Sasikanth Avancha

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RESEARCH INTERESTS

Wireless networking, mobile computing and pervasive computing with emphasis on sensor networks, network security, service discovery and management, routing and transport protocols.

EDUCATION

Ph.D., Computer Science, (Expected Graduation Date: May 2005)
University of Maryland, Baltimore County (UMBC)
Dissertation title: A Holistic Approach to Secure Sensor Networks
Thesis advisor: Dr. Anupam Joshi

M.S., Computer Science, 2002
University of Maryland, Baltimore County (UMBC)
Thesis title: Enhancing the Bluetooth Service Discovery Protocol
Thesis advisor: Dr. Anupam Joshi

B.S., Computer Science and Engineering, 1994
Bangalore University, Bangalore, India

WORK & RESEARCH EXPERIENCE

Aug. 2002 to Present	Research Assistant	Computer Science and Electrical Engineering
Aug. 2000 to Feb. 2002		University of Maryland Baltimore County
Feb. 2002 to May 2002	Graduate Intern	Fujitsu Laboratories of America, Inc., College Park, MD
Aug. 1999 to Aug. 2000	Research Assistant	Diagnostic Radiology
		University of Maryland Medical School
Sep. 1997 to Aug. 1999	Senior Software Engineer	Peritus Software Services, Inc., Westborough, MA
Mar. 1996 to Sep. 1997	Systems Engineer	BFL Software Limited, Bangalore, India
Nov. 1994 to Mar. 1996	Project Assistant	Department of Instrumentation
		Indian Institute of Science, Bangalore, India

PUBLICATIONS

BOOK CHAPTERS

1. S. Avancha, J. Undercoffer, A. Joshi and J. Pinkston, "Security for Wireless Sensor Networks", Chapter 12 in Wireless Sensor Networks (C. S. Raghavendra et al. eds.), January 2004.
2. S. Avancha, D. Chakraborty, F. Perich and A. Joshi, "Data and Services for Mobile Computing", Practical Handbook of Internet Computing, (Munindar Singh ed.), CRC Press, November 2004.

REFEREED JOURNALS

3. S. Avancha, J. Undercoffer, A. Joshi and J. Pinkston, "Secure Sensor Networks for Perimeter Protection", Computer Networks, Vol. 43, No. 4, 421-435, November 2003.
4. S. Avancha, P. D'Souza, F. Perich, A. Joshi and Y. Yesha, "P2P M-Commerce in Pervasive Environments", ACM SIGecom Exchanges, Vol. 3, No. 4, pp. 1-9, January 2003.
5. S. Avancha, V. Korolev, A. Joshi, T. Finin and Y.Yesha, "On Experiments with a Transport Protocol for Pervasive Computing Environments", Computer Networks, Vol. 40, No. 4, pp. 515-535, November 2002.
6. L. Kagal, V. Korolev, S. Avancha, A. Joshi, T. Finin and Y. Yesha, "Centaurus: An Infrastructure for Service Management in Ubiquitous Computing", Wireless Networks, Volume 8, No. 6, pp. 619-635, November 2002.
7. T. Finin, A. Joshi, L. Kagal, O. Ratsimor, S. Avancha, V. Korolev, H. Chen, F. Perich and R. Scott Cost, "Intelligent Agents for Mobile and Embedded Devices", International Journal of Cooperative Information Systems, Vol. 11, Nos. 3&4, pp. 205-230, Sept./Dec. 2002.

MAGAZINE ARTICLES

8. S. Avancha, A. Joshi and T. Finin, "Enhanced Service Discovery in Bluetooth", IEEE Computer, Vol. 35, No. 6, pp 96-99, June 2002.

REFEREED CONFERENCES

9. S. Avancha, C. Patel and A. Joshi, "Ontology-driven Adaptive Sensor Networks", In Proc. The First Annual International Conference on Mobile and Ubiquitous Systems: Networking and Services, August 2004
10. F. Perich, S. Avancha, D. Chakraborty, A. Joshi and Y. Yesha, "Profile Driven Data Management in Pervasive Environments", In Proc. 13th International Workshop on Database and Expert Systems Applications, Aix-en-Provence, pp 361-370, September 2002.
11. B. Bethala, A. Joshi, D. Phatak, S. Avancha and T. Goff, "Simulation of a Common Access Point for Bluetooth, 802.11 and Wired LANs", In Proc. International Conference on Parallel and Distributed Processing Techniques and Applications, June 2002.
12. S. Avancha, D. Chakraborty, H. Chen, L. Kagal, F. Perich, T. Finin and A. Joshi, "Issues in Data Management for Pervasive Environments", In Proc. NSF Workshop on Context Aware Mobile Database management (CAMM), January 24-25, 2002.
13. D. Chakraborty, F. Perich, S. Avancha and A. Joshi, "An Agent Discovery Architecture using Ronin and DReggie", In Proc. 1st GSFC/JPL Workshop on Radical Agent Concepts (WRAC), January 2002.
14. D. Chakraborty, F. Perich, S. Avancha and A. Joshi, "DReggie: Semantic Service Discovery for M-Commerce Applications", In Proc. Workshop on Reliable and Secure Applications in Mobile Environments, 20th Symposium on Reliable Distributed Systems, October 28-31, 2001.
15. S. Avancha, V. Korolev and A. Joshi, "Transport Protocols in Wireless Networks", In Proc. 10th IEEE International Conference on Computer Communications and Networks, September 2001.
16. S. Avancha, D. Chakraborty, D. Gada, T. Kamdar and A. Joshi, "Fast and Efficient Handoff Scheme using Forwarding Pointers and Hierarchical Foreign Agents", In Proc. Conference on Design and Modeling of Wireless Networks, ITCom, August 2001.

POSTERS

17. A Framework for Secure, Adaptive Wireless Sensor Networks, IBM University Day, IBM Research Triangle Park, NC, February 2004

AFFILIATIONS

Student Member of the ACM
Student Member of the IEEE

PROFESSIONAL ACTIVITIES

Reviewed papers submitted to conferences and journals including

- Journal of Systems and Software
- IEEE Transactions on Mobile Computing
- IEEE International Conference on Pervasive Computing and Communications (PerCom)
- IEEE International Conference on Sensor and Ad Hoc Communications and Networks
- IEEE International Conference on Communications
- IEEE Wireless Communications and Networking Conference
- IEEE Infocom
- ACM International Conference on Mobile Computing and Networking

References available upon request

Research Summary

Sasikanth Avancha

I am a PhD Candidate in the Department of Computer Science and Electrical Engineering at UMBC and a member of the eBiquity Group. My research interests are primarily in the areas of wireless networks and network security, which I combined in my PhD dissertation on security and adaptivity of wireless sensor networks. As a member of the eBiquity Group I worked on empirically evaluating the performance of TCP in different wireless environments including cellular networks, WLANs and Bluetooth piconets. Results of this work appeared in the Computer Networks journal. I was also involved in the design of a service management infrastructure for pervasive environments. We reported results of this work in the Wireless Networks journal. For my M.S thesis, I designed and implemented enhancements to the Service Discovery Protocol in Bluetooth to enable semantic matching and allow service registration. I evaluated them empirically on actual Bluetooth devices. The results were published in the IEEE Computer magazine. My current research in wireless sensor networks focuses on designing secure and adaptive networks. Papers describing this work appeared in the Computer Networks journal and proceedings of Mobiquitous 2004, while others are under preparation. I have also co-authored book chapters on wireless sensor network security and mobile computing.

As a graduate intern at Fujitsu Laboratories of America, Inc., I was involved in the design and evaluation of a novel client-location-determination technique that uses IEEE 802.11b access points as beacons. Applications to patent this technique are pending in the U.S and Japan. Part of my research included analyzing Microsoft's UPnP specification for service discovery in a wireless home networking environment to determine the extent of enhancements required to enable semantic matching in the protocol. Based on my analysis, I suggested adding new primitives and modifying existing ones to enable semantic service discovery in UPnP.

Dissertation: A Holistic Approach to Secure Sensor Networks

The miniaturization of devices that can sense their surroundings and wirelessly communicate with the rest of the world is generating tremendous interest in wireless sensor networks (WSN). Sensor networks span a broad range of civilian and military applications relating to monitoring and control, including health care, habitat monitoring, building surveillance, battlefield reconnaissance and perimeter defense. Problems in WSN can be placed in one of four broad categories: networking, data management, energy consumption and security. Current research efforts are primarily focused on solving problems in the first two categories, applying energy minimization as a constraint. The fourth, security, has received minor attention compared to the others. The main drawback of a compartmentalized approach to WSN is that unlike high capability wired devices, sensors rarely have enough resources to allow security to be ``wrapped'' around existing networking or data management approaches. The algorithms for routing and data management also tend to be inflexible and cannot adapt to environmental changes which change security levels of individual nodes and the entire network.

I have taken a holistic approach to the problem and created a framework that enables one to design secure WSN that can employ any network, data and energy management solution, while operating in a flexible and adaptive manner with respect to their environments. To validate the framework and demonstrate its applicability to the design of secure WSN, I focus on the WSN adaptivity problem with respect to security. The first issue in this problem is to organize into a network in a secure, energy-efficient manner that is suitable to the application domain. My

solution to this issue consists of a set of centralized and distributed protocols. Each of these protocols enables sensor nodes to self-organize in a secure, energy-efficient manner commensurate with the needs of the application. The centralized protocol employs a limited number of tamper-resistant base stations to distribute keying material to sensor nodes for pair wise key establishment and to assist in network formation. In the distributed protocol, sensor nodes exchange keying material using temporary session keys to compute pair wise keys and subsequently exchange topology information. I have analyzed the performance of these approaches using simulations and shown that they are scalable and energy-efficient. I have also analyzed their security aspects and shown their resilience to node capture and node collusion.

The second issue is to ensure that the WSN is able to dynamically adapt to changes to its security environment and continue to serve its primary purpose. To address this issue I have designed a comprehensive set of parameters associated with a sensor node, a logical construct to help compute a sensor node's security state and a set of operational states associated with each security state. The parameters capture the raw security state of a sensor node at a given point in time and contain information related to the energy, sensor and communications components. Each parameter is associated with lower and upper bounds that prescribe the range of *normality*. Values of the parameter outside this range indicate abnormality and contribute to a possible change in the security environment. The logical construct combines the observed values of different parameters, derives logical conclusions based on the combinations and computes the current security state of a node. Based on its previous and current security states, the node chooses the most appropriate operational state and transitions to it. Performance evaluations of the adaptivity component are currently in progress.

The overall contributions of my research to the field of wireless sensor networks are in advancing the state-of-the-art of self-organization and sensor network adaptivity.

Directions for future research

I would like to pursue both short-term and long-term research goals upon completion of my dissertation.

My short-term research area would continue to be sensor network security and adaptivity. An important, open problem that extends my current research is to build a generic model for sensor network adaptivity. Adaptivity to variations in the physical environment and changes in node capabilities are issues that must be addressed in order to successfully deploy wireless sensor networks. Another interesting, open problem in WSN security research is to accurately detect node compromise and misbehavior in WSN. One of the issues in detecting node compromise and/or misbehavior is the rate of false alarms. Another issue is to ensure reliable and accurate detection of node compromise at low cost.

In the long-term I am interested in addressing interesting research problems in the areas of mobile, wireless and pervasive computing in conjunction with network security. Autonomic computing is a growing research area, which I believe is particularly relevant to wireless ad hoc and sensor networks. I would like to pursue interesting research issues such as self-healing, intrusion detection and re-organization in wireless ad hoc and sensor networks. Another area of research that I am interested in pursuing is secure mobility management across heterogeneous networks. One open problem in this area is to determine how to preserve security associations as mobile nodes in the network move across heterogeneous networks, so that they can continue to use network resources in a secure manner.

Statement of Teaching Philosophy

Sasikanth Avancha

I am very interested in teaching and am confident that I can perform the task competently. I have been a student for a decade of my life and a software engineer and researcher for over 5 years. I can honestly and with confidence say that my years of learning and being involved in research will stand me in good stead when I begin my career as a teacher. I believe that the experience I have gained from working with the software industry will help me provide students with an additional perspective of Computer Science study. My interactions with colleagues at work have helped me develop ways of effectively conveying ideas and concepts to others. I am comfortable with public speaking and quite experienced at giving presentations. Being a senior member of our research group and a PhD student, I have had the experience of mentoring junior students in their research efforts. I intend to gain teaching experience before graduating by assisting my advisor in teaching certain aspects of Operating Systems. I also intend to teach a course on Computer Networking in the summer semester this year.

As a student, I have experienced different teachers and their individual methods of teaching. One of the common characteristics I have found in my good teachers is that they constantly motivate me to think "outside the book". They have encouraged me to look at all sides of a particular problem and to try to validate or invalidate each idea before accepting a particular viewpoint. As a graduate research assistant, I am involved in discussions on various ongoing projects with other members of our research group. I have found that, during these discussions, my contribution is usually to encourage my colleagues to consider different views of a particular problem. This aspect, of encouraging students to take a broad, integrated view of what they learn in the classroom, will be the basis of my teaching philosophy.

I strongly believe that a sound grasp of fundamental concepts of any subject, especially topics in Computer Science, is essential. My goal will be to ensure that, at the end of every classroom meeting the students have grasped the principal points of the topic discussed. New ideas are usually formed through vigorous discussion on any subject. Topics in Computer Science are especially interesting enough to allow for in depth discussion sessions. In my job as a teacher, one of my roles will be that of a facilitator of classroom discussions. The vigor and level of discussion session would, I believe, be tempered by the class level. Senior and graduate level courses would be more discussion oriented than introductory courses in Computer Science. I know that constant interactions with my teachers and colleagues have helped me develop new ideas that were successfully validated. I intend to maintain a high level of interaction with my students, in and out of the classroom. I am comfortable teaching most undergraduate courses. My primary area of teaching interest is software systems. I have always enjoyed studying courses in the systems area like Operating Systems, Computer Networking and Software Engineering. I would, therefore, be very comfortable teaching these and similar courses like Systems Programming.

My primary areas of interest in Computer Science research include computer networking, mobile computing and pervasive systems including ad hoc networks and wireless sensor networks. As a research assistant to my advisor, I have worked on projects related to wireless networking and mobile computing. These are especially interesting and challenging fields of computer networking that I am interested in researching and teaching. With the exponential growth in the Internet and related technologies, I believe that knowledge of Computer Networking fundamentals is a very important requirement. I am interested in teaching both fundamental and advanced concepts of computer networking. I would also be happy to teach courses in mobile,

pervasive and ubiquitous computing. I would like to encourage students to gain hands-on experience with systems and protocols discussed in the classroom. I firmly believe that understanding the concepts behind a Computer Science topic cannot be complete unless one has examined the topic from a practical perspective. To this end, I would design my courses to be project-oriented. I would also be interested in working with students on individual or group research oriented projects that would allow students to acquire hands-on experience.