

Jonathan C. Beard

CRAZY AWESOME MAD SCIENTIST · COMPUTER SYSTEMS ARCHITECT

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“My goal is to make high performance computing easy to use and portable, it’s time to make the hardware work for the software and not the other way around.”

Summary

Jonathan is an experienced researcher, leader, and technical manager. He has a broad educational background and a history of successfully leading diverse teams to accomplish extremely difficult, complex technical tasks.

Education

Washington University in St. Louis

PH.D. COMPUTER SCIENCE

St. Louis, Missouri

Aug. 2010 - Aug. 2015

The Johns Hopkins University

M.S. BIOINFORMATICS

Baltimore, Maryland

May 2006 - May 2010

Louisiana State University

B.S. IN BIOLOGICAL SCIENCES

- *minor(s): history*

Baton Rouge, Louisiana

Aug. 2001 - Dec. 2005

Louisiana State University

B.A. IN INTERNATIONAL STUDIES, CENTRAL ASIAN FOCUS

Baton Rouge, Louisiana

Aug. 2001 - Dec. 2005

Work Experience

Arm Inc.

PRINCIPAL RESEARCH ENGINEER

Austin, Texas, USA

Apr. 2020 - current

Arm Inc.

STAFF RESEARCH ENGINEER

Austin, Texas, USA

Apr. 2017 - Apr. 2020

Arm Inc.

SENIOR RESEARCH ENGINEER

Austin, Texas, USA

Feb. 2015 - Apr. 2017

- I am the technical lead for the development of next generation systems architectures focused on scalability and reduced data movement. This work includes virtual memory systems, accelerator integration, low overhead communications, and improving programmability of heterogeneous systems. In previous roles I've investigated hardware and workloads for compute near data as part of the DOE FastForward-2 Project, as well as programming models for massively parallel distributed computation. Arm representative to Sandia National Labs led Data Movement Dominates DOE Project, developing methodologies to reduce the cost of data movement, improve the utilization of memory relative to computation through a variety of innovative technologies. Developing simulation techniques to deal with massive scale-out issues that arise from the need to simulate high throughput traffic on hardware that doesn't yet exist.

FastData

ADVISOR

- Advisor and technical consultant.

Los Angeles, CA

Nov. 2016 - current

Arkhesoft LLC

CHIEF EXECUTIVE OFFICER

- Sole proprietor and consultant.

Austin, Texas, USA

Jun. 2010 - current

Washington University in St. Louis

RESEARCH ASSISTANT

- Ph.D. Student at Washington University in St. Louis. I worked as a research assistant under the direction of Dr. Roger Chamberlain in the Stream Based Supercomputing Lab. My research involved using machine learning, queuing theory, signal processing, and control theory to improve the understanding and application of mathematical models for the optimization of stream compute systems.

St. Louis, MO, USA

Jun. 2010 - Apr. 2015

Washington University in St. Louis

LECTURER

- Co-Instructed CSE 462M (Computer Systems Design), introduction to modern design practices and the use of FPGA hardware prototyping. Students used a commercial CAE/CAD system for VHDL-based design and simulation while designing a computation system. Students focused on the hardware / software co-design of a novel bio-sequence assembly algorithm deployed on a field programmable gate array and multiple multi-core processors.
- course webpage: <http://goo.gl/dPEdC9>

St. Louis, MO, USA

Jan. 2012 - May 2012

United States Army Europe, Europe Regional Medical Command

DEPUTY DIRECTOR OF MEDICAL INFORMATICS

- Started the medical informatics department for the European Regional Medical Command as the interim director. I was responsible for all initial hiring, planning (long term and short term), office procurement and provisioning. Long term responsibilities included development of medical information management systems, software development, IT and healthcare provider contract management, mathematical modeling of patient flow and outcomes, development of data mining systems. Managed over 200 employees as well as an \$8 million budget in four countries. Fostered relationships with partners in both industry and within the military community.

Heidelberg, Deutschland

Jan. 2009 - Jun. 2010

United States Army Europe, Europe Regional Medical Command

AIDE-DE-CAMP

- Aide-de-Camp for two consecutive Commanding Generals of the Europe Regional Medical Command which has health care facilities in 11 countries (both Eastern & Western Europe and Balkan) with over 92,000 beneficiaries. I coordinated all types of actions with international state officials, handled international logistics and was personally responsible for the security of the general. This role afforded me the opportunity to meet U.S. Senators, Congressmen, their staffers as well as heads of state. I became an expert multi-tasker. I finished a graduate degree, while juggling traveling out-of-country six out of seven weekdays while making the general's job look easy.

Heidelberg, Deutschland

Jul. 2007 - Jan. 2009

1st Heavy Brigade Combat Team, 2nd Infantry Division

BRIGADE SAFETY MANAGER

- Program manager in charge of directing and monitoring company (~ 6000 personnel) compliance with OSHA, international safety and environmental standards. Responsible for strategic planning, technical support, and overall management for environment, health, safety, training, and industrial hygiene programs.

Dongducheon, Republic of South

Korea

Mar. 2007 - Jul. 2007

1st Battalion, 72nd Armor Regiment "First Tank"

MEDICAL ADMINISTRATOR (COMBAT UNIT MEDICAL PLATOON LEADER)

- Responsible for directing a multi-national team of healthcare providers and support staff in daily operations. Managed and maintained equipment assets worth over 12 million USD. Instituted teamwork driven processes incorporating monitoring, analysis, and planning of the patient cycle to improve patient care.

Dongducheon, Republic of South

Korea

Mar. 2007 - Jul. 2007

Extracurricular Open Source Software

RaftLib C++ DSL

PRIMARY AUTHOR, MAINTAINER, EVANGELIST

International

May. 2013 - current

- Designed and authored C++ DSL.
- Built asynchronous FIFOs.
- Designed novel instrumentation approaches.
- Applied machine learning, queueing theory, flow-network theory, and heuristics to auto-tuning dataflow/streaming applications.
- Evangelized the benefits of RaftLib, did two presentations at C++Now (2016/2017), RaftLib has since been to the top of Y Combinator's Hacker News twice.
- Provide on-demand support for open-source code, provide pay-support on request (e.g., custom FPGA plug-ins), and continue to evolve the DSL / framework for the open-source community.
- <http://raftlib.io>

Thesis

Beard, J. C. (2015). *Online Modeling and Tuning of Parallel Stream Processing Systems*. PhD thesis, Department of Computer Science and Engineering, Washington University in St. Louis, link to thesis: <https://bit.ly/387cGgY>

Journal Publications

Li, P., Beard, J. C., and Buhler, J. D. (2017). Deadlock-free buffer configuration for stream computing. *The International Journal of High Performance Computing Applications*, 31(5):441–450

Beard, J. C., Li, P., and Chamberlain, R. D. (2017). RaftLib: a C++ template library for high performance stream parallel processing. *The International Journal of High Performance Computing Applications*, 31(5):391–404

Conference Publications

Asri, M., Rusitoru, R., Dunham, C., Gerstlauer, A., and Beard, J. C. (To be published, 2020). The Non-Uniform Compute Device (NUCD) Architecture for Lightweight Accelerator Offload. In *2020 28th Euromicro International Conference on Parallel, Distributed, and Network-Based Processing*, page ... IEEE

Cabrera, A. M., Chamberlain, R. D., and Beard, J. C. (2019). Multi-spectral Reuse Distance: Divining Spatial Information from Temporal Data. In *The IEEE High Performance Extreme Computing Conference 2019*, HPEC2019

Barredo, A., Beard, J. C., and Moretó, M. (2019). SPiDRE: Accelerating Sparse Memory Access Patterns. In *Proceedings of the 28th International Conference on Parallel Architectures and Compilation Techniques*, PACT2019. ACM

Beard, J. C. (2017). The Sparse Data Reduction Engine (SPiDRE): Chopping Sparse Data One Byte at a Time. In *Proceedings of the Second International Symposium on Memory Systems*. ACM

- Beard, J. C., Epstein, C., and Chamberlain, R. D. (2015b). Online Automated Reliability Classification of Queueing Models for Streaming Processing using Support Vector Machines. In *Proceedings of Euro-Par 2015 Parallel Processing*, pages 82–93. Springer
- Beard, J. C. and Chamberlain, R. D. (2015a). Run Time Approximation of Non-blocking Service Rates for Streaming Systems. In *Proceedings of the 17th IEEE International Conference on High Performance and Communications*, pages 792–797. IEEE
- Beard, J. C., Epstein, C., and Chamberlain, R. D. (2015a). Automated Reliability Classification of Queueing Models for Streaming Computation using Support Vector Machines. In *Proceedings of the 6th ACM/SPEC international conference on Performance engineering, ICPE 2015*, pages 325–328, New York, NY, USA. ACM
- Beard, J. C. and Chamberlain, R. D. (2013a). Analysis of a Simple Approach to Modeling Performance for Streaming Data Applications. In *Proceedings of the IEEE International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems*, pages 345–349
- Beard, J. C. and Chamberlain, R. D. (2013b). Use of Simple Analytic Performance Models of Streaming Data Applications Deployed on Diverse Architectures. In *Proceedings of the International Symposium on Performance Analysis of Systems and Software*, pages 138–139
- Lancaster, J. M., Wingbermuehle, J. G., Beard, J. C., and Chamberlain, R. D. (2011). Crossing Boundaries in TimeTrial: Monitoring Communications Across Architecturally Diverse Computing Platforms. In *Proceedings of 9th IEEE/IFIP International Conference on Embedded and Ubiquitous Computing*, pages 280–287

Workshop Publications

- Dunham, C. and Beard, J. C. (2018). This Architecture Tastes Like Microarchitecture. In *Online Proceedings of the 2nd Workshop on Pioneering Processor Paradigms, WP3. The 2nd Workshop on Pioneering Processor Paradigms*
- Beard, J. C. and Randall, J. (2017). Eliminating Dark Bandwidth: a data-centric view of scalable, efficient performance, post-Moore. In *Proceedings of the High Performance Computing Post-Moore (HCPM'17) Workshop*. Lecture Notes in Computer Science
- Li, P., Beard, J. C., and Buhler, J. (2015). Deadlock-free Buffer Configuration for Stream Computing. In *Proceedings of Programming Models and Applications on Multicores and Manycores, PMAM 2015*, pages 164–169, New York, NY, USA. ACM
- Beard, J. C., Li, P., and Chamberlain, R. D. (2015c). Raftlib: A C++ template library for high performance stream parallel processing. In *Proceedings of Programming Models and Applications on Multicores and Manycores, PMAM 2015*, pages 96–105, New York, NY, USA. ACM
- Beard, J. C. and Chamberlain, R. D. (2014). Use of a Levy Distribution for Modeling Best Case Execution Time Variation. In Horvath, A. and Wolter, K., editors, *Computer Performance Engineering*, volume 8721 of *Lecture Notes in Computer Science*, pages 74–88. Springer International Publishing

Beard, J. C. and Chamberlain, R. D. (2015b). Run Time Approximation of Non-blocking Service Rates for Streaming Systems. *arXiv preprint arXiv:1504.00591v2*

Presentations

9th Workshop on Irregular Applications: Architectures and Algorithms

Denver, Colorado

PANEL MEMBER FOR DEBATE ON: "EASY EXPRESSION CAN GO WITH HIGH PERFORMANCE"

Nov. 2019

- An argument against the proposition that abstractions and performance cannot go together.
- link to slides: <https://bit.ly/2RmqaiN>

The International Symposium on Memory Systems

Washington, DC

PANEL MEMBER FOR NEW AND COOL MEMORY TECHNOLOGIES

Oct. 2019

- Introduced several critical problems for accelerator rich systems, system efficiency, and programmability.
- link to slides: <https://bit.ly/2YhCTEV>

Smoky Mountains Computational Science and Engineering Conference

Kingsport, TN

INVITED TALK ON EDGE COMPUTING

Aug. 2019

- What is the edge, where's the edge, and why not talk about the edge with the rest of the system?
- Systems-level concepts that could enable more portable edge computing.
- link to slides: <https://tinyurl.com/qs5xp4u>

Workshop on Memory-Centric High Performance Computing (MCHPC-2018)

Dallas, Texas, USA

PANELIST ON CHALLENGES FOR MEMORY CENTRIC COMPUTING

Nov. 2018

- Introduction to near-memory compute as just another form of an accelerator rich system.
- Introduction to key challenges and some potential avenues of research to solve them
- link to slides: <https://bit.ly/2LnGWdr>

University Corporation for Atmospheric Research Software Engineering Assembly

Boulder, Colorado

SPEAKER: REDUCING DARK BANDWIDTH THROUGH DATA REDUCTION NEAR MEMORY

April 2018

- Dark bandwidth and some ways to get rid of it through near memory gather/scatter.
- link to slides: <https://bit.ly/2reuEOh>

University Corporation for Atmospheric Research Software Engineering Assembly

Boulder, Colorado

INVITED TALK: A VISION FOR DESTRUCTION OF POST-MOORE DISRUPTION

Apr. 2018

- My views on architecture from a biological evolution perspective.
- Technical debt is evolutionary pressure.
- All novel hardware has a huge chance of going extinct, unless we reduce impact of failing.
- link to slides: <https://bit.ly/33RJNli>

The International Symposium on Memory Systems

Washington, DC

PANELIST ON NEW AND COOL MEMORY TECHNOLOGIES

Oct. 2017

- A panel discussion on how to use new memory technologies, challenges, and in general what is new and cool in the field.
- link to slides: <https://goo.gl/rqkAmQ>

CPPNow 2017

Aspen, Colorado

ACCEPTED TALK: RAFTLIB TUTORIAL

May 2017

- Tutorial on a simple, easy to use stream computation library for C++.
- link to slides: <https://bit.ly/33VgOwW>
- link to talk: <https://youtu.be/liQ787fJgmU>

CPPNow 2017

Aspen, Colorado

ACCEPTED TALK: GOOD FIFOs MAKE GOOD NEIGHBORS

May 2017

- FIFO Optimization for Software Engineers
- link to slides: <https://goo.gl/TIRQFG>
- link to talk: <https://youtu.be/pvp-QQD0Xx0>

Supercomputing 2016

Salt Lake City, Utah

INVITED PANELIST FOR FUTURE OF MEMORY TECHNOLOGY FOR EXASCALE AND BEYOND IV

Nov. 2016

- Panel discussion on the future of memory technology for exascale. My take: instead of focusing just on new technologies, lets focus on systems.
- link to slides: <https://goo.gl/mKM0jK>

CPPNow 2016

Aspen, Colorado

ACCEPTED TALK: RAFTLIB TUTORIAL

May 2016

- Tutorial on a simple, easy to use stream computation library for C++.
- link to slides: <https://bit.ly/2OSdyyg>
- link to talk: <https://youtu.be/gghGLDDaROw>

Patents

Fault tolerant memory system

U.S. 16/043,975

CO-INVENTOR

Filed 24 July 2018

Dynamic SVE Vectorization of Scalar Operations using Dataflow Vectorization

U.S. 10,620,954

CO-INVENTOR

Granted 14 April 2020

An efficient method for Scalable Range Based Coherence Modification

U.S. 10,592,424

CO-INVENTOR

Granted 17 March 2020

The Memory Storm Fabric for Hardware Accelerated, Scalable Virtual Shared Memory

U.S. 10,467,159

CO-INVENTOR

Granted 26 November 2019

Apparatus and method for predicting a redundancy period

U.S. 10,423,510

CO-INVENTOR

Granted 24 September 2019

Method and Apparatus for Two-Layer Copy-on-Write

U.S. 10,565,126

CO-INVENTOR

Granted 18 February 2020

Memory Node Controller

U.S. 10,467,159

CO-INVENTOR

Granted 5 November 2019

Method and Apparatus for Fast Context Cloning in a Data Processing System

U.S. 10,353,826

CO-INVENTOR

Granted 16 July 2019

Memory Address Translation

U.S. 10,489,304

CO-INVENTOR

Granted 26 November 2019

Cache-Based Communication Between Execution Threads of a Data Processing System

U.S. 10,474,575

CO-INVENTOR

Granted 12 November 2019

Fast Address Translation for Virtual Machines

CO-INVENTOR

U.S. 10,613,989

Granted 7 April 2020

Virtual Context Table for Fast Heterogeneous Context Migration

CO-INVENTOR

U.S. 10,423,466

Granted 24 September 2019

Smart Sparse Data Movement Engine for Increasing Utilization of Bandwidth and Cache Lines

CO-INVENTOR

U.S. 10,353,601

Granted 16 July 2019

Efficient Lazy Migration of Virtual Compute Contexts

CO-INVENTOR

U.S. 10,552,212

Granted 4 February 2020

Virtual Context Format for Fast Heterogeneous State Migration

CO-INVENTOR

U.S. 15/361,770

Filed 28 November 2016

Method and Apparatus for Reordering in a Non-Uniform Compute Device

CO-INVENTOR

U.S. 10,445,094

Granted 15 October 2019

Method and Apparatus for Scheduling in a Non-Uniform Compute Device

CO-INVENTOR

U.S. 10,552,152

Granted 4 February 2020

Memory Synchronization Filter

CO-INVENTOR

U.S. 10,067,708

Granted 4 September 2018

Program Committees

2020	Technical Program Committee Member , IEEE/ACM International Symposium on Microarchitecture (MICRO53)	Greece
2020	Committee Member , 2020 Smoky Mountains Computational Sciences & Engineering Conference	United States
2020	Architecture and Networks Member , Supercomputing 2020 Technical Program Committee	United States
2019	Architecture and Networks Co-Chair , Supercomputing 2019 Technical Program Committee	United States
2018	Architecture and Networks Member , Supercomputing 2018 Technical Program Committee	United States
2017	Architecture and Networks Member , Supercomputing 2017 Technical Program Committee	United States
2016	Architecture and Networks Member , Supercomputing 2016 Technical Program Committee	United States
2017	Organizing Committee Member , Arm Research Summit	United Kingdom
2018	Organizing Committee Member , Arm Research Summit	United Kingdom
2019	General Chair , Arm Research Summit	United States
2020	Organizing Committee Member , The International Conference on Memory Systems (MEMSYS)	United States
2018	Organizing Committee Member , The International Conference on Memory Systems (MEMSYS)	United States
2017	Organizing Committee Member , The International Conference on Memory Systems (MEMSYS)	United States
2018	Report co-author , US Department of Energy Extreme Heterogeneity Workshop	United States
2019	Technical Program Committee , 9 th Workshop on Irregular Applications: Architectures and Algorithms	United States
2020	Committee Member , US Department of Energy Performance, Portability, and Productivity (P3HPC)	United States
2019	Committee Member , US Department of Energy Performance, Portability, and Productivity (P3HPC)	United States
2018	Architecture Technical Program Committee , 47 th International Conference on Parallel Processing (ICPP)	United States
2020	Architectures, Networks & Infrastructure Technical Program Committee Member , ISC 2020	Germany
2019	Architectures, Networks & Infrastructure Technical Program Committee , ISC 2019	Germany
2017	Co-general Chair , GoingArm 2017	Germany
2018	Co-general Chair , GoingArm 2018	Germany

Honors & Affiliations

2015	Member , ACM Upsilon Pi Epsilon	United States
2013	Google Scholarship , Google-Student Veterans of America (SVA)	Mountainview, California
2010	Meritorious Service Medal , United States Army	Heidelberg, Germany
2007	Commendation Medal , United States Army	Republic of South Korea
2006	Commendation Medal , United States Army	Republic of South Korea