

# Jay Kumar Sundararajan

77 Massachusetts Avenue, 32-D642, Cambridge, MA 02139

Phone: (617) 230 1078, E-mail: jaykumar@mit.edu

<http://web.mit.edu/jaykumar/www>

## Education

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<b>Massachusetts Institute of Technology</b> <b>Ph. D. Candidate, EECS</b> <i>Advisor:</i> Prof. Muriel Médard <i>Thesis:</i> The role of feedback in network coding	GPA: 5.0/5.0 <i>Co-advisor:</i> Prof. Devavrat Shah	2005–9/2009 (expected)
<b>Massachusetts Institute of Technology</b> <b>S.M., EECS</b> <i>Advisor:</i> Prof. Muriel Médard <i>Thesis:</i> Extending the Birkhoff-von Neumann switching strategy to multicast switching	GPA: 4.8/5.0 <i>Co-advisor:</i> Dr. Supratim Deb	2003–2005
<b>Indian Institute of Technology, Madras</b> <b>B.Tech., Electrical Eng.</b> Ranked first in the EE department, Class of 2003	GPA: 9.52/10.00	1999–2003

## Research Interests

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Network coding, reliability and congestion control protocols, network algorithms, wireless networks, information theory and coding theory

## Awards and Distinctions

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- **Marconi Young Scholar Award** – Awarded by the *Marconi Society* in recognition of research and academic performance during graduate study, September 2008.
- **Morris Joseph Levin Award** – Best Oral Presentation of Master’s Thesis, awarded by the Department of EECS, *MIT*, April 2005.
- **Siemens Prize** – Best academic record in B.Tech. (EE), Class of 2003, at the *Indian Institute of Technology, Madras*, with a CGPA of 9.52 out of 10.
- Received **merit certificates** from the *Director of Education, Govt. of India*, in recognition of the high position in the 10<sup>th</sup> (1997) and 12<sup>th</sup> grade (1999) board exams.
- NTSE Scholar – Award of scholarship and a certificate of merit for the **National Talent Search Examination 1997 (NTSE)**, conducted by the *National Council for Educational Research and Training, India*.

## Courses

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Digital Communications, Coding Theory, Data Networks, Advanced Algorithms, Wireless Communications, Information Theory, Stochastic Processes, Detection & Estimation, Optical Networks, Nonlinear Programming, Combinatorial Optimization, Network Algorithms, Network Coding. **Research Experience**

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### Dept. of EECS, MIT

2003–Present

- *The role of feedback in network coding:*

We introduce a novel acknowledgment mechanism for networks which use network coding. Instead of ACKing packets, the nodes can now acknowledge innovative linear combinations of packets using the same framework as before. This idea is used to design feedback-based online coding schemes that optimize queue size and decoding delay. In addition, the new ACK allows network coding to naturally fit into the existing TCP/IP protocol stack.

- *Network coding in a multicast switch:*  
We present a novel approach to the crossbar-switch scheduling problem in the presence of multicast traffic, by using network coding in combination with fanout-splitting. The use of coding improves throughput. In addition, it enables a graph-theoretic description of the capacity region, which in turn leads to a structured approach to solving the scheduling problem.
- *Birkhoff-von Neumann switching strategy for multicast:*  
We extend the Birkhoff-von Neumann unicast switching strategy to the multicast case when no fanout splitting is allowed. Using a graph-theoretic model we show that the rate region for a traffic pattern is precisely the stable set polytope of the pattern's 'conflict graph'.

**Dept. of EE, IIT Madras, India**

Jan–Jun 2003

- *Throughput Enhancement in WCDMA using the Generalized Rake Receiver:*  
B. Tech. Final Year Project, under Prof. David Ravinder Koilpillai.

**Information Systems Networking Lab, Stanford University**

Summer 2002

- *Random Assignment Problem:*  
Undergraduate summer internship under Prof. Balaji Prabhakar.

## Teaching Experience

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- *Teaching Assistant – Probabilistic Systems Analysis & Applied Probability* Fall 2006  
*Instructors:* Prof. John Wyatt and Prof. Muriel Médard  
– Designed new problems for, and graded, problem sets and exams; Provided solutions and managed office hours and review sessions

## Professional Experience

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- **Qualcomm Flarion Technologies, Bridgewater NJ** Summer 2007  
*Interim Engineering Intern*  
Design and simulation of scheduling algorithms for a wireless system
- **Hewlett Packard Laboratories, Palo Alto, CA** Jan 2007  
*Researcher in residence*  
“Codes for Packet Erasure Channels”, under Dr. Mitchell Trott
- **Bell Labs, Murray Hill, NJ** Summer 2005  
*Summer Intern*  
“Comparison of Schemes for Streaming Multicast in Cellular Networks with Relays”, and “Heuristic for backpressure based network coding algorithm for wireless multicast”, under Dr. Harish Viswanathan

## Journal publications

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1. J. K. Sundararajan, D. Shah, M. Médard, “Feedback-based online network coding”, submitted to *IEEE Transactions on Information Theory*, April 2009.
2. M. Kim, J. K. Sundararajan, M. Médard, A. Eryilmaz, R. Koetter, “Network coding in a multicast switch”, submitted to *IEEE Transactions on Information Theory*, October 2008.
3. J. K. Sundararajan, S. Deb, M. Médard, “Extending the Birkhoff-von Neumann Switching Strategy for Multicast – On the use of Optical Splitting in Switches”, *IEEE Journal on Selected Areas in Communications – Optical Communications and Networking Series*, 25(6) (Part supplement): 36–50, August, 2007.
4. J. K. Sundararajan, V. Maheshwari, R. D. Koilpillai, “Throughput Enhancement In WCDMA Using The Generalized Rake Receiver”, *IETE Journal of Research (India)*, January, 2005.

## Conference papers

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1. J. K. Sundararajan, D. Shah, M. Médard, M. Mitzenmacher, J. Barros, “Network coding meets TCP”, to appear in *Proc. of IEEE INFOCOM 2009*, Rio de Janeiro, Brazil (April 2009).
2. J. K. Sundararajan, D. Shah, M. Médard, “Online network coding for optimal throughput and delay - the three-receiver case”, *Proc. of International Symposium on Information Theory and its Applications (ISITA 2008)*, Auckland, New Zealand (December 2008).
3. J. K. Sundararajan, D. Shah, M. Médard, “ARQ for Network Coding”, *Proc. of IEEE International Symposium on Information Theory (ISIT 2008)*, Toronto, Canada (July 2008).
4. J. K. Sundararajan, D. Shah, M. Médard, “On Queueing in Coded Networks - Queue Size Follows Degrees of Freedom”, *Proc. of IEEE Workshop on Information Theory for Wireless Networks 2007*, Bergen, Norway (July 2007) (Invited paper).
5. M. Kim, J. K. Sundararajan, M. Médard, “Network Coding for Speedup in Switches”, *Proc. of IEEE International Symposium on Information Theory (ISIT 2007)*, Nice, France (June 2007).
6. J. K. Sundararajan, M. Médard, M. Kim, A. Eryilmaz, D. Shah, R. Koetter, “Network Coding in a Multicast Switch”, *Proc. of IEEE INFOCOM 2007*, Anchorage, USA (May 2007).
7. J. K. Sundararajan, H. Viswanathan, “Comparison of Schemes for Streaming Multicast in Cellular Networks with Relays”, *Proc. of IEEE Wireless Comm. and Networking Conference (WCNC)*, Las Vegas, USA (March 2006).
8. J. K. Sundararajan, M. Médard, R. Koetter, E. Erez, “A Systematic Approach to Network Coding Problems using Conflict Graphs”, Invited paper at the *2006 Information Theory and Applications Inaugural Workshop*, UCSD, San Diego, USA (February 2006) (Invited paper).
9. J. K. Sundararajan, S. Deb, M. Médard “Extending the Birkhoff-von Neumann Switching Strategy to Multicast Switches”, Short paper in the *Proc. of the IFIP Networking 2005 Conference*, Waterloo, Canada (May 2005).
10. J. K. Sundararajan, F. Zhao, P. Youssef-Massaad, M. Médard, “A Modification to RED AQM for CIOQ Switches”, *IEEE Global Telecommunications Conference (Globecom 2004)*, Dallas, USA (December 2004).
11. J. K. Sundararajan, S. Deb, M. Médard, “On the Implication of Optical Splitting for Multicasting”, *2004 IEEE Computer Communications Workshop*, (October 2004) (Invited talk).
12. J. K. Sundararajan, H. Venkatachari, S. Ranganathan, “A Generic Fragile Watermarking Algorithm for Image Authentication”, *National Conference on Communication*, Chennai, India (January 2003).
13. J. K. Sundararajan, V. Anoop, A. Kumar, B. Bamba, C. Venkataseshiah, R. Sarathi, “Condition Monitoring of Outdoor Polymeric Insulation Structures Using Wavelet Technique”, *National Power Systems Conference*, Kharagpur, India (December 2002).

## Patent applications

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1. J. K. Sundararajan, D. Shah, M. Médard, M. Mitzenmacher, J. Barros, “A network-coding based method for flow and congestion control”.
2. J. K. Sundararajan, D. Shah, M. Médard, “ARQ for Network Coding”.
3. X. Wu, J. Li, S. Tavildar, J. K. Sundararajan, “Methods and apparatus for data exchange in peer to peer communications”.
4. X. Wu, J. Li, S. Shakkottai, R. Laroia, S. Tavildar, T. Richardson, J. K. Sundararajan, “Methods and apparatus supporting adaptive decentralized traffic scheduling for wireless communications”

5. X. Wu, J. Li, S. Shakkottai, R. Laroia, S. Tavildar, T. Richardson, J. K. Sundararajan, “Methods and apparatus supporting adaptive decentralized traffic scheduling including a dynamic receiver yielding threshold”
6. X. Wu, J. Li, S. Shakkottai, R. Laroia, S. Tavildar, T. Richardson, J. K. Sundararajan, “Methods and apparatus supporting adaptive decentralized traffic scheduling including a dynamic transmitter yielding threshold”

### **Professional service**

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- Co-chair of the 10<sup>th</sup> Annual LIDS Student Conference at MIT (January 2005)
- Reviewer for IEEE Transactions on Wireless Communications and IEEE International Symposium on Information Theory
- Currently on the program committee for the ACM MobiHoc 2009 S<sup>3</sup> Workshop to be held in New Orleans in May 2009

### **References**

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Available upon request