

Vincent M. Weaver

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Education

Ph.D.	Electrical and Computer Engineering, Cornell University <i>Using Dynamic Binary Instrumentation to Create Faster, Validated Multi-core Simulations</i> Advisor: Sally McKee	May 2010
M.S.	Electrical and Computer Engineering, Cornell University	Jan 2009
B.S.	Electrical Engineering, Univ. of Maryland College Park	Dec 2000

Work Experience

University of Maine		<i>Orono, ME</i>
2018-	Associate Professor	
2012-2018	Assistant Professor	
Innovative Computing Lab, University of Tennessee		<i>Knorville, TN</i>
	Post-doctoral Research Associate	
2010-2012	Develop PAPI performance counter library for use in high-performance computing, low-power embedded systems, and virtualized cloud environments	
Center for Applied Math, Cornell University		<i>Ithaca, NY</i>
2008-2009	TA: Sysadmin for CAM department Maintain network and 30+ RHEL4 machines	
ECE, Cornell University		<i>Ithaca, NY</i>
2006-2008	TA, Head TA: ECE314 (Computer Organization)	
CASC, Lawrence Livermore National Lab		<i>Livermore, CA</i>
2005	Summer Intern: Cache Conscious Data Placement	
ECE Techshop, Cornell University		<i>Ithaca, NY</i>
2003-2004	TA: Sysadmin of Linux, BSD, and Solaris network	
US Army SBCCOM		<i>Aberdeen Proving Ground, MD</i>
2002-2003	ORISE: Web-interfaces for legacy Fortran models	
Frontpath Inc.		<i>Billerica, MA</i>
2000-2001	Jr. Software Engineer: Transmeta Tablet PC Linux, Gtk+, and x86 BIOS development	
US Army SBCCOM		<i>Aberdeen Proving Ground, MD</i>
1995-2000	GWU, ORISE Summer/Winter intern: Web-interfaces for legacy Fortran models	

Publications

Refereed Conferences

1. P. Francis-Mezger and V.M. Weaver. “**A Raspberry Pi Operating System for Exploring Advanced Memory System Concepts**”, The International Symposium on Memory Systems (MEMSYS18), Washington, DC, October 2018. Won “Chair’s Choice” award.
2. Q. He, B. Segee, V.M. Weaver. “**Comparing Power and Energy Usage for Scientific Calculation with and without GPU Acceleration on a Raspberry Pi Model B+ and 3B**”, The 19th International Conference on Internet Computing and IoT, Las Vegas, Nevada, July 2018, (20% acceptance rate).
3. Q. He, B. Segee, V.M. Weaver. “**Raspberry Pi 2 B+ GPU Power, Performance, and Energy Implications**”, The International Conference on Computational Science and Computational Intelligence, Las Vegas, Nevada, December 2016.
4. S. Desrochers, C. Paradis, V.M. Weaver. “**A Validation of DRAM RAPL Power Measurements**”, The International Symposium on Memory Systems (MEMSYS16), Washington, DC, October 2016.
5. I. Lopez, S. Moore, V.M. Weaver. “**A prototype sampling interface for PAPI**”, Extreme Science Engineering Discovery Environment Conference (XSEDE’15), St. Louis, Missouri, July 2015.
6. V.M. Weaver. “**Self-monitoring Overhead of the Linux perf_event Performance Counter Interface**”, IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS 2015), Philadelphia, Pennsylvania, March 2015, (33% acceptance rate).
7. V.M. Weaver, D. Terpstra, S. Moore. “**Non-Determinism and Overcount on Modern Hardware Performance Counter Implementations**”, IEEE International Symposium on Performance Analysis of Systems and Software (ISPASS 2013), Austin, Texas, April 2013, pp. 215-224, (26% acceptance rate).
8. J. Dongarra, H. Ltaief, P. Luszczek, V.M. Weaver. “**Energy Footprint of Advanced Dense Numerical Linear Algebra using Tile Algorithms on Multicore Architecture**”, 2nd International Conference on Cloud and Green Computing (CGC 2012), Xiangtan, China, November 2012, (30% acceptance rate).
9. V.M. Weaver, S.A. McKee. “**Code Density Concerns for New Architectures**”, 27th IEEE International Conference on Computer Design (ICCD 2009), Lake Tahoe, California, October 2009, pp 459-464, (35% acceptance rate).
10. M. Bhadauria, V.M. Weaver, S.A. McKee. “**Understanding PARSEC Performance on Contemporary CMPs**”, IEEE International Symposium on Workload Characterization (IISWC 2009), Austin, Texas, October 2009, pp. 98-107, (41% acceptance rate).
11. M. Bhadauria, V.M. Weaver, S.A. McKee. “**Accommodating Diversity in CMPs with Heterogeneous Frequencies**”, 4th EC International Conference on High Performance Embedded Architectures and Compilers (HiPEAC’09), Cyprus, January 2009, pp. 248-262, (28% acceptance rate).
12. V.M. Weaver, S.A. McKee. “**Can Hardware Performance Counters be Trusted?**”, IEEE International Symposium on Workload Characterization (IISWC 2008), Seattle, Washington, September 2008, pp. 141-150, (34% acceptance rate).

13. V.M. Weaver, S.A. McKee. “**Using Dynamic Binary Instrumentation to Generate Multi-Platform Simpoints: Methodology and Accuracy**”, 3rd EC International Conference on High Performance Embedded Architectures and Compilers (HiPEAC’08), Göteborg, Sweden, January 2008, pp. 305-319, (32% acceptance rate).

Refereed Journals

1. M.F. Cloutier, C. Paradis, V.M. Weaver. “**A Raspberry Pi Cluster Instrumented for Fine-Grained Power Measurement**”, MDPI Electronics, Special Issue on Raspberry Pi Technology, 2016, 5, 61.

Book Chapters

1. S.V. Moore, D.K. Terpstra, V.M. Weaver. “**Chapter 3: Software Interfaces to Hardware Counters**”, D.H. Bailey, R.F. Lucas (Eds.) *Performance Tuning of Scientific Applications*, Taylor and Francis, 2010.

Refereed Workshops

1. F. Smith, V.M. Weaver. “**Advanced Event-Sampling Support for PAPI**”, The 7th Workshop on Extreme-Scale Programming Tools, Dallas, Texas, November 2018.
2. Y. Liu, V.M. Weaver. “**Enhancing PAPI with Low-Overhead rdpmc Reads**”, The 6th Workshop on Extreme-Scale Programming Tools, Denver, Colorado, November 2017, (62% acceptance rate).
3. M.F. Cloutier, C. Paradis, V.M. Weaver. “**Design and Analysis of a 32-bit Embedded High-Performance Cluster Optimized for Energy and Performance**”, Co-HPC 2014: The 1st International Workshop on Hardware-Software Co-Design for High Performance Computing, New Orleans, Louisiana, November 2014.
4. V.M. Weaver. “**Linux perf_event Features and Overhead**”, FastPath 2013: The 2nd International Workshop on Performance Analysis of Workload Optimized Systems, Austin, Texas, April 2013.
5. V. Weaver, M. Johnson, K. Kasichayanula, J. Ralph, P. Luszczek, D. Terpstra, S. Moore. “**Measuring Energy and Power with PAPI**”, PASA’12: The 1st International Workshop on Power-Aware Systems and Architectures, Pittsburgh, Pennsylvania, September 2012.
6. M. Johnson, H. Jagode, S. Moore, P. Mucci, J. Nelson, D. Terpstra, V. Weaver, T. Mohan. “**PAPI-V: Performance Monitoring for Virtual Machines**”, CloudTech-HPC 2012, Pittsburgh, Pennsylvania, September 2012.
7. P. Luszczek, E. Meek, S. Moore, D. Terpstra, V.M. Weaver, J. Dongarra. “**Evaluation of the HPC Challenge Benchmarks in Virtualized Environments**”, VHPC’11: The 6th Workshop on Virtualization in High-Performance Cloud Computing, Bordeaux, France, August 2011.
8. V.M. Weaver, J. Dongarra. “**Can Hardware Performance Counters Produce Expected, Deterministic Results?**”, FHPM-2010: The 3rd Workshop on Functionality of Hardware Performance Monitoring, Atlanta, Georgia, December 2010.
9. V.M. Weaver, S.A. McKee. “**Are Cycle Accurate Simulations a Waste of Time?**”, WDDD: Workshop on Duplicating, Deconstructing and Debunking, Beijing, China, June 2008, pp. 40-53.

Other Workshop Presentations

1. S. Desrochers, C. Paradis and V. Weaver. “**Initial Validation of DRAM and GPU RAPL Power Measurements**”, ESPT’15: 4th Workshop on Extreme-Scale Programming Tools, Austin, Texas, November 2015.

Theses

1. V.M. Weaver. “**Using Dynamic Binary Instrumentation to Create Faster, Validated Multi-core Simulations**”, S.A. McKee, D.A. Albonesi, R. Manohar (committee), Cornell University Ph.D. Thesis, May 2010.

Posters

1. J. Dongarra, H. Jagode, A. Danalis, V. Weaver. “**SI2-SSI Performance Application Programming Interface for Extreme-scale Environments: PAPI-EX**”, NSF SI2 PI Meeting, May 2017.
2. H. Jagode, A. YarKhan, A. Danalis, J. Dongarra, Y. Liu, V.M. Weaver. “**Recent Advances in the Performance API (PAPI)**”, Supercomputing (SC’17), November 2017. (58% acceptance rate). Nominated for best poster.
3. S. Desrochers and V. Weaver. “**Optimizing Power Usage of Modern Computing Systems**”. 2016 Center For Undergraduate Research Academic Showcase, Bangor, Maine, April 2016.
4. V.M. Weaver, S. Moore, T. Mohan, P. Mucci, D. Terpstra, H. McCraw, M. Johnson, K. Kasichayanula, J. Ralph, J. Nelson. “**PAPI 5: Measuring Power, Energy, and the Cloud**”, ISPASS 2013, Austin, Texas, April 2013.
5. S. Moore, D. Terpstra, V. Weaver, H. Jagode, J. Ralph, P. Mucci, K. Kasichayanula, E. Meek and J. Dongarra. “**New Features of the PAPI Hardware Counter Library**”, Supercomputing 2011, Seattle, Washington, November 2011.
6. S. Moore, D. Terpstra, V. Weaver, H. Jagode, J. Ralph, P. Mucci, K. Kasichayanula, E. Meek and J. Dongarra. “**New Features of the PAPI Hardware Counter Library**”, Teragrid 2011, Salt Lake City, Utah, July 2011.
7. H. Jagode, B. Sheely, D. Terpstra, V. Weaver and J. Dongarra. “**PAPI-C: Collecting Performance Data beyond the CPU**”, SciDAC 2010, Chattanooga, Tennessee, July 2010.
8. M. Bhadauria, V.M. Weaver, S.A. McKee. “**Hardware Profiling of PARSEC for CMP Design**”, International Conference on Supercomputing (ICS’09), New York, June 2009.
9. V.M. Weaver, S.A. McKee. “**Optimizing for Size: Exploring the Limits of Code Density**”, Architectural Support for Programming Languages and Operating Systems (ASPLOS’09), Washington DC, March 2009.
10. V.M. Weaver, M. Schulz. “**A Cache Conflict Analysis Tool**”, Poster UCRL-POST-214300, LLNL, 11 August 2005.

Articles (Not academically peer-reviewed)

1. V.M. Weaver. “**An 8 Kilobyte Mode 7 Demo for the Apple II**”, PoC||GTFO, Volume 0x18, June 2018, pp 4-10.
2. V.M. Weaver. “**Fuzzing perf.events**”, Linux Weekly News, 5 August 2015, <http://lwn.net/Articles/653382/>.

Linux manual pages

1. V. Weaver. “**perf event open manual page**”, `perf_event_open.2`, in Linux Programmer’s Manual, M. Kerrisk, Ed., 2016.

Technical Reports

1. V.M. Weaver, S.A. McKee. “**Can Hardware Performance Counters be Trusted?**” Technical Report CSL-TR-2008-1051, Cornell University, August 2008.
2. V.M. Weaver. “**Web Plotting: Using gnuplot and vis5d in a Web Environment**”, SBCCOM/ORISE End of Year Report, 19 August 2003.
3. V.M. Weaver. “**Hypertext Interfaces for Models: Modeling on the World Wide Web**”, ERDEC SEAP/GWU End of Year Report, 9 August 1996.
4. V.M. Weaver. “**Creating X Window Graphical User Interfaces for Text Programs**”, ERDEC SEAP/GWU End of Year Report, 9 August 1995.

Picture Credits

1. V.M. Weaver. **Picture of Cliffs at Monkey Run**, B. Bowers, E. McNulty-Bowers. *50 Hikes in Central New York’s Leatherstocking Region*, The Countryman Press, 2010.

Honors and Awards

- Demosplash 2019: second place in Modern-demo category.
Third place in Retro-demo category.
- Demosplash 2018: first place in Retro-demo category.
- MEMSYS'18: Chair's Choice Award
- Kansasfest 2018: second place in hackfest.
- SC'17: Poster nominated for best poster award
- MEMSYS'16: Most Gratuitous Use of Umlauts in a Scientific Presentation
- 2015 University of Maine Engineering Early Career Teaching Award
- 2009 Cornell University Library Book Collection Contest: Honorable Mention
Guinea Pigs: Obscurity in both Domestication and Literature
- 2005 International Obfuscated C-Code Competition (IOCCC'05): Most Beauteous Visuals

Media Mentions

The following projects were all featured on the “Hack a Day” website:

- Another World for Apple II, 26 August 2019
- STM32L476G Discovery Board PT3 Player, 7 June 2019
- Apple II Cycle Counting Megademo, 5 December 2018
- Raspberry Pi Chiptune Player, 11 June 2017, 4 September 2016
Also featured on the official Raspberry Pi Foundation blog.
- Portal Ported to the Apple II, 12 January 2017
Also featured in The Register, Gizmodo, Onion AV Club, and the front page of HackerNews.
- Apple II BASIC Webserver, 17 December 2016
Also featured in Call-A.P.P.L.E. magazine.
- Kerbal Space Program for the Apple II, 31 May 2016
- Raspberry Pi PS/2 Keyboard, 14 January 2016
- DOS Christmas Demos, 20 December 2015
- Raspberry Pi Time Circuits, 11 November 2015
- Falling Blocks Embedded project, 14 December 2013
- Apple IIe Slide Presentation, 17 May 2012
- LED Nightlight Repair, 30 September 2011
- Custom LED CPU Meter project, 7 April 2011

Invited Talks

- “Writing a PT3 Vortex Tracker Player for the Apple II” *Demosplash, Pittsburgh PA* 9
November 2019
- “Writing Demos for the Apple II” *Demosplash, Pittsburgh PA* 3 November 2018
- “Apple II Programming Adventures” *KansasFest, Kansas City, MO* 19 July 2018
- “All About the perf_fuzzer”
Linux Plumbers, Testing and Fuzzing track 3 November 2016

- “The Challenge of Measuring Power on Modern Computing Systems”
University of Maryland Alumnus Talk 7 October 2016
- “Hardware Performance Counter Accuracy on Modern Processors”
Johns Hopkins Applied Physics Lab 26 June 2014
- “Tracking the Sources of Performance Measurement Variation”
University of Waterloo 6 June 2014
- “The Upcoming PAPI 5.0 Release”
CScADS Performance Tools for Extreme-scale Computing Workshop 27 June 2012
- “Video Game Programming under Linux”
UM Linux Users Group, University of Maryland December 2000

Research Advising

UMaine PhD Students

1. Pascal Francis-Mezger 2017-

UMaine M.S. Students

1. Colin Leary 2018-
2. Forrest Smith 2018
3. Yanxiang Mao 2015-2018
“**Detailed Power Measurement with ARM Embedded Boards**”
4. Yan Liu 2015-2017
“**Optimizing PAPI For Low-Overhead Counter Measurement**”
5. Chad Paradis 2013-2015
“**Detailed Low-cost Energy and Power Monitoring of Computing Systems**”

UMaine Undergraduate Students

1. Spencer Desrochers (CUGR) (Energy measurement) 2015
2. Daniel Vaughn (SNES, Ray-tracing) 2014-2015
3. Michael Cloutier (Raspberry Pi Cluster) 2014

NSF Sensors! Summer REU Students

1. Ben Schaff (UMaine) 2016
2. Ian Wright (UMaine) 2014
3. Juan Mont (University of Puerto Rico Arecibo) 2014
4. Philipp-Alain Bastien (Syracuse University) 2013

Cornell M.Eng Students

1. I-Chun Li, M.Eng ECE Cornell University, 2006
“**Comparing Two Implementations of a Memory Reference Analysis Tool.**”

Teaching Experience

- University of Maine
 - **ECE471 Embedded Systems**
(Fall 2013, Fall 2014, Fall 2015, Fall 2016, Fall 2017, Fall 2018, Fall 2019)
 - **ECE435 Network Engineering**
(Fall 2016, Fall 2017, Fall 2018)
 - **ECE571 Advanced Microprocessor-Based Design**
(Spring 2013, Fall 2014, Spring 2016, Spring 2017, Spring 2018, Fall 2019)
 - **ECE574 Cluster Computing**
(Fall 2015, Spring 2017, Spring 2019)
 - **ECE598 Advanced Operating System Design**
(Spring 2015, Spring 2016, Spring 2018)
 - **ECE214 Electrical Networks Laboratory**
(Spring 2015)

- **ECE271 Microcomputer Architecture and Applications**
(Spring 2014 [co-taught with Yi-feng Zhu], Spring 2019)
- **ECE498 Linux Assembly Language**
(Fall 2012)
- University of Tennessee
 - **CS 594 Scientific Computing for Engineers**
(Spring 2011, Spring 2012): Jack Dongarra’s class, Guest-taught 1-week on performance analysis
 - **CS 340 Software Engineering**
(Spring 2012): Guest Lecture
- Cornell University
 - **ECE/COMS 314 Computer Organization**
(Spring 2006, 2007): Teaching Assistant, (Spring 2008): Head Teaching Assistant

Funding

External

- NSF SI2-SSI: Collaborative Proposal: Performance Application Programming Interface for Extreme-Scale Environments (PAPI-EX), PI
https://www.nsf.gov/awardsearch/showAward?AWD_ID=1450122
Award amount: \$274,828
- NSF SI2-SSI: REU Supplement
Award amount: \$8,000

Internal UMaine

- 2014 Pre-tenure Research and Creative Activity Fellowship, PI
Reducing Wasted Energy in High Performance Computers
Award amount: \$25,000

Travel Grants

- Fall 2014 BSB Faculty Travel Award (to SC’14 in New Orleans)

Research Projects

Low-Cost Power Measurement *2013-present*

We use low-cost ARM boards that can gather detailed Power and Energy measurements for much cheaper than traditional methods that require complex expensive equipment. This will enable advanced power analysis of small embedded systems (such as cell-phones) up through large servers and supercomputers.

Performance Counter Fuzzing *2013-present*

I have constructed a program that automatically “fuzzes” the Linux performance counter interface in an attempt to find bugs. Many problems have been found with this tool, some of which were security vulnerabilities. Fixes have been merged back into the main Linux repositories.

Performance Counters in the Cloud *2010-present*

Large computations are increasingly being moved to cloud computing infrastructures. There is a need to analyze performance on these systems; I am investigating the feasibility of using performance counters inside the virtualized operating systems used on these systems.

Performance Counter Validation *2007-present*

In conjunction with my simulator validation, BBV generation, and PAPI work I have investigated the accuracy and causes of divergences in hardware performance counters. This has involved validating performance counters on a wide variety (more than 10 types) of x86 machines, as well as several RISC machines. Improvements to the `libpfm` and `perf_events` Linux performance monitoring projects have been merged upstream.

Code Density *2000-present*

Code density (that is, having the most compact possible program executables) can be an important performance consideration. I have ported an assembly-language benchmark to over 25 different architectures, using it to determine which architectural features contribute most to code density.

Multi-Platform BBV Generation *2007-present*

The SimPoint reduced-execution methodology can speed up simulation times with only a minor degradation in accuracy. However, generating the Basic Block Vector (BBV) files needed by the SimPoint tool can be difficult. Previously only a limited number of tools on a limited number of architectures could generate these files. I extend Valgrind and Qemu to be able to generate these files, making BBV generation much easier. I also validated the results against the existing PinPoints implementation. The Valgrind work has resulted in the `exp-bbv` component that I maintain and which is included with current Valgrind releases.

Fast Memory Hierarchy Simulation *2007-present*

When attempting to speed up simulations, shortcuts are often taken. I investigate which methodologies have what amount of error, and attempt to validate against real hardware. After investigating single-core machines, the work is extended to look at multi-core. The end goal is to find the fastest most accurate method of simulating memory hierarchies.

SimSnap *2004-2006*

The SimSnap methodology uses user-level checkpointing to speed simulations, by enabling instant-loading of interesting portions of a program without having to fast-forward. My research was adding file I/O save/restore to the checkpointing method, so that benchmarks utilizing I/O could be handled.

Invalid Heap Access Detection *2004-2005*

I worked on a project to use the OWL hardware monitoring infrastructure to catch invalid heap accesses. A library intercepts memory allocation calls, and informs the hardware monitor of valid ranges. A small set of ranges is cached in hardware and checked at each memory access. If a range is not cached, a trap into the OS acts as a fall-back mechanism. Initial results show cache misses are infrequent enough to allow invalid access detection with much lower overhead than a pure software implementation.

Cache-Conscious Data Placement *2004-2005*

I investigated the feasibility of using DBI tools to aid in cache-conscious data placement. The tool related conflicting addresses back to the corresponding data structures, including dynamically allocated structures, that traditionally are hard to track. The resulting conflicts were graphed and gave insight into which structures were causing poor cache behavior.

Open Source Software Development

Linux

I have contributed patches that were accepted into the Linux kernel (performance counters, parallel port changes, the Xeon-Phi PMU driver, numerous minor fixes).

Valgrind

I have written the `exp-bbv` component distributed with Valgrind; also have contributed patches to enable support for unimplemented instructions.

Qemu

I have provided patches that enhance Qemu's usefulness in computer architecture research. Have also fixed bugs in SPARC, Alpha, and MIPS support that allow the SPEC benchmarks to run.

m5 simulator

I contributed to the x86_64 support, enabling the SPEC benchmarks to run.

PAPI

I am a primary developer of PAPI and have contributed heavily in the move to use the new Linux `perf_events` subsystem.

perfmon2/libpfm

I contributed various fixes, including ARM support for libpfm4.

Other

I am the author and maintainer of several freely available Linux utilities including `linux_logo`, `fontprint`, `ansi2gif`, `perf_event_test`, `perf_fuzzer`.

Other Computer Skills

Built and maintain large computer clusters:

- Cornell: Built four large computer clusters (16, 40, 40 and 44 machines respectively). Maintained network of 10 different architectures, with 169 machines totaling over 468 cores.
- UMaine: maintain various compute/GPU servers, a 24-node Raspberry Pi cluster, as well as a large network of embedded systems.

System Administration experience: Linux (21 years) and Unix (IRIX and Solaris) (22 years).

Fluent in C and Assembly Language (30+ kinds). Previous experience with Fortran, Pascal and BASIC.

Video game programming experience, both 2D and 3D.

Service and Scholarly Activity

Member of ACM, IEEE and USENIX.

Program Committee Member for: MEMSYS (2017, 2018), ICPP (2018), ISPASS (2017), Computing Frontiers Conference (2015), Co-HPC Workshop (2014, 2015).

External Paper reviewer for: SIMPAT (2016), ASPLOS (2014), Computing Frontiers (2014), IEEE Computer Architecture Letters (2014, 2017), EuroPar (2014), ACM TACO (2014), CCGrid (2012), Micro Journal (2011)

Served as Judge at the UMaine Grad Student Expo: 2013, 2015, 2016

Served as proctor for the IEEEExtreme 24-hour Programming Competitions: 2012, 2016, 2017.

Vincent M. Weaver's 21 research works with 436 citations and 1,128 reads, including: Advanced Event-Sampling Support for PAPI. Vincent M. Weaver's research while affiliated with University of Maine and other places. Overview. Publications (21).