

# ASHOK ANAND

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## EDUCATION

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### **Ph.D. Computer Science, August 2007 - December 2011(Expected)**

University of Wisconsin, Madison

GPA: 3.93/4.00

Advisor: Prof. Aditya Akella

Title: Architectural Support for Effective Redundancy Elimination

Area: Networking and Systems.

### **M.S., Computer Science, August 2007 - May 2010**

University of Wisconsin, Madison

GPA: 3.9/4.00

### **B.Tech., Computer Sciences and Engineering, May 2003**

Indian Institute of Technology, Kharagpur

GPA 9.13/10.00.

## WORK EXPERIENCE

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**Research Assistant** with advisor *Prof. Aditya Akella*. Jan'08 – Present.

My research spans across networking, distributed and storage systems.

- **Implications of in-network caching** Explored the implications of a new architecture, where middleboxes are deployed per link that can cache packets and remove redundant contents on the fly. Designed a new routing algorithm which leverages in-network caching to reduce network traffic by upto 35%. Developed a Click-based router prototype, which can remove redundancy at OC48 speeds. Based on this work, a demo was shown in GENI - an initiative towards platform for future Internet research. (**SIGCOMM 2008**)
- **Practical network-wide redundancy elimination** Designed algorithms and techniques for practical network-wide redundancy elimination in distributed fashion, while considering resource constraints on network devices. (**SIGCOMM 2009**)
- **Flash-based key-value store** Designed a new flash SSDs based key-value store for high-performance data-intensive networked systems in cost-effective manner. (**NSDI 2010**)
- **End-system redundancy elimination** Explored the design space of where only end hosts participate in removing duplicate network traffic. Developed techniques for reducing memory and processing overhead in redundancy elimination. Showed that our techniques can reduce network traffic by 26%, reduce end-to-end latency by upto 30% and similar energy savings on smartphones. (**NSDI 2010**)
- **Data-center traffic management** Investigated the traffic characteristics of data centers. Designed a new traffic engineering approach which takes into account of predictable component of data center traffic at short time scales. (**INM 2009, INM 2010**)
- **Information-bound references for flexible multimedia dissemination** Conceptualized notion of references, which could bound to underlying information for any multimedia object (e.g. different formats of same video from different publishers have same reference). Designed algorithms and techniques for creating such references, and built scalable system for resolving such references. (**SIGCOMM 2010 Demo, HotNets 2010**)

- **Range writes for Disks** Explored a new write interface for disks, which allows disks to select locations to write. Implemented this concept for journaling systems. (**OSDI 2008**)
- **New expressive Internet Architecture** Currently exploring new Internet architecture, which could accomodate services, content and hosts as first-order entities.
- **Cloud resource management techniques** Currently exploring new algorithms for resource allocation in Cloud in fair and efficient manner. Also exploring, security challenges.

**Summer Intern**, Microsoft Research Lab, India. May – Aug'10. Mentor: *Dr. Ramachandran Ramjee and Dr. Venkat Padmanabhan.*

- **Making virtual machine migration faster** Developed techniques to speedup virtual machine migration (Details kept confidential).

**Summer Intern**, Microsoft Research Lab, India. May – Aug'08. Mentor: *Dr. Ramachandran Ramjee.*

- **Charaterizing redundancy in network traffic** Investigated the nature of redundancy in network traffic using several enterprise network traces and our University traces, which led into better understanding and new designs. (**SIGMETRICS 2009** )

**Technical Staff Member**, IBM Research Lab, India. June'03 – July'07. Manager: *Dr. Manish Gupta*, Mentor: *Dr. Pradeep Varma.*

- **Automated analysis of porting issues for large C/C++ programs** Built a tool which could analyze porting issues in large C/C++ program, and could simplify the huge effort needed in porting. (**ICSM 2004, SAC 2005** )
- **Store placement techniques on parallel disks** Developed techniques to place storage on parallel disks in a way to optimize average response time. (**ICDCS 2006, JPDC 2007**)
- **Management models for composite applications in service oriented architecture (SOA)** Developed a framework which could allow to integrate different models (e.g., infrastructure model, deployment model, design artifacts, runtime model, monitoring models etc.) of composite applications. Built tool which could display such integrated models. (**NOMS 2008**)
- **Concurrency improvements for SOA middleware** Explored deficiencies in SOA middleware, and developed techniques to improve concurrency. (**Middleware 2008**)

**Summer Intern**, INRIA Research Lab, France. May – July'02. Mentor: *Isabelle Astic.*

- **Building tool to support MIB for IPV6** Developed tool to extend MIB support for IPV6.

## PUBLICATIONS

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### Conferences

1. **Using Information-Bound Referencing to Disentangle Multimedia Links**, In Preparation.  
*Ashok Anand, Athula Balachandran, Vyas Sekar, Aditya Akella and Srinivasan Seshan.*
2. **MicroTE: Fine Grained Traffic Engineering for Data Centers**, in Submission.  
*Theophilus Benson, Ashok Anand, Aditya Akella and Ming Zhang.*
3. **XIA: An Architecture for an Evolvable and Trustworthy Internet**, Technical Report.  
*Ashok Anand, Fahad Dogar, Dongsu Han, Boyan Li, Hyeontaek Lim, Michel Machadoy, Wenfei Wu, Aditya Akella, Davide Andersen, John Byersy, Srinivashan Seshan and Peter Steenkiste.*

4. **Refactoring Content Overhearing to Improve Wireless Performance.** *MOBICOM 2011*(**13.5%** acceptance rate).  
Shan Hsiang-Shen, Aaron Gember, *Ashok Anand* and Aditya Akella
5. **Cheap and Large CAMs for High-performance Data-intensive Networked Systems.** *NSDI 2010*(**16.5%** acceptance rate).  
*Ashok Anand*, Chitra Muthukrishnan, Steven Kappes, Aditya Akella and Suman Nath.
6. **EndRE: An End-System Redundancy Elimination Service for Enterprises.** *NSDI 2010* (**16.5%** acceptance rate).  
Bhavish Aggarwal, Aditya Akella, *Ashok Anand*, Pushkar Chitnis, Chitra Muthukrishnan, Athula Nair, Ram Ramjee and George Varghese.
7. **SmartRE: An Architecture for Coordinated Network-wide Redundancy Elimination.** *SIGCOMM 2009* (**12.5%** acceptance rate). Also appeared as a poster in *NSDI 2009*.  
*Ashok Anand*, Vyas Sekar and Aditya Akella.
8. **Redundancy in Network Traffic: Findings and Implications.** *SIGMETRICS 2009* (**15%** acceptance rate).  
*Ashok Anand*, Chitra Muthukrishnan, Aditya Akella and Ramachandran Ramjee.
9. **Avoiding File System Micromanagement with Range Writes.** *OSDI 2008*(**13.4%** acceptance rate)  
*Ashok Anand*, Sayandeep Sen, Andrew Krioukov, Florentina Popovici, Aditya Akella, Andrea Arpaci-Dusseau, Remzi Arpaci-Dusseau and Suman Banerjee.
10. **Packet Caches on Routers: The Implications of Universal Redundant Traffic Elimination.** *SIGCOMM 2008*(**12.5%** acceptance rate).  
*Ashok Anand*, Archit Gupta, Aditya Akella, Srinivasan Seshan and Scott Shenker.
11. **On Store Placement for Response Time Minimization in Parallel Disks.** *ICDCS 2006*. Extended version in *JPDC 2007*.  
Akshat Verma and *Ashok Anand*.

## Workshops and Short Papers

1. **A Comparative Study of Handheld and Non-Handheld Traffic in Campus WiFi Networks.** *PAM 2011*(workshop).  
Aaron Gember, *Ashok Anand*, and Aditya Akella
2. **A Case for Information-Bound Referencing.** *HotNets 2010*(workshop).  
*Ashok Anand*, Vyas Sekar, Aditya Akella and Srinivasan Seshan
3. **Tracking Semantic Relationships for Effective Data Management in Home Networks.** *HomeNets 2010*(workshop).  
*Ashok Anand*, Aaron Gember, Vyas Sekar and Aditya Akella.
4. **The Case for Fine-grained Traffic Engineering in Data Centers.** *WREN 2010*(workshop).  
Theophilus Benson, *Ashok Anand*, Aditya Akella and Ming Zhang.
5. **Understanding Data Center Traffic Characteristics.** *WREN 2009*(workshop).  
Theophilus Benson, *Ashok Anand*, Aditya Akella and Ming Zhang.
6. **Net-Replay: A New Network Primitive.** *Hotmetrics 2009*(workshop).  
*Ashok Anand* and Aditya Akella.

### 7. On Concurrency Improvements in Enterprise SOA Middleware.

*Middleware, 2008* (short paper).

Manish Sethi and *Ashok Anand*.

### 8. An open framework for federating integrated management model of distributed IT environment. *NOMS 2008* (short paper).

Manish Sethi, *Ashok Anand*, Venkateswara Reddy Madduri, Manish Gupta and Dipayan Gangopadhyay.

## Posters and Demos

### 1. On lookups in content based routers *NSDI 2011 Poster*.

*Ashok Anand*, Nilay Vaish and Aditya Akella

### 2. Toward Universal Redundant Traffic Elimination *GENI GEC9 2010 Plenary Session Demo*.

*Ashok Anand*, Athula Balachandran, Aditya Akella and Srinivasan Seshan

### 3. Flexible Multimedia Content Retrieval Using InfoNames. *SIGCOMM 2010*(Demo).

Arun Kumar, *Ashok Anand*, Athula Balachandran, Vyas Sekar, Aditya Akella and Srinivasan Seshan

### 4. A Framework and Tool for Porting Assessment and Remediation. *ICSM 2004* (industrial applications).

Donald P. Pazel, Pradeep Varma, Amit M. Paradkar, Beth Tibbits, Ashok Anand and Philippe Charles

## PATENTS

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1. *Asymmetric end host redundancy elimination for networks*. Filed; Bhavish Aggarwal, Pushkar V. Chitnis, George Varghese, Ashok Anand, Chitra Muthukrishnan, Athula Balachandran, and Ramachandran Ramjee.

2. *SmartRE: A Framework for Coordinated Network-wide Caching*. Filed; Aditya Akella, Ashok Anand and Vyas Sekar.

3. US Patent 7721259 *System and Method for interactive and integrated software development process and phases*. Issued on May 18,2010; Amit M. Paradkar, Donald Pazel, Pradeep Varma, Beth Tibbits and Ashok Anand.

4. *Deploying Redundancy Elimination on Routers: Algorithms and Applications to Traffic Engineering*. Filed; Aditya Akella, Ashok Anand and Srinivasan Seshan.

5. *Determining System Level Dependencies*. Filed on 30th April 2009; Ashok Anand, Dipayan Gangopadhyay, Manish Gupta and Manish Sethi.

6. *Prevention of Deadlock in Distributed SOA Computing Environment*. Filed on 29th Nov 2007; Manish Sethi and Ashok Anand.

7. *System and Method for placement of logical data stores to minimize response time*. Filed on 13th Jan 2007; Akshat Verma and Ashok Anand.

8. *Software Migration Orchestration*. Filed on 6th July 2005; Pradeep Varma, Ashok Anand, Beth Tibbits and Donald Pazel.

9. US Patent 7469375 *Systems and methods for managing error dependencies*. Issued on 23rd

December, 2008; Ashok Anand, Amit M. Paradkar, Donald P. Pazel, Beth Tibbits and Pradeep Varma.

10. US Patent 7472377 *Systems and methods for determining software package identity during a system build*. Issued on 30th December, 2008; Ashok Anand, Philippe Charles, Amit M. Paradkar, Donald P. Pazel, Beth Tibbits and Pradeep Varma.

## TALKS

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1. **A Case for Information-Bound Referencing** HotNets 2010
2. **Tracking Semantic Relationships for Effective Data Management in Home Networks** HomeNets 2010
3. **Fast and Scalable Approximate Key Lookups** DIMACS (Center for Discrete Mathematics and Theoretical Computer Science), 2010
4. **Cheap and Large CAMs for High-performance Data-intensive Networked Systems.** NSDI 2010
5. **Redundancy in Network Traffic: Findings and Implications.** SIGMETRICS 2009, Microsoft Research Lab Redmond
6. **Net-Replay: A New Network Primitive.** Hotmetrics 2009
7. **Avoiding File System Micromanagement with Range Writes.** OSDI 2008
8. **Packet Caches on Routers: The Implications of Universal Redundant Traffic Elimination.** SIGCOMM 2008

## AWARDS AND ACHIEVEMENTS

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Google fellowship recipient 2010, one among 15 recipients in total over United States/Canada.

Finalist for Microsoft Research Fellowship, 2009.

IBM Bravo Award for contribution towards IQUILT project.

IBM Research Division Technical Group Award for contribution towards DAT porting tool.

IBM Research Invention Achievement Award for contribution in patents.

AIR 186 in IIT JEE 1999 among more than one lakh applicants.

## REFERENCES

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**Prof. Aditya Akella**, University of Wisconsin-Madison; [akella@cs.wisc.edu](mailto:akella@cs.wisc.edu)

**Prof. Remzi Arpaci-Dusseau**, University of Wisconsin-Madison; [remzi@cs.wisc.edu](mailto:remzi@cs.wisc.edu)

**Prof. Srinivasan Seshan**, Carnegie Mellon University; [srini@cs.cmu.edu](mailto:srini@cs.cmu.edu)

**Dr. Ramachandran Ramjee**, Microsoft Research Lab, Bangalore; [ramjee@microsoft.com](mailto:ramjee@microsoft.com)

**Dr. Suman Nath**, Microsoft Research Lab, Redmond; [sumann@microsoft.com](mailto:sumann@microsoft.com)