

Huaicheng LI

CONTACT	Phone Number: (540) 231-4482 Gilbert Place 4109, Blacksburg, VA 24060	Email: huaicheng@cs.vt.edu Website: https://people.cs.vt.edu/~huaicheng
RESEARCH INTERESTS	Areas: Operating Systems, Storage/Memory Systems, Systems Support for Emerging Hardware/Applications Focus: Design and build novel computing systems for emerging storage/memory hardware to achieve <ol style="list-style-type: none">1. <i>Performance:</i> Cross-stack software/hardware co-designs for predictable latencies and high throughput2. <i>Efficiency:</i> Offloaded and disaggregated system designs for improved system resource and cost efficiency3. <i>Programmability:</i> Systems support for emerging storage/memory technologies to ease development efforts	
ACADEMIC POSITIONS	Virginia Tech Assistant Professor, Department of Computer Science	Blacksburg, VA 2022–Present
	Carnegie Mellon University Postdoctoral Researcher, Parallel Data Lab (PDL) Supervisor: Gregory R. Ganger	Pittsburgh, PA 2020–2022
EDUCATION	University of Chicago Ph.D. in Computer Science (<i>M.S. conferred in 2018</i>) Advisor: Haryadi S. Gunawi Thesis: Evolving Storage Stack for Predictability and Efficiency	Chicago, IL 2015–2020
	Wuhan University M.S. in Computer Science (<i>dropped out to attend the Ph.D. program</i>) B.S. in Computer Science and Technology	Wuhan, China 2013–2015 2009–2013
HONORS & AWARDS	Rising Star Faculty Award, Department of Computer Science, Virginia Tech NSF CAREER Award IEEE Micro Top Picks 2024 Honorable Mention: Pond [C1] ASPLOS'23 Distinguished Paper Award: Pond [C1] SYSTOR'22 Best Paper Award: Fantastic SSD Internals [C3] SYSTOR'21 Distinguished Reviewer Award Nomination for the SIGOPS Dennis M. Ritchie Doctoral Dissertation Award (<i>1 per department</i>) University Unrestricted (UU) Fellowship, University of Chicago FAST'18 Best Paper Nominee: Fail-Slow at Scale [C7] FAST'17 Best Paper Nominee: Tiny-Tail Flash [C9]	2024 2024 2024 2023 2022 2021 2020 2019 2018 2017
CONFERENCE PUBLICATIONS	Bibliometrics on Google Scholar and DBLP	
	ASPLOS'23 [C1] Huaicheng Li , Daniel S. Berger, Stanko Novakovic, Lisa Hsu, Daniel Ernst, Pantea Zardoshti, Monish Shah, Ishwar Agarwal, Mark D. Hill, Marcus Fontoura, Ricardo Bianchini. Pond: CXL-Based Memory Pooling Systems for Cloud Platforms . In the Proceedings of the 28th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), 2023. Distinguished Paper Award IEEE Micro Top Picks 2024 Honorable Mention	
	ASPLOS'23 [C2] Thomas Kim, Jekyeom Jeon, Nikhil Arora, Huaicheng Li , Michael Kaminsky, David G. Andersen, Gregory R. Ganger, George Amvrosiadis, Matias Bjørling. RAIZN: Redundant Array of Independent Zoned Namespaces . In the Proceedings of the 28th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), 2023.	

- SYSTOR'22 [C3] Nanqinqin Li, Mingzhe Hao, **Huaicheng Li**, Xing Lin, Tim Emami, Haryadi S. Gunawi. **Fantastic SSD Internals and How to Learn and Use Them**. In the Proceedings of the 15th ACM International Systems and Storage Conference (SYSTOR), 2022.
Best Paper Award
- SOSP'21 [C4] **Huaicheng Li**, Martin L. Putra, Ronald Shi, Xing Lin, Gregory R. Ganger, Haryadi S. Gunawi. **IODA: A Host/Device Co-Design for Strong Predictability Contract on Modern Flash Storage**. In the Proceedings of the 28th Symposium on Operating Systems Principles (SOSP), 2021.
- ASPLOS'20 [C5] **Huaicheng Li**, Mingzhe Hao, Stanko Novakovic, Vaibhav Gogte, Sriram Govindan, Dan R. K. Ports, Irene Zhang, Ricardo Bianchini, Haryadi S. Gunawi, Anirudh Badam. **LeapIO: Efficient and Portable Virtual NVMe Storage on ARM SoCs**. In the Proceedings of the 25th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), 2020.
- FAST'18 [C6] **Huaicheng Li**, Mingzhe Hao, Michael Hao Tong, Swaminathan Sundararaman, Matias Bjørling, Haryadi S. Gunawi. **The CASE of FEMU: Cheap, Accurate, Scalable and Extensible Flash Emulator**. In the Proceedings of the 16th USENIX Conference on File and Storage Technologies (FAST), 2018.
- FAST'18 [C7] Haryadi S. Gunawi, Riza Suminto, Russell Sears, Casey Golliver, Swaminathan Sundararaman, Xing Lin, Tim Emami, Weiguang Sheng, Nematollah Bidokhti, Caitie McCaffrey, Gary Grider, Parks M. Fields, Kevin Harms, Robert B. Ross, Andree Jacobson, Robert Riccio, Kirk Webb, Peter Alvaro, H. Biral Runesh, Mingzhe Hao, **Huaicheng Li**. **Fail-Slow at Scale: Evidence of Hardware Performance Faults in Large Production Systems**. In the Proceedings of the 16th USENIX Conference on File and Storage Technologies (FAST), 2018.
Best Paper Nominee
- SOSP'17 [C8] Mingzhe Hao, **Huaicheng Li**, Michael Hao Tong, Chrisma Pakha, Riza Suminto, Cesar A. Stuardo, Andrew A. Chien, Haryadi S. Gunawi. **MittOS: Supporting Millisecond Tail Tolerance with Fast Rejecting SLO-Aware OS Interface**. In the Proceedings of the 26th Symposium on Operating Systems Principles (SOSP), 2017.
- FAST'17 [C9] Shiqin Yan, **Huaicheng Li**, Mingzhe Hao, Michael Hao Tong, Swaminathan Sundararaman, Andrew A. Chien, Haryadi S. Gunawi. **Tiny-Tail Flash: Near-Perfect Elimination of Garbage Collection Tail Latencies in NAND SSDs**. In the Proceedings of the 15th USENIX Conference on File and Storage Technologies (FAST), 2017.
Best Paper Nominee

JOURNAL PUBLICATIONS

- TODAES'24 [J1] Ping-Xiang Chen, Dongjoo Seo, Changhoon Sung, Jongheum Park, Minchul Lee, **Huaicheng Li**, Matias Bjørling, Nikil Dutt. **ZoneTrace: A Zone Monitoring Tool for F2FS on ZNS SSDs**. ACM Transactions on Design Automation of Electronic Systems (TODAES), 2024.
- IEEE Micro'23 [J2] Daniel S. Berger, Daniel Ernst, **Huaicheng Li**, Pantea Zardoshti, Monish Shah, Samir Rajadnya, Scott Lee, Lisa Hsu, Ishwar Agarwal, Mark D. Hill, Ricardo Bianchini. **Design Tradeoffs in CXL-Based Memory Pools for Cloud Platforms**. IEEE Micro Special Issue on Emerging System Interconnects, 2023.
- TOS'23 [J3] **Huaicheng Li**, Martin L. Putra, Ronald Shi, Fadhil I. Kurnia, Xing Lin, Jaeyoung Do, Achmad I. Kistijantoro, Gregory R. Ganger, Haryadi S. Gunawi. **Extending and Programming the NVMe I/O Determinism Interface for Flash Arrays**. ACM Transactions on Storage (TOS), Volume 19, Issue 1, February 2023. [Extended version of C4]
- TOS'18 [J4] Haryadi S. Gunawi, Riza Suminto, Russell Sears, Casey Golliver, Swaminathan Sundararaman, Xing Lin, Tim Emami, Weiguang Sheng, Nematollah Bidokhti, Caitie McCaffrey, Gary Grider, Parks M. Fields, Kevin Harms, Robert B. Ross, Andree Jacobson, Robert Riccio, Kirk Webb, Peter Alvaro, H. Biral Runesh, Mingzhe Hao, **Huaicheng Li**. **Fail-Slow at Scale: Evidence of Hardware Performance Faults in Large Production Systems**. ACM Transactions on Storage (TOS), Volume 14, Issue 3, November 2018. [Extended version of C7]
Fast-tracked
- TOS'17 [J5] Shiqin Yan, **Huaicheng Li**, Mingzhe Hao, Michael Hao Tong, Swaminathan Sundararaman, Andrew A. Chien, Haryadi S. Gunawi. **Tiny-Tail Flash: Near-Perfect Elimination of Garbage Collection Tail Latencies in NAND SSDs**. ACM Transactions on Storage (TOS), Volume 13, Issue 3, October 2017. [Extended version of C9]
Fast-tracked

WORKSHOP PUBLICATIONS

HotStorage'23 [W1] Dongjoo Seo, Ping-Xiang Chen, **Huaicheng Li**, Matias Bjørling, Nikil Dutt. **Is Garbage Collection Overhead Gone? Case study of F2FS on ZNS SSDs**. In the Proceedings of the 15th ACM Workshop on Hot Topics in Storage and File Systems (HotStorage), 2023.

NVMW'23 [W2] **Huaicheng Li**, Daniel S. Berger, Lisa Hsu, Daniel Ernst, Pantea Zardoshti, Stanko Novakovic, Monish Shah, Samir Rajadnya, Scott Lee, Ishwar Agarwal, Mark D. Hill, Marcus Fontoura, Ricardo Bianchini. **Pond: The Case of CXL Memory Pooling for Cloud Datacenters**. In the 14th Annual Non-Volatile Memories Workshop (NVMW), 2023.

**WORK
EXPERIENCE**

Research Internships at Industrial Labs

Microsoft Research (Redmond), Systems Research Group Summer 2020
Research Intern working on resource disaggregation for datacenter deployment [ASPLOS'23]

Microsoft Research (Redmond), Database Group Summer 2019
Research Intern working on programmable storage

Microsoft Research (Redmond), Systems Research Group Summer 2018
Research Intern working on offloading cloud storage stack to ARM SoCs [ASPLOS'20]

NetApp, Advanced Technology Group (ATG) Spring 2020
Research Intern working on new file system designs for emerging storage hardware

Research Experience at Universities

Carnegie Mellon University, Parallel Data Lab (PDL) 2020–2022
Postdoctoral Researcher collaborating with Gregory R. Ganger, George Amvrosiadis, David G. Andersen and CMU students on new storage and memory technologies [ASPLOS'23]

University of Chicago, Systems Group 2015–2020
Graduate Student Researcher working on Operating and Storage Systems research [SOSP'21, ASPLOS'20, FAST'18, SOSP'17, FAST'17]

Wuhan University, Cloud Computing Lab 2012–2015
Research Assistant working on I/O virtualization and cloud resource scheduling

Engineering Internship in Industry

Tencent (Shenzhen) Summer 2012
Undergraduate Intern working on cluster resource monitoring and kernel optimization

SERVICE

Program Committee (PC)

FAST'25: The 23rd USENIX Conference on File and Storage Technologies 2025

ASPLOS'25: The 30th ACM Intl' Conf. on Architectural Support for PL and OS 2025

NSDI'25: The 22nd USENIX Symposium on Networked Systems Design and Implementation 2025

ASPLOS'24: The 29th ACM Intl' Conf. on Architectural Support for PL and OS 2024

NSDI'24: The 21st USENIX Symposium on Networked Systems Design and Implementation 2024

CCGRID'24: The 24th IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing 2024

ASPLOS'23: The 28th ACM Intl' Conf. on Architectural Support for PL and OS (*Fall cycle*) 2023

SySDW'23: Doctoral Workshop at SOSP 2023 2023

SYSTOR'23: The 16th ACM International Systems and Storage Conference 2023

NVMW'23: The 14th Annual Non-Volatile Memories Workshop 2023

APSys'21: The 12th ACM SIGOPS Asia-Pacific Workshop on Systems 2021

SYSTOR'21: The 14th ACM International Systems and Storage Conference 2021

External Review Committee (ERC)

ISCA'24: The 51st International Symposium on Computer Architecture (ISCA) 2024

ASPLOS'23: The 28th ACM Intl' Conf. on Architectural Support for PL and OS (*Spr/Smr cycles*) 2023

Organization Committee

	FAST'25 Artifact Evaluation Committee, Co-chair	2025
	FAST'24 Artifact Evaluation Committee, Co-chair	2024
	Shadow Program Committee	
	EuroSys'20: The 15th European Conference on Computer Systems	2020
	EuroSys'18: The 13th European Conference on Computer Systems	2018
	Journal Reviewer	
	IEEE Micro	2022
	TC: IEEE Transactions on Computers	2019, 2020, 2022, 2023
	TOCS: ACM Transactions on Computer Systems	2019, 2023
	TPDS: IEEE Transactions on Parallel and Distributed Systems	2019
	JPDC: Journal of Parallel and Distributed Computing	2019, 2021
	TOS: ACM Transactions on Storage	2018, 2023, 2024
	CACM: Communications of the ACM	2018
	External Reviewer	
	FAST'19: The 17th USENIX Conference on File and Storage Technologies	2019
	ATC'18: The 2018 USENIX Annual Technical Conference	2018
	Secondary/Sub-reviewer	
	FAST'20: The 18th USENIX Conference on File and Storage Technologies	2020
	SOSP'19: The 27th ACM Symposium on Operating Systems Principles	2019
	ASPLOS'19: The 24th ACM Intl' Conf. on Architectural Support for PL and OS	2019
	FAST'18: The 16th USENIX Conference on File and Storage Technologies	2018
	Artifact Evaluation Committee (AEC)	
	SOSP'21: The 28th ACM Symposium on Operating Systems Principles	2021
	Departmental Service	
	PhD Qualification Exam Committee, VT CS	2024
	Graduate Admission Committee, VT CS	2023
	Graduate Student Ministry - Minister for Faculty Hiring, CS Dept, University of Chicago	2019
	Other Activities	
	DOE ASCR ALCC Proposal Reviewer	2024
	FAST'24 Mentoring Program	2024
	Co-organizer of FAST 2024 Bird-of-Feather (BoF) Session on Reproducibility	2024
	VT CS Graduate Admission Committee	2024
	Co-Organizer of ATC/OSDI 2023 Bird-of-Feather (BoF) Session on Reproducibility	2023
	VTURCS Research Symposium Judge	2023
	ASPLOS'23 Mentoring Program	2023
	Session Chair: ASPLOS'23 ("Storage Session")	2023
	SOSP'21 Mentoring Program	2021
	Session Chair: SYSTOR'21 ("Storage Session")	2021
	USENIX HotStorage'20 Program Committee Meeting Scribe	2020
	Chameleon Cloud Testbed Student Ambassador	2020
	USENIX ATC'18 Program Committee Meeting Scribe	2018
TALKS	Dissecting Memory Performance: Quantification, Analysis, and Optimization	
	Memory Solutions Lab (MSL), Samsung	2024
	Pond: CXL-based Memory Pooling for Cloud Platforms	
	Conference Talk, ASPLOS'23, Vancouver, BC, Canada	2023
	Conference Talk, NVMW'23, San Diego, CA, USA	2023
	Cornell Networked System Seminar	2023

	Guest Lecture at University of British Columbia	2024
	Guest Lecture at University of Chicago	2024
	Towards Predictable and Efficient Datacenter Storage	
	Invited Talk, Intel/VMware Crossroads 3D-FPGA Academic Research Center	2022
	IODA: Host/Device Co-Design for Strong Predictability Contract on Modern Flash Storage	
	Conference Talk, SOSp'21, Online	2021
	Parallel Data Lab (PDL) Seminar, Carnegie Mellon University, PA, USA	2021
	Towards Hardware-based Memory Disaggregation	
	Invited Talk, Microsoft Research (Redmond), WA, USA	2020
	NVMeFS: SmartNIC-centric File System Offloading	
	Invited Talk, NetApp, CA, USA	2020
	Evolving Storage Stack for Predictability and Efficiency	
	Invited Talk, University of Illinois at Urbana-Champaign, IL, USA	2021
	Ph.D. Thesis Defense, University of Chicago, IL, USA	2020
	Invited Talk, Carnegie Mellon University, PA, USA	2020
	Invited Talk, Microsoft Research - Cambridge, UK	2020
	Invited Talk, University of California - Berkeley, CA, USA	2020
	Invited Talk, University of Wisconsin - Madison, WI, USA	2020
	LeapIO: Efficient and Portable Virtual NVMe Storage on ARM SoCs	
	Invited Talk, CAS ICT Young Scholar Forum, Beijing, China	2020
	Conference Talk, ASPLOS'20, Lausanne, Switzerland	2020
	Ph.D. Thesis Proposal, University of Chicago, IL, USA	2019
	Invited Talk, Microsoft Research (Redmond), WA, USA	2018
	The CASE of FEMU: Cheap, Accurate, Scalable and Extensible Flash Emulator	
	Master Thesis Defense, University of Chicago, IL, USA	2018
	Conference Talk, FAST'18, Oakland, CA, USA	2018
TEACHING	Instructor	
	CS5204: Operating Systems (Fall 2023), Virginia Tech	2023
	CS6204: Advanced Operating Systems (Spring 2023), Virginia Tech	2023
	CS3214: Computer Systems (Fall 2022), Virginia Tech	2022
	Co-Instructor	
	18-746: Storage Systems (Fall 2021), Carnegie Mellon University	2021
	Course website: https://course.ece.cmu.edu/ece746/index.html	
	↔ Co-teaching with Gregory R. Ganger and George Amvrosiadis, ~100 students (BS/MS/PhD)	
	↔ Designing and giving lectures on storage management, file systems, etc.	
	↔ End-to-end class administration: course website, weekly TA meetings, designing quizzes, grading, etc.	
	Guest Lecturer	
	18-746: Storage Systems (Fall 2020), Carnegie Mellon University	2020
	↔ Topic: "Ins and Outs of Storage Offloading using ARM SoCs"	
	Teaching Assistant	
	CMSC 230: Operating Systems, University of Chicago, TA	2015, 2018, 2019
	↔ Hosting lab sessions about Pintos projects (tutorials/lectures, office hours, grading, etc.)	
	Computer Organization and Design, Wuhan University, TA	2014
STUDENTS	Current PhD Students (* indicates co-advised students)	
	1. Hanchen Xu	2024–Present

- 2. [Hansen Idden](#) 2024–Present
- 3. [Sijia Li](#) 2024–Present
- 4. [Shoaib Asif Qazi](#) 2023–Present
- 5. [Inho Song*](#) (with Sam Noh) 2023–Present
- 6. [Jinshu Liu](#) 2022–Present
- 7. [Hamid Hadian](#) 2022–Present
- 8. [Yuze Li*](#) (primary advisor: Ali Butt) 2021–Present
- 9. [Yuyue Wang*](#) (at UCLA) 2021–Present
- 10. [Sumit Kumar Monga](#) 2019–Present

Current MS Students

- 11. [Subhalakshmi Selvanathan](#) (ECE) 2022–Present

Current Undergraduate Students

- 12. [Saddam Annais Shaquille](#) (ITB) 2024–Present

Alumni

- 13. [Subhalakshmi Selvanathan](#) (ECE MS → Microsoft, internship: Qualcomm) 2022–2024
- 14. [Hansen Idden](#) (ITS BS → VT CS PhD) 2022–2024
- 15. [Fauzhan Wahyudi](#) (ITS) 2022–2023
- 16. [Muhammad Daffa Al Fahreza](#) (Udinus) 2022–2023
- 17. [Muhammad Akmal Arifin](#) (ITB) 2022–2023
- 18. [Hanchen Xu](#) (UCLA, intern → VT CS PhD) Summer 2023
- 19. [Edward Halim](#), (BS → CS PhD student at University of Wisconsin - Madison) 2022–2023
- 20. [Sumanth Rao](#) (CMU MCDS MS → Snowflake) 2022–2023
- 21. [Jiuzhi Yu](#) (CMU MCDS MS → Amazon AWS) 2022–2023
- 22. [Zixu Chen](#) (CMU MCDS MS → Google) 2021–2022
- 23. [Aditya Shetty](#) (CMU MCDS MS → Google) 2021–2022
- 24. [Fadhil I. Kurnia](#) (ITB BS → CS PhD student at UMass - Amherst, co-author of [J3]) 2018–2020
- 25. [Martin L. Putra](#) (ITB BS → CS PhD student at University of Chicago, co-author of [C4, J3]) 2018–2020
- 26. [Ronald Shi](#) (UChicago BS/MS → Meta, co-author of [C4, J3]) 2018–2019

Student Awards/Recognitions

- 27. [Hamid Hadian](#), Pratt Fellowship 2024
- 28. [Subhalakshmi Selvanathan](#), Pratt Fellowship 2024
- 29. [Jiuzhi Yu](#), Best Science Award (for CMU MCDS Capstone Project on Programmable Storage) 2022
- 30. [Sumanth Rao](#), Best Science Award (for CMU MCDS Capstone Project on Programmable Storage) 2022

PhD Thesis Committee

- 31. [Sumit Kumar Monga](#), VT ECE, **co-chair**
- 32. [Yuze Li](#), VT CS

MS Thesis Committee

- 33. [Subhalakshmi Ramakrishnapuram Selvanathan](#), VT ECE MS, **co-chair**

GRANTS

- 1. “Rethinking System Stack for the Load-Store I/O Era” 2024–2029
Huaicheng Li (PI). NSF [CNS-2339901](#). ~\$677K
- 2. “Converged Memory and Storage Systems” 2024–2025
Huaicheng Li (PI). Samsung. \$250K
- 3. “A Cross-stack Approach to Reduce Memory Carbon for Cloud Data Centers” 2023–2026
Huaicheng Li (Co-PI). NSF [CNS-2312785](#). \$1M
- 4. “Near-data Processing for Machine Learning Workloads Acceleration” 2023–2024
Huaicheng Li (PI). 4-VA. \$30K.
- 5. “CXL for Reduced Memory Management Tax” 2023–2024
Huaicheng Li (PI). Samsung. ~\$270K.

	6. “Disaggregation and Offloading for Improved System Efficiency”	2023–2024
	Huaicheng Li (PI). The Indonesian Ministry of Education, Culture, Research and Technology. \$30K.	
	7. “Characterization Driven Data Placement Optimizations for CXL Memory”	2023–2024
	Huaicheng Li (PI). Samsung. ~\$110K (<i>research gift</i>).	
	8. “Enhancing Storage Stack Design for the Computational Storage Era”	2023–2024
	Huaicheng Li (Co-PI, <i>major proposal writer</i>). Samsung. ~\$120K.	
	9. New Faculty Mentoring Grant	2023–2024
	Huaicheng Li (PI). Virginia Tech. \$1.5K.	
	10. “Fortified Computational Storage Stack for Efficient Application Offloading”	2022–2023
	Huaicheng Li (Co-PI, <i>major proposal writer</i>). Samsung. \$110K.	
SOFTWARE	1. RAZIN : https://github.com/ZonedStorage/RAIZN-release	2023
	An array of independent zoned namespace SSDs built on top of a virtual zone interface.	
	2. Pond : https://github.com/vtess/Pond	2022
	A CXL memory emulator utilizing zero-core NUMA nodes with benchmarking results for more than 100 workloads.	
	3. Queenie : https://github.com/ucare-uchicago/Queenie	2022
	A user-level tool for extracting SSD internal properties.	
	4. IODA : https://github.com/huaicheng/IODA	2021
	A host/device co-designed flash array for strong deterministic performance.	
	5. LeapIO : https://github.com/huaicheng/LeapIO	2020
	A cost-efficient cloud storage stack design that has been deployed in Microsoft datacenters.	
	6. FEMU : https://github.com/vtess/FEMU	2018
	A popular storage research platform widely used by top venue papers at ASPLOS, FAST, OSDI, and SOSP, etc.	
	7. MITSSD : https://github.com/ucare-uchicago/mittssd	2018
	An OS design with millisecond service level agreement interface.	
	8. TTFLASH : https://github.com/ucare-uchicago/tinyTailFlash	2017
	An SSD architecture design eliminating garbage collection overhead for tiny-tail latencies.	
	9. Linux Kernel Contributor: Linux Open-Channel SSD Subsystem - pblk (120☆)	2017
MEDIA COVERAGE	Pond: CXL-Based Memory Pooling Systems for Cloud Platforms [ASPLOS’23]	
	Software Engineering, https://semiengineering.com	2023
	The Next Platform, https://nextplatform.com	2022
	Semi Analysis, https://semianalysis.com	2022
	Tech Powerup, https://www.techpowerup.com	2022
	Screen Hacker, https://www.screenhacker.com	2022
	Fail-Slow at Scale [FAST’18]	
	The Morning Paper, https://blog.acolyer.org , search “fail slow at scale”	2018
	ZDNet, https://www.zdnet.com/article/how-clouds-fail-slow	2018
	Hacker News, https://news.ycombinator.com/item?id=16463714	2018