Ramnatthan Alagappan

Assistant Professor
Department of Computer Science
University of Illinois Urbana-Champaign

Curriculum Vitae - August 10, 2022

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Research Interests

File and Storage Systems, Distributed Systems, and Operating Systems.

Research Summary: *My research improves the reliability and performance of distributed storage systems by co-designing distributed protocols and local-storage stacks.* Distributed storage systems treat local-storage layers as a black box. While this abstraction eases development, it masks vital information about the below layers to distributed protocols, resulting in poor reliability and missed performance opportunities. In my work, I build new distributed systems that use cross-layer information to improve reliability and performance.

My research vision is to make systems software *future-proof*, i.e., developers can build a system for today's target stacks but be confident that the system will function correctly and deliver peak performance on any future infrastructure (e.g., managed environments such as Kubernetes, and rack-scale computers).

Academic Appointments

Assistant Professor
University of Illinois Urbana-Champaign — Fall 2022 –

Postdoctoral Researcher
VMware Research — Fall 2020 – Fall 2022

Research Associate
University of Wisconsin Madison — Fall 2019 – Fall 2020

Education

Ph.D. in Computer Sciences
University of Wisconsin – Madison — 2019
Advisors: Andrea C. Arpaci-Dusseau and Remzi H. Arpaci-Dusseau
Thesis: Protocol- and Situation-Aware Distributed Storage Systems

M.S. in Computer Sciences
University of Wisconsin – Madison — 2018

B.Tech in Information Technology
Coimbatore Institute of Technology, Anna University, India — 2010

Honors & Awards

Research	Best Paper Award at FAST	2020
	UW CS Graduate Student Research Award - Best Thesis - Honorable Mention	2019
	Best Paper Award at FAST	2018
	Best Paper Award at FAST	2017
	Best Paper Nominee at FAST	2017

Teaching	CS 739 ranked 1st among all courses in student evaluations	2020
	Nominated for SACM CoW Teaching Award for CS 739	2020
Service	Best Shadow PC Reviewer at EuroSys	2019
	Distinguished Reviewer at HotStorage	2021
Grants & Scholarships	MS Azure Credits Research Award for $\$50,000$	2019
	Facebook Distributed Systems Research Award for $\$50,000$	2019
	CS Alumni Scholarship, University of Wisconsin – Madison	2013

Peer-Reviewed Conference Publications

OSDI '22 **C13.** Xudong Sun, Wenqing Luo, Tyler Gu, Aishwarya Ganesan, **Ramnatthan Alagappan**, Michael Gasch, Lalith Suresh, and Tianyin Xu. *Automatic Reliability Testing For Cluster Management Controllers.* In Proceedings of the 16th USENIX Symposium on Operating Systems Design and Implementation, 2022. Acceptance rate: 49/251 = 19.5%

SOSP '21 **C12.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Exploiting Nil-Externality for Fast Replicated Storage. In Proceedings of the 28th ACM Symposium on Operating Systems Principles, 2021. Acceptance rate: 54/348 = 15.5%*
Invited to Transactions on Storage

FAST '21 **C11.** Kan Wu, Zhihan Guo, Guanzhou Hu, Kaiwei Tu, **Ramnatthan Alagappan**, Rathijit Sen, Kwanghyun Park, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *The Storage Hierarchy is Not a Hierarchy: Optimizing Caching on Modern Storage Devices with Orthus.* In Proceedings of the 19th USENIX Conference on File and Storage Technologies, 2021. Acceptance rate: 28/130 = 21.5%

OSDI '20 **C10.** Yifan Dai, Yien Xu, Aishwarya Ganesan, **Ramnatthan Alagappan**, Brian Kroth, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *From Wisckey to Bourbon: A Learned Index for Log-structured Merge Trees.* In Proceedings of the 14th USENIX Conference on Operating Systems Design and Implementation, 2020. Acceptance rate: 70/398 = 17.6%

ATC '20 **C09.** Anthony Rebello, Yuvraj Patel, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Can Applications Recover from Fsync Failures?* In Proceedings of the 2020 USENIX Annual Technical Conference, 2020. Acceptance rate: 65/348 = 18.7%
Fast-tracked to Transactions on Storage

FAST '20 **C08.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Strong and Efficient Consistency with Consistency-aware Durability.* In Proceedings of the 18th USENIX Conference on File and Storage Technologies, 2020. Acceptance rate: 23/138 = 16.7%
Best Paper Award
Fast-tracked to Transactions on Storage

OSDI '18 **C07.** **Ramnatthan Alagappan**, Aishwarya Ganesan, Jing Liu, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Fault Tolerance, Fast and Slow: Exploiting Failure Asynchrony in Distributed Systems .* In Proceedings of the 13th USENIX Conference on Operating Systems Design and Implementation, 2018. Acceptance rate: 47/257 = 18.3%

FAST '18 **C06.** **Ramnatthan Alagappan**, Aishwarya Ganesan, Eric Lee, Aws Albarghouthi, Vijay Chidambaram, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Protocol-Aware Recovery for Consensus-Based Storage.* In Proceedings of the 16th USENIX Conference on File and Storage Technologies, 2018. Acceptance rate: 23/140 = 16.4%
Best Paper Award
Fast-tracked to Transactions on Storage
Invited to ATC 19 Best of the Rest

EuroSys'17 **C05.** Amir Saman Memaripour, Anirudh Badam, Amar Phanishayee, Yanqi Zhou, **Ramnatthan Alagappan**, Karin Strauss, Steven Swanson. *Atomic In-Place Updates for Non-Volatile Main Memories with KaminoTx.* In Proceedings of the European Conference on Computer Systems, 2017. Acceptance rate: 41/200 = 20.5%

FAST '17 **C04.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Redundancy Does Not Imply Fault Tolerance: Analysis of Distributed Storage Reactions to Single Errors and Corruptions.* In Proceedings of the 15th USENIX Conference on File and Storage Technologies, 2017. Acceptance rate: 28/118 = 23.7%
Best Paper Nominee
Invited to Usenix ;login:
Fast-tracked to Transactions on Storage

FAST '17 **C03.** Thanumalayan Sankaranarayana Pillai, **Ramnatthan Alagappan**, Lanyue Lu, Vijay Chidambaram, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Application Crash Consistency and Performance with C2FS.* In Proceedings of the 15th USENIX Conference on File and Storage Technologies, 2017. Acceptance rate: 28/118 = 23.7%
Best Paper Award
Fast-tracked to Transactions on Storage
Invited to ATC 18 Best of the Rest

OSDI '16 **C02.** **Ramnatthan Alagappan**, Aishwarya Ganesan, Yuvraj Patel, Thanumalayan Sankaranarayana Pillai, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Correlated Crash Vulnerabilities.* In Proceedings of the 12th USENIX Conference on Operating Systems Design and Implementation, 2016. Acceptance rate: 47/267 = 17.6%

OSDI '14 **C01.** Thanumalayan Sankaranarayana Pillai, Vijay Chidambaram, **Ramnatthan Alagappan**, Samer Al Kiswany, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *All File Systems Are Not Created Equal: On the Complexity of Crafting Crash-Consistent Applications.* In Proceedings of the 11th USENIX Conference on Operating Systems Design and Implementation, 2014. Acceptance rate: 42/232 = 18.1%
Invited to Communications of the ACM
Invited to ACM Queue

Peer-Reviewed Workshop Publications

HotOS '21 **W04.** Xudong Sun, Lalith Suresh, Aishwarya Ganesan, **Ramnatthan Alagappan**, Michael Gasch, Lilia Tang, Tianyin Xu. *Reasoning about Modern Datacenter Infrastructures using Partial Histories* 18h Workshop on Hot Topics in Operating Systems, 2021.

NVMW '21 **W03.** Kan Wu, Zhihan Guo, Guanzhou Hu, Kaiwei Tu, **Ramnatthan Alagappan**, Rathijit Sen, Kwanghyun Park, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *The Storage Hierarchy is Not a Hierarchy: Optimizing Caching on Modern Storage Devices with Orthus* Non-volatilve Memory Workshop, 2021.

HotStorage '20 **W02.** Konstantinos Kanellis, **Ramnatthan Alagappan**, Shivaram Venkataraman. *Too Many Knobs to Tune? Towards Faster Database Tuning by Pre-selecting Important Knobs.* 12th Workshop on Hot Topics in Storage and File Systems, 2020.

HotOs '15 **W01.** **Ramnatthan Alagappan**, Vijay Chidambaram, Thanumalayan Sankaranarayana Pillai, Aws Albarghouthi, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Beyond Storage APIs: Provable Semantics for Storage Stacks.* 15th Workshop on Hot Topics in Operating Systems, 2015.

Peer-Reviewed Journal Publications

TOS '22 **J06.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Exploiting Nil-External Interfaces for Fast Replicated Storage.* ACM Transactions on Storage (TOS), May 2022. **Fast-tracked**

TOS '21 **J05.** Anthony Rebello, Yuvraj Patel, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Can Applications Recover from fsync Failures?* ACM Transactions on Storage (TOS), June 2021. **Fast-tracked**

TOS '21 **J04.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Strong and Efficient Consistency with Consistency-aware Durability.* ACM Transactions on Storage (TOS), January 2021. **Fast-tracked**

TOS '18 **J03.** **Ramnatthan Alagappan**, Aishwarya Ganesan, Eric Lee, Aws Albarghouthi, Vijay Chidambaram, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Protocol-Aware Recovery for Consensus-Based Distributed Storage.* ACM Transactions on Storage (TOS), October 2018. **Fast-tracked**

TOS '17 **J02.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Redundancy Does Not Imply Fault Tolerance: Analysis of Distributed Storage Reactions to File-System Faults.* ACM Transactions on Storage (TOS), September 2017. **Fast-tracked**

TOS '17 **J01.** Thanumalayan Sankaranarayana Pillai, **Ramnatthan Alagappan**, Lanyue Lu, Vijay Chidambaram, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Application Crash Consistency and Performance with C2FS.* ACM Transactions on Storage (TOS), September 2017. **Fast-tracked**

Other Publications

;login: **P04.** Aishwarya Ganesan, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Redundancy Does Not Imply Fault Tolerance: Analysis of Distributed Storage Reactions to Single Errors and Corruptions.* ;login: The USENIX Magazine, Summer 2017. **Invited**

MSR TR **P03.** Yanqi Zhou, **Ramnatthan Alagappan**, Amir Samam Memaripour, Anirudh Badam, David Wentzlaff. *Hybrid NVM Enabled Datacenter Design and Optimization.* MSR-TR-2017-8, February 2017.

ACMQueue **P02.** Thanumalayan Sankaranarayana Pillai, Vijay Chidambaram, **Ramnatthan Alagappan**, Samer Al Kiswany, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Crash Consistency: Rethinking the Fundamental Abstractions of the File System.* ACM Queue, July 2015. **Invited**

CACM **P01.** Thanumalayan Sankaranarayana Pillai, Vijay Chidambaram, **Ramnatthan Alagappan**, Samer Al Kiswany, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Crash Consistency.* Communications of the ACM - Vol. 58, No. 10, October 2015. **Invited**

WIP Posters

NVMW '18: Amir Saman Memaripour, Anirudh Badam, Amar Phanishayee, Yanqi Zhou, **Ramnatthan Alagappan**, Karin Strauss, Steven Swanson. *Atomic In-Place Updates for Non-Volatile Main Memories with KaminoTx.*

FAST '16: Thanumalayan Pillai, **Ramnatthan Alagappan**, Andrea C. Arpaci-Dusseau, Remzi H. Arpaci-Dusseau. *Simple Crash Consistency With Streams.*

Research Impact

Corruption-tolerant Replication. The CTRL protocol from my FAST '18 paper has been adopted and implemented in TigerBeetle (Link1, Link2), a financial database, making it resilient to storage corruptions and errors. This work has also influenced systems at Facebook (Link).

ErrFS and ErrBench. ErrFS is a user-level FUSE file system that systematically injects file-system faults. Ideas from ErrFS have been adopted by other popular testing tools. ErrBench is a suite of distributed-storage-system workloads which drives systems to interact with their local storage. Through ErrFS and ErrBench, we have exposed many serious bugs in popular distributed systems such as ZooKeeper, Cassandra, and Kafka.
Link to Artifacts

PACE. PACE is a framework to systematically generate and explore persistent states that can occur in a distributed execution, exposing crash vulnerabilities in distributed storage systems. PACE found 26 serious, real-world bugs in popular systems including ZooKeeper, Redis, etcd, and Kafka. Many bugs found by PACE have been fixed by developers.
Link to Artifacts

ALICE. ALICE is a crash-consistency testing framework that I helped build. ALICE has been adopted by others (including an open-source version). ALICE found several real-world bugs in 12 widely used commercial storage software products, including Google's LevelDB, Git, and SQLite.
Link

Press Articles on Research

The Morning Paper. Protocol-Aware Recovery for Consensus-Based Storage
Link to Article — Feb 2018

ZDNet. Eliminating Storage Failures in the Cloud
Link to Article — Feb 2018

The Morning Paper. Crash Consistency and Performance with CCFS
Link to Article — Mar 2017

The Morning Paper. Redundancy Does Not Imply Fault Tolerance
Link to Article — Mar 2017

DHSR's Blog. Redundancy Does Not Imply Fault Tolerance
Link to Article — Mar 2017

StorageMojo. Redundancy Does Not Imply Fault Tolerance
Link to Article — Mar 2017

The Morning Paper. All File Systems are Not Created Equal
Link to Article — Feb 2016

Teaching

Instructor, *University of Wisconsin – Madison*
CS 739 - Distributed Systems (graduate-level) — Spring '20
Link to Course Webpage
Instructor evaluation score: **6.42/7.00** (ranked 2nd among graduate-course instructors in Spring 2020)
Nominated for SACM CoW Award (yearly teaching award given to UW CS professors)
Course evaluation score: **6.50/7.00** (ranked 1st among all courses at UW CS in Spring 2020)
Description: I designed a graduate-level distributed systems course. This course was research-oriented: every class, students read 1-2 foundational papers in distributed systems on topics including fault tolerance,

consensus (e.g., Paxos), distributed transactions, BFT, and distributed storage. Students also did a considerably large research project.

Teaching Assistant, *University of Wisconsin – Madison*
CS 537 - Intro to Operating Systems — Spring '19
Responsibilities: Guest lectures, exam review lectures, designing and evaluating assignments on the xv6 research operating system.

Guest Lectures, *University of Wisconsin – Madison*
Shivaram Venkatramans's CS 537 (concurrency, RAID) — Spring '20, Spring '19
Mike Swift's CS 736 (AFS) — Fall '18
Remzi Arpaci-Dusseau's CS 739 - (Paxos, storage faults) — Fall '18, Fall '17'

Teaching Assistant, *University of Wisconsin – Madison*
CS 302 - Introduction To Programming — Fall '13

Student Mentoring

VMware Research

Yi Xu, graduate student at UC San Diego
Research Internship Mentor
Exploiting Persistent Memory in SplinterDB

Undergrads at UW Madison

Neil Perry, now a graduate student at Stanford University
Corruption Analysis of Ethereum Blockchain

Graduate Students at UW Madison

Yifan Dai, Yien Xu
Learned Indexes for Log-Structured Merge Trees (CS 739 final project, OSDI 2020)

Dax Chen, Yi-Shiun Chang, Chia-Wei Chen, Pei-Hsuan Wu
Performance and Reliability Isolation in ZooKeeper

Sreya Dutta Roy, Nikita Kad, Venkat Allam, Shreeshrita Patnaik
Predicted Ordering in Geo-replicated Logs

Akshat Jain, Grishma Gupta, Venkata Malireddy
Learning-based Ordering for Replicated State Machines

Ruohui Wang, Kaiwei Tu, Max (Mengxiao) Zhang, Emma (Yi) He
Read-trigerred Durability for HDFS

Aashish Richhariya, Akanksha, Sanchit Jain
Consistency at the Edge

Muthunagappan Muthuraman, Srivatsan Ramesh, Suryadev Sahadevan Rajesh, Vinith Venkatesan
Consistency-Aware Durability for Highly Available Systems

Deepak Srinath, Lokit Kumar Paras, Nithin Venkatesh, Phanindra Moganti
Speculative Geo-Replicated Message Ordering

Kumar Biplav, Aditya Rungta, Nisarg Shah, Shaurya Shekhar
Fast Consensus for Fast Storage

Prior Professional Experience

University of Wisconsin - Madison — Madison, WI
Research Associate — Sep '19 – Jul '20

University of Wisconsin - Madison — Madison, WI
Research Assistant — Jan '14 – Aug '19

Microsoft Research — Redmond, WA
Research Intern, Systems Research Group — Summer '15
Mentor: Anirudh Badam

Microsoft Research — Bangalore, India
Research Intern, Mobility, Networks, and Systems Group — Summer '14
Mentor: Ramachandran Ramjee

Microsoft — Hyderabad, India
Software Development Engineer — Jul '10 – Jun '13

Reviewing Service

OSDI '23 Program Committee	2023
FAST '23 Poster Co-chair	2023
SOCC '22 Program Committee	2022
HotStorage '22 Program Committee	2022
SOSP '21 Ask-Me-Anything Co-chair	2021
SOSP '21 Mentoring	2021
OSDI '21 Mentoring	2021
EuroDW '21 Mentoring	2021
Journal of Systems SEB Co-chair	2021
EuroDW '21 Program Committee	2021
HotStorage '21 Program Committee (**Distinguished Reviewer**)	2021
Systor '21 Program Committee	2021
ACM Transactions on Computer Systems, Reviewer	2020
HotStorage '20 Program Committee	2020
SOSP '19 Artifact Evaluation Committee	2019
Eurosys '19 Shadow PC (**Best Reviewer**)	2019
ACM Transactions on Storage, Reviewer	2018
FAST '18, External Reviewer	2018
EuroSys '17, Contributor to PC Reviews	2017
OSDI '16, External Reviewer	2016
FAST '16, External Reviewer	2016

Presentations & Invited Talks

Co-designing Distributed Systems and Storage Stacks for Improved Reliability

University of Waterloo	Jan '22
Virginia Tech	Jan '22
Pennsylvania State University	Feb '22
University of Virginia	Feb '22
Purdue University	Feb '22
University of Utah	Feb '22
University of Toronto	Mar '22
University of Illinois at Urbana-Champaign	Mar '22
University of Washington	Mar '22
University of Michigan	Mar '22
Massachusetts Institute of Technology	Mar '22
University of North Carolina at Chapel Hill	Mar '22
University of Southern California	Mar '22
University of California, Santa Cruz	Mar '22
University of California, Irvine	Apr '22

Co-designing Distributed Systems and Storage Stacks
University of Waterloo (invited) — Oct '21

Reliable Distributed Storage: A Local-storage Perspective
Rutgers University (invited) — Aug '20

Reliable Distributed Storage: A Local-storage Perspective
VMware Research Group (postdoc interview talk) — Jun '20

Protocol-Aware Recovery for Consensus-Based Storage
Usenix ATC (invited conference talk) — Jul '19

Storage Systems at the Edge
NSF-VMWare ECDI Summit (invited) — Nov '18

Fault-Tolerance, Fast and Slow
Usenix OSDI (conference talk) — Oct '18

Protocol-Aware Recovery for Consensus-Based Storage
SNIA Storage Developer Conference (invited) — Sep '18

Resiliency to Storage Faults in Distributed Systems
Google Madison (invited) — May '18

Protocol-Aware Recovery for Consensus-Based Storage
Usenix FAST (conference talk) — Feb '18

Rethinking Consensus with Local Storage in Mind
SCI Labs Kickoff Meeting — May '17

Correlated Crash Vulnerabilities
Usenix OSDI (conference talk) — Oct '16

Correlated Crash Vulnerabilities
Microsoft Gray Systems Lab (invited) — Jun '16

Grants

Facebook Distributed Systems Research Award for $\$50,000$ - with Aishwarya Ganesan, Andrea Arpaci-

Dusseau, and Remzi Arpaci-Dusseau to work on distributed storage reliability, especially blockchains.

MS Azure Credits Research Award for $\$50,000$ - with Andrea Arpaci-Dusseau and Remzi Arpaci-Dusseau to work on distributed storage reliability, building new testing and analysis frameworks

Travel grants for OSDI '14, FAST '17, FAST '18

References

Andrea C. Arpaci-Dusseau
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Remzi H. Arpaci-Dusseau
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remzi@cs.wisc.edu

Michael Swift
Professor of Computer Sciences, University of Wisconsin Madison
swift@cs.wisc.edu

Sujata Banerjee
Senior Director of Research, VMware Research Group
sujatab@vmware.com

Jason Flinn
Software Engineer, Facebook
Previously Professor of Computer Science, University of Michigan Ann Arbor
jasonflinn@fb.com