Chris Fallin

https://cfallin.org/ <chris@cfallin.org>

Education

Carnegie Mellon University
Aug 2009 – Jul 2013,
Jun 2015 – Feb 2019

Ph.D. Electrical & Computer Engineering
Thesis: *Finding and Exploiting Parallelism with Data-Structure-Aware Static and Dynamic Analysis*
Advisors: Profs. Todd C. Mowry and Phillip B. Gibbons

Carnegie Mellon University
Aug 2009 – Dec 2011

M.S. Electrical & Computer Engineering
GPA: 4.000

University of Notre Dame
Aug 2006 – May 2009

B.S. Computer Engineering, *summa cum laude*
GPA: 3.924

Full-Time Work Experience

F5 (San Jose, CA) Senior Architect Nov 2024 – present

- **WebAssembly and compilers expert** covering research and development in the Office of the CTO to evolve a standards-based, high-performance, secure WebAssembly platform and its associated compiler tooling.

Fastly (San Francisco, CA) Principal Software Engineer Apr 2022 – Nov 2024
Staff Software Engineer Oct 2020 – Mar 2022

- **Tech lead for the Cranelift compiler** open-source project as part of the WebAssembly team for the Compute product, driving overall compiler quality. Rewrote compiler backend to improve compile-time and runtime performance significantly: built new register allocator, instruction selector DSL and metacompiler, and new mid-end optimization framework based on novel application of e-graphs. Mentored and onboarded contributors. Guided multi-organization collaborations and grew compiler to approximately 5 fulltime contributors, 4 supported ISAs, and comparable performance to peer JIT compilers (and average within 10% of LLVM with much faster compilation). Compiler ships in Wasmtime and also as an alternative backend for the Rust compiler.
- Developed **JS-to-Wasm ahead-of-time compiler** based on the SpiderMonkey JS engine. Began by porting SpiderMonkey to run inside a Wasm module. Added and upstreamed new interpreter tier (Portable Baseline) that supports inline-cache acceleration without requiring runtime code generation. Developed novel partial-evaluation compiler toolchain that combines interpreter with user code to produce compiled Wasm bytecode. Achieved 3-5x speedups with full compatibility. Gave several talks on novel approach with emphasis on correct-by-construction derivation.
- Contributed to **Wasmtime runtime**: used virtual-memory techniques and lazy initialization to achieve single-microsecond Wasm module instantiation times (400x improvement). Built lightweight compiler-based cooperative async scheduling.
- Focused on **correctness techniques**: proof-carrying code for sandboxing primitives, symbolic checker for register allocator, formal verification for compiler backend, rigorous fuzzing.
- Academic **research collaborations**: coauthored two ASPLOS papers ('23 and '24) on Wasm sandboxing and Cranelift formal verification. Gave invited keynote at EGRAPHS workshop on Cranelift's optimizer.

Mozilla (Mountain View, CA) Senior Compiler Engineer Aug 2019 – Oct 2020

- Advanced the **Cranelift JIT compiler** backend to provide production-grade WebAssembly support in **Firefox on aarch64 (ARM64)**, including developing a new aarch64 backend with a small team. Analyzed and carefully optimized to generate code that is competitive with other JITs.
- Worked on the **SpiderMonkey JavaScript JIT engine**.

Google (Mountain View, CA) Software Engineer Apr 2014 – May 2015

- Analyzed and enhanced performance of **Protocol Buffers**, a data serialization/marshalling framework used extensively in server-side infrastructure, by improving generated code and runtime library.

- Co-developed and led the release of **custom memory allocation (arena) support** for Protocol Buffers, saving significant CPU resources in production.
- Developed **Protocol Buffers bindings** as native-code plugins for Ruby and Node.js, and adapted a pure-JavaScript implementation for external release.

Intel (Hillsboro, OR) Silicon Architecture Engineer Aug 2013 – Apr 2014

- Worked on the core microarchitecture team for a **future-generation Atom core**.
- Defined **branch predictors** and related logic; worked with cycle-accurate simulator and estimated power and area.
- Worked with RTL engineers to specify implementation details and hand off documentation.

Conference Publications

- Michael McLoughlin, Ashley Sheng, Chris Fallin, Bryan Parno, Fraser Brown, Alexa VanHattum. "Scaling Instruction-Selection Verification against Authoritative ISA Semantics." In *OOPSLA 2025*, Singapore, October 2025.
- Chris Fallin, Maxwell Bernstein. "Partial Evaluation, Whole-Program Compilation." In *PLDI 2025*, Seoul, South Korea, June 2025.
- Alexa VanHattum, Monica Pardeshi, Chris Fallin, Adrian Sampson, Fraser Brown. "Lightweight, Modular Verification for WebAssembly-to-Native Instruction Selection." In *ASPLOS 2024*, San Diego, CA, April 2024.
- Shravan Narayan, Tal Garfinkel, Mohammadkazem Taram, Joey Rudek, Daniel Moghimi, Evan Johnson, Chris Fallin, Anjo Vahldiek-Oberwagner, Michael LeMay, Ravi Sahita, Dean Tullsen, Deian Stefan. "Going beyond the Limits of SFI: Flexible and Secure Hardware-Assisted In-Process Isolation with HFI." In *ASPLOS 2023*, Vancouver, BC, Canada, March 2023.
- Chris Fallin. "Safe, Flexible Aliasing with Deferred Borrows." In *ECOOP 2020*, Virtual Conference, Nov 2020.
- Chris Fallin, Chris Wilkerson, Onur Mutlu. "The Heterogeneous Block Architecture." In *ICCD 2014*, Seoul, South Korea, Oct 2014.
- Rachata Ausavarungnirun, Chris Fallin, Xiangyao Yu, Kevin Chang, Greg Nazario, Reetuparna Das, Gabriel Loh, Onur Mutlu. "Design and Evaluation of Hierarchical Rings with Deflection Routing." In *SBAC-PAD 2014*, Paris, France, Oct 2014.
- Yoongu Kim, Ross Daly, Jeremie Kim, Chris Fallin, Ji Hye Lee, Donghyuk Lee, Chris Wilkerson, Konrad Lai, Onur Mutlu. "Flipping Bits in Memory Without Accessing Them: An Experimental Study of DRAM Disturbance Errors." In *ISCA-41*, Minneapolis, MN, Jun 2014.
- Vivek Seshadri, Yoongu Kim, Chris Fallin, Donghyuk Lee, Rachata Ausavarungnirun, Gennady Pekhimenko, Yixin Luo, Onur Mutlu, Michael A. Kozuch, Phillip B. Gibbons, Todd C. Mowry. "RowClone: Fast and Energy-Efficient In-DRAM Bulk Data Copy and Initialization." In *MICRO-46*, Davis, CA, Dec 2013.
- Kevin Chang, Rachata Ausavarungnirun, Chris Fallin, Onur Mutlu. "HAT: Heterogeneous Adaptive Throttling for On-Chip Networks." In *SBAC-PAD 2012*, New York, NY, Oct. 2012.
- George Nychis, Chris Fallin, Thomas Moscibroda, Onur Mutlu, Srinivasan Seshan. "On-Chip Networks from a Networking Perspective: Congestion and Scalability in Many-core Interconnects." In *ACM SIGCOMM 2012 (**SIGCOMM**)*, Helsinki, Finland, Aug. 2012.
- Chris Fallin, Greg Nazario, Xiangyao Yu, Kevin Chang, Rachata Ausavarungnirun, Onur Mutlu. "MinBD: Minimally-Buffered Deflection Routing for Energy-Efficient Interconnect." In *6th ACM/IEEE International Symposium on Networks-on-Chip (**NOCS**)*, Lyngby, Denmark, May 2012. *One of five papers nominated for Best Paper award.*
- Eiman Ebrahimi, Rustam Miftakhutdinov, Chris Fallin, Chang Joo Lee, Onur Mutlu, Yale Patt. "Parallel Application Memory Scheduling." In *44th Annual IEEE/ACM International Symposium on Microarchitecture (**MICRO**)*, Porto Alegre, Brazil, Dec. 2011.

- Howard David, Chris Fallin, Eugene Gorbatov, Ulf R. Hanebutte, Onur Mutlu. "Memory Power Management via Dynamic Voltage/Frequency Scaling." In *8th IEEE/ACM International Conference on Autonomic Computing (**ICAC**)*, Karlsruhe, Germany, Jun. 2011.

- Chris Fallin, Chris Craik, Onur Mutlu. "CHIPPER: A Low-complexity Bufferless Deflection Router." In *17th International IEEE Symposium on High Performance Computer Architecture (**HPCA**)*, San Antonio, TX, Feb. 2011.

- George Nychis, Chris Fallin, Thomas Moscibroda, Onur Mutlu. "Next-Generation On-Chip Networks: What Kind of Congestion Control Do We Need?" In *Ninth ACM Workshop on Hot Topics in Networks (**HotNETS**)*, Monterey, CA, Oct. 2010.

Book Chapters

- Chris Fallin, Greg Nazario, Xiangyao Yu, Kevin Chang, Rachata Ausavarungnirun, Onur Mutlu. "Bufferless and Minimally-Buffered Deflection Routing" (book chapter). In *Routing Algorithms in Networks on-Chip*, pp. 241—275, Springer, 2014.

Technical Reports

- Chris Fallin, Chris Wilkerson, Onur Mutlu. "The Heterogeneous Block Architecture." SAFARI Technical Report No. 2014-001. March 13, 2014.

- Chris Fallin, Xiangyao Yu, Kevin Chang, Rachata Ausavarungnirun, Greg Nazario, Reetuparna Das, Onur Mutlu. "HiRD: A Low-Complexity, Energy-Efficient Hierarchical Ring Interconnect." SAFARI Technical Report No. 2012-004: December 13, 2012.

- Chris Fallin, Greg Nazario, Xiangyao Yu, Kevin Chang, Rachata Ausavarungnirun, Onur Mutlu. "MinBD: A Minimally-Buffered Deflection Router Approaching Conventional Buffered-Router Performance." SAFARI Technical Report No. 2011-008: September 13, 2011.

- Chris Fallin, Xiangyao Yu, Greg Nazario, Onur Mutlu. "A High-Performance Hierarchical Ring On-Chip Interconnect with Low-Cost Routers." SAFARI Technical Report No. 2011-007: September 6, 2011.

- Kevin Chang, Rachata Ausavarungnirun, Chris Fallin, Onur Mutlu. "Adaptive Cluster Throttling: Improving High-Load Performance in Bufferless On-Chip Networks." SAFARI Technical Report No. 2011-006: September 6, 2011.

- George Nychis, Chris Fallin, Thomas Moscibroda, Srinivasan Seshan, Onur Mutlu. "Congestion Control for Scalability in Bufferless On-Chip Networks." SAFARI Technical Report No. 2011-003: July 20, 2011.

- Chris Fallin, Chris Craik, Onur Mutlu. "CHIPPER: A Low-complexity Bufferless Deflection Router." SAFARI Technical Report No. 2010-001: December 29, 2010. (Extended version of our HPCA-17 conference paper.)

Research Talks

- "Debugging in Wasmtime: Recording, Snapshots, and Reversibility." At *Bytecode Alliance Plumber's Summit*, virtual, Oct. 2026.

- "Ahead-of-time Compilation of JavaScript to WebAssembly, Episode 2: The Return of the Compiler." Wasm Research Day, Princeton, NJ, Aug. 2026.

- "Guest Debugging in Wasmtime." At *Bytecode Alliance Plumber's Summit*, virtual, Feb. 2026.

- "ægraphs: Acyclic E-graphs for Efficient Optimization in a Production Compiler." At Dagstuhl seminar 26022 (*Program Optimization with E-Graphs*), Wadern, Germany, Jan. 2026.

- "Partial Evaluation, Whole-Program Compilation." At *PLDI 2025*, Seoul, South Korea, Jun. 2025.

- "Verifying Wasm-to-Native Compilation with Authoritative ISA Specifications." At Dagstuhl seminar 25241 (*Utilising and Scaling the WebAssembly Semantics*), Wadern, Germany, Jun. 2025.

- "Full-Stack Correctness in Wasm: Eliminating Bugs Inside and Outside the Sandbox." Invited keynote at *WebAssembly Workshop (WAW) 2025* at *POPL*, Denver, CO, Jan. 2025.
- "wevaling the wasms: AOT JS Compilation (or: Stuffing a Dynamic Language onto a Very Static Platform)." Wasm Research Day, Pittsburgh, PA, Jun. 2024.
- "wevaling the wasms: AOT JS Compilation (or: Stuffing a Dynamic Language onto a Very Static Platform)." Carnegie Mellon University, Apr. 2024.
- "wevaling the wasms: AOT JS Compilation (or: Stuffing a Dynamic Language onto a Very Static Platform)." PL Seminar, Northeastern University, Apr. 2024.
- "ægraphs: Acyclic E-graphs for Efficient Optimization in a Production Compiler." Invited keynote at *EGRAPHS 2023* workshop at *PLDI*, Orlando, FL, Jun. 2023.
- "Finding and Exploiting Parallelism with Data-Structure-Aware Static and Dynamic Analysis." *Thesis Defense*, CMU, Pittsburgh, PA, Feb. 2019.
- "Data-structure-aware program analysis for macro-scale optimizations." *CMU PDL Fall Retreat*, Bedford Springs, PA, Oct. 2018.
- "Finding hidden concurrency: a data-structure-aware analysis for auto-parallelization." *CMU PDL Fall Retreat*, Bedford Springs, PA, Oct. 2017.
- "Finding hidden concurrency: a data-structure-aware analysis for auto-parallelization." *MIT-CMU Annual Parlay Meeting*, Cambridge, MA, Sep. 2017.
- "Macro-scale program optimizations by inferring semantic intent." *CMU PDL Fall Retreat*, Bedford Springs, PA, Oct. 2016.
- "Heterogeneous Core Microarchitecture for Energy Efficiency." *CMU CALCM (Computer Architecture Lab at Carnegie Mellon) Lecture*, Pittsburgh, PA, Apr. 2013.
- "Block-Based Heterogeneous Core Designs for Higher System Performance and Efficiency." *Qualcomm Innovation Fellowship Finals*, San Diego, CA, Mar. 2013 (co-presented with Gennady Pekhimenko).
- "Enabling Fine-grained Heterogeneity with Atomic Blocks." *Intel ARO Workshop*, Hillsboro, OR, Mar. 2013.
- "MinBD: Minimally-Buffered Deflection Routing for Energy-Efficient Interconnect." *6th ACM/IEEE International Symposium on Networks-on-Chip (**NOCS**)*, Lyngby, Denmark, May 2012.
- "Memory Latency Tolerance: Skipahead & Efficient Runahead." *Intel ARO Workship*, Hillsboro, OR, Feb. 2012.
- "Memory Power Management via Dynamic Voltage/Frequency Scaling," *8th IEEE/ACM International Conference on Autonomic Computing (**ICAC**)*, Karlsruhe, Germany, Jun. 2011.
- "CHIPPER: A Low-complexity Bufferless Deflection Router," *17th International IEEE Symposium on High Performance Computer Architecture (**HPCA**)*, San Antonio, TX, Feb. 2011.

Service

- External review committee for MICRO 2025.
- Program committee for EGRAPHS 2025.
- Program committee for PLDI 2025.
- External review committee for ASPLOS 2025.
- External review committee for ISCA 2024.

Research Experience

- Post-doc for Prof. Todd Mowry and Prof. Phil Gibbons, CS, CMU, Mar 2019 – Jun 2019. Continuing thesis research on program analysis for parallelization and other transforms. Developed type-system approach to deriving program parallelizability.
- Ph.D. research assistant for Prof. Todd Mowry and Prof. Phil Gibbons, ECE, CMU, Jun 2015 – Feb 2019. Developing techniques for auto-parallelization and other high-level code transforms via static and dynamic code analysis.
- Ph.D. research assistant for Prof. Onur Mutlu, ECE, CMU, Aug 2009 – Jul 2013. Developed new energy-efficient core microarchitecture designs, energy-efficient network-on-chip designs, and memory system power scaling techniques.

Teaching Experience

Carnegie Mellon University, spring 2010, spring 2012, Teaching Assistant, ECE Dept.

- TA for Introduction to Computer Architecture, 18-447, in spring 2012. Developed pipeline timing simulator in C and series of lab assignments, updated existing Verilog lab assignments, ran one lab session/recitation and held office hours, played major role in developing exams.
- TA for Parallel Comp. Arch., 18-742, in spring 2010. Mentored student research projects, delivered several lectures.

University of Notre Dame, spring 2008, fall 2008, spring 2009, Teaching Assistant, Computer Science & Engr. Dept.

- TA for Logic Design, CSE 20221, in spring 2008 and spring 2009. Graded homeworks and supervised one lab section.
- TA for Computer Architecture I, CSE 30321, in fall 2008. Supervised weekly lab, held office hours, wrote homeworks.

Internships

Intel Corporation, Graduate Technical Intern (Hillsboro, OR), May – September 2012

- Worked in Intel Architecture Development Group on core architecture. Performed simulation studies to investigate mechanisms for memory latency tolerance.

Intel Corporation, Graduate Technical Intern (Hillsboro, OR), June – September 2010

- Conducted research in Power Management Architecture group, System Architecture Lab, Intel Labs.
- Evaluated mechanisms for processor and memory frequency and voltage scaling for server platforms. Resulted in ICAC 2011 publication on memory DVFS (dynamic voltage/frequency scaling).

Cypress Semiconductor, Undergraduate Co-op (Beaverton, OR), May – August 2007 and May – August 2008

- Worked on integrated development environment and EDA (electronic design automation) tools for programmable FPGA-like mixed analog/digital chips.
- Built generic design-rule check (DRC) framework to highlight errors in schematic design editor which became an user-visible feature in shipping software.

Graduate Coursework

- CMU: Grad. Computer Architecture (ECE/CS), Advanced OS & Dist. Sys (CS), Algorithms in the Real World (CS), Optimizing Compilers (CS), Storage Systems (ECE), Analytical Performance Modeling (CS), VLSI CAD (ECE)
- ND: Graduate Algorithms (CSE)

Research Fellowships

SRC Graduate Research Fellowship, Aug 2009 – Jul 2010. Awarded April 2009.
NSF Graduate Research Fellowship, Aug 2010 – Jul 2013. Awarded April 2009.
Bertucci Fellowship, 2013. Internal CMU College of Engineering fellowship. Awarded January 2013.
Qualcomm Innovation Fellowship Honorable Mention, 2013-2014 (with Gennady Pekhimenko). Awarded April 2013.

Honors

- Distinguished Paper Award, ASPLOS 2023.
- One of five papers nominated for Best Paper Award, NOCS 2012.
- Steiner Award in Engineering, Notre Dame, April 2009
  (awarded to one graduating senior in each engineering discipline)
- Tau Beta Pi and Upsilon Pi Epsilon engineering honors societies
- Engineering Honors Program, Notre Dame
- Dean's List, all semesters at Notre Dame

Professional Associations

- Member, Association for Computing Machinery (ACM) since Nov. 2006 (Full professional member since Mar. 2019)

References

Available upon request.