

Sudarsun Kannan

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Research Interests

Operating Systems, Computer Architecture, Storage, Distributed Systems, High Performance Computing, Software and Hardware Co-design

Research Summary

My research goal is to build scalable and efficient systems for emerging heterogeneous memory and storage technologies. Given the multi-faceted differences among these technologies, a critical step toward maximizing their impact is to shield applications and upper-level software stacks from the consequent complexity. My research approach is based on empowering operating systems and runtimes with new abstractions and techniques that can tap into the transformative benefits offered by new hardware technologies, while also effectively bridging the performance, capacity and energy gaps among them. I favor a principled approach to unearthing the systems software opportunities and challenges to build practical OS and runtime techniques. My research also studies the hardware-software interfaces and co-design opportunities, particularly in the context of data-intensive applications.

Academic Experience

University of Wisconsin-Madison

Postdoctoral Research Associate, Dept. of Computer Sciences Sep. 2016 - Current
Topic: File Systems For Modern Storage
Advisers - Prof. Andrea C. Arpaci-Dusseau and Prof. Remzi H. Arpaci-Dusseau

Georgia Institute of Technology, Atlanta

Ph.D. in Computer Science May 2010 - Aug 2016
Thesis: Operating System Support for Heterogeneous Memory
Advisers - The late Prof. Karsten Schwan and Prof. Ada Gavrilovska

Georgia Institute of Technology, Atlanta

M.S in Computer Science Aug 2008 - May 2010
Masters Research Project: Virtual Storage for Mobile Devices
Advisers - The late Prof. Karsten Schwan and Prof. Ada Gavrilovska

Anna University, Chennai

B.E in Computer Science (with distinction) July 2001- May 2005
Research project: Embedded Web Server Management

Reviewed Publications

- Sudarsun Kannan**, Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau
Yuangang Wang, Jun Xu, Gopinath Palani
Designing a True Direct-Access File System with DevFS
USENIX Conference on File and Storage Technologies, 2018 (Accepted) **FAST '18**
- Sudarsun Kannan**, Ada Gavrilovska, Vishal Gupta, Karsten Schwan
HeteroOS - OS Design for Heterogeneous Memory Management in Datacenter
44th International Symposium on Computer Architecture, 2017. **ISCA '17**
- Jun He, **Sudarsun Kannan**, Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau
The Unwritten Contract of Solid State Drives
European Conference on Computer Systems, 2017. **EuroSys '17**
- Sudarsun Kannan**, Moinuddin Qureshi, Ada Gavrilovska, Karsten Schwan
Reducing Energy Overheads of Memory-based Persistence in NVMs
25th International Conference on Parallel Architectures and Compilation Techniques, 2016. **PACT '16**
- Pradeep Fernando, **Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan
Phoenix: Memory Speed HPC I/O with NVM
23rd annual IEEE International Conference on High Performance Computing,
Data, and Analytics, 2016. **HiPC '16**
- Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan
pVM – Persistent Virtual Memory for Efficient Capacity Scaling and Object Storage
European Conference on Computer Systems, 2016. **EuroSys '16**
- Sudarsun Kannan**, Moinuddin Qureshi, Ada Gavrilovska, Karsten Schwan
Energy Aware Persistence: Reducing the Energy Overheads of Persistent Memory
Computer Architecture Letters, 2015 (also presented at NVMW 2016). **CAL '15**
- Sudarsun Kannan**, Naila Farooqui, Ada Gavrilovska, Karsten Schwan
HeteroCheckpoint: Efficient Checkpointing for Accelerator-based Systems
4th Workshop on Fault-Tolerance for HPC at Extreme Scale (in DSN), 2014. **FTXS '14**
- Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan
Reducing the Cost of Persistence for NonvolatileHeaps in End User Devices
20th International Symposium on High Performance Computer Architecture, 2014. **HPCA '14**
- Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan
NVM Heaps for Accelerating Browser-based Applications
USENIX Interactions of NVM/Flash with Operating Systems and Workloads, 2013. **INFLOW '13**
- Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan, Dejan Milojicic
Optimizing Checkpoints Using NVM as Virtual Memory
27th IEEE International Parallel & Distributed Processing Symposium, 2013. **IPDPS '13**
- Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan, Dejan Milojicic, Vanish Talwar
Using Active NVRAM for I/O Staging
Petascale Data Analytics: Challenges and Opportunities, SC workshop, 2011. **PDAC '11**
- Sudarsun Kannan**, Ada Gavrilovska, and Karsten Schwan
Cloud4Home – Enhancing Data Services with @Home Clouds
31st International Conference on Distributed Computing Systems, 2011. **ICDCS '11**

Sudarsun Kannan, Karishma Babu, Ada Gavrilovska, Karsten Schwan
VStore++: Virtual Storage Services for Mobile Devices
International Workshop on Mobile Computing and Clouds, 2010.

MobiCloud '10

Short Papers and Posters

Sudarsun Kannan, Moinuddin Qureshi, Ada Gavrilovska, and Karsten Schwan
Energy Aware Persistence for Nonvolatile Memory
Non-volatile Memories Workshop (NVMW), 2016, University of California San Diego.

Pradeep Fernando, **Sudarsun Kannan**, Ada Gavrilovska, Karsten Schwan
Fast Restarts/Recovery with NVM memory for HPC systems
Non-volatile Memories Workshop (NVMW), 2015, University of California San Diego.

Sudarsun Kannan, Ada Gavrilovska, and Karsten Schwan
Reducing I/O Sandboxing Overheads for Browser-based Applications
Non-volatile Memories Workshop (NVMW), 2013, University of California San Diego.

Sudarsun Kannan, Ada Gavrilovska, and Karsten Schwan
Rich Client Services using Persistent Memory
Non-volatile Memories Workshop (NVMW), 2015, University of California San Diego.

Hrishi Amur, Alex Merritt, **Sudarsun Kannan**, Ada Gavrilovska, and Karsten Schwan
MESSY Library for Memory Consistency on 48 core Intel SCC
Intel Marc Symposium 2011, Hillsboro.

Industrial Patents

Sudarsun Kannan, Palo Faraboschi, Murray McLaren, Dejan Milojcic
Checkpoint Generation
U.S. Patent, Publication number US20140214770 A1.

Sudarsun Kannan, Dejan Milojcic, Vanish Talwar
Active Non Volatile Memory Post Processing
U.S. Patent, Publication number US9619430 B2.

James E. Donahue, Ricky Ho, **Sudarsun Kannan**, Pradnyesh S. Gore
System and Method for Installation and Management of Cloud-Independent Multi-Tenant Applications
U.S. Patent, Publication number US8812627 B2.

Talks

OS design for Heterogeneous Memory Management in Datacenter, ISCA June 2017, Toronto.

Reducing Energy Overheads of Memory-based Persistence in NVMs, PACT, Sep. 2016, Haifa.

Persistent Virtual Memory for Capacity Scaling and Object Storage, Eurosys, Mar. 2016, London.

Heterogeneous Memory Management, Univ. of Wisconsin-Madison, May 2016, Madison.

Energy Aware Persistence, NVMW, March 2016, Univ. of Sand Diego, Sand Diego.

Reducing the Cost of Persistence for Nonvolatile Heaps, HPCA, Feb. 2014, Orlando.

NVM for Rich Client Services, Intel Labs, Aug 2013, Hillsboro, Oregon.

Optimizing Checkpoints Using NVM as Virtual Memory, IPDPS, June 2013, Boston.

NVM Heaps for Accelerating Browser-based Applications, INFLOW (SOSP Workshop), Nov. 2013, Pennsylvania.

Using Active NVRAM for I/O Staging, PDAC, Nov. 2011 (SC Workshop), Seattle.

Active NVRAM for in-memory processing, HP Labs, Aug. 2011, Palo Alto.

Cloud4Home – Enhancing Data Services with @Home Clouds, ICDCS, June 2011, Minneapolis.

Teaching Experience

Guest Lecturer, UW-Madison

CS 736 - Advanced Operating Systems, Fault tolerance and recovery Spring 2017

Guest Lecturer, UW-Madison

CS 739 - Distributed Systems, Logical clocks, SSD storage Fall 2017

Head Teaching Assistant, Georgia Tech

CS 3210 - Undergraduate OS Introduction, Lectures, project design, grading Spring 2016

Guest Lecturer, Georgia Tech

CS 3210, Undergraduate OS Introduction, OS memory management, synchronization Spring 2015

Guest Lecturer, Georgia Tech

CS 6210 - Advanced OS, OS memory management, synchronization, virtualization Fall 2014

Guest Lecturer, Georgia Tech

CS 6210 - Advanced OS, Trust and Protection in the OS Fall 2013

Head Teaching Assistant, Georgia Tech

CS 4210 - Graduate OS Introduction, Lectures, project design and grading Fall 2011

Conference and Journal Services

2017 - Program committee - 46th International Conference on Parallel Processing (ICPP)

2017 - Reviewer - IEEE Transactions on Computers (TC)

2017 - Shadow PC committee - Eurosys

2017 - Reviewer - Science of Computer Programming

2016 - Shadow PC committee - Eurosys

2016 - Reviewer - IEEE Computer Architecture Letters (CAL)

2016 - Reviewer - IEEE Transactions on Computers (TC)

2014 - Reviewer - IEEE Transactions on Cloud Computing (TCC)

2012 - Reviewer - IEEE Transactions on Parallel and Distributed Systems (TPDS)

Industrial Experience

Intel Labs, System Architecture Lab, Hillsboro

May 2013 - Aug 2013

Research Intern with Dr. Sanjay Kumar

I studied the performance impact of NVM on end-user applications by developing a benchmark suite for

end-user applications. Intel researchers and our research group used the benchmark for papers published at INFLOW 2013, HPCA 2014, CAL 2015, EuroSys 2016.

HP Labs, Intelligent Infrastructure Lab, Palo Alto May 2012 - Aug 2012

Research Intern with Dr. Dejan Milojcic

I designed and developed a NVM checkpointing mechanism for HPC application. The work was published in IPDPS 2013 paper. The techniques were also patented, and I was the lead author of the patent.

HP Labs, Intelligent Infrastructure Lab, Palo Alto May 2011 - Aug 2011

Research Intern with Dr. Dejan Milojcic, Dr. Partha Ranganathan, Dr. Vanish Talwar

I explored and designed a technique for using NVM for in-memory processing. The work was published as a workshop paper at PDAC 2011. Due to its novelty, the work was also patented, and I was the lead author of the patent.

Adobe Labs, Advanced technology Labs, San Jose May 2010 - Aug 2010

Research Intern with Dr. Jim Donnahue

I worked with Dr. Donnahue to develop a novel application deployment framework in public clouds. The work was patented and is currently used in Adobe cloud services.

Research in Motion, OS development, Fort Lauderdale, Florida May 2009 - Aug 2009

OS intern

I had an opportunity to learn about mobile OS. I also developed OS-level live-debugging tools for the Blackberry OS.

I|Nautix Technologies, Windows Development, Chennai May 2005 - July 2008

Senior Application Developer

I was one of the five architects involved in designing next-generation trading platform (www2.netx360.com) for Bank of New York used by more than 100K users. Our goal was to develop a latency-critical framework, which also supports dynamic code compilation techniques for just-in-time deployment.

Midas Communication at Indian Institute of Technology, Chennai May 2004 - May 2005

Intern

I developed a webserver for micro-controllers that manage wireless communication towers. The project was ranked third out of 60 projects in the undergraduate research competition.

Research Experience

Hardware-accelerated filesystems Dec 2016 - Present

I worked on designing a new hardware-accelerated filesystem that provides applications with near-hardware latency and high bandwidth without compromising critical properties such as integrity, crash consistency, and security (FAST '18). I also collaborated and explored methods to optimize software-level file systems (EuroSys '17).

Designing OS for heterogeneous memory Oct 2015 - August 2016

There is a growing consensus to support heterogeneous memory technologies such as stacked 3D-DRAM and NVM in the system stack for addressing the DRAM capacity scaling and performance limitations. I designed an application-transparent heterogeneous memory management mechanism for virtualized

data center systems. To support memory heterogeneity, I redesigned the Linux OS's and the hypervisor's virtual memory management (ISCA '17).

Energy aware persistence

Oct 2015 - August 2016

I collaborated with Professor Moinuddin Qureshi (Georgia Tech) and my advisers to dissect the energy overheads of persistence in NVMs. I analyzed the energy cost of four main properties of persistence – atomicity, consistency, isolation, and durability (ACID). We concluded that data and metadata durability as the most energy expensive property. I also developed techniques to reduce the NVM energy usage without affecting the correctness of an application (PACT '16).

pVM - Persistent virtual memory

Aug 2013 - Oct 2015

To exploit the large capacity of NVMs, I designed pVM (persistent virtual memory) that can seamlessly expand main memory to NVM for higher capacity and also provide fast persistent object storage. pVM extends the OS virtual memory instead of the file system for persistent storage because of their cache and TLB efficiency. I presented this research at EuroSys '16.

Cache overheads on NVM-based persistence

May 2012 - Aug 2013

I studied the implications of using byte-addressable NVMs for their dual use of additional memory capacity and storage. I observed that applications using NVM hide NVM write latency by buffering writes to the cache; however, frequent cache flushes impact all applications that share the cache. To overcome this problem, I proposed an OS and library-level design that efficiently partitions the cache between applications using the NVM for persistence versus applications using NVM or DRAM for additional heap capacity. (HPCA '14).

Memory checkpointing for HPC applications

May 2012 - Aug 2013

High-performance computing applications are long-running and use thousands of cores. To recover and restart from a system failure, these applications checkpoint their intermediate state which can waste significant compute cycles. Just replacing disks with byte-addressable NVMs will not solve this problem due to substantially large checkpoint sizes coupled with limited NVM write bandwidth. To address this problem, I collaborated with HP Labs to design a high-performance checkpoint/restart mechanism that exploits the memory-ness of NVM to overcome the limited NVM bandwidth problem (IPDPS '13).

Cloud4Home

Aug 2010 - Dec 2011

I studied the benefits of combining the cloud infrastructure and the hardware capabilities of home devices for time-sensitive applications (e.g., intruder detection). I designed a framework to virtualize CPU, memory, and storage across home devices and seamlessly use them across multiple home devices. The research was published at ICDCS '11.

Student Mentoring

Hakan Memisoglu, Ph.D. Student at UW-Madison
Optimizing file system for fast storage

Fall 2017-current

Pradeep Fernando, Ph.D. Student at Georgia Tech
Resilience in HPC applications and other topics

Fall 2015-current

Thaleia-Dimitra Doudali, Ph.D. Student at Georgia Tech
Resource allocation in Cloud

Spring 2016

Andrea Hu, BS Student at Georgia Tech Graph analytics and storage performance	Spring 2016
Albert, BS Student at Georgia Tech Persistent memory durability overheads	Spring 2016
Nitish Bhatt, MS Student at Georgia Tech (now at VMWare) NoSQL database on new memory technologies	2016
Amaro Emmanuel, MS Student at Georgia Tech, (Ph.D. Student, U.C. Berkeley) Reducing virtualization system call cost	Spring 2015
Preethi Sreenivasan, MS Student at Georgia Tech, (now at Amazon) Architectural analysis of thin clients	Summer 2015
Ravi Mangal, Ph.D. Student at Georgia Tech Virtual storage for @home cloud	Spring 2011
Sasi Siddharth, MS Student @ Georgia Tech, (now at HP) Virtual storage for @home cloud	Spring 2011

Awards and Achievements

Travel Grants for ICDCS 11, NVMW 11, NVMW 12, IPDPS 13, SOSP 13, NVMW 13, HPCA 14, NVMW 14, Eurosys 16 Shadow PC, Eurosys 16, NVMW 16, OSDI 16, ISCA 17.

Nominated for Georgia Tech-wide Outstanding Teaching Assistant Award, **One nominee** from School of Computer Science, Fall 2013.

Research on NVM lead to multi-year Intel Labs funding and also presented the research progress every quarter.

Associate of Month Award, I|Nautix Technologies, Windows development, March 2007.

Leadership Activities

Student Representative , Faculty Recruitment Committee, Georgia Tech	Jan 2015 - Aug 2016
Lab Reading Group Organizer , CERCS, Georgia Tech	Jan 2014 - Aug 2016
Research Award Committee , Undergraduate research competition, Georgia Tech	2014 - 2015
Technical Interviewer , I-Nautix Technologies, Chennai	2007 - 2008
Student Dept. Secretary , Computer Society, SaiRam Eng. College, Anna University	2004 - 2005

References

Prof. Ada Gavrilovska
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University of Wisconsin-Madison
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Prof. Andrea C. Arpaci-Dusseau
Department of Computer Sciences
University of Wisconsin-Madison
dusseau@cs.wisc.edu

Prof. Moinuddin Qureshi
School of Electrical and Computer Engineering
Georgia Institute of Technology
moin@ece.gatech.edu