# Biography of Dr. Raj Jain

Raj Jain is a Professor of Computer Science and Engineering at Washington University in St. Louis. He was one of the Co-founders of Nayna Networks, Inc - a next generation telecommunications systems company in San Jose, CA. Previously, he was a Senior Consulting Engineer at Digital Equipment Corporation in Littleton, Mass and then a professor of Computer and Information Sciences at Ohio State University in Columbus, Ohio
URL: http://www.cse.wustl.edu/~jain/index.html

He is a Fellow of IEEE, a Fellow of ACM and is on the Editorial Boards of Computer Communications (UK), Journal of High Speed Networks (USA), Mobile Networks and Applications, International Journal of Virtual Technology and Multimedia (UK), International Journal of Wireless and Optical Communications (Singapore), and International Journal of Communication Networks and Distributed Systems (IJCNDS). In the past, he was also on the Editorial Board of IEEE/ACM Transactions on Networks and Computer Networks: The International Journal of Computer and Telecommunications Networking and has served as a Guest Editor of IEEE Communications Magazine April 2001 special issue on TCP Performance over Emerging High-Speed Networks, IEEE Communications Magazine March and July 1999 special issues on Satellite Networks, Computer Networks and ISDN System October 1998 special issue on ATM Traffic Management, and Computer Communications (UK), April-May 1993 issue.

He has served as a Distinguished Lecturer for the IEEE Communications Society (1997, 1999-2006), ACM Lecturer (1991-97), IEEE Computer Society Distinguished Visitor (1993-96), Vice-Chair of ACM SIGCOMM (1991-95), Chair of TIA/SCD/CIS Working Group on "ATM Traffic Management," (1996-1998), Editor of ATM Forum Performance Testing Specification (1996-1998), Member of IEEE Computer Society Education Board, Member of IEEE Computer Society Publication Board (1995-1997), Member of the 1997 National Science Foundation Research Infrastructure Program Final Evaluation Panel, Member of U.S. delegation (Computer Communications) to People's Republic of China in July 1987, Member of National Science Foundation's site visit team to evaluate NSF Engineering Research Center program at Center for Telecommunications Research, Columbia University 1991.

Dr. Jain is the General Chair of International Conference on Convergence and Broadband Networking (ICCBN 2008), and has served as the General Chair of the First International Conference on Broadband Networking (Broadnets 2004), General Co-Chair of SPIE's Broadband Access Communication Technologies Conferences in 2007 and 2008, and as program committee member on 100+ other conferences. He was the keynote speaker at AccessNets 2007, 11th IEEE International Conference on Parallel and Distributed Systems (ICPADS-2005), IEEE Local Computer Networking Conference (LCN) 2004, International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS'04), Concord Users Group Conference 2002, OpNetwork 2001, NREN Gigabit Networking Workshop 2000, Summer Computer Simulation Conference SCSC/SPECTS 2000, International Conference on Networking (ICON) 1999, High Performance Computing (HiPC) 1998, ATM: Technology, Standards, Trials and Applications 1994, Gigabit Networks- Key to Information Superhighway, 1994, IEEE Local Computer Networking Conference LCN92, International Conference on Modeling Techniques and Tools for Performance Evaluation 1992.

A distinguishing factor of his research is its relevance to the Industry. As a faculty member, Dr. Jain actively participates in industry forums like IEEE Standards group, ATM Forum and Internet Engineering Task Force and has made over 100 contributions that ensured that his research was implemented and not just published as papers. Based on his active participation in the computer industry, Dr. Jain was awarded 1999 siliconindia Leadership Awards for Excellence and Promise in Business and Technology. He is also the recipient of

"Lumley Engineering Research Award 1999" and "Research Accomplishment Award 1996" by The Ohio State University, College of Engineering and "Ameritech Prize 1995" by Ohio State University.

Raj Jain has served on the Board of Technical Advisors to Mercury, Mountain View, CA (2004), Teradiant Networks, San Jose, CA, Corona Networks, Inc., Milpitas, CA (2000-2004), Avatar Networks, Fremont, CA (2001-2002), Rhonet Systems, Columbus, OH (2002-2003), Chip Engines, Inc., Sunnyvale, CA (2000-2002), EdgeNet Communications Corporation, Burlingame, CA (2000-2002), Tivre Networks, San Jose, CA (2001-2002), Irvine Networks, Irvine, CA acquired by Simple Technologies. (2000-2001), Beacon Telco, Boston, MA (2001-2002), iBEAM Broadcasting Corporation, Sunnyvale, CA (2000-2001), Nexabit Networks, Westborough, MA acquired by Lucent Corporation. (March 1997-1999), Amber Networks, Fremont, CA acquired by Nokia (1999-2001) and on the Board of Directors of MED-I-PRO Systems, LLC, Pomona, CA, (1998-2000). He was also a consultant to several networking companies.

He is listed in Who's Who in the World (since 1998), Who's Who in America (since 2000), Who's Who in American Education (since 2002), Who's Who in Finance and Business (since 2001), Who's Who in Science and Engineering (since 1998), Writer's Directory 1997, and Who's Who in Midwest (1996-2000).

His Ph.D. thesis entitled ``Control theoretic Formulation of Operating Systems Resource Management Policies" was published in the Outstanding Dissertations in the Computer Sciences Series by Garland Publishing Company, New York, NY.

In 1984, 1985, and 1987 he taught a graduate course on performance analysis at Massachusetts Institute of Technology. This led him to write a book entitled ``Art of Computer Systems Performance Analysis," which is now a popular textbook on the subject. It is used at numerous universities and has won the 1991 ``Best Advanced How-to Book, Systems" award from Computer Press Association. His third book ``FDDI Handbook: High-Speed Networking with Fiber and Other Media" was published in 1994 by Addison Wesley.

His fourth book entitled "High-Performance TCP/IP: Concepts, Issues, and Solutions," was published by Prentice Hall in November 2003. He has contributed chapters to 11 other books.

Until 1994, he was a Senior Consulting Engineer at Digital Equipment Corporation, Littleton, Massachusetts, where for 16 years, he lead the design and analysis of many computer systems and networking technologies including VAX Clusters, Ethernet, DECnet, OSI, FDDI, and ATM networks. He was also an active member of the All-Optical Networking (AON) consortium consisting of Digital, M.I.T./Lincoln Lab, and AT&T that successfully bid for DARPA funding and started the research on Dense Wavelength Division Multiplexing (DWDM) networks.

He is very active in the areas of wireless networking, network security, optical networking, traffic management and quality of service in data networks. His research has influenced the directions of Traffic Management and Testing working groups of ATM Forum. He is an active participant in several other industry forums including WiMAX Forum, Internet Engineering Task Force (IETF), Optical Interoperability Forum (OIF), Institute of Electrical and Electronic Engineering (IEEE), American National Institute (ANSI), and Telecommunications Institute of America (TIA).

He has 14 patents, 45+ journal and magazine papers, and 65+ conference papers. His papers have been widely referenced and he is known for his research on congestion control and avoidance, traffic modeling, performance analysis, and error analysis. He is a co-inventor of the DECbit scheme, which has been implemented in various forms in DECnet, OSI, Frame Relay, and ATM Networks (Explicit Forward Congestion Indication). The DECbit paper has received ACM SIGCOMM Test of Time Award. His team has developed several switch algorithms for explicit rate-based congestion avoidance in ATM networks. Recently, Dr. Jain and his team have introduced the concept of "Congestion Coherence" for wireless networks and "Multi-level ECN" (MECN) that uses TCP/IP's two ECN bits to indicate four different levels of congestion instead of a binary feedback. Dr. Jain has also contributed to signaling, protection and restoration in optical networks.

## Appointments

- August 2005 - Present, Professor, Washington University, St. Louis, MO
- April 2000-July 2007, Co-Founder and Chief Technology Officer, Nayna Networks, Inc., Milpitas, CA
- September 2002-June 2003 and November 2003-Present, Adjunct Professor, Ohio State Univ., Columbus, OH
- April 1994 –August 2002, Professor, Ohio State Univ., Columbus, OH
- May 1978- March 1994, Senior Consulting Engineer, Digital Equipment Corp., Littleton, MA
- January 1987-June 1987, Honorary Lecturer, Massachusetts Inst. of Technology, Cambridge, MA
- January 1985-June 1985, Honorary Lecturer, Massachusetts. Inst. of Technology, Cambridge, MA
- September 1983-June 1984, Visiting Scholar, Massachusetts. Inst. of Technology, Cambridge, MA

## EDUCATION

- Ph. D. (Applied Math/Comp. Sci), Harvard University, Cambridge, MA. Thesis published as distinguished dissertations in Computer Science. GPA 4.0/4.0, 1978
- M. E. (Comp. Sc. _& Controls), Indian Institute of Science, Bangalore, India, GPA: 4.0/4.0, 1974
- B. E. (Electrical. Engineering), A. P. S. University, Rewa, India, Marks 92%. Record not yet broken, 1972

**Selected Publications:**

1. K. Ramakrishnan and R. Jain, "A Binary Feedback Scheme for Congestion Avoidance in Computer Networks with Connectionless Network Layer," Proc. SIGCOMM'88, August 1988, pp. 303-313. Selected as the best paper and published in ACM Transactions on Computer Systems, Vol. 8, No. 2, May 1990, pp. 158-181, Reprinted in 25th Anniversary Special Issue of Computer Communication Review, Vol. 25, No. 1, Jan 1995, pp. 138-156, http://www.cse.wustl.edu/~jain/papers/cr2.htm. According to CiteSeer (http://citeseer.ist.psu.edu/cs), this paper has been cited in 221+ other papers.

2. D. Chiu and R. Jain, "Analysis of the Increase/Decrease Algorithms for Congestion Avoidance in Computer Networks," Journal of Computer Networks and ISDN, Vol. 17, No. 1, June 1989, pp. 1-14, http://www.cse.wustl.edu/~jain/papers/cong_av.htm. According to CiteSeer, this paper has been cited in 234+ other papers.

3. R. Jain, "Congestion Control and Traffic Management in ATM Networks: Recent Advances and A Survey," Computer Networks and ISDN Systems, Vol. 28, No. 13, October 1996, pp. 1723-1738, http://www.cse.wustl.edu/~jain/papers/cnis.htm. According to CiteSeer, this paper has been cited in 170+ other papers.

4. R. Jain and S. Routhier, "Packet Trains-Measurements and a New Model for Computer Network Traffic," IEEE Journal of Selected Areas in Communications, Vol. SAC-4, No. 6, September 1986, pp. 986-995. Reprinted in Amit Bhargava, Ed., "Integrated Broadband Networks," Artech House, Norwood, MA, 1990, http://www.cse.wustl.edu/~jain/papers/train.htm. According to CiteSeer, this paper has been cited in 138+ other papers.

5. R. Jain, K. Ramakrishnan, D. Chiu, "Congestion Avoidance in Computer Networks with a Connectionless Network Layer," DEC-TR-506, reprinted in C. Partridge, Ed., "Innovations in Internetworking," published by Artech House, October 1988, http://www.cse.wustl.edu/~jain/papers/cr5.htm. According to CiteSeer, this article has been cited in 221+ other articles.

6. Shivkumar Kalyanaraman, Raj Jain, Sonia Fahmy, Rohit Goyal, and Bobby Vandalore, "The ERICA Switch Algorithm for ABR Traffic Management in ATM Networks," IEEE/ACM Transactions on Networking, Vol. 8, No. 1, Feburary 2000, pp. 87-98, http://www.cse.wustl.edu/~jain/papers/erica.htm. According to CiteSeer, this paper has been cited in 43+ other papers.

7. Vijay Bulusu, Arjan Durresi, Vamsi Paruchuri, Raj Jain, "Key Distribution in Mobile Heterogeneous Sensor Network", Proceedings IEEE GLOBECOM 2006, San Francisco, CA, November 27 - December 1, 2006, http://www.cse.wustl.edu/~jain/papers/key.htm

8. Jinjing Jiang, Raj Jain, “Analysis of Backward Congestion Notification (BCN) for Ethernet Datacenter Applications,” accepted for IEEE Infocom minisymposium, Anchorage, Alaska, May 7-11, 2007, http://www.cse.wustl.edu/~jain/papers/bcn.htm

Further information about Dr. Jain including all his publications can be found at http://www.cse.wustl.edu/~jain/index.html. In particular, a detailed CV is at http://www.cse.wustl.edu/~jain/cv_jain.htm