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Professional Preparation

- Post-Doctoral Studies, Computer Science, Institute for Advanced Computer Studies, University of Maryland, USA, September 1990
- Ph.D., Computer Science, The Center for Advanced Computer Studies, University of Louisiana, USA, July 1988.
- M.Sc.(Engg.), Dept. of Computer Science and Automation, Indian Institute of Science, Bangalore, India, December 1985.
- B.Tech., Dept. of Electrical Engineering, Indian Institute of Technology, Kanpur, India, May 1983.

Appointments

- July 2004 – present: Professor, Department of Computer Science, University of California, Davis, CA 95616.
- July 1999 – June 2004: Associate Professor, Department of Computer Science, University of California, Davis, CA 95616.
- January 1996 - June 1999: Assistant Professor, Department of Computer Science, University of California, Davis, CA 95616.
- September 1990 - December 1995: Member of the Technical Staff, Bell Communications Research, Red Bank, New Jersey 07701, USA.
- September 1988 - August 1990: Research Associate, Institute for Advanced Computer Studies, The University of Maryland, College Park, MD 20742, USA.
- July 1986 - July 1988: Research Assistant, The Center for Advanced Computer Studies, University of Louisiana, Lafayette, LA, 70504, USA.
- August 1983 - December 1985: Research Fellowship, Department of Computer Science and Automation, Indian Institute of Science, Bangalore, India.

Selected Publications (2004 - Present)

1. Ahmed Ahmedin, Kartik Pandit, Dipak Ghosal, Amitabha Ghosh, Exploiting Scalable Video Coding for Content Aware Downlink Video Delivery over LTE, Distributed Computing and Networking Lecture Notes in Computer Science Volume 8314, 2014, pp 423-437
2. Liu, Yu; Huynh, Minh; Mangla, Ashima; Ghosal, Dipak, "Performance analysis of adjustable discontinuous reception (DRX) mechanism in LTE network," Wireless and

Optical Communication Conference (WOCC), 2014 23rd , vol., no., pp.1,6, 9-10 May 2014

3. Nathan Hanford, Vishal Ahuja, Mehmet Balman, Matthew K. Farrens, Dipak Ghosal, Eric Pouyoul, and Brian Tierney. 2013. Characterizing the impact of end-system affinities on the end-to-end performance of high-speed flows. In Proceedings of the Third International Workshop on Network-Aware Data Management (NDM '13). ACM, New York, NY, USA,
4. Kartik Pandit, Dipak Ghosal, Member, IEEE, H. Michael Zhang, and Chen-Nee Chuah, Adaptive Traffic Signal Control With Vehicular Ad hoc Networks, IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 62, NO. 4, MAY 2013.
5. Rennie Archibald and Dipak Ghosal, A Covert Timing Channel Based on Fountain Codes," IEEE TrustCom, ACS Workshop, Liverpool, June, 2012.
6. Vishal Ahuja, Dipak Ghosal, Matt Farrens, "Minimizing the Data Transfer Time Using Multicore End-System Aware Flow Bifurcation," IEEE/ACM CCGRID, Ottowa, May, 2012.
7. Bojin Liu. Dipak Ghosal, Chen-Nee Chuah, H. Michael Zhang, "Reducing Greenhouse Effects via Fuel Consumption-Aware Variable Speed Limit (FC-VSL)" IEEE Transactions on Vehicular Technology, 2012.
8. Bojin Liu. Dipak Ghosal, Chen-Nee Chuah, H. Michael Zhang, "Analysis of the Information Storage Capability of VANET for Highway and City Traffic," Transportation Research Part C, Special Issue on Data Management in Vehicular Networks, 2012.
9. Abu S. Reaz, Vishwanath Ramamurthi, Massimo Tornatore, Suman Sarkar, Dipak Ghosal, and Biswanath Mukherjee, "Cost-Efficient Design for Higher Capacity Wireless-Optical Broadband Access Network (WOBAN)," Accepted for publication in Computer Networks, The International Journal of Computer and Telecommunications Networking, 2011.
10. Vishwanath Ramamurthi, Abu S. Reaz, Dipak Ghosal, Sudhir Dixit, and Biswanath Mukherjee,"Channel, Capacity, and Flow Assignment in Wireless Mesh Networks," Accepted for publication in Computer Networks, The International Journal of Computer and Telecommunications Networking, 2011.
11. V. Ahuja, A. Banerjee, M. Farrens, G. Serazzi, D. Ghosal, "Introspective End-system Modeling to Optimize the Transfer Time of Rate Based Protocols", In Proceedings of the 20th International ACM Symposium on High Performance Parallel and Distributed Computing, San Jose, CA, June 8-11, 2011.
12. Rennie Archibald, Cherita Corbett, Yali Liu, and Dipak Ghosal, "Diambiguating HTTP: Classifying Web Applications," In IWCMC-Traffic Analysis and Classification, July 2011, Istanbul, Turkey.
13. Haiping Liu, Xiaoling Qiu, Dipak Ghosal, Chen-Nee Chuah, Xin Liu, and Yueyue Fan, "Traffic-Tracing Gateway (TTG)," The30th IEEE International Conference on Computer Communications, IEEE INFOCOM 2011, April 10-15, Shanghai,China.
14. Bejrooz Khorashadi, Fred Liu, Dipak Ghosal, Chen-Nee Chuah, Michael Zhang, "Distributed Automated Incident Detection with VGrid," IEEE Wireless Communications, February, 2011.

15. Xiaoling Qiu; Haiping Liu; Dipak Ghosal; Biswanath Mukherjee; John Benko; Wei Li; Rashmi Bajaj, Enhancing the Performance of Video Streaming in Wireless Mesh Networks, Wireless Personal Communications, 56, no. 3 (2011): 535-557.
16. Yali Liu, Dipak Ghosal, Biswanath Mukherjee and Ahmad-Reza Sadeghi. Video Streaming Forensic - Content Identification with Traffic Snooping, 13th Information Security Conference (ISC 2010), Boca-Raton, Florida, October 25-28, 2010.
17. Andre Dragos, Massimo Tornatore, Chip Martel, Dipak Ghosal, Biswanath Mukherjee, Provisioning Subwavelength Multicast Sessions with Flexible Scheduling over WDM Networks, OSA/IEEE Journal of Optical Communication and Networking. 2010
18. Y. Liu, F. Armknecht, D. Ghosal, S. Katzenbeisser, A. Sadeghi, S. Schulz, "Robust and Undetectable Covert Timing Channels for i.i.d. Traffic," 12th Information Hiding Conferences (IH10), 2010.
19. Bojin Liu, Behrooz Khorashadi, Dipak Ghosal, Chen-Nee Chuah, Michael Zhang, "Assessing the VANET's Local Information Storage Capability under Different Traffic Mobility," 2010 IEEE INFOCOM, San Diego, CA.
20. Bojin Liu; Behrooz Khorashadi; Haining Du; Dipak Ghosal; Chen-Nee Chuah;VGSIM: AN INTEGRATED NETWORKING AND MICROSCOPE VEHICULAR MOBILITY SIMULATION PLATFORM, IEEE communications Magazine. 47, no. 5, (2009): 134.
21. Yali Liu, Frederik Armknecht, Dipak Ghosal, Stefan Katzenbeisser, Ahmad-Reza Sadeghi, Steffen Schulz, Hide and Seek in Time - Robust Covert Timing Channels, 14th European Symposium on Research in Computer Security Saint Malo, France | September 21-25, 2009.
22. Xiaoling Qiu, Haiping Liu, Dipak Ghosal, Biswanath Mukherjee, John Benko, Wei Li, and Rashmi Bajaj, Adaptive Video Compression Rate Optimization in Wireless Access Network, in The 34th IEEE Conference on Local Computer Networks (LCN), Zürich, Switzerland, October 21-23, 2009.
23. A. Banerjee, W.-C. Feng, D. Ghosal, and B. Mukherjee, Algorithms for Integrated Routing and Scheduling for Aggregating Data from Distributed Resources on a Lambda Grid, IEEE Transactions on Parallel and Distributed Systems, vol. 19, no. 1, pp. 24-34, January 2008.
24. H. Du, M. Zhang, C-N. Chuah, and D. Ghosal, A Finer Resolution Cellular Automata Model for Inter-Vehicle Communication Applications, Transportation Research Board 2008 Annual Meeting, pp 13, January 2008.
25. Y. Liu, K. Chiang, C. Corbett, R. Archibald, B. Mukherjee, and D. Ghosal, A Novel Audio Steganalysis Based on High-Order Statistics of a Distortion Measure with Hausdorff Distance. Information Security Conference (ISC) 2008, pp. 487-501.
26. Y. Liu, C. Corbett, K. Chiang, R. Archibald, B. Mukherjee, D. Ghosal, Detecting Sensitive Data Exfiltration by an Insider Attack, Proc. the 4th Annual Workshop on Cyber Security and Information Intelligence Research (CSIIRW '08), pp. 1-3, New York, 2008.
27. A. S. Reaz, V. Ramamurthi, D. Ghosal, J. Benko, W. Li, S. Dixit, and B. Mukherjee, Enhancing Multi-hop Wireless Mesh Networks with a Ring Overlay, IEEE WiMesh, San Francisco, June 16, 2008.
28. C-N. Chuah, H. Du, D. Ghosal, B. Khorashadi, B. Liu, C. Smith, and H. M. Zhang, Distributed Vehicular Traffic Control and Safety Applications with VGrid, IEEE Wireless Hive Networks Conference, Austin, TX, August, 2008.

29. V. Ramamurthi, A. S. Reaz, D. Ghosal, and B. Mukherjee, MIMO-based Rate Adaptation to Enhance TCP Throughput over Wireless fading Channels, IEEE Globecom 2008,New Orleans, LA, Nov. 30 - Dec. 3, 2008.
30. .J. Yick, B. Mukherjee, and D Ghosal, Wireless sensor network survey, Computer Networks, Volume 52, Issue 12, 22 August 2008, Pages 2292-2330
31. J. Yick, B. Mukherjee, and D. Ghosal, Distributed target tracking and boundary estimation in wireless sensor networks, International Journal of Autonomous and Adaptive Communications Systems, Volume 1, Number 3 / 2008, Pages: 308 - 331.
32. A. S. Reaz, V. Ramamurthi, S. Sarkar, D. Ghosal, S. Dixit, and B. Mukherjee, "CaDAR: an Efficient Routing Algorithm for Wireless-Optical Broadband Access Network," Proc., IEEE International Conference on Communications (ICC) '08, Beijing, China, May 2008.
33. Y. Liu, C. Ou, Z. Li, C. Corbett, B. Mukherjee, D. Ghosal, "Wavelet-Based Traffic Analysis for Identifying Video Streams over Broadband Networks," IEEE Global Communications Conference (GLOBECOM), Nov., 2008 .
34. A. S. Reaz, V. Ramamurthi, S. Sarkar, D. Ghosal, B. Mukherjee, "Hybrid Wireless-Optical Broadband Access Network (WOBAN): Capacity Enhancement for Wireless Access", accepted for publication in IEEE Globecom 2008,New Orleans, LA, Nov. 30 - Dec. 3, 2008.
35. H. Du, M. Zhang, C-N. Chuah, and D. Ghosal, "A Finer Resolution Cellular Automata Model for Inter-Vehicle Communication Applications," Transportation Research Board 2008 Annual Meeting, 13 pp, January 2008.
36. V. Pandey, D. Ghosal, B. Mukherjee, and X. Wu, "Call admission and handoff control in multi-tier cellular networks: algorithms and analysis," Wireless Personal Communications, vol. 43, no. 3, pp. 857-878, Nov. 2007.
37. B. Khorashadi, A. P. Chen, C. –Nee Chuah, D. Ghosal, "Impact of power on the performance of TCP in vehicular ad hoc networks," Invited Paper, Fourth Annual Conference on Wireless On demand Network Systems and Services, January 24-26, 2007, Obergurgl, Austria.
38. J. Yick, G. Pasternack, B. Mukherjee, and D. Ghosal, Placement of network services in a wireless Sensor Network, International Journal of Wireless and Mobile Computing, 2007.
39. J. Yick, B. Mukherjee, and D. Ghosal, Mobile Target Tracking with Boundary Estimation Using Wireless Sensor Networks, under review in Journal of Ad Hoc Networks.
40. V. Pandey, D. Ghosal, B. Mukherjee, Call Admission and Handoff Control in Cellular Wireless Networks, under review in International Journal Wireless Personal Communication.
41. V. Pandey, D. Ghosal and B. Mukherjee, Pricing-Based Approaches in the Design of Next-Generation Wireless Networks: A Review and a New Proposal, under review in IEEE Communications Surveys and Tutorials.
42. A. Banerjee, D. Ghosal, B. Mukherjee, and W. Feng, Algorithms for Integrated Routing and Scheduling for Aggregating Data from Distributed Resources on a Lambda Grid" under review for publication in IEEE Transaction on Parallel and Distributed Systems.
43. A. Banerjee, D. Ghosal, and B. Mukherjee, Modeling and Analysis to Estimate the End-System Performance Bottleneck Rate for High-Speed Data Transfer, Fifth International Workshop on Protocols for Fast Long-Distance Networks (PFLDNet) 2007, Los Angeles.

44. Dragos Andrei, Dipak Ghosal and Biswanath Mukherjee, “A High-Performance Online Cooperative File-Transfer Mechanism over Lambda Grids,” under review in International Communications Conference (ICC) 2007.
45. Dragos Andrei, Biswanath Mukherjee, and Dipak Ghosal, “Online Scheduling of Large File Transfers over Lambda Grids,” under review in International Communications Conference (ICC) 2007.
46. A. Banerjee, W. Feng, B. Mukherjee, and D. Ghosal, RAPID: An End-System Aware Protocol for Intelligent Data-Transfer over Lambda-Grids, in the Proceedings of the IEEE/ACM International Parallel and Distributed Processing Symposium (IPDPS 2006), Rhode Island, Greece, April 2006.
47. A. Banerjee, W. Feng, B. Mukherjee, and D. Ghosal, "End-system Performance Aware Transport over Optical Circuit-Switched Connections," IEEE INFOCOM High-Speed Networking Workshop: The Terabits Challenge, April 2006.
48. N. Rao, Q. Wu, S. Carter, W. Wing, A. Banerjee, D. Ghosal, and B. Mukherjee, "Control Plane for Advance Bandwidth Scheduling in Ultra High-Speed Networks," IEEE INFOCOM High-Speed Networking Workshop: The Terabits Challenge, April 2006.
49. A. P. Chen, B. Khorashadi, C.-Nee Chuah, D. Ghosal, and H. M. Zhang, “Smoothing Vehicular Traffic Flow using Vehicular-based Ad Hoc Networking & Computing Grid (VGrid),” IEEE ITSC 2006, September 17-20, 20006, Toronto, Canada.
50. B. Khorshadi, X. Liu, and D. Ghosal, Determining the Peer Resource Contributions in a P2P Contract, Second International Workshop on Hot Topics in Peer-to-Peer Systems (HOT-P2P 2005), San Diego, California, July 2005.
51. S. Narayan, J. Pandya, P. Mohapatra, and D. Ghosal, Analysis of Windowing and Peering Schemes for Cache Coherency in Mobile Devices, International Conference on Networking, Waterloo Canada, May 2005.
52. S. Mueller and D. Ghosal, Analysis of a Distributed Algorithm to Determine Multiple Routes with Path Diversity in Ad Hoc Networks, 3rd Intl. Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks, WiOpt 2005, Riva del Garda, Trentino, Italy, April 3 - 7, 2005.
53. J. LeBrun, C.-N. Chuah, D. Ghosal, and H. M. Zhang, Knowledge-Based Opportunistic Forwarding in Vehicular Wireless Ad Hoc Networks, IEEE 61st Vehicular Technology Conference VTC 2005 Spring, 29th May - 1st June, Stockholm, Sweden.
54. J. Anda, J. LeBrun, D. Ghosal, C.-N. Chuah and M. Zhang, VGrid: Vehicular AdHoc Networking and Computing Grid for Intelligent Traffic Control, IEEE 61st Vehicular Technology Conference VTC 2005 Spring, 29th May - 1st June, Stockholm, Sweden.
55. A. Banerjee, W.-C. Feng, B. Mukherjee, and D. Ghosal, Routing and Scheduling Large File Transfers over Lambda Grids, Third International Workshop on Protocols for Fast Long-Distance Networks PFLDNet 2005, February 3,4 2005,Lyon France.
56. V. Pandey, D. Ghosal, and B. Mukherjee, Exploiting User Profiles to Support Differentiated Services in Next-Generation Wireless Networks. IEEE Network Magazine, September 2004.
57. H. C. Chang, H. Du, J. Anda, C.-Nee Chuah, D. Ghosal, and H. M. Zhang. Enabling Energy Demand Response with Vehicular Mesh Networks, in Sixth IFIP IEEE International Conference on Mobile and Wireless Communication Networks, October 25-27, Paris, France.

58. A. Banerjee, N. Singhal, J. Zhang, D. Ghosal, C. -N Chuah, and B. Mukherjee, A Time–Path Scheduling Problem (TPSP) for Aggregating Large Data Files from Distributed Databases using an Optical Burst-Switched Network, in International Communication Conference (ICC), Paris, 2004.
59. X. Wu, B. Mukherjee, and D. Ghosal, Hierarchical Architectures in the Third Generation Cellular Network, in IEEE Wireless Communication Magazine, June 2004.
60. V. Ponduru, B. Mukherjee, and D. Ghosal, A Distributed Coverage-Preserving Multipath Routing Protocol in Wireless Sensor Networks, Technical Report, Department of Computer Science, University of California, Davis, March 2004.
61. D. Ghosal, B. Poon, and D. Ghosal, Analysis of Implementation Strategies for Resource and Service Exchange Using P2P Contracts, Technical Report, Department of Computer Science, University of California, Davis, March 2004.
62. J. P. Pandya, P. Mohapatra, and D. Ghosal, Asymptotic Analysis of a Peer Enhanced Cache Invalidation Scheme, in Proceeding WiOPT: Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks 24th - 26th of March, 2004, University of Cambridge, UK.
63. J.Yick, A. Bharatidhasan, B. Mukherjee, G. Pasternack, and D. Ghosal, Optimizing Placement of Beacons and Data Loggers in a Sensor Network, in Proceedings Wireless Communications and Networking Conference (WCNC) 2004, Atlanta, March 24-26, 2004.
64. D. Ghosal, B. Poon, and K. Kong, P2P Contracts: A Framework for Resource and Service Exchange, Future Generation Computer Systems, Special issue on Peer-to-Peer Networks, 2004.
65. S. Mueller and D. Ghosal, Multipath Routing in Mobile Ad Hoc Networks: Issues and Challenges, Invited paper in Lecture Notes in Computer Science, Edited by Maria Carla Calzarossa and Erol Gelenbe, 2004.

Patents and Trademarks

Teaching

Undergraduate Courses

ECS 10 – Basics Concepts of Computing: The class should teach students to write programs in the Python programming language, including the features of Python described below. After completing the class, students should be well-prepared for course 30 and for independent programming projects.

ECS 132 – Probability and Statistics for Computer Science: Univariate and multivariate distributions. Markov models. Sampling, estimation and model building. Regression analysis. Applications to data mining, networks, disk systems, security, software engineering and bioinformatics.

ECS 152A - Computer Networks: This course educates the student on the physical aspects of data transmission, on the protocols at the data-link level, on the seven-layer model (and the functions of the various layers) of the ISO Open System Interconnection Model, on transport and application level protocols, and on the principles in local area networks (LANs) and wide area networks (WANs). At the end of the course, students are able to understand the underlying principles in computer networks, and to

develop network applications and interfaces with reasonable effort. They are also prepared to undertake an in-depth study of local and wide area networks dealing with their access mechanisms, performance evaluation methodologies, and related issues.

ECS 152B - Computer Networks: This course is a follow-on to ECS 152A. While ECS 152A deals with the fundamental principles of networking and concentrates on the lower layers of the protocol stack, ECS 152B is devoted to upper-layer protocols, in particular on the development of software that are used in computer networks. The course provides the required basics that are needed to develop networking software along with case studies of several networking applications. Students understand how to design and develop networking software and determine where improvements can be made by critically examining some existing applications. Through a number of assignments/ projects, students gain hands-on experience by developing a number of simple network protocols and applications on an experimental Ethernet network in the Computer Science Department's Instructional Facility.

Graduate Level Courses

ECS 252: This is the core graduate level course in computer networks. The course educates the student on the principles in circuit and packet switched (wide area) networks as well as broadcast (local area and satellite) networks, on the principles of transport, network and data link layer protocols, on the design issues in computer networking applications. At the end of the course, students will be able to understand the underlying principles in computer networks, and to design and analyze network architectures. They will also be prepared to start research work in local and wide area networks dealing with their access mechanisms, routing algorithms, performance evaluation methodologies, and related issues. Students will gain experience in the design and analysis of network protocols through simulation and analytical models.

ECS 257: While ECS 252 is the core graduate course in computer networks and deals with the fundamental principles of networking, ECS 257 is devoted to mobile and wireless networks, in particular, on the protocols and architectures of existing and emerging wireless networks. The course will develop the fundamental concepts in wireless networks; the different access technologies, handoff control and mobility management protocols, and existing and emerging applications. Through assignments, and projects, the students will learn the key design issues in wireless networks supporting traditional voice applications as well as Personal Communication Services (PCS) and new multimedia applications. This course will prepare the students to start research in the area of the mobile and wireless networks.

ECS 256: Analytical Techniques for Design and Analysis of Computer and Communication System. In this course we study analytical and simulation techniques to evaluate computer and communication systems. The analytical techniques are based on queueing theory and simulation technique is on discrete event simulation models. The course emphasize application of these techniques in real computer and communication system design.

Professional Activities

- General Chair of 14 Information Hiding Conference, Berkeley, CA, May 15-18.
- Served in many NSF and UC Core panels
- Program committee member of various computer networking conferences.
- Consultant to AT&T Labs.

Current Research Projects

INTIME: This National Science Foundation (NSF) project investigates optimizing network transfers using introspective modeling of end-systems. The bottleneck for the transferring data at very high speeds often turns out to be the end-system performance. In the absence of definitive knowledge about the workload at the receiving end-system, the sender's transmission rate often overshoots the critical bottleneck rate of the receiver. This typically results in oscillations between the extremes and poor performance. To optimize the performance of the transport protocols and achieve the important flow control functionality, it is important to estimate the receiving end-system effective bottleneck rate. In this project we will use modeling and active analysis of the end-system to estimate this rate. We will develop queueing network models for representing the different multi-core and multiprocessor end-systems running different types of workloads. We will develop a software tool to be integrated with existing transport protocols. We will carry out experimental analysis for different types of end-systems with different configurations and workloads. We will apply and extend methods that have been proposed to address the limitations of queueing network models for performance analysis of computer systems with bursty workloads and correlated service times. The software tool will be made available to the research community to analyze and optimize distributed applications and systems. The research project will provide a framework to train graduate and undergraduate students in both analytical and experimental methods, and develop knowledge and intuition about next generation computer systems and distributed applications.

PPNS: A wide variety of network security application (malware detection, rule-based network intrusion detection, covert channel detection, etc.) require packet inspection and processing. The processing is required not only on individual packets but also on sequences of packets and across flows to detect security policy breaches and attacks. Performing these functions at very high network line rates (10 Gbps now and soon scaling up to 40 to 100 Gbps) is critical to safeguarding enterprise networks. Solutions based on the use of Field Programmable Gate Arrays (FPGA's) and/or multi-core CPUs have limitations with regards to performance, flexibility, power, and programmability. In this research project, we propose to investigate the applicability of MPPA (Massively Parallel Processing Array) architectures to scale packet processing and analysis tasks to meet the security challenges presented by next generation high-speed networks. MPPA based parallel processing devices have a number of advantages that make them particularly attractivefor parallelizing stream-based data-intensive computation. For example, they use a large number of low clock rate processors, which allows them to provide significant computing capability while consuming relatively little power. Furthermore, these devices provide a processor interconnection topology that guarantees bounded communication delays between processors. Additionally, since the interconnection network is programmable, it enables optimizing the parallel implementation of algorithms by programming the interconnection to match the parallelism in the algorithm. Finally, the MPPA devices provide high-level language support that can make programming these devices much easier than FPGA based systems.

The technical merits of this NSF project are the following: 1) We will carry out a comparative analysis of different MPPA architectures for network security applications. Important aspects for comparison will be the programmability of the processor interconnection network, the performance of the inter-processor communication, and the amount and configuration of the on-chip memory. The delay guarantees on the communication between processors far apart in the grid will determine the communication synchronization trade-off and hence how the algorithms can be parallelized. 2) We will build upon our preliminary work and design parallel implementations of algorithms that are required in many different network security applications. These include 1) the K-means clustering algorithm used in traffic classification, 2) the entropy computation algorithm used in anomaly detection, 3) pattern matching used in rule-based network intrusion detection, and 4) encryption and decryption acceleration engines. We will investigate how these algorithms can be parallelized in a MPPA architecture and study the scalability issues. A key constraint in the current generation MPPA devices is the amount of local memory — thus we will design implementations that can tolerate a limited amount of memory. We will consider different implementations of the network security applications and compare their performance in terms of throughput and the accuracy of detection. 3) The research will have a major experimental component. We will acquire an MPPA device and build a testbed

system. We will develop appropriate interfaces between the MPPA device and a network link or a high-performance disk system that will allow both network traffic based and trace driven analysis of the parallel algorithms. We will develop a resource management algorithm that can effectively allocate the resources in the MPPA device among multiple concurrent security applications.

Names advisors, advisees, and collaborators

- Ph.D. advisor: Dr. Laxmi N. Bhuyan, Chair and Professor of Department of Computer Science, University of California, Riverside.
- Post-doctoral advisor: Dr. Satish K. Tripathi, President University at Buffalo, Buffalo, NY.
- Advisees: Richard Bromley, Ross Gegan, Yu Liu, Kartik Pandit Rennie Archibald, Vishal Ahuja, Sayeem Abu Reaz, Vishwanath Ramamurthi, Amitabha Banerjee, Behrooz Khorashadi, Jennfer Yick, Stephen Mueller, Archana Bhratidhasan, Vijay Ponduru, Brennen Reynolds, Julee Pandya, Jeremy Abramsom, James Xiao-yan Fang, Keith Kong, Vijoy Pandey, Sujatha Balaraman, Xiaoxin Wu, Raja Mukhopadhaya, Ashok Swamy, Arijit Mukherji, Narana Kannappan (Total number of Phd students 15, Total number of MS students 10, Total number of post-doc students 1).
- Research Collaborators: Mung Chaing (Princeton University), Sam Ou (AT&T), Zhi Li (AT&T), Rose Tsang (Sandia Labs), Biswanath Mukherjee (UC Davis), Michael Zhang (UC Davis), Wu-Chun Feng (LANL), Chen-Nee Chuah (UC Davis), Xin Liu (UC Davis), Greg Pasternack (UC Davis), Prasant Mohapatra (UC Davis), Felix Wu (UC Davis), Randy Katz UC Berkeley), Rajeev Motwani (Stanford University), Matthew Caesar (UC Berkeley), T. V. Lakshman (Bell Labs), Debanjan Saha (IBM TJW), Satish Tripathi (SUNY Buffalo), Erol Gelenbe (Imperial College), Guiseppe Serazzi (Milan Politechnic).