

Curriculum Vita

An-I Andy Wang

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GENERAL INFORMATION

University Address: Department of Computer Science
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Professional Preparation

- 1998-2003 Ph.D. in Computer Science, University of California, Los Angeles.
Major: operating systems
Minors: computer vision and queueing theory.
Dissertation: *Conquest: An Affordable, Fast, and Practical Disk/Persistent-RAM Hybrid File System.*
Dissertation supervisor: Gerald Popek.
- 1995-1998 M.S. in Computer Science, University of California, Los Angeles.
Major: operating systems.
Thesis: A Simulation Evaluation for Optimistically Replicated (Peer-to-Peer) Filing Environments.
Thesis supervisor: Gerald Popek.
- 1991-1995 B.A. in Computer Science, University of California, Berkeley. summa cum laude.

Professional Experience

- 2003-present Assistant Professor, Department of Computer Science, College of Arts and Sciences, Florida State University, Tallahassee

Teaching: Taught courses in data structures, graduate advanced operating systems, undergraduate advanced operating systems, kernel programming, and special topics seminars. Graduated 6 Masters thesis students, 1 Masters project student, and 2 Honors thesis students. Sponsored 14 undergraduate independent research projects. Currently advising 3 Ph.D. students, 2 Masters thesis students, 1 Masters project student, and 2 undergraduates for independent studies. Nominated for the University Undergraduate Teaching Award.

Research: Published at venues such as USENIX, USENIX FAST, ACM TOS, ACM SIGMOBILE, ACM SIGMETRICS, IEEE RTAS, ACM MSWiM, IEEE MASCOTS, SCS Simulation, and others, totaling 4 journal papers, 11 conference and workshop papers, and 1 patent since 2003. Obtained \$1,000,000 in NSF grants and \$26,000 in internal funding. Attracted students carrying grants from DoE, Harris, MCI, and other scholarships.

Service: Served on 11 departmental committees, including the faculty evaluation committee, the equipment and network committee, the faculty recruiting committee, the admission and aid committee, etc. Served on 2 program committees for international conferences. Served as reviewer for venues such as ACM TOCS, USENIX, ACM ICS, John Wiley & Sons, IEEE TC, IEEE TMC, IEEE ICNP, IEEE HPCA, IEEE RTAS, etc.

2003 Lecturer, Computer Science Department, Henry Samueli School of Engineering and Applied Science, University of California, Los Angeles.

Operating Systems Principles: Prepared and presented lectures on process management, CPU scheduling, process synchronization, deadlocks, memory management, virtual memory, file systems, distributed systems, and security. Directed teaching assistants for project preparations, presentations, and grading. Received student evaluation averaging 7.7 out of 9 (highest).

1995-2003 Research Assistant, LASR Research Group, Samueli School of Engineering and Applied Science, University of California, Los Angeles

The Conquest File System. Designed and implemented a disk/RAM file system that can outperform disk-caching solutions by 24% to 1900% under popular benchmarks. Press coverage by *eWeek* (June 17, 2002).

A Simulation Evaluation for Optimistically Replicated (Peer-to-Peer) Filing Environment. Developed a generalized, validated simulation framework for evaluating optimistically replicated filing environments. Studied and bounded the behavior of the popular conflict rate metric.

2000 Teaching Assistant, Computer Science Department, Samueli School of Engineering and Applied Science, University of California, Los Angeles

Operating Systems Principles: Prepared and presented Linux projects on /proc file system, UNIX shell, signal handling, kernel modules, system calls, and system V shared memory interface. Received student evaluations averaging 8.2 of out 9 (highest).

1994 EECS Summer Intern, IBM Almaden Research Center, San Jose

Tiger Shark Video-on-Demand Server Simulation: Simulated video request servers, switch connections, disk servers, SCSI buses, and RAID. Explored system configurations to maximize the number of video streams and minimize glitches and user response times.

Honors and Awards

Nominee, University Undergraduate Teaching Award, Florida State University (2006).

Membership in Professional Organizations

ACM
USENIX

TEACHING

Courses Taught

CIS8976 Masters Thesis Defense (2005, 2007-2008)
CIS6980 Dissertation (2007-2008)
CIS5970 Thesis (2004-2008)
COP5641 / CIS 4930 Kernel/Device-driver Programming (2007-2008)
COP5611 Advanced Operating Systems (2004-2008)
COP4610 / CGS5765 Introduction to Operating Systems (2004-2008)
CIS8962 Ph.D. Qualifying Exam (2007)
CIS6935 Energy-aware Storage Systems (2007)
CIS6900 Secure File Systems (2007)
CIS6900 Independent Study (2007)
CIS6900 Conquest-2 Research (2005-2007)
CIS5900 Storage Research (2007)
CIS5915 Graduate-level Software Project (2004, 2007)
CIS4900 Virtual Storage Simulation (2007)
CIS4933 Honors Work (2004-2006)
CIS6935 Laboratory of Network and Systems Seminar (2005)
CIS4900 Research Systems I (2005)
CIS6935 Operating Systems Reading Group (2004)
COP4530 Undergraduate Data Structures, Algorithms, and Generic Programming (2003)

#CS111 Undergraduate Operating Systems Principles (2003)

New Course Development

COP5641 Kernel/Device-driver Programming (2007)

COP5611 Advanced Operating Systems (2004)

COP4610 / CGS5765 Introduction to Operating Systems (2004)

COP4530 Undergraduate Data Structures, Algorithms, and Generic Programming (2003)

#CS111 Undergraduate Operating Systems Principles (2003)

Chair of Doctoral Dissertation Supervisory Committees

Mark Stanovic. (co-directed with Ted Baker).

Sarah Diesburg. (2009).

Christopher Meyers. (2009).

Member of Doctoral Dissertation Supervisory Committees

Stephen Hines. (2008).

Chair of Master's Thesis Supervisory Committees

Saransh. (2009).

Cory Fox. (2008). Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path

Mark Stanovic. (2008, co-directed with Ted Baker). Throttling On-disk Schedulers to Meet Soft-real-time Requirements

Jin Qian. (2007). A Behind-the-scenes Story on Applying Cross-layer Coordination to Disks and RAIDs

Nirajan Potnis. (2006, co-directed with Kartik Gopalan). Evaluating Urban Deployment Scenarios for Vehicular Wireless Networks

Atulya Mahajan. (2006, co-directed with Kartik Gopalan). Cluster: Urban Mobility Models for Vehicular Ad Hoc Networks

Charles Weddle. (2005). PARaid: The Gear-shifting Power-Aware RAID

Chair of Master's Project Supervisory Committees

Ravi Vyas. (2009).

Joseph Ryan Fishel. (2008).

David Lary. (2008). PonyFS: File-system-level Encryption-based Secure Erasure

Chair of Master's Supervisory Committees

Sarah Diesburg. (2008).

Teaching activities that occurred prior to employment at FSU.

Dragan Lojpur. (2008).
Huan Keat Sean Toh. (2005).
Zhiqian Hu. (2004).

Member of Master's Thesis/Project Supervisory Committees

Monika Achury. (2009).
Paul West. (2008).
Mahesh Erande. (2007).
Sai Lakshminarayana. (2007).
Garret Reece. (2006).
Christopher Rivera. (2005).
Haifeng Zhao. (2004).
MiaoMiao Xu. (2004).
Jonathon Busey. (2004).

Chair of Honors Thesis Supervisory Committees

Mark Carpenter. (2006). File Clustering for Efficient Backup Systems.
Mathew Oldham. (2005). A Power and Performance Measurement Framework for Server-class Storage.

Sponsor of Undergraduate Independent Research

Daniel Rosenthal. (2008).
Nicholas Zatkovich. (2008).
Jitan Patel. (2007).
BillyJoe Garcia. (2007).
Christopher Meyers. (2007).
Fang Zhu. (2006, co-directed with Kartik Gopalan).
Stephen Baylis (2005, co-directed with Kartik Gopalan).
Bill Iliff. (2005).
Amey Kulkarni. (2005).
Cory Fox. (2005).
James Gonzales. (2005).
Kelly Jones. (2005).
Micah Villmow. (2005).
Noriel Lu (2005).

SCHOLARLY OR CREATIVE ACTIVITIES

In the following pages, authors shown in *italics* were current students at the time the research associated with the paper was accomplished.

Publications

Refereed Journal Articles Submitted

1. *Sarah Diesburg* and **An-I Andy Wang**. 2008. A Survey of Confidential Data Storage and Deletion Methods. *ACM Computing Surveys*. [39 pages].

This paper surveys how existing systems achieve confidentiality and secure erasure of data from digital media. Sarah Diesburg is a Ph.D. student at FSU, supervised by Andy Wang.

Refereed Journal Articles Published

1. *Charles Weddle*, *Mathew Oldham*, *Jin Qian*, **An-I Andy Wang**, Peter Reiher, and Geoff Kuenning. 2007. PARAID: A Gear-shifting Power-Aware RAID. *ACM Transactions on Storage (TOS)*, 3(3), article no. 13., 33 pages. [invited, top 7 papers (7%) from the 5th *USENIX Conference on File and Storage Technologies (FAST)*, 2007]

This paper details the design, implementation, and measurements of one of the first energy-efficient storage systems, PARAID (version 3), which can save up to 34% of power. Andy Wang is the designer and the patent holder of PARAID. Charles Weddle and Jin Qian were Masters students at FSU, supervised by Andy Wang. Mathew Oldham was an Honors Thesis student at FSU, supervised by Andy Wang. Peter Reiher is an adjunct professor at UCLA and a Co-PI on the NSF grant. Geoff Kuenning is a professor at Harvey Mudd College, also senior personnel on the NSF grant.

2. **An-I Andy Wang**, Geoff Kuenning, and Peter Reiher. 2007. Using Permuted States and Validated Simulation to Analyze Conflict Rates in Optimistic Replication, *SCS Simulation: Transactions of the Society for Modeling and Simulation International*, 83(3), pp. 551-569. [25% acceptance rate, based on a refereed paper published at *the ACM International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)*, 2005]

The paper presents a detailed analysis of a concept called permuted states, which can simplify the analysis of replicated storage systems, by removing 99.9999% of redundant and unreachable system states. Andy Wang invented the concept of permuted states and is the primary author of this paper. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher is an adjunct professor at UCLA.

3. **An-I Andy Wang**, Geoff Kuenning, Peter Reiher, and Gerald Popek. 2006. The *Conquest* File System: Better Performance through a Disk/Persistent-RAM Hybrid Design, *ACM Transactions on Storage (TOS)*, 2(3), pp. 309-348. [24% acceptance rate, based on the refereed paper published at the *USENIX Annual Technical Conference*, 2002]

This paper details the design, implementation, and measurements of the *Conquest* File System, which combines the speed of memory and storage capability of disks to achieve 1.4x to 2.0x performance improvement over all other leading disk-based file systems. Andy Wang designed, implemented, and measured the *Conquest* file system. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher and Gerald Popek are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

4. *Nam T. Nyugen*, **An-I Andy Wang**, Geoffrey H. Kuenning, and Peter Reiher. 2004. Electric-field-based Routing: A Reliable Framework for Routing in MANETs, *ACM SIGMOBILE Mobile Computing and Communications Review (MC²R)*, 8(2), pp. 35-49.

The paper demonstrates, in simulation, how electric-field equations can be applied to construct disjoint network routes to enhance reliability of network transmissions. Andy Wang is the inventor of electric-field-based routing. Nam Nyugen was a Master's student at UCLA, co-supervised by Peter Reiher and Andy Wang. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher is an adjunct professor at UCLA.

Invited Book Chapters Published

- #1. **An-I Andy Wang**, Peter Reiher, and Geoffrey Kuenning. 2003. Multipath Routing for Ad Hoc Networks. *Mobile and Wireless Internet: Protocols, Algorithms, and Systems*, pp. 245-262, Hingham, Massachusetts, USA: Kluwer Academic Publishers.

This chapter surveys ways to construct multiple routes for mobile *ad hoc* networks and introduces the concept of applying electric-field lines to construct multiple disjoint network routes. Andy Wang is the inventor of electric-field-based routing. Peter Reiher is an adjunct professor at UCLA. Geoff Kuenning is a professor at Harvey Mudd College.

Refereed Proceedings Published

1. *Sarah Diesburg*, *Christopher Meyers*, *David Lary*, and **An-I Andy Wang**. When Cryptography Meets Storage. *Proceedings of the 4th International Workshop on Storage Security and Survivability*, October 2008.

This paper empirically shows mismatching assumptions and vulnerabilities when cryptography methods used in the networking context are applied to the storage contexts.

Scholarly and creative activities that occurred prior to employment at FSU.

Andy identified various vulnerabilities and built a program to automate the exploits for various cryptographic schemes. Sarah Diesburg and Christopher Meyers are Ph.D. students at FSU, supervised by Andy Wang. David Lary was a Master's student at FSU, supervised by Andy Wang.

2. *Cory Fox, Dragan Lojpur, and An-I Andy Wang.* 2008. Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path Components. *Proceedings of the 16th Annual Meeting of the IEEE International Symposium on Modeling, Analysis, and Simulation (MASCOTS)*, Baltimore, Maryland, USA, 10 pages, Boston, Massachusetts, USA: IEEE Computer Society. [38% acceptance rate]

This paper proposes and evaluates new metrics to quantify temporal and spatial clustering of storage accesses. Cory Fox and Dragan Lojpur were Masters students at FSU, supervised by Andy Wang.

3. *Jin Qian, Christopher Meyers, and An-I Andy Wang.* 2008. A Linux Implementation Validation of Track-aligned Extents and Track-aligned RAIDs. *Proceedings of the 2008 USENIX Annual Technical Conference*, Boston, Massachusetts, USA. 6 pages, Berkeley, California, USA: USENIX Association. [15% acceptance rate]

Through redesign and reimplementing of two existing disk optimizations, this paper demonstrates the importance of independent empirical validations in the field of computer science, which is given less emphasis when compared to other science disciplines. Jin Qian was a Master's student at FSU, supervised by Andy Wang. Christopher Meyers is a Ph.D. student at FSU, supervised by Andy Wang.

4. *Mark J. Stanovich, Theodore P. Baker, and An-I Andy Wang.* 2008. Throttling On-disk Schedulers to Meet Soft-real-time Requirements. *Proceedings of the 14th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, St. Louis, Missouri, USA. pp. 331-341, Boston, Massachusetts, USA: IEEE Computer Society. [24% acceptance rate]

This paper examines how operating systems can coordinate with on-disk scheduling optimizations to improve the performance of I/Os with timing constraints. Andy Wang developed a disk simulator to help explain various timing characteristics observed. Mark Stanovich is a Ph.D. student at FSU, co-supervised by Ted Baker and Andy Wang. Ted Baker is a professor at FSU.

5. *Atulya Mahajan, Niranjan Potnis, Kartik Gopalan, and An-I Andy Wang.* 2007. Modeling VANET Deployment in URBAN Settings. *Proceedings of the 10th ACM/IEEE International Symposium on Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM)*, Chania, Crete Island, Greece. pp. 151-158, New York, New York, USA, ACM. [25% acceptance rate]

This paper studies how the service quality of a mobile network interacts with the moving patterns of vehicles in a metropolitan area. Andy Wang initiated the project in 2004 and demonstrated the parameterization of obstacles and its mapping on radio models. Atulya Mahajan and Niranjana Potnis were Masters students at FSU, co-supervised by Kartik Gopalan and Andy Wang. Kartik Gopalan was an assistant professor at FSU, now at SUNY, Binghamton.

6. *Niranjana Potnis, Atulya Mahajan, **An-I Andy Wang**, and Kartik Gopalan.* 2007. Evaluation of Mesh-enhanced VANET Deployment Models. *Proceedings of the 16th International Conference on Computer Communications and Networks (ICCCN), Workshop on Advanced Networking and Communications*, Honolulu, Hawaii, USA, pp. 862-867, Boston, Massachusetts, USA: IEEE Computer Society. [45% acceptance rate]

This paper evaluates the feasibility of combining a mobile network by using vehicles and the infrastructural network in a metropolitan area to achieve good service quality. Andy Wang initiated the project in 2004 and demonstrated the parameterization of obstacles and its mapping on radio models. Atulya Mahajan and Niranjana Potnis were Masters students at FSU, co-supervised by Kartik Gopalan and Andy Wang. Kartik Gopalan was an assistant professor at FSU, now at SUNY, Binghamton.

7. Theodore P. Baker, **An-I Andy Wang**, and *Mark Stanovich.* 2007. Fitting Linux Device Drivers into an Analyzable Scheduling Framework. *Proceedings of the 3rd Workshop on Operating System Platforms for Embedded Real-Time Applications*, Pisa, Italy, pp. 1-10, New York, New York, USA, ACM.

This paper, based on the original NSF proposal, identifies the gap between theories of scheduling I/Os with time constraints and operating system implementations. Ted Baker is a professor at FSU. Mark Stanovich is a Ph.D. student at FSU, co-supervised by Ted Baker and Andy Wang.

8. *Mark Lewandowski, Mark Stanovich, Theodore Baker, Kartik Gopalan, and **An-I Andy Wang.*** 2007. Modeling Device Driver Effects in Real-time Schedulability Analysis: Study of a Network Driver. *Proceedings of the 13th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, Bellevue, Washington, USA. pp. 151-158, Boston, Massachusetts, USA: IEEE Computer Society. [36% acceptance rate]

This paper presents an empirical approach to bound the level of interference between the operating system component that schedules I/O and the component that schedules CPU. Andy Wang suggested the need to investigate the worst-case interference theoretically achievable, in addition to gathering empirical data points. Mark Lewandowski was a Ph.D. student at FSU, co-supervised by Ted Baker, Kartik Gopalan, and Andy Wang. Mark Stanovich is a Ph.D. student at FSU, co-supervised by Ted Baker and Andy Wang. Ted Baker is a professor at FSU. Kartik Gopalan was an assistant professor at FSU, now at SUNY, Binghamton.

9. *Charles Weddle, Mathew Oldham, Jin Qian, **An-I Andy Wang**, Peter Reiher, and Geoff Kuenning. 2007. PARAID: A Gear-shifting Power-Aware RAID. *Proceedings of the 5th USENIX Conference on File and Storage Technologies (FAST)*, San Jose, California, USA. pp. 245-260, Berkeley, California, USA: USENIX Association. [19% acceptance rate]*

This paper presents the design, implementation, measurements of one of the first energy-efficient storage systems, PARAID (version 3), which can save up to 34% of power. Andy Wang is the designer and the patent holder of PARAID. Charles Weddle and Jin Qian were Masters students at FSU, supervised by Andy Wang. Mathew Oldham was an Honors Thesis student at FSU, supervised by Andy Wang. Peter Reiher is an adjunct professor at UCLA and a Co-PI on the NSF grant. Geoff Kuenning is a professor at Harvey Mudd College, senior personnel on the NSF grant.

10. *Atulya Mahajan, Niranjana Potnis, Kartik Gopalan, and **An-I Andy Wang**. 2006. Urban Mobility Models for VANETs. *Proceedings of the 2nd IEEE International Workshop on Next Generation Wireless Networks (WoNGeN)*, Bangalore, India, 13 pages, Boston, Massachusetts, USA: IEEE Computer Society.*

This paper presents various ways to enhance the modeling realism of vehicle movements in urban settings and their effects on the quality of service in mobile networks. Andy Wang initiated the project in 2004 and demonstrated the parameterization of obstacles and its mapping on radio models. Niranjana Potnis and Atulya Mahajan were Masters students at FSU, co-supervised by Kartik Gopalan and Andy Wang. Kartik Gopalan was an assistant professor at FSU, now at SUNY, Binghamton.

11. ***An-I Andy Wang**, Geoff Kuenning, and Peter Reiher. 2005. Using Permuted States and Validated Simulation to Analyze Conflict Rates in Optimistic Replication. *Proceedings of the 2005 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, Cherry Hill, Philadelphia, USA. pp. 929-939, San Diego, California, USA, SCS. [50% acceptance rate]*

The paper demonstrates how a concept called permuted states can be used to validate simulations for replicated storage systems, with a 99.9999% reduction in the number of system states. Andy Wang invented the concept of permuted states and is the primary author of this paper. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher is an adjunct professor at UCLA.

12. ***An-I Andy Wang**, Geoff Kuenning, and Peter Reiher. 2005. Using Permuted States to Analyze Conflict Rates in Optimistic Peer-to-Peer Replication. *Proceedings of the ACM International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)*, Banff, Alberta, Canada. pp. 376-377, New York, New York, USA, ACM. [20% acceptance rate]*

The paper introduces a concept called permuted states, which can simplify the analysis of replicated storage systems, by removing 99.9999% of redundant and unreachable system states. Andy Wang invented the concept of permuted states and is the primary author of this paper. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher is an adjunct professor at UCLA.

- #13. **An-I Andy Wang**, Geoff Kuenning, Peter Reiher, and Gerald Popek. 2003. The Effects of Memory-rich Environments on File System Microbenchmarks *Proceedings of the 2003 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, Montreal, Montreal, Canada. pp. 745-754, San Diego, California, USA, SCS. [50% acceptance rate]

This paper demonstrates how modern disk benchmarks fail to reflect the abundance of memory and yield misleading results. Andy Wang performed the entire evaluation study as a Ph.D. student at UCLA, supervised by Gerald Popek. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher and Gerald Popek are adjunct professors at UCLA.

- #14. **An-I Andy Wang**, Peter Reiher, Rajive Bagrodia, and Geoffrey Kuenning. 2002. Understanding the Behavior of Conflict-rate Metric in Optimistic Peer Replication. *Proceedings of the 5th IEEE International Workshop on Mobility in Databases and Distributed Systems (MDDS)*, Aix-en-Provence, France, pp. 757-761, Boston, Massachusetts, USA: IEEE Computer Society.

This paper presents the first analytical model that caps the probability of conflicting updates, occurring when data replicas are updated concurrently. As a Ph.D. student at UCLA, supervised by Gerald Popek, Andy Wang derived the analytical bound and compared the results with his prior simulation studies. Peter Reiher is an adjunct professor at UCLA. Rajive Bagrodia is a professor at UCLA. Geoff Kuenning is a professor at Harvey Mudd College.

- #15. **An-I Andy Wang**, Geoff Kuenning, Peter Reiher, and Gerald Popek. 2002. *Conquest*: Better Performance through a Disk/Persistent-RAM Hybrid File System. *Proceedings of the 2002 USENIX Annual Technical Conference*, Montreal, Montreal, Canada. pp. 15-28, Monterey, California, USA: USENIX Association. [24% acceptance rate]

This paper presents the design, implementation, and evaluation of the *Conquest* File System, which combines the speed of memory and storage capability of disks to achieve 1.4x to 2.0x performance improvement over all leading disk-based file systems. Andy Wang designed, implemented, and measured the *Conquest* file system as a Ph.D. student at UCLA, supervised by Gerald Popek. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher and Gerald Popek are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

Scholarly and creative activities that occurred prior to employment at FSU.

- #16. **An-I Andy Wang**, Geoffrey Kuenning, Peter Reiher, and Gerald Popek. 2001. Position Summary: The *Conquest* File System—Life after Disks. *Proceedings of the 8th IEEE Workshop on Hot Topics in Operating Systems (HotOS)*, Schloss Elmau, Germany, pp. 186, Boston, Massachusetts, USA: IEEE Computer Society.

This paper presents the design of the *Conquest* File System, which combines the speed of memory and storage capability of disks. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher and Gerald Popek are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

- #17. **An-I Andy Wang**, Peter Reiher, and Rajive Bagrodia. 1999. A Simulation Evaluation of Optimistically Replicated Filing in Mobile Environments. *Proceedings of the 18th IEEE International Performance, Computing, and Communication Conference (IPCCC)*, Scottsdale, Arizona, USA. pp. 43-51, Boston, Massachusetts, USA: IEEE Computer Society.

This paper examines the performance behaviors of relaxed consistency model when updating replicated files in mobile environments. Andy Wang conducted the simulation experiments as a Master's student at UCLA, co-supervised by Rajive Bagrodia and Gerald Popek. Peter Reiher is an adjunct professor at UCLA. Rajive Bagrodia is a professor at UCLA.

- #18. Geoffrey Kuenning, Richard Guy, Gerald Popek, Peter Reiher, and **An-I Andy Wang**. 1998. Measuring the Quality of Service of Optimistic Replication. *Proceedings of the 12th European Conference on Object-Oriented Programming (ECOOP) Workshop on Mobility and Replication*, Brussels, Belgium, 1543, pp. 319-320, London, UK, Springer-Verlag.

This paper demonstrates how the commonly used conflict-rate metric is flawed when comparing file systems with a relaxed consistency model. As a Master's student supervised by Gerald Popek, Andy Wang designed and implemented a simulation framework that led to this finding. Geoff Kuenning is a professor at Harvey Mudd College. Richard Guy was a lecturer at UCLA. Gerald Popek and Peter Reiher are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

Non-Refereed Publications Published

1. *Sarah Diesburg* and **An-I Andy Wang**. 2008. A Survey of Confidential Data Storage and Deletion Methods. Technical Report TR-080508, Department of Computer Science, Tallahassee, Florida: Florida State University.

Scholarly and creative activities that occurred prior to employment at FSU.

This paper surveys how existing systems achieve confidentiality and secure erasure of data from digital media. Sarah Diesburg is a Ph.D. student at FSU, supervised by Andy Wang.

2. *Cory Fox, Dragan Lojpur, and An-I Andy Wang*. 2008. Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path Components. Technical Report TR-080406, Department of Computer Science, Tallahassee, Florida: Florida State University.

This paper proposes and evaluates new metrics to quantify temporal and spatial clustering of storage accesses. Cory Fox and Dragan Lojpur were Masters students at FSU, supervised by Andy Wang.

3. *Cory Fox, Dragan Lojpur, and An-I Andy Wang*. 2008. Work-in-Progress Report: Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path Components. *Online Proceedings of the 6th USENIX Conference on File and Storage Technologies (FAST)*, San Jose, California, USA, Berkeley, California, USA: USENIX Association. [1 page]

This abstract summarizes our proposed metrics to quantify temporal and spatial clustering of storage accesses. Cory Fox and Dragan Lojpur were Masters students at FSU, supervised by Andy Wang.

4. *Mark J. Stanovich, Theodore P. Baker, and An-I Andy Wang*. 2007. Throttling On-disk Schedulers to Meet Soft-real-time Requirements. Technical Report TR-071025, Department of Computer Science, Tallahassee, Florida: Florida State University.

This paper examines how operating systems can coordinate with on-disk scheduling optimizations to improve the performance of I/Os with timing constraints. Andy Wang developed a disk simulator to help explain various timing characteristics observed. Mark Stanovich is a Ph.D. student at FSU, co-supervised by Ted Baker and Andy Wang. Ted Baker is a professor at FSU.

5. *Jin Qian and An-I Andy Wang*. 2007. A Behind-the-scenes Story on Applying Cross-layer Coordination to Disks and RAIDs. Technical Report TR-071015, Department of Computer Science, Tallahassee, Florida: Florida State University.

Through the independent validations of two disk optimizations, this paper explores the challenges involved in applying the concept of coordinating multiple storage components to improve performance. Jin Qian was a Master's student at FSU, supervised by Andy Wang.

6. *Charles Weddle, Mathew Oldham, Jin Qian, An-I Andy Wang, Peter Reiher, and Geoff Kuenning*. 2006. PARAID: A Gear-shifting Power-Aware RAID. Technical Report TR-060323, Department of Computer Science, Tallahassee, Florida: Florida State University.

This paper presents the design, implementation, and measurements of one of the first energy-efficient storage systems, PARaid (version 1), which can save up to 34% of power. Andy Wang is the designer and the patent holder of PARaid. Charles Weddle and Jin Qian were Masters students at FSU, supervised by Andy Wang. Mathew Oldham was an Honors Thesis student at FSU, supervised by Andy Wang.

7. *Atulya Mahajan, Niranjana Potnis, Kartik Gopalan, and An-I Andy Wang.* 2005. Evaluation of Mobility Models for Vehicular Ad Hoc Network Simulations. Technical Report TR-0512220, Department of Computer Science, Tallahassee, Florida: Florida State University.

This paper presents various ways to enhance the modeling realism of vehicle movements in urban settings and their effects on the quality of service in mobile networks. Andy Wang initiated the project in 2004 and demonstrated the parameterization of obstacles and its mapping on radio models. Niranjana Potnis and Atulya Mahajan were Masters students at FSU, co-supervised by Kartik Gopalan and Andy Wang. Kartik Gopalan was an assistant professor at FSU, now at SUNY, Binghamton.

- #8. **An-I Andy Wang.** 2003. The *Conquest* File System: A Disk/Persistent-RAM Hybrid Design for Better Performance and Simpler Data Paths. Ph.D. Dissertation. Computer Science Department, University of California, Los Angeles.

This dissertation details the background, design, implementation, and measurements of the *Conquest* File System, which combines the speed of memory and storage capability of disks to achieve 1.4x to 2.0x performance improvement over all leading disk-based file systems. Andy Wang designed, implemented, and measured the *Conquest* file system.

- #9. **An-I Andy Wang,** Geoffrey Kuenning, Peter Reiher, and Gerald Popek. 2002. Work-in-Progress Report: *Conquest*: Better Performance through a Disk/RAM Hybrid File System. *Online Proceedings of the 1st USENIX Conference on File and Storage Technologies (FAST)*, Monterey, California, USA, Berkeley, California, USA: USENIX Association. [1 page]

This abstract presents the design of *Conquest* File System, which combines the speed of memory and storage capability of disks. Geoff Kuenning is a professor at Harvey Mudd College. Peter Reiher and Gerald Popek are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

- #10. **An-I Andy Wang,** Peter Reiher, and Rajive Bagrodia. 2001. A Simulation Framework and Evaluation for Optimistically Replicated Filing Environments. Technical Report CSD-990042, Computer Science Department, Los Angeles, California, University of California, Los Angeles.

Scholarly and creative activities that occurred prior to employment at FSU.

Through a simulation framework, this paper investigates the performance behaviors of file replication with relaxed consistency semantics. Andy Wang designed and implemented the simulation framework as a Master's student, co-advised by Rajive Bagrodia and Gerald Popek. Peter Reiher is an adjunct professor at UCLA. Rajive Bagrodia is a professor at UCLA.

- #11. Mark Yarvis, **An-I Andy Wang**, Alexey Rudenko, Peter Reiher, and Gerald Popek. 1999. Conductor: Distributed Adaptation for Complex Networks. Technical Report CSD-990042, Computer Science Department, Los Angeles, California, University of California, Los Angeles.

This paper presents a Conductor framework, which distributes the responsibility of optimizations out of the applications into the network. Andy Wang designed and implemented the archeological network application to showcase the Conductor framework. Mark Yarvis is a researcher at Intel. Alexey Rudenko was a Ph.D. student at UCLA. Peter Reiher and Gerald Popek are adjunct professors at UCLA. Gerald Popek is also a CTO at United Online, formerly NetZero.

- #12. **An-I Andy Wang**. A Simulation Evaluation for Optimistically Replicated Filing Environments. Master's Thesis. Computer Science Department, University of California, Los Angeles.

This thesis details the background, design, implementation, validation, and applications of a simulation framework to evaluate file replications with relaxed consistency semantics. Andy Wang designed and built the framework as a Master's student, co-supervised by Gerald Popek and Rajive Bagrodia.

- #13. **An-I Andy Wang**, Peter Reiher, and Rajive Bagrodia. 1997. A Simulation Framework for Evaluating Optimistically Replicated Filing Environments. Technical Report CSD-970018. Computer Science Department, Los Angeles, California, University of California, Los Angeles.

This thesis details the design and implementation of a simulation framework to evaluate file replications with relaxed consistency semantics. Andy Wang built the framework as a Master's student, co-supervised by Gerald Popek and Rajive Bagrodia.

Presentations

Refereed Papers Presented at Conferences and Symposia

For refereed papers presented at conferences and symposia, 100% were international.

Scholarly and creative activities that occurred prior to employment at FSU.

1. Sarah Diesburg, Christopher Meyers, David Lary, and **An-I Andy Wang**. When Cryptography Meets Storage. *Proceedings of the 4th International Workshop on Storage Security and Survivability*, October 2008.
2. Cory Fox, Dragan Lojpur, and **An-I Andy Wang**. 2008. Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path Components. Refereed paper presented at the *16th Annual Meeting of the IEEE International Symposium on Modeling, Analysis, and Simulation (MASCOTS)*, sponsored by the IEEE Computer Society, Baltimore, Maryland, USA. (international)
3. Jin Qian, Christopher Meyers, and **An-I Andy Wang**. June 2008. A Linux Implementation Validation of Track-aligned Extents and Track-aligned RAIDs. Refereed paper presented at the *2008 USENIX Annual Technical Conference*, sponsored by the USENIX Association, Boston, Massachusetts, USA. (international)
4. Mark J. Stanovich, Theodore P. Baker, and **An-I Andy Wang**. April 2008. Throttling On-disk Schedulers to Meet Soft-real-time Requirements. Refereed paper presented at the *14th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, sponsored by the IEEE Computer Society, St. Louis, Missouri, USA. (international)
5. Atulya Mahajan, Niranjana Potnis, Kartik Gopalan, and **An-I Andy Wang**. October 2007. Modeling VANET Deployment in URBAN Settings. Refereed paper presented at the *10th ACM/IEEE International Symposium on Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWiM)*, sponsored by ACM, Chania, Crete Island, Greece. (international)
6. Niranjana Potnis, Atulya Mahajan, **An-I Andy Wang**, and Kartik Gopalan. August 2007. Evaluation of Mesh-enhanced VANET Deployment Models. Refereed paper presented at the *16th International Conference on Computer Communications and Networks (ICCCN), Workshop on Advanced Networking and Communications*, sponsored by the IEEE Computer Society, Honolulu, Hawaii, USA. (international)
7. Theodore P. Baker, **An-I Andy Wang**, and Mark Stanovich. July 2007. Fitting Linux Device Drivers into an Analyzable Scheduling Framework. Refereed paper presented at the *3rd Workshop on Operating System Platforms for Embedded Real-Time Applications*, sponsored by ACM, Pisa, Italy. (international)
8. Mark Lewandowski, Mark Stanovich, Theodore Baker, Kartik Gopalan, and **An-I Andy Wang**. April 2007. Modeling Device Driver Effects in Real-time Schedulability Analysis: Study of a Network Driver. Refereed paper presented at the *13th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, sponsored by the IEEE Computer Society. Bellevue, Washington, USA. (international)
9. Charles Weddle, Mathew Oldham, Jin Qian, **An-I Andy Wang**, Peter Reiher, and Geoff Kuenning. February 2007. PARAD: A Gear-shifting Power-Aware RAID. Refereed paper presented at the *5th USENIX Conference on File and Storage Technologies (FAST)*, sponsored by the USENIX Association, San Jose, California, USA. (international)
10. Atulya Mahajan, Niranjana Potnis, Kartik Gopalan, and **An-I Andy Wang**. December 2006. Urban Mobility Models for VANETs. Refereed paper presented at the *2nd IEEE International Workshop on Next Generation Wireless Networks (WoNGeN)*, sponsored by the IEEE Computer Society, Bangalore, India.

11. **An-I Andy Wang**, Geoff Kuenning, and Peter Reiher. July 2005. Using Permuted States and Validated Simulation to Analyze Conflict Rates in Optimistic Replication. Refereed paper presented at the *2005 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, sponsored by SCS, Cherry Hill, Philadelphia, USA. (international)
12. **An-I Andy Wang**, Geoff Kuenning, and Peter Reiher. June 2005. Using Permuted States to Analyze Conflict Rates in Optimistic Peer-to-Peer Replication. Refereed paper presented at the *ACM International Conference on Measurement and Modeling of Computer Systems (SIGMETRICS)*, sponsored by ACM, Banff, Alberta, Canada. (international)
- #13. **An-I Andy Wang**, Geoff Kuenning, Peter Reiher, and Gerald Popek. July 2003. The Effects of Memory-rich Environments on File System Microbenchmarks. Refereed paper presented at the *2003 International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*, sponsored by SCS, Montreal, Montreal, Canada. (international)
- #14. **An-I Andy Wang**, Peter Reiher, Rajive Bagrodia, and Geoffrey Kuenning. September 2002. Understanding the Behavior of Conflict-rate Metric in Optimistic Peer Replication. Refereed paper presented at the *5th IEEE International Workshop on Mobility in Databases and Distributed Systems (MDDS)*, sponsored by the IEEE Computer Society, Aix-en-Provence, France. (international)
- #15. **An-I Andy Wang**, Geoff Kuenning, Peter Reiher, and Gerald Popek. June 2002. *Conquest: Better Performance through a Disk/Persistent-RAM Hybrid File System*. Refereed paper presented at the *2002 USENIX Annual Technical Conference*, sponsored by the USENIX Association, Montreal, Canada. (international)
- #16. **An-I Andy Wang**, Peter Reiher, and Rajive Bagrodia. February 1999. A Simulation Evaluation of Optimistically Replicated Filing in Mobile Environments. Refereed paper presented at the *18th IEEE International Performance, Computing, and Communication Conference (IPCCC)*, sponsored by the IEEE Computer Society, Scottsdale, Arizona, USA. (international)
- #17. Geoffrey Kuenning, Richard Guy, Gerald Popek, Peter Reiher, and **An-I Andy Wang**. July 1998. Measuring the Quality of Service of Optimistic Replication. Refereed paper presented at the *12th European Conference on Object-Oriented Programming (ECOOP) Workshop on Mobility and Replication*, sponsored by ACM, Brussels, Belgium. (international)

Non-Refereed Papers Presented at Conferences and Symposia

For non-refereed work-in-progress papers presented at conferences, 100% were international.

1. *Cory Fox, Dragan Lojpur, and An-I Andy Wang*. February 2008. Quantifying Temporal and Spatial Localities in Storage Workloads and Transformations by Data Path Components. Work-in-progress report presented at the *6th USENIX Conference on File and Storage (FAST)*, sponsored by the USENIX Association, San Jose, California, USA. (international)

Scholarly and creative activities that occurred prior to employment at FSU.

- #2. **An-I Andy Wang**, Peter Reiher, Geoffrey Kuenning, and Gerald Popek. January 2002. *Conquest*: Better Performance through a Disk/Persistent-RAM Hybrid File System. Work-in-progress report presented at the *1st USENIX Conference on File and Storage Technologies (FAST)*, Monterey, California, USA. (international)

Invited Presentations and Symposia

For invited presentations at conferences and symposia, 60% were national, and 40% were local in scope.

1. **An-I Andy Wang**. April 2008. PARAID: A Gear-shifting Power-Aware RAID. Computer Science Research Seminar, University of Wisconsin, Madison, Wisconsin, USA. (national)
2. **An-I Andy Wang**. March 2008. PARAID: A Gear-shifting Power-Aware RAID. Computer Science Research Seminar, University of California, Santa Cruz, California, USA. (national)
3. **An-I Andy Wang**. November 2007. Some Research Frontiers in Storage Systems. Computer Science Colloquium, Florida State University, Tallahassee, Florida, USA. (local)
4. **An-I Andy Wang**. November 2007. PARAID: A Gear-shifting Powr-Aware RAID. Computer Science Colloquium, Harvey Mudd College, Claremont, California, USA. (national)
5. **An-I Andy Wang**. November 2006. Some Research Frontiers in Storage Systems. Computer Science Colloquium, Florida State University, Tallahassee, Florida, USA. (local)
6. **An-I Andy Wang**. May 2006. *Conquest-2*: Improving Energy Efficiency and Performance through a Disk/RAM Hybrid File System. Computer Science Colloquium, University of California, Los Angeles, California, USA. (national)
7. **An-I Andy Wang**. December 2005. *Conquest-2*: Improving Energy Efficiency and Performance through a Disk/RAM Hybrid File System. Computer Science Colloquium, Florida State University, Tallahassee, Florida, USA. (national)
8. **An-I Andy Wang**. November 2005. *Conquest-2*: Improving Energy Efficiency and Performance through a Disk/RAM Hybrid File System. Computer Science Colloquium, University of Delaware, Newark, Delaware, USA. (national)
9. **An-I Andy Wang**. May 2005. *Conquest-2*: Improving Energy Efficiency and Performance through a Disk/RAM Hybrid File System. Computer Science Colloquium, University of California, Riverside, California, USA. (national)
10. **An-I Andy Wang**. November 2004. Some Research Frontiers in Storage Systems. Computer Science Colloquium, Florida State University, Tallahassee, Florida, USA. (local)
11. **An-I Andy Wang**. February 2004. Electric-field-based Routing. Secure Spatially Disjoint Routes in MANETs. DARPA's Proposer's Day for Defense against Cyber Attacks on Mobile Ad Hoc Networks, Virginia, USA. (national)

Scholarly and creative activities that occurred prior to employment at FSU.

12. **An-I Andy Wang**. October 2003. Preparing for Life after Disks. Computer Science Colloquium, Florida State University, Tallahassee, Florida, USA. (local)
- #13. **An-I Andy Wang**. November 2002. Conquest: Preparing for Life after Disks. UCLA Advanced Operating Systems Lecture, University of California, Los Angeles, California, USA. (local)
- #14. **An-I Andy Wang**. November 2001. *Conquest*: RAM as Storage, Disks as Tapes. UCLA Advanced Operating Systems Lecture, University of California, Los Angeles, California, USA. (local)
- #15. **An-I Andy Wang**. October 1999. Integration of Memory and File System Services via Persistent RAM. Computer Science Colloquium, Harvey Mudd College, Claremont, California, USA. (national)

Press Coverage

Conquest FS: The Disk is Dead. *Slashdot*, April 21, 2003.

Henry Baltazar. DAFS, Conquest May Pave Way for Future File Systems, *eWeek*, Ziff Davis Media, June 17, 2002.

Information and Communication Technology

Computer Software Development

Charles Weddle, Mathew Oldham, Jin Qian, An-I Andy Wang. 2007. Power-Aware RAID. Tallahassee, Florida: Florida State University.

An-I Andy Wang. 2003. Conquest File System. Los Angeles, California: University of California, Los Angeles.

Inventions

Patented Inventions

An-I Andy Wang. 2005. Power-Aware Redundant Array of Inexpensive Disks (PARAID). Florida State University. Tallahassee, Florida.

Contracts and Grants

Contracts and Grants Funded

An-I Andy Wang. Exploring Opportunities between RAIDs and Storage Components. Council of Research and Creativity, Florida State University, 2007-2008. \$11,999.

Ted Baker, **An-I Andy Wang**, and Kartik Gopalan (SUNY, Binghamton). Next-Generation Real-time Device Architecture. National Science Foundation, 2005-2009. \$547,324.

Scholarly and creative activities that occurred prior to employment at FSU.

An-I Andy Wang and Peter Reiher (UCLA). *Conquest-2: Improving Energy Efficiency and Performance Through a Disk/RAM Hybrid File System*. National Science Foundation, 2004-2007. \$450,000 (\$267,338 to FSU).

An-I Andy Wang. *Conquest-2—Combining Battery-backed RAM and Threshold-based Storage Scheme to Conserve Power*. Council on Research and Creativity, Florida State University, 2004-2005. \$13,000.

Contracts and Grants Approved but Not Funded

An-I Andy Wang and David Whalley. (2004). *CSR—PDOS: Virtual Content: Exploiting Data-Process Dependencies for Performance, Storage Capacity, Network Bandwidth, and Energy Savings*. National Science Foundation, \$80,000.

Contracts and Grants Pending

Sudhir Aggarwal, Zhenhai Duan, **An-I Andy Wang**, and Hongmei Chi (FAMU). (2008). *Forensics and Virtual-machine-monitoring Support for Resilient Computing*. Army Research Office. \$1,000,000.

An-I Andy Wang. (2008). *In-memory File System*. Spansion Inc., \$217,141.

SERVICE

Florida State University

Department of Computer Science

Committee Member, *Ph.D. Portfolio Committee*, (2005-2008).

Committee Member, *Equipment and Network Committee*, (2003- 2005, 2007-2008).

Committee Member, *COP4610 Course Committee*, (2006-2008).

Judge, *FSU ACM Programming Contest*, (2004, 2006-2008).

Committee Member, *Faculty Evaluation Committee*, (2006-2007).

Judge, *FSU Computer Science Graduate Research Conference*, (2005-2006).

Committee Member, *Faculty Recruiting Committee*, (2003-2005).

Head Judge, *FSU ACM Programming Contest*, (2005).

Committee Member, *Graduate Curriculum Committee*, (2003-2004).

Committee Member, *Admission and Aid Committee*, (2003-2004).

The Profession

Reviewer for Refereed Journals

2008. *ACM Transactions on Computers (TOCS)*

2008. *IEEE Transactions on Computers (TC)*

2006-2007. *IEEE Transactions on Mobile Computing (TMC)*

Reviewer for Book Chapters

2006. *John Wiley & Sons*

Reviewer for Conferences

2008. *IEEE International Conference on High Performance Computing (HiPC)*

2008. *IEEE Real-Time Systems Symposium (RTSS)*

2008. *Euromicro Conference on Real-Time Systems (ECRTS)*

2007-2008. *ACM International Conference on Supercomputing (ICS)*

2006-2007. *IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*

2006. *IEEE International Symposium on High-Performance Computer Architecture (HPCA)*

2006. *IEEE International Conference on Network Protocols (ICNP)*

2005. *USENIX Conference on File and Storage Technologies (FAST)*

2005. *SCS International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS)*

2004. *ICST International Conference on Quality of Service in Heterogeneous Wired/Wireless Networks*

2003. *Annual ACM Symposium on Applied Computing (SAC)*

Service to Professional Associations

Program Committee, *IFIP International Conference on Embedded and Ubiquitous Computing (2008)*.

Program Committee, *International Workshop on Network Design and Architecture (2004)*.