Channel Diversity for Key Establishment in Wireless Sensor Networks. In *IEEE Conference on Computer Communications (Infocom) 2006*, April 2006.
Acceptance rate = 18% (252/1400).

Matthew J. Miller and Nitin H. Vaidya. Improving Power Save Protocols Using Carrier Sensing for Dynamic Advertisement Windows. In *IEEE Mobile Ad hoc and Sensor Systems (MASS) 2005*, November 2005.
Acceptance rate = 35.7% (59/165).

Matthew J. Miller, Cigdem Sengul, and Indranil Gupta. Exploring the Energy-Latency Trade-off for Broadcasts in Energy-Saving Sensor Networks. In *IEEE International Conference on Distributed Computing Systems (ICDCS) 2005*, pages 17–26, June 2005.
Acceptance rate = 13.8% (75/542) overall and 10.1% (9/89) for papers on sensors.

Matthew J. Miller and Nitin H. Vaidya. Power Save Mechanisms for Multi-Hop Wireless Networks. In *IEEE International Conference on Broadband Networks (BROADNETS) 2004*, pages 518–526, October 2004. Invited paper.

Matthew J. Miller and Nitin H. Vaidya. Minimizing Energy Consumption in Sensor Networks Using a Wakeup Radio. In *IEEE Wireless Communications and Networking Conference (WCNC) 2004*, March 2004.
Acceptance rate = 43.2% (470/1087).

Technical Reports

Matthew J. Miller. An Errata for *Delay Efficient Sleep Scheduling in Wireless Sensor Networks*. Technical report, University of Illinois at Urbana-Champaign, September 2005.

Matthew J. Miller and Nitin H. Vaidya. On-Demand TDMA Scheduling for Energy Conservation in Sensor Networks. Technical report, University of Illinois at Urbana-Champaign, June 2004.

Matthew J. Miller, William D. List, and Nitin H. Vaidya. A Hybrid Network Implementation to Extend Infrastructure Reach. Technical report, University of Illinois at Urbana-Champaign, 2003.

Research Experience

Graduate Work

My work focuses on *security* and *energy efficiency* in wireless multihop networks, particularly sensor networks. In the security domain, I proposed a key distribution protocol to provide symmetric, pairwise keys that, with high probability, are unknown to eavesdroppers. This was the first work to use the underlying wireless channel diversity to address this problem. In the energy efficiency domain, most power save protocols use static sleeping and listening intervals regardless of the network environment. My work looks at adaptively adjusting these intervals in response to network traffic. Additionally, I have proposed methods of using carrier sensing to further improve the energy efficiency of power save protocols and a lightweight protocol to address the energy-latency tradeoff for broadcast dissemination in sensor networks.

Graduate Class Projects

- *Exploring the Energy-Latency Trade-off of Broadcasts in IEEE 802.11 Power Save Networks*
  Joint work with Cigdem Sengul in Fall 2003. Designed, analyzed, simulated, and evaluated (using

ns-2) a protocol for power save networks and the impact of its parameters on energy and latency. Selected by the professor as one of the three best two-person projects in the class. Published in IEEE ICDCS 2005.

- *Improving Fault Tolerance in AODV*
  Joint work with Jungmin So in Fall 2002. Designed, simulated, and evaluated (using *ns-2*) techniques to maintain multiple routes in an ad-hoc routing protocol.
- *Improving Connectivity in a Scatternet Formation Algorithm*
  Joint work with Cristina L. Abad in Spring 2002. Designed, simulated, and evaluated (using a custom built simulator written in C) a protocol to provide greater connectivity in Bluetooth scatternet formation.
- *Log Correlation for Intrusion Detection*
  Group project in Spring 2003. Investigated how information from various system logs can be used to identify specific attacks. Subsequent work by some group members led to a publication based on the project:
  C. Abad, J. Taylor, C. Sengul, W. Yurcik, Y. Zhou, and K. Rowe, "Log Correlation for Intrusion Detection: A Proof of Concept," in *Annual Computer Security Applications Conference (ACSAC 2003)*, December 2003.
- *Tools for Middle School Students to Create Vignettes*
  Joint work with Jeffrey Naisbitt and Naomi Caldwell in Spring 2003. Designed, implemented, and did user-testing on a tool (using Java Swing) to allow students to create life stories using an instant messenger-like interface.

Awards

- NSF Student Travel Grant (US $500) for IEEE BROADNETS 2004
- NSF Student Travel Grant (US $750) for ACM SenSys 2004
- DARPA/NSF Student Travel Grant (US $400–750) for IEEE MASS 2005

Undergraduate Work

- Participated in the NSF-funded Summer Undergraduate Research Experience (SURE) at Clemson University in 1999.
- Worked in Parallel Architecture Research Lab (PARL) at Clemson University for two years.
- Projects included designing user interfaces (using Java Swing) for scientific computing problem solving environments to allow message passing between modules and array partitioning.

External Reviewer

- *IEEE Transactions on Mobile Computing*, *IEEE Transactions on Dependable and Secure Computing*, *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Information Forensics and Security*, and *IEEE Communications Magazine*.
- MobiQuitous 2004, IEEE WCNC 2004, IEEE ICC 2005, IEEE MASS 2006, and IEEE VTC 2006.
- Cisco Research funding proposals.
- Judge for Duke University Computer Science graduate class projects (2007–2011).
- Judge for AMIE Design Challenge for HBCUs (2022)

Memberships

1997–2012 Member, Institute of Electrical and Electronics Engineers (IEEE)

Technical Skills

Most Recently Used

C, C++, Python

Proficient (used on a daily basis for large projects)
C, C++

Competent (moderate-sized scripts and semester or longer projects)
Python, Java, Perl, LaTeX, *ns-2* Network Simulator (C++ based), TinyOS/TOSSIM

Familiar (small programs and scripts)
Tcl/Tk, ML, Prolog, Lisp, PHP, Matlab

Extracurricular

2014–2019 YMCA Y-Princesses
Chief of tribes for both of my kids

2012–2015 Children Soccer Coach
Town of Apex (5-6 year olds and 6-7 year olds)

2004–2005 Large Group Coordinator
UIUC Graduate InterVarsity Christian Fellowship

- Responsible for contacting and scheduling about 20 speakers
- Responsible for arranging facility and equipment reservations
- Helped restructure the chapter budget

Miscellaneous

Citizenship: United States of America

Marital Status: Married

Erdös Number: ≤ 4

October 2, 2022