

## Research Interests

Computer architecture, neuromorphic hardware accelerators, emerging memory technologies, high-performance memory systems, architecture-circuit interaction, and energy-efficient computing.

## Education

- Ph.D. in Electrical and Computer Engineering**, Cornell University 2008  
Adviser: Professor José F. Martínez.  
Dissertation: “Reconfigurable and Self-Optimizing Multicore Architectures.”  
(Nominated for the 2008 ACM Doctoral Dissertation Award by Cornell University.)
- M.S. in Electrical and Computer Engineering**, Cornell University 2007  
Thesis: “Efficiently Exploring Architectural Design Spaces via Predictive Modeling.”
- B.S. in Electrical and Computer Engineering**, Cornell University 2003

## Honors and Awards

- IEEE MICRO Top Picks in Computer Architecture 2017
- HPCA 2016 Distinguished Paper Award 2016
- IEEE Computer Society TCCA Young Computer Architect Award 2014
- IEEE MICRO Top Picks in Computer Architecture 2013
- National Science Foundation CAREER Award 2011
- ASPLOS 2010 Best Paper Award 2010
- IEEE MICRO Top Picks in Computer Architecture 2009
- Communications of the ACM Research Highlight 2009

## Work Experience

- Associate Professor of ECE & CS, University of Rochester 6/15 – present
- Assistant Professor of ECE & CS, University of Rochester 9/09 – 6/15
- Researcher, Computer Architecture Group, Microsoft Research 9/07 – 8/09
- Intern, Computer Architecture Group, Microsoft Research 5/07 – 8/07
- Intern, Architecture Research Lab, Intel Corporation 6/05 – 8/05
- Intern, Center for Advanced Scientific Computing, LLNL 5/04 – 8/05
- Undergraduate Intern, TriQuint Semiconductor 6/01 – 01/02

## Fully Refereed Archival Publications

B. Feinberg, S. Wang, and E. Ipek, “Making Memristive Neural Network Accelerators Reliable”, *International Symposium on High Performance Computer Architecture (HPCA)*, 2018.

- M. Marinella, S. Agarwal, A. Hsia, I. Richter, R. Jacobs-Gedrim, J. Niroula, S. Plimpton, E. Ipek, and C. James, "Multiscale Co-design Analysis of Energy, Latency, Area, and Accuracy of a ReRAM Analog Neural Training Accelerator", *IEEE Journal on Emerging and Selected Topics in Circuits and Systems (IEEE JETCAS)*, 2018.
- E. Ipek, F. Longnos, S. Xiao, and W. Yang, "Vertical Writes: Closing the Throughput Gap Between Scaled STT-MRAM and DRAM", *IEEE Computer Architecture Letters (IEEE CAL)*, 2017.
- M. N. Bojnordi and E. Ipek, "The Memristive Boltzmann Machines", *IEEE Micro Special Issue: Top Picks from 2016 Computer Architecture Conferences (IEEE MICRO)*, 2017.
- E. Ipek, F. Longnos, S. Xiao, and W. Yang, "Bit-Level Load Balancing: A New Technique to Improve the Write Throughput of Deeply Scaled STT-MRAM", *IEEE Computer Architecture Letters (IEEE CAL)*, 2017.
- Y. Bai, V. W. Lee, and E. Ipek, "Voltage Regulator Efficiency Aware DVFS Power Management", *International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, 2017.
- S. Wang and E. Ipek, "Reducing Data Movement Energy via Online Data Clustering and Encoding", *International Symposium on Microarchitecture (MICRO)*, 2016.
- M. N. Bojnordi and E. Ipek, "Memristive Boltzmann Machine: A Hardware Accelerator for Combinatorial Optimization and Deep Learning", *International Symposium on High Performance Computer Architecture (HPCA)*, 2016.
- Y. Song and E. Ipek, "More is Less: Improving the Energy Efficiency of Data Movement via Opportunistic Use of Sparse Codes", *International Symposium on Microarchitecture (MICRO)*, 2015.
- M. Kazemi, E. Ipek, and E. G. Friedman, "Compact Model for Spin-Orbit Magnetic Tunnel Junctions", *IEEE Transactions on Electron Devices (IEEE TED)*, accepted in 2015.
- Y. Bai, Y. Song, M. N. Bojnordi, A. Shapiro, E. Ipek, and E. G. Friedman, "Architecting a MOS Current Mode Logic (MCML) Processor for Fast, Low Noise and Energy-Efficient Computing in the Near-Threshold Regime", *International Conference on Computer Design (ICCD)*, 2015.
- Y. Song, M. N. Bojnordi, and E. Ipek, "Energy-Efficient Data Movement with Sparse Transition Encoding", *International Conference on Computer Design (ICCD)*, 2015.
- Q. Guo, X. Guo, E. Ipek, Y. Bai, R. Patel, and E. G. Friedman, "Resistive TCAM Systems for Data-Intensive Computing", *IEEE Micro Special Issue: Alternative Computing Designs and Technologies (IEEE MICRO)*, 2015.
- M. Kazemi, E. Ipek, and E. G. Friedman, "Energy Efficient Nonvolatile Flip Flop with Subnanosecond Data Backup for Fine Grain Power Gating", *IEEE Transactions on Circuits and Systems – II (IEEE TCAS-II)*, accepted 2015.
- Y. Bai, Y. Song, M. N. Bojnordi, A. Shapiro, E. G. Friedman, and E. Ipek, "Back to the Future: Current Mode Processors in the Era of Deeply Scaled CMOS", *IEEE Transactions on Very Large Scale Integration Systems (IEEE TVLSI)*, accepted 2015.
- S. Wang, Y. Song, M. N. Bojnordi, and E. Ipek, "Enabling Energy Efficient Hybrid Memory Cube Systems with Erasure Codes", *International Symposium on Low Power Electronics and Design (ISLPED)*, 2015.

- R. Patel, X. Guo, Q. Guo, E. Ipek, and E. G. Friedman, "Reducing Switching Latency and Energy in STT-MRAM Caches with Field-Assisted Writing", *IEEE Transactions on Very Large Scale Integration Systems (IEEE TVLSI)*, accepted 2015.
- I. Richter, K. Pas, X. Guo, R. Patel, J. Liu, E. Ipek, and E. G. Friedman, "Memristive Accelerator for Extreme Scale Linear Solvers", *Government Microcircuit Applications & Critical Technology Conference (GOMACTech)*, 2015.
- M. Kazemi, E. Ipek, and E. G. Friedman, "Adaptive Compact Magnetic Tunnel Junction Model", *IEEE Transactions on Electron Devices (IEEE TED)*, Vol. 61, No. 11, pp. 3883-3891, 2014.
- R. Patel, E. Ipek, and E. G. Friedman. "Field Driven STT-MRAM Cell for Reduced Switching Latency and Energy", *IEEE Symposium on Circuits and Systems (ISCAS)*, 2014.
- E. Ipek and E. G. Friedman. "Resistive Memory Based Acceleration of Data Intensive Computing", *Government Microcircuit Applications & Critical Technology Conference (GOMACTech)*, 2014.
- R. Patel, E. Ipek, and E. G. Friedman. "2T-1R STT-MRAM Memory Cells for Enhanced On/Off Current Ratio", *Microelectronics Journal (MEJ)*, 2014.
- M. N. Bojnordi and E. Ipek, "DESC: Energy Efficient Data Exchange using Synchronized Counters", *International Symposium on Microarchitecture (MICRO)*, 2013.
- M. N. Bojnordi and E. Ipek, "A Programmable Memory Controller for the DDRx Interfacing Standards", *ACM Transactions on Computer Systems (ACM TOCS)*, accepted 2013.
- M. N. Bojnordi and E. Ipek, "Programmable DDRx Controllers," *IEEE Micro Special Issue: Top Picks from 2012 Computer Architecture Conferences (IEEE MICRO)*, 2013.
- Q. Guo, X. Guo, R. Patel, E. Ipek, and E. G. Friedman. "AC-DIMM: Associative Computing with STT-MRAM," *International Symposium on Computer Architecture (ISCA)*, 2013.
- R. Patel, E. Ipek, and E. Friedman. "STT-MRAM Memory Cells with Enhanced On/Off Ratio," *International System-on-Chip Conference (SOCC)*, 2012.
- M. N. Bojnordi and E. Ipek. "PARDIS: A Programmable Memory Controller for the DDRx Interfacing Standards," *International Symposium on Computer Architecture (ISCA)*, 2012.
- J. Mukundan, S. Ghose, R. Karmazin, E. Ipek, and J. F. Martinez. "Overcoming Single-Thread Performance Hurdles in the Core Fusion Reconfigurable Multicore Architecture," *International Symposium on Supercomputing (ICS)*, 2012.
- G. Guo, X. Guo, Y. Bai, and E. Ipek. "A Resistive TCAM Accelerator for Data Intensive Computing," *International Symposium on Microarchitecture (MICRO)*, 2011.
- X. Guo, E. Ipek, and T. Soyata. "Resistive Computation: Avoiding the Power Wall with Low-Leakage STT-MRAM Based Computing," *International Symposium on Computer Architecture (ISCA)*, 2010.
- E. Ipek, J. Condit, E. Nightingale, D. Burger, and T. Moscibroda. "Dynamically Replicated Memory: Building Reliable Systems from Nanoscale Resistive Memories," *International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, 2010.
- B. Lee, E. Ipek, O. Mutlu, and D. Burger, "Phase Change Memory Architecture and the Quest for Scalability," *Communications of the ACM (CACM)*, 2010.

B. Lee, P. Zhou, E. Ipek, O. Mutlu, J. Yang, Y. Zhang, B. Zhao, and D. Burger, "Phase Change Technology and the Future of Main Memory," *IEEE Micro Special Issue: Top Picks from 2009 Computer Architecture Conferences (IEEE MICRO)*, 2010.

J. Condit, E. Nightingale, C. Frost, E. Ipek, D. Burger, B. Lee, and D. Coetzee, "Better I/O Through Byte-Addressable, Persistent Memory," *Symposium on Operating Systems Principles (SOSP)*, 2009.

J. F. Martínez and E. Ipek, "Dynamic Multicore Resource Management: A Machine Learning Approach," *IEEE Micro, Vol. 29, No. 5 (IEEE MICRO)*, 2009.

B. Lee, E. Ipek, O. Mutlu, and D. Burger, "Architecting Phase-Change Memory as a Scalable DRAM Alternative," *International Symposium on Computer Architecture (ISCA)*, 2009.

R. Bitirgen, E. Ipek, and J.F. Martínez, "Coordinated Management of Multiple Interacting Resources in Chip Multiprocessors: A Machine Learning Approach," *International Symposium on Microarchitecture (MICRO)*, 2008.

E. Ipek, O. Mutlu, J.F. Martínez, and R. Caruana, "Self-Optimizing Memory Controllers: A Reinforcement Learning Approach," *International Symposium on Computer Architecture (ISCA)*, 2008.

E. Ipek, S. A. McKee, K. Singh, R. Caruana, B. R. de Supinski, and M. Schulz, "Efficient Architectural Design Space Exploration via Predictive Modeling," *ACM Transactions on Architecture and Code Optimization (TACO)*, 2008.

C. LaFrieda, E. Ipek, J.F. Martínez, and R. Manohar, "Utilizing Dynamically Coupled Cores to Form a Resilient Chip Multiprocessor," *International Symposium on Dependable Systems and Networks (DSN)*, 2007.

E. Ipek, M. Kirman, N. Kirman, and J.F. Martínez, "Core Fusion: Accommodating Software Diversity in Chip Multiprocessors," *International Symposium on Computer Architecture (ISCA)*, 2007.

E. Ipek, S. A. McKee, B. R. de Supinski, M. Schulz, and R. Caruana, "Efficiently Exploring Architectural Design Spaces via Predictive Modeling," *International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS)*, 2006.

E. Ipek, J.F. Martínez, B. R. de Supinski, S. A. McKee, and M. Schulz, "Dynamic Program Phase Detection in Distributed Shared-Memory Multiprocessors," *International Parallel and Distributed Processing Symposium (IPDPS)*, 2006.

E. Ipek, B. R. de Supinski, M. Schulz, and S. A. McKee, "An Approach to Performance Prediction for Parallel Applications," *European Conference on Parallel Computing (EURO-PAR)*, 2005.

## Book Chapters

G. Guo, X. Guo, Y. Bai, and **E. Ipek**. "Resistive Memories in Associative Computing," *Emerging Memory Technologies: Design, Architecture, and Applications*, Y. Xie (Editor), Springer, July 2013.

## Patents

**E. Ipek**, J. P. Condit, E. B. Nightingale, D. C. Burger, and T. Moscibroda, "Dynamically Replicated Memory," US patent 8,255,742.

**E. Ipek**, T. Moscibroda, D. C. Burger, E. B. Nightingale, and J. P. Condit, "Efficiency of Hardware Memory Access using Dynamically Replicated Memory," US patent 8,543,863.

J. P. Condit, E. B. Nightingale, B. Lee, **E. Ipek**, C. Frost, and D. C. Burger, “Hardware and Operating System Support for Persistent Memory on a Memory Bus,” US patent 8,984,239.

J. P. Condit, E. B. Nightingale, B. Lee, **E. Ipek**, C. Frost, and D. C. Burger, “Hardware and Operating System Support for Persistent Memory on a Memory Bus,” US patent 8,533,404.

J. P. Condit, **E. Ipek**, E. B. Nightingale, B. Lee, C. Frost, and D. Burger, “Hardware and Operating System Support for Persistent Memory on a Memory Bus,” US patent 8,219,741.

J.F. Martínez, **E. Ipek**, M. Kirman, and N. Kirman, “Systems and Methods for Reconfiguring On-Chip Multiprocessors,” US patent 7,809,926.

## Grants

- Intelligence Advanced Research Projects Activity award, “Spin Transfer, Energy-Efficient 64-bit Memory (STEM64).” \$50,000 to **PI E. Ipek** and Co-PI E. G. Friedman. 2017-2018
- Sandia National Laboratories Grant, “Energy Efficient Neural Network Training with Memristors.” \$28,000 to **PI E. Ipek**. 2017
- Intelligence Advanced Research Projects Activity award, “EDA Development for Cryogenic Memory.” \$190,000 to **Co-PIs E. Ipek** and E. G. Friedman. 2017-2018
- National Science Foundation XPS award, “A Memristive Hardware Platform for Large Scale Combinatorial Optimization.” \$298,283 to **PI E. Ipek**. 2016 - 2018
- National Science Foundation CNS EAGER award, “Memristive Accelerator for Extreme Scale Linear Solvers.” \$125,000 to **PI E. Ipek**; Co-PIs E. Friedman, J. Liu, and J. Dongarra. 2015 - 2016
- Intelligence Advanced Research Projects Activity award, “Spin Transfer, Energy-Efficient 64-bit Memory (STEM64).” \$845,000 to **PI E. Ipek** and Co-PI E. G. Friedman. 2014 - 2017
- National Science Foundation SHF award, “Application-Specific Memory System Optimizations using Programmable Memory Controllers.” \$300,000 to **PI E. Ipek**. 2012 - 2015
- Samsung grant, “Programmable Memory Controllers.” \$51,300 to **PI E. Ipek**. 2012
- National Science Foundation CAREER award, “Overcoming the Many-Core Power Wall with Resistive Computation.” \$489,053 to **PI E. Ipek**. 2011 - 2016
- Samsung grant, “Flexible Memory Systems.” \$47,321 to **PI E. Ipek**. 2011
- Qualcomm grant, “STT-MRAM based Resistive Computing Microarchitecture for Mobile Applications.” \$75,000 to **PI E. Ipek**. 2010

## Teaching

- ECE 402: Computer Architecture
- CSC 573: Memory Systems
- CSC 293: Analytical and Stochastic Modeling of Computer Systems
- CSC 252: Computer Organization

## Current Ph.D. Students

- Benjamin Feinberg (ECE)
- Ahmad Azizimanesh (ECE)
- Afagh Farhadi (ECE)

## Ph.D. Graduates

- Xiaochen Guo, Ph.D.'15 (ECE)  
**First Job:** Assistant Professor of ECE, Lehigh University  
IBM Ph.D. Fellow, 2012-2013, 2014-2015
- Qing Guo, Ph.D.'15 (CS)  
**First Job:** Senior Architect, NVidia
- Yanwei Song, Ph.D.'16 (ECE)  
**First Job:** Software Developer, Tower Research Capital
- Yuxin Bai, Ph.D.'16 (ECE)  
**First Job:** Power and Performance Software Engineer, Apple
- Mahdi Nazm Bojnordi, Ph.D.'16 (ECE)  
**First Job:** Assistant Professor of CS, University of Utah
- Shibo Wang, Ph.D.'17 (CS)  
**First Job:** Software Engineer, Google

## M.S. Graduates

- Sean Wang, ECE, M.S. 2017
- Chinmai Panibathe, ECE, M.S. 2017
- Dan Snyder, ECE, M.S. 2011
- Peter McLoone, ECE, M.S. 2011
- Guanghui Zhou, ECE, M.S. 2011
- Zihe Liu, ECE, M.S. 2011

## Past MSR Interns

- Biplab Deka (IIT Kanpur), Summer 2009
- Janani Mukundan (Cornell), Spring 2009
- Ramazan Bitirgen (Cornell), Spring 2008

## Professional Activities

- **IEEE Computer Society Technical Committee on Computer Architecture (TCCA):** Member of the executive committee (2015-2017), communications chair (2010-2017)
- **Conference Program Committee:** Top Picks'18, HPCA'18, MICRO'17, DAC'17, HPCA'17, ICS'16, DAC'16, ISCA'16, HPCA'16, ISCA'15, DAC'15, HPCA'15, CF'14, MICRO'13, ICCD'13,

MICRO'12, IISWC'12, ICCD'12, ISPASS'12, IPDPS'12, IPDPS'11, ICCD'11, ICCD'10, MICRO'09, ICCD'09

- **Conference Organizing Committee:** HPCA'12, ISCA'11, HPCA'11, IISWC'11, IISWC'10, IISWC'08
- **Workshop Program Committee:** MSPC'14, HotPower'13, MSC'12, DCA'11, SMART'11, SMART'10
- **Workshop Co-organizer:** EAMA'10, NDCA'09, EAMA'09
- **Panels:** National Science Foundation, Department of Energy, Microsoft Research Fellowship

## Service

- Participant at the “IARPA Cryogenic Computing Complexity” workshop, sponsored by the Intelligence Advanced Research Projects Activity (IARPA), 03/12/2013.
- Participant at the “Energy-Efficient Cryogenic Memory” workshop (**invitation only**), sponsored by the National Security Agency, 7/19/2011.
- Participant at the “Cross-layer Power Optimization and Management” workshop (**invitation only**), sponsored by the National Science Foundation, 2/11/2012.
- Participant at the workshop on “a Community Supported Computer Architecture Design and Evaluation” (**invitation only**), sponsored by the National Science Foundation, 5/31/2012.

## Presentations

### “Memristive Accelerators for Data Intensive Computing: From Machine Learning to High Performance Linear Algebra”

- USC Computer Engineering Seminar, University of Southern California, Invited talk, 11/30/2017.
- 5<sup>th</sup> Berkeley Symposium on Energy Efficient Electronics and Steep Transistor Workshop, Invited talk, 10/19/2017.
- IEEE IRDS Beyond Moore Workshop, Sandia National Laboratory, Invited Talk. 07/06/2017.
- Seiden Frontiers in Engineering and Science Workshop. Technion, Israel Institute of Technology. Invited Talk, 06/05/2017.

### “Content Aware Memory Systems for High-Performance, Energy Efficient Data Movement”

- IBM Architecture Seminar. Invited talk. 6/13/2017.

### “Accelerator Design with Emerging Memory Technologies”

- AMD, 11/14/2016.
- In-Memory and In-Storage Computing with Emerging Technologies Workshop (co-located with PACT 2016), Keynote Talk, 09/11/2016.

### “Computer Architecture Design Utilizing Novel Memories”

- University of Wisconsin, Architecture Seminar, 04/08/2014.
- ISQED (invited tutorial), 03/04/2013.

### “Associative Computing with Emerging Nonvolatile Memories”

- University of Rochester, Laboratory for Laser Energetics, 11/30/2012.
- IBM, 10/25/2012.

- Qualcomm, 7/21/2011.

#### **“Resistive Memories and the Future of Memory Systems Architecture”**

- Qualcomm, 10/15/2010.
- University of Rochester, ECE Colloquium, 9/29/2010.

#### **“Dynamically Replicated Memory”**

- 1<sup>st</sup> UCSD Nonvolatile Memories Workshop, 4/13/2010
- 15<sup>th</sup> Intl. Conf. on Architectural Support for Programming Languages and Operating Systems, 3/15/2010

#### **“Reconfigurable and Self-Optimizing Multicore Architectures” (February – April 2009)**

- Northwestern University
- University of California, Santa Barbara
- Massachusetts Institute of Technology
- University of Texas at Austin
- Georgia Institute of Technology
- Purdue University
- University of Rochester
- NC State University
- Rutgers State University of New Jersey

#### **“Coordinated Management of Multiple Interacting Resources in CMPs: A Machine Learning Approach”**

- 41<sup>st</sup> International Symposium on Microarchitecture (MICRO), 11/11/2008.

#### **“Self-Optimizing Memory Controllers: A Reinforcement Learning Approach”**

- Princeton University, Computer Engineering Seminar, 10/16/2008.
- Georgia Institute of Technology, Architecture Seminar, 10/10/2008.
- 35<sup>th</sup> International Symposium on Computer Architecture (ISCA), 06.23.2008.
- 4<sup>th</sup> Annual IBM P=ac2 Conference, 04/01/2008.
- University of Illinois, Urbana-Champaign, Architecture Seminar, 03/07/2008.

#### **“Core Fusion: Accommodating Software Diversity in Chip Multiprocessors”**

- 34<sup>th</sup> International Symposium on Computer Architecture (ISCA), 06/23/2007.

#### **“Efficiently Exploring Architectural Design Spaces via Predictive Modeling”**

- 12<sup>th</sup> Intl. Conf. on Architectural Support for Programming Languages and Operating Systems, 10/23/2006.
- Intel Innovative Platform Architecture Group, Architecture Research Lab, 06/01/2005.

## **Consulting**

- Research consultant for **Huawei Technologies**, September 2016 – October 2017.
- Patent portfolio analyst on behalf of **Nokia**, August 2015 – May 2016.
- Expert witness on behalf of plaintiff, **Bunsow De Mory Smith & Allison LLP**, *Longitude Licensing LTD. vs Apple Inc.*, Case No. 3:14-cv-4275, July 2015 - March 2016.