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APPOINTMENT

- Assistant Professor   Aug. 2009 - present
  Lehigh University

- Visiting Post-Doctoral Associate   Sep. 2007 - Aug. 2009
  University of California, Berkeley
  Advisor : Prof. Venkat Anantharam

EDUCATION

- Ph.D in Electrical and Computer Engineering   Aug. 2007
  Cornell University, Ithaca, NY
  Dissertation Title: Communication, Compression and Confidentiality in Wireless Sensor Networks
  Advisor : Prof. Lang Tong

- B.Tech. in Electrical Engineering   Jul. 2002
  Indian Institute of Technology (IIT) - Madras, India

RESEARCH INTERESTS

Security and Privacy in Cyber Physical Systems, Statistical Signal Processing, Information Theory, Network Science, Distributed Statistical Inference, Multiaccess Communication.

ACADEMIC HONORS

- Received an NSF CAREER Award in 2012 to pursue research in Anonymity in Networked Systems.

- Awarded a P. C. Rossin Assistant Professorship of Engineering at Lehigh University in 2010.

- Received an **IEEE Best Student Paper Award** at the 2006 IEEE International Conference on Acoustics, Speech and Signal Processing.

- Received the **2004 Leonard G Abraham Award** from the IEEE Communication Society along with Srihari Adireddy and Prof. Lang Tong.

RESEARCH EXPERIENCE

- **Assistant Professor at Lehigh University: Aug. 2009 - present**
  Privacy in Dynamical systems[J1][C1-C4]
  Tradeoffs between privacy and utility are observed in several cyber physical systems, notably healthcare, financial and smart energy grids. In particular, the vulnerability of observed network activity to timing analysis is a critical issue in such systems. Protection against this information retrieval would require distortion/delay of the transmitted data, which would in turn reduce the utility for the consumer. We use our analytical framework to quantify the privacy of activity, and understand the fundamental tradeoff between privacy and utility in such dynamical systems.

Game-Theoretic Approach to Anonymous Networking[J8, J9][C5, C15-C17]
We study the anonymity in networking when an unknown fraction of links are monitored by an adversary. We pose this problem as a two-player game— the goal of the adversary is to choose a subset of links to monitor and the goal of the network designer is to choose a subset of relays to act covertly— and study the existence of Nash equilibria strategies.

Anonymity in Resource Constrained Systems[J2, J3][C6-C11]
Under constraints on resources such as memory and energy, it is known that existing anonymous systems are vulnerable to timing analysis. We study the maximum achievable anonymity under resource constraints using information theoretic and signal processing tools. We demonstrate that the analytical approach provides significant gains over the state-of-the-art Chaum mixing systems for anonymous networking. We also provide the relationship between achievable anonymity and the network topological parameters to facilitate optimal design of anonymous systems.

Protecting against Router based Traffic Analysis in Packet Networks[J4-J7, C9, C11]
When common resources such as routers are shared by multiple users in a network it is possible to use return times to identify the pattern of traffic flow and consequently the websites being accessed. We study the design of novel router policies that prevent the inference of such traffic activity without compromising the packet delay.

- **Post-Doctoral Associate, Cornell University: Sep. 2007 - Aug. 2009**

  Source Anonymity using Mix Networks [C18,C19]
  In collaboration with Prof. Venkat Anantharam, we studied the information theoretic analysis of source anonymity under latency constraints. We consider the optimal design of networks of Chaum mixes (proxy servers or relay nodes) to obfuscate the interarrival times of packets so that an external eavesdropper cannot determine the source of any transmitted packet. Using an entropy based measure of anonymity, we designed mixing strategies and characterize bounds on the fundamental trade-off between anonymity and latency in arbitrary mix networks.

  Incentivizing Anonymous Peer-to-peer Reviews [C20]
  In collaboration with Prof. Anant Sahai, we consider the problem of reducing delays in peer-review of journal submissions by incentivizing the timely review of papers. We proposed a public reputation system that provides an incentive for fast review, but could reduce the anonymity of the reviewers. Using an information theoretic measure of anonymity, we introduce distortions to user reputations, and explore the tension between the two objectives of the system, namely low delay and high anonymity.

- **Graduate Student at Cornell University: 2003-2007**

  Anonymity of Routes in Ad Hoc Wireless and Sensor Networks [J10, J11], [C21-C26]
  We consider the problem of hiding routes of traffic flow in a wireless multihop network. Using information-theoretic equivocation to quantify the anonymity of routes, we designed forwarding strategies for individual relays to decorrelate the routing information from observeable network traffic. Using ideas from channel coding and lossy source coding, we characterize tradeoffs between achievable network throughput, delay and the anonymity of routes.

  Coding and Communication for Distributed Inference in Sensor Networks [J12-J15], [C27-C33].
  - We consider the problem of source coding for distributed parameter estimation in large sensor networks. Parallel to the optimality of likelihood ratio quantizers in distributed detection, we developed the notion of *score-function quantizers* which provided similar performance benchmarks in the context of distributed estimation. We applied this to distributed estimation in a large scale sensor network, where sensors have access to a few measurements, and the quality of the quantizer is measured by the asymptotic relative efficiency between quantized and unquantized estimators. We show that for a sizeable class of distributions, the optimal set of score-function quantizers for sensor nodes can be computed efficiently.

Parvathinathan (Parv) Venkitasubramaniam

TEACHING EXPERIENCE

- **Instructor** Circuits and Systems. An undergraduate level course in Electrical Engg. at Lehigh University.

- **Instructor** Fundamentals of Information Theory. A graduate level course in Electrical Engg. at Lehigh University.

- **Instructor** Fundamentals of Data Networks. A graduate level course in Electrical Engg. at Lehigh University.

PROFESSIONAL ACTIVITIES

- Associate Member of IEEE Sensor and Multichannel Signal Processing Committee

- Co-Organizer for the Cyber Security and Privacy Symposium at IEEE GlobalSIP 2013.

- Technical Program Committee Member of IEEE DCOSS 2010, IEEE MILCOM 2010, 2011, 2012, IEEE ICASSP 2012, IEEE PIMRC 2010, 2011, 2013.

- Reviewer for IEEE Trans. on Information Theory, IEEE Trans. Wireless Communication, IEEE Journal for Selected Areas in Communication, IEEE Trans. Signal Processing.

PUBLICATION LIST

Journal Publications

[J1] C. Chen, L. He, **P. Venkitasubramaniam**, S. Kishore and L. Snyder, "Achievable Privacy in Aggregate Residential Energy Management Systems," submitted to *ASCE Journal of Energy Engineering*, June 2013.

[J2] **P. Venkitasubramaniam** and A. Mishra, "Anonymity of Mix Networks under Memory Limitations: An Information Theoretic Perspective," submitted to *IEEE Transactions on Information Theory*, Aug. 2013.

[J3] A. Mishra and **P. Venkitasubramaniam**, "Anonymity and Fairness in Packet Scheduling: A Quantitative Tradeoff," submitted to IEEE Transactions on Networking, Nov. 2012.

[J4] X. Gong, N. Kiyavash and **P. Venkitasubramaniam**, "Information Theoretic Analysis of Side Channel Information Leakage in FCFS Schedulers," submitted to IEEE Transactions on Information Theory, Nov. 2012.

[J5] S. Kadloor, N. Kiyavash and **P. Venkitasubramaniam**, "Mitigating Timing based Information Leakage in Shared Schedulers," submitted to IEEE Transactions on Networking, Oct. 2012.

[J6] S. Kadloor, **P. Venkitasubramaniam** and N. Kiyavash, "A Statistical Inference Approach to Preventing Timing Analysis in Networks," accepted to IEEE Signal Processing Magazine, Apr. 2013.

[J7] S. Kadloor, N. Kiyavash and **P. Venkitasubramaniam**, "Designing Router Scheduling Policies: A Privacy Perspective," IEEE Transactions on Signal Processing, Vol. 60, Issue 4, April 2012.

[J8] A. Mishra and **P. Venkitasubramaniam**, "Admissible Length Study in Anonymous Networking: A Signal Processing Perspective," accepted to IEEE Journal for Selected Areas in Communication: Special Issue on Signal Processing Techniques for Wireless Physical Layer Security, Mar. 2013.

[J9] **P. Venkitasubramaniam** and L. Tong, "A Game Theoretic Approach to Anonymous Networking," IEEE/ACM Transactions on Networking, Vol. 20, Issue 3, pp. 892 – 905, June 2012.

[J10] **P. Venkitasubramaniam**, T. He and L. Tong, "Anonymous Networking amidst Eavesdroppers," *IEEE Transactions on Information Theory: Special Issue on Information Theoretic Security*, Vol. 54, No 6, pp. 2770-2784, June 2008.

[J11] **P. Venkitasubramaniam**, T. He, L. Tong and S. Wicker, "Towards an Analytical Approach to Anonymous Wireless Networking," *IEEE Communications Magazine: Special Issue on Security in Ad Hoc Wireless Networks*, Vol. 46, No 2, pp. 140-146, Feb. 2008.

[J12] **P. Venkitasubramaniam**, L. Tong and A. Swami, "Quantization for Maximin ARE in Distributed Estimation," *IEEE Transactions on Signal Processing*, Vol. 55, Issue 7, Part 2, July 2007, pp. 3596-3605.

[J13] **P. Venkitasubramaniam**, S. Adireddy and L. Tong, "Sensor Networks with Mobile Access: Optimal Random Access and Coding," *IEEE Journal on Selected Areas in Communications*, Vol. 22 , Issue: 6 , Aug. 2004, pp. 1058 - 1068.

[J14] L. Tong, V. Naware and **P. Venkitasubramaniam**, "Signal Processing in Random Access: A Cross-Layer Perspective," *IEEE Signal Processing Magazine*, Vol. 21 , Issue: 5 , Sept. 2004, pp. 29-39.

[J15] **P. Venkitasubramaniam**, S. Adireddy and L. Tong, "Sensitivity and Coding of Opportunistic ALOHA for Sensor Networks with Mobile Access," *Journal of VLSI Signal Processing*, Vol. 41, No. 3, pp. 329-344, Nov. 2005.

Conference Publications

[C1] **P. Venkitasubramaniam**, "Privacy in Stochastic Control: A Dynamic Programming Framework," accepted to *2013 Allerton Conference on Communications, Control and Computing*, Monticello, IL, Oct 2013.

[C2] J. Yao and **P. Venkitasubramaniam**, "The Privacy Cost Tradeoff of an In-Home Storage Mechanism," accepted to *2013 Allerton Conference on Communications, Control and Computing*, Monticello, IL, Oct 2013.

[C3] **P. Venkitasubramaniam**, "Privacy in Decision Making: A Markov Decision Process Perspective," accepted to *2013 IEEE Conference on Decision and Control (CDC)*, Dec. 2013.

[C4] J. Yao and **P. Venkitasubramaniam**, "On the Privacy of Variable Bit Rate Coding," in Proc. *2013 IEEE International Conference on Accoustics, Speech and Signal Processing (ICASSP)*, Vancouver, Canada, May 2013.

[C5] Abhishek Mishra and **P. Venkitasubramaniam**, "Thwarting Traffic Analysis: A Signal Processing Perspective," in Proc. *2012 IEEE Sensor and Multichannel Signal Processing Conference*, Hoboken, NJ, June 2012.

[C6] Abhishek Mishra and **P. Venkitasubramaniam**, "Anonymity of a Buffer Constrained Chaum Mix: Optimal Strategy and Asymptotics," in Proc. *2013 IEEE International Symposium on Information Theory (ISIT)*, Istanbul, Turkey, July 2013.

[C7] Abhishek Mishra and **P. Venkitasubramaniam**, "Anonymity in Fair Scheduling: A Case for the Proportional Method," in Proc. *IEEE Conference on Communication*, June 2012.

[C8] Abhishek Mishra and **P. Venkitasubramaniam**, "Anonymity in Packet Scheduling under Max-Min Fairness Criterion," in Proc. *2012 Conference on Information Systems and Sciences*, Mar. 2012.

[C9] Abhishek Mishra and **P. Venkitasubramaniam**, "Anonymity of an Almost Fair Chaum Mix," in Proc. *50th Annual Allerton Conference on Communication, Control and Computing*, Monticello, IL, Sep. 2011.

[C10] Abhishek Mishra and **P. Venkitasubramaniam**, "Anonymity in Buffer Constrained Mix Networks," poster *2011 ACM SIGCOMM*, Aug 2011.

[C11] **P. Venkitasubramaniam**, "Anonymity under Memory Constraints," in Proc. *2010 IEEE Conference on Communications*, Cape Town, South Africa, May 2010.

[C12] S. Kadloor N. Kiyavash and **P. Venkitasubramaniam**, "Mitigating timing based information leakage in shared schedulers," in Proc. IEEE INFOCOM 2012, vol., no., pp.1044-1052, 25-30 March 2012

[C13] X. Gong, N. Kiyavash and **P. Venkitasubramaniam**, "Information theoretic analysis of side channel information leakage in FCFS schedulers." 2011 IEEE International Symposium on Information Theory Proceedings (ISIT), July 2011.

[C14] S. Kadloor, X. Gong, N. Kiyavash and **P. Venkitasubramaniam**, "Designing privacy preserving router scheduling policies," in Proc. *2011 Conference on Information Systems and Sciences*, Princeton, NJ, Mar. 2011.

[C15] **P. Venkitasubramaniam**, "Anonymity amidst Active Adversaries: A Game-Theoretic Approach," in Proc. *2009 IEEE Military Communication Conference*, Boston, MA, Oct. 2009.

[C16] **P. Venkitasubramaniam** and L. Tong, "Anonymity in Parallel Relay Networks under Partial Observation: Nash Equilibria and Scaling Behaviour," in Proc. *48th Annual Allerton Conference on Communication, Control and Computing*, Monticello, IL, Sep. 2009.

[C17] **P. Venkitasubramaniam** and L. Tong, "Anonymity in Wireless Networks with Localized Eavesdroppers: A Game-Theoretic Approach," in Proc. 2009 Conference on Information Sciences and Systems, Mar. 2009.

[C18] **P. Venkitasubramaniam** and V. Anantharam, "Anonymity under Light Traffic Conditions using a network of Mixes," in Proc. *47th Annual Allerton Conference on Communication, Control and Computing*, Monticello, IL, Sep. 2008.

[C19] **P. Venkitasubramaniam** and V. Anantharam, "On the Anonymity of Chaum Mixes," in Proc. *IEEE Symposium on Information Theory*, Toronto, Canada, July 2008.

[C20] **P. Venkitasubramaniam** and A. Sahai, "Incentivizing Anonymous Peer-to-peer Reviews," in Proc. *47th Annual Allerton Conference on Communication, Control and Computing*, Monticello, IL, Sep. 2008.

[C21] **P. Venkitasubramaniam** and L. Tong, "Anonymous Networking for Minimum Latency in Multihop Networks," in Proc. *IEEE Symposium on Security and Privacy*, Jan. 2008 (11% **Acceptance Rate**).

[C22] **P. Venkitasubramaniam** and L. Tong, "Throughput-Anonymity Tradeoff in Wireless Networks under Latency Constraints," in Proc. *IEEE INFOCOM 2008*, April 2008 (14% **Acceptance Rate**).

[C23] **P. Venkitasubramaniam**, T. He and L. Tong, "A Rate-Distortion Approach to Anonymous Networking," in Proc. *Allerton 2007*, Sep. 2007, Monticello, IL.

[C24] **P. Venkitasubramaniam**, T. He and L. Tong, "Networking with Secrecy Constraints," in Proc. *IEEE MILCOM 2006*, Oct. 2006, Washington DC.

[C25] T. He, **P. Venkitasubramaniam** and L. Tong, "Packet Scheduling against Stepping Stone Attacks with Chaff," in Proc. *IEEE MILCOM 2006*, Oct. 2006, Washington DC.

[C26] **P. Venkitasubramaniam**, T. He and L. Tong, "Relay Secrecy in Networks with Eavesdroppers," in Proc. *Allerton 2006*, Sep. 2006, Monticello, IL.

[C27] **P. Venkitasubramaniam**, L. Tong and A. Swami, "Minimax Quantization for Distributed Estimation," in Proc. *IEEE ICASSP 2006*, Toulouse, France, May 2006.

[C28] **P. Venkitasubramaniam**, L. Tong and A. Swami, "Score Function Quantization for Distributed Estimation," in Proc., *CISS 2006*, Princeton, NJ, March 2006.

[C29] **P. Venkitasubramaniam**, G. Mergen, L. Tong, A. Swami, "Quantization for Distributed Estimation in Large Scale Sensor Networks," in Proc. *2005 ICISIP*, Bangalore, India, December 2005.

[C30] **P. Venkitasubramaniam** and L. Tong, Cross-Layer Energy Allocation in Wireless Mesh Networks," Submitted to *IEEE Transactions on Wireless Communications*, Apr. 2007, Revised Nov. 2007.

[C31] **P. Venkitasubramaniam**, S. Adireddy and L. Tong, "Opportunistic ALOHA and Cross-Layer Design in Sensor Networks," in Proc. *IEEE MILCOM*, Boston, MA, Oct. 2003.

[C32] **P. Venkitasubramaniam**, Q. Zhao and L. Tong, "Sensor Networks with Multiple Mobile Access Points," in Proc. *38th Annual Conference on Information Systems and Sciences*, Princeton, NJ, March, 2004.

[C33] **P. Venkitasubramaniam** and L. Tong, "Energy Efficient Data Collection in Sensor Networks," in Proc. *39th Annual Conference on Information Systems and Sciences*, Baltimore, MD, March, 2005.