Bhaskaran Raman

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Research Interests

Computer networks, large-scale Internet-based systems, Internet middleware for heterogeneous network integration; cross-cutting issues in networking and distributed systems; mobile and wireless networks. I'm also particularly interested in the development of appropriate technology.

Teaching Interests

Graduate as well as undergraduate teaching; computer networks and protocols, Internet-based distributed systems, wireless networks, operating systems.

Education

- **Aug 1997-present: Doctor of Philosophy (PhD) in Computer Science**
  University of California at Berkeley, CA
  Research advisor: Prof. Randy H. Katz
  Expected date of completion: Dec 2002
  Thesis topic: An Architecture for Performance and Availability Constrained Composition of Services in the Wide-Area Internet
- **Aug 1997-May 1999: Master of Science (M.S.) in Computer Science**
  University of California at Berkeley, CA
  Research advisor: Prof. Randy H. Katz
  Thesis topic: Personal Mobility in the ICEBERG Integrated Communication Network
- **Aug 1993-May 1997: Bachelor of Technology (B. Tech) in Computer Science & Engineering**
  Indian Institute of Technology - Madras, India
  Research Advisor: Prof. C. R. Muthukrishnan

Research Experience

- **Graduate Student Researcher, SAHARA Project, University of California at Berkeley, EECS Department, Summer 2001 to present.**

As a senior graduate student, I am currently playing an active part in the development of the SAHARA architecture. My PhD thesis explores a specific form of *service composition* – the central theme of the SAHARA project.

- **Summer Intern, IBM T.J.Watson Research Center, New York, 1999.**
  I worked on issues related to service discovery and network layering in Bluetooth scatternets. (See paper titled "Arguments for Cross-layer optimizations in Bluetooth Scatternets" below).

- **Graduate Student Researcher, ICEBERG Project, University of California at Berkeley, EECS Department, Summer 1998 to Summer 2001.**

  – I have been part of the team involved with the design of ICEBERG – an Internet-based architecture for integration of services across heterogeneous access networks and devices.
  – I have played a lead role in the two code releases of different versions of ICEBERG software.
  – In Summer 1998, I worked on building a gateway to interface cell-phones on a GSM wireless network to the Internet. This was done as part of testbed development for the ICEBERG project.
  – I worked on the design and implementation of the "Universal Inbox" for my Master's thesis.

- **Graduate Operating Systems Course, University of California at Berkeley, Fall 1997.**
  I worked on a project that looked at techniques for reordering data on the fly in data processing applications. The idea was to reorder the data based on continuous user feedback so that the user has control over which data items are processed first. (See under "publications" below).

Teaching and Mentoring Experience

- Summer 2000: Mentor for SUPERB (Summer Undergraduate Program for Engineering Research at Berkeley), U.C.Berkeley. I mentored the student for a project involving the development of a voice-response user-interface. The interface was for a piece of the Universal-Inbox that read out email to users over a cellular-phone.

- Summer 1998 to Summer 1999: Mentor for undergraduate student working on a project within the scope of the ICEBERG project. He developed a graphical user-interface for management of the user-preference profiles of the Universal-Inbox architecture.

- Fall 1997, Spring 1998: Teaching Assistant for CS61a - "Structure and Interpretation of Computer Programs", U.C.Berkeley. My work involved managing lab sessions, discussion sessions to supplement class-room teaching, as well as inputs toward setting examination questions.

- Fall 1996, Spring 1997: Teaching Assistant for CS110 - "Introduction to Computing", Indian Institute of Technology, Madras. My responsibilities included helping students in lab sessions, as well as setting programming assignments for these sessions.

Publications

- "An Architecture for Highly Available Wide-Area Service Composition", Bhaskaran Raman and Randy H. Katz, Computer Communications Journal, special issue on "Recent Advances in Communication Networking", May 2003.
- "Load Balancing and Stability Issues in Algorithms for Service Composition", Bhaskaran Raman and Randy H. Katz, The 22nd Annual Joint Conference of the IEEE Computer and Communications Societies, IEEE INFOCOM, Apr 2003. [Acceptance rate: 21%].
- "Emulation-based Evaluation of an Architecture for Wide-Area Service Composition", Bhaskaran Raman and Randy H. Katz, International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS 2002), July 2002. [Acceptance rate: 60%].
- "The SAHARA Model for Service Composition Across Multiple Providers", Bhaskaran Raman, Sharad Agarwal, Yan Chen, Matthew Caesar, Weidong Cui, Per Johansson, Kevin Lai, Tal Lavian, Sridhar Machiraju, Z. Morley Mao, George Porter, Timothy Roscoe, Mukund Seshadri, Jimmy Shih, Keith Sklower, Lakshminarayanan Subramanian, Takashi Suzuki, Shelley Zhuang, Anthony D. Joseph, Randy H. Katz, Ion Stoica, *Invited Paper*, International Conference on Pervasive Computing (Pervasive 2002), Aug 2002.
- "Arguments for Cross-Layer Optimizations in Bluetooth Scatternets", Bhaskaran Raman, Pravin Bhagwat, and Srinivasan Seshan, Symposium on Applications and the Internet (SAINT'01), Jan 2001. [Acceptance rate: 18.5%].
- "Universal Inbox: Providing Extensible Personal Mobility and Service Mobility in an Integrated Communication Network", Bhaskaran Raman, Randy H. Katz, and Anthony D. Joseph, Workshop on Mobile Computing Systems and Applications (WMSCA'00), Dec 2000. [Acceptance rate: 37.7%].
- "ICEBERG: An Internet-core Network Architecture for Integrated Communications", Helen J. Wang, Bhaskaran Raman, Chen-nee Chuah, Rahul Biswas, Ramakrishna Gummadi, Barbara Hohlt, Xia Hong, Emre Kiciman, Zhuoqing Mao, Jimmy S. Shih, Lakshminarayanan Subramanian, Ben Y. Zhao, Anthony D. Joseph, and Randy H. Katz, IEEE Personal Communications, Aug 2000: Special Issue on IP-based Mobile Telecommunication Networks.
- "The ICEBERG Project: Defining the IP and Telecom Intersection", Bhaskaran Raman, Helen J. Wang, Jimmy S. Shih, Anthony D. Joseph, and Randy H. Katz, IT Professional, Nov/Dec 1999.
- "Online Dynamic Reordering for Interactive Data Processing", Vijayshankar Raman, Bhaskaran Raman, and Joseph M. Hellerstein, Proc. of the 25th International Conference on Very Large Databases (VLDB), September 1999. **(Selected one of the best papers).** [Acceptance rate: 16%].

Theses

- "An Architecture for Performance and Availability Constrained Service Composition in the Wide-Area Internet", Bhaskaran Raman, PhD Thesis, *In Preparation*.
- "Personal Mobility in the ICEBERG Integrated Communication Network", Bhaskaran Raman, Master's Thesis, EECS Department, U.C.Berkeley, May 1999.
- "A Portable User-Level Thread Package", Bhaskaran Raman, B. Tech Project Report, May 1997.

Selected Posters and Presentations

- "Service Encapsulation in ICEBERG", Presentation at Ericsson, End of the ICEBERG Review, Sweden, Jun 2001.
- "A Framework for Highly Available Internet Services", Bhaskaran Raman and Prof. Randy H. Katz, SIGCOMM'00 Student Poster Session, Aug 2000.
- "Universal Inbox for Personal Mobility and Service Mobility", Presentation at Ericsson, ICEBERG Project Review, Sweden, Aug 2000.
- "Walkthrough of ICEBERG V0.0 Release", Presentation at the Endeavour Retreat, Jun 2000.

Professional Activities

Student member of IEEE (Communications Society, Computer Society),
Student member of ACM
Refereed papers for ASPLOS 1998, ACM Mobicom 1998/1999/2000, WMCSA 2000, IEEE Infocom 2000/2001, IEEE Personal Communications Magazine 2001.

Honors

- Ranked 12th (100,000 total candidates) in the Joint Entrance Examination for admission to the Indian Institute of Technology - 1993
- Recipient of National Talent Scholarship (1991-1997)
- Placed among top 0.1% of students in Mathematics in All India Senior School Certificate Examination - 1991

Other Activities

I'm an active volunteer for "Asha for Education" (http://www.ashanet.org/), an organization that works to promote basic education in India.

References

- **Dr. Randy H. Katz**
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- **Dr. Anthony D. Joseph**
  Assistant Professor,
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- **Dr. Srinivasan Seshan**
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- **Dr. Pravin Bhagwat**
  Principal Architect, ReefEdge, Inc.
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  Computer Science & Engineering Department,
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PhD Thesis Summary

An Architecture for Performance and Availability Constrained Service Composition in the Wide-Area Internet

Service Composition offers flexible ways to quickly enable new application functionality by putting together existing components. Unix pipelining is a very simple example of composition. In my thesis, I focused on the scenario where there are multiple service providers that develop, implement, deploy, and manage different *component* services at different points on the Internet. Other portal providers *compose* a set of these services to enable new applications.

An example of such a model in today's Internet is the Yahoo portal making use of a third-party search engine to provide an end service to its subscribers. Such a model is likely to emerge given the importance of services in 3G+ networks. There are several multimedia applications that can built on this framework of composition – for instance, we built an application that was capable of reading out news to a cell-phone user, by composing a news source service with a text-to-speech conversion engine component.

While past work has addressed performance and fault-tolerance issues in service composition within a single service provider cluster, composition in our scenario brings up new challenges. Since service providers are independent, the components could be spread across the wide-area Internet. This makes it challenging to choose a *set* of service instances for a particular client session (more challenging than the problem of *single* web-mirror selection), based on current network and server performance. Further, studies by Labovitz et.al. have shown that Internet path availability can be very poor, and also inter-domain path recovery can take several minutes. Improving this availability by detecting and recovering from failures *quickly* is a challenge that I address in my work.

In my thesis, I have proposed and prototyped an architecture to address these performance and availability issues in service composition. My architecture is based on an overlay network of service execution platforms. The execution platforms form the middleware layer on which providers deploy their services. And the overlay network provides the context for exchange of network/server performance information exchange – this enables an "optimal" choice of service instances for client sessions. Further, the overlay network also allows detection of network path failures, and the subsequent choice of alternate service instances. Some of the key design features of this architecture are: (a) the separation of service location information from that of performance/liveness information, (b) the client session is setup as a virtual-circuit in the overlay network – this means that session recovery on failure need not depend on the propagation and stabilization of the failure information across the network, and (c) the use of soft-state to maintain the virtual circuit – this makes it easy to implement session tear-down in a distributed fashion.

I have built a prototype of the system, and evaluated it using an *emulation platform* – there is an actual implementation of the algorithms and interfaces, and the wide-area network characteristics are *emulated* to study issues of time-to-session-recovery, scaling, and stability. My evaluations show that multi-media sessions can be recovered within a few seconds after wide-area network failure. This represents a significant improvement over Internet-path recovery which takes several 10s of seconds to several minutes.