VIJAY G. SUBRAMANIAN

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PERSONAL INFORMATION

Citizenship: Indian Immigration Status: Permanent Resident of USA

EDUCATION

Bachelor of Technology (B.Tech.) in Electronics and Communication from Indian Institute of Technology (IIT), Madras, India. (July 1993).

Master of Science (Engineering) (M.Sc.(Engg.)) in Electrical Communication Engineering from Indian Institute of Science (IISc), Bangalore, India. (October 1995).
Master's Thesis : Performance Analysis of a Variation of the Distributed Queuing Access Protocol

Ph.D. October 1999 in the department of Electrical and Computer Engineering, University of Illinois at Urbana Champaign.

Advisor: Prof. B. Hajek.

Thesis Title: Broadband Fading Channels: Signal Burstiness and Capacity

INTERESTS

Stochastic modelling of Communication Networks, Design and analysis of distributed scheduling and routing algorithms for Wireless Networks, Stochastic modelling of Biological systems, Mathematical Immunology, Applied mathematics: Information Theory, Probability Theory and Stochastic Processes, Queuing Theory, Large Deviations, Optimization.

EXPERIENCE

- **Research Fellow**, Hamilton Institute, National University of Ireland, Maynooth, Co. Kildare, Ireland. May 2006–present.
- **Distinguished Member of Technical Staff**, Performance Analysis and Availability Department, Networks Business, Motorola Inc., Arlington Heights, IL, USA. Oct 2004–May 2006.
- **Senior Staff Engineer**, Mathematics of Communication Networks, Global Telecommunications Solutions Sector, Motorola Inc., Arlington Heights, IL, USA. Jan 2001–Sept 2004.
- **Lead Engineer**, Mathematics of Communication Networks, Global Telecommunications Solutions Sector, Motorola Inc., Arlington Heights, IL, USA. Nov 1999–Dec 2000.
- **Research Assitant**, In the Coordinated Sciences Lab., University of Illinois at Urbana-Champaign, Urbana, IL, USA. Aug 1995–Oct 1999.
- **Teaching Assistant**, Dept. of ECE, University of Illinois at Urbana-Champaign, Urbana, IL, USA. For the course ECE371BH, "Wireless Communication Networks." Instructor: Prof. B. Hajek. Aug 1996–Dec 1996.
- **Summer Intern**, Information Sciences Dept., AT&T Research, Florham Park, NJ, USA. May 1997–Aug 1997.

FUNDING

- Science Foundation of Ireland Short-Term Travel Fellowship 2009 - 11,090.43 Euros for a 3 month research visit to LIDS, MIT in 2010.

PUBLICATIONS

JOURNAL PAPERS:

1. V. Subramanian and R. Srikant, "Statistical multiplexing with priorities: Tail probabilities of queue-lengths and waiting times," *Queueing Systems: Theory and Applications*, 34(1-4), 2000, pp. 215-236.
2. V. G. Subramanian and B. Hajek, "Broadband fading channels: Signal burstiness and capacity," *IEEE Transactions on Information Theory*, 48(4), April 2002, pp. 809-827.
3. B. Hajek and V. G. Subramanian, "Capacity and reliability function for small signal constraints," *IEEE Transactions on Information Theory*, 48(4), April 2002, pp. 828-839.
4. V. G. Subramanian, K. R. Duffy, M. L. Turner and P. D. Hodgkin, "Determining the expected variability of immune responses using the Cyton Model," *Journal of Mathematical Biology*, 56(6), 861-892, June 2008.
5. K. R. Duffy and V. G. Subramanian, "On the impact of correlation between collaterally consanguineous cells on lymphocyte population dynamics," *Journal of Mathematical Biology*, 59(2), 255-285, 2009.
6. J. Huang, V. G. Subramanian, R. Agrawal and R. Berry, "Downlink scheduling and resource allocation for OFDM systems," *IEEE Trans. on Wireless Communications*, 8(1), 2009, 288-296.
7. J. Huang, V. G. Subramanian, R. Agrawal and R. Berry,"Joint scheduling and resource allocation in Uplink OFDM systems for broadband wireless access networks," *IEEE JSAC Special Issue on Broadband Access Networks*, 27(2), 2009 226-234.
8. V. G. Subramanian, K. R. Duffy and D. J. Leith, "Existence and uniqueness of fair rate allocations in lossy wireless networks," *IEEE Transactions on Wireless Communications*, 8(7), 3401-3406, 2009.
9. V. Badarla, V. G. Subramanian and D. J. Leith, "Low-delay Dynamic Routing Using Foutain Codes," *IEEE Comm. Letters*, 13(7), 552-554, 2009.
10. R. Agrawal, V. G. Subramanian and R. Berry, "Joint scheduling and resource allocation in DL of CDMA systems," accepted to *IEEE Trans. on Information Theory*, Sept 2009.
11. D. J. Leith, V. G. Subramanian and K. R. Duffy, "Log Convexity of Rate Region in 802.11e WLANs," accepted to *IEEE Comm. Letters*, Nov 2009.

BOOK CHAPTERS:

1. J. Huang, V. G. Subramanian, R. Berry and R. Agrawal, "Scheduling and resource allocation in OFDMA wireless systems," Book Chapter in *Orthogonal Frequency Division Multiple Access, Auerbach Publications*, CRC Press, to appear Mar 2010.

SUBMITTED JOURNAL PAPERS/BOOK CHAPTER DRAFTS:

1. T. P. Coleman, N. Kiyavash and V. G. Subramanian, "The rate-distortion function of a Poisson process with a queueing distortion measure," submitted to *IEEE Trans. on Info. Theory*, May 2008.
2. V. G. Subramanian, "LDP for Max-Weight scheduling over convex compact rate-regions," submitted May 2008.
3. V. G. Subramanian, S. Kittipiyakul and T. Javidi, "Many-sources Large Deviations of Max-Weight Scheduling," submitted to *IEEE Trans. on Info. Theory*, Feb 2009.
4. X. Chen, V. G. Subramanian and D. J. Leith, "PHY Modulation/Rate Control for Fountain Codes in 802.11 WLANs," submitted to *IEEE Trans. on Wireless Comm.*, June 2009.

PRESENTATIONS:

1. "Analysis of Multiuser Diversity in Wireless Networks," presentation at *INFORMS 2002*, Boca Raton, FL, USA.
2. "Scheduling in Wireless Networks," Tutorial at *IEEE VTC Fall 2005*, Dallas, TX, USA.
3. "Many-source large deviations for Max-Weight Scheduling," Presentation at YEQT-II , EURANDOM, Eindhoven, The Netherlands, 2008.
4. "On a class of optimal rateless codes," Presentation at The Claude Shannon Workshop on Coding and Cryptography 2009, Boole Centre, University College Cork, Cork, Ireland, May 2009.
5. "The rate distortion function of a Poisson process with a queueing distortion measure," Presentation at 5th Workshop on Coding and Systems 2009, University College Dublin, Dublin, Ireland, Sept 2009.

CONFERENCE PAPERS:

1. V. G. Subramanian and U. Madhow, "Blind demodulation of direct-sequence CDMA signals using an antenna array," in *Proceedings of CISS 1996*.
2. V. Subramanian and R. Srikant, "Tail probabilities of queuelengths, workloads and waiting times," in *Proceedings of CDC 1997*.
3. V. G. Subramanian and B. Hajek, "Capacity and reliability function per unit cost for WSSUS fading channels," in *Proceedings of CISS 1999*.
4. B. Hajek and V. G. Subramanian, "Capacity and reliability function per fourth moment cost for WSSUS fading channels," in *Proceedings of ITW June 1999*.
5. V. G. Subramanian and B. Hajek, "Capacity and reliability function for small signal constraints," in *Proceedings of CISS 2000*.
6. R. Agrawal, A. Bedekar, R. La, R. Pazhyannur, and V. Subramanian, "A Class and Channel-Condition based Weighted Proportionally Fair Scheduler for EDGE/GPRS," in *Proceedings of ITCOM'01*.
7. R. Agrawal, A. Bedekar, R. La, and V. Subramanian, "A Class and Channel-Condition based Weighted Proportionally Fair Scheduler," in *Proceedings of ITC 2001*.
8. R. Agrawal and V. Subramanian, "Optimality of Certain Channel Aware Scheduling Policies," in *Proceedings of the Allerton Conference 2002*.
9. R. Agrawal, V. Subramanian, and R. Berry, "Joint Scheduling and Resource Allocation in CDMA Systems," in *Proceedings of WiOpt04*.
10. J. Huang, V. G. Subramanian, R. Agrawal and R. Berry, "Scheduling and resource allocation for DL of OFDM systems," appeared in *Proceedings of CISS 2006*.
11. R. Agrawal, R. Berry, J. Huang and V, G. Subramanian, "Scheduling and resource allocation for DL of OFDM systems," appeared in *Proceedings of Asilomar 2006*.
12. J. Huang, V. G. Subramanian, R. Berry and R. Agrawal, "Scheduling and resource allocation for UL of OFDM systems," appeared in *Proceedings of Asilomar 2007*.
13. V. G. Subramanian and D. J. Leith, "Draining-time based scheduling algorithm," appeared in *Proceedings of CDC 2007*, New Orleans, LA.
14. V. G. Subramanian, "Large deviations of max-weight scheduling policies on convex rate regions," appeared in *Proceedings of ITA 2008*, UCSD, SD.
15. T. Coleman, N. Kiyavash and V. G. Subramanian, "Alternate proof of rate-distortion function of a Poisson Process," appeared in *Proceedings of DCC 2008*, Snowbird, Utah.
16. S. Bodas, S. Viswanath and V. G. Subramanian, "Random access over multiple access channels: A queueing perspective," appeared in *Proceedings of CISS 2008*, Princeton, NJ.

17. V. G. Subramanian and D. J. Leith, "On a class of optimal rateless codes," appeared in *Proceedings of Allerton Conference 2008*, Monticello, IL.
18. S. Kittipiyakul, T. Javidi and V. G. Subramanian, "Many sources large deviations of max-weight scheduling," appeared in *Proceedings of Allerton Conference 2008*, Monticello, IL.
19. A. Nedich, V. G. Subramanian, "Approximately Optimal Utility Maximization," appeared in *Proceedings of IT Workshop 2009*, Volos, Greece.

PATENTS

GRANTED:

1. US Patent, A method for packet scheduling and resource allocation in a wireless communication system, #6987738, Jan. 2006.
2. European Patent, Method for packet scheduling and radio resource allocation in a wireless communication system, #EP1227626, Oct. 2006.
3. Japan/Korea Patent, Method and apparatus for resource allocation and scheduling, #JP3950460, Jan. 2007.
4. US Patent, Method to facilitate determination of a data rate, #7447154, Nov. 2008.
5. US Patent, System and method for increased battery saving during idle mode in a wireless communication system, #7471942, Dec. 2008.
6. US Patent, Method and apparatus for improved channel maintenance signaling, #7492752, Feb. 2009.
7. US Patent, Variable reliability wireless communication transmission method and apparatus, #7539214, May 2009.
8. US Patent, Methods for dividing base station resources, #7558577, Jul. 2009.
9. US Patent, Method and apparatus for resource allocation and scheduling, #7564820, Jul. 2009.
10. US Patent, Method and system for allocating subcarriers to subscriber devices, #7586990, Sept. 2009.

APPLIED:

1. Patent applied for "Packet Boundary/ARQ based Adaptation of Coding/Power," Dec 2003.
2. Patent applied for "Dynamic Scheduler Time-Scale Adjustment based on Anticipated Transfer Time," Dec 2003.
3. Patent applied for "Method for increasing capacity/battery life through indicator channel/QPCH/PICH Management," Aug 2004.
4. Patent applied for "Streaming/Application aware DTXing of CQI with predefined implicit start and stop triggers," Dec 2004.
5. Patent applied for "Fast Channel Descriptor Availability to subscribers in OFDM sys- tems," August 2005.
6. Patent applied for "Method and apparatus for spreading channel code selection," 2007.
7. Patent applied for "Method and apparutus for decreasing latencies during handover," 2007.

STANDARDS CONTRIBUTIONS

1. 802.16g - Contribution on Network Reference Model - October 2004.
2. 802.16e - Contributions on handover triggers, clarification on association procedures, May- June 2005.

GRADUATE STUDENTS/SUMMER INTERNS

- Xiaomin Chen, 2008- (Ph.D. Engineering), National University of Ireland Maynooth, co-supervised with Prof. Doug J. Leith.
- Mohammad Jahromi, 2008- (M.Sc. Engineering), National University of Ireland Maynooth, co-supervised with Prof. Doug J. Leith.
- Jianwei Huang, 2004-2005, Summer Intern, Motorola Inc., Scheduling algorithms for Downlink and Uplink for WiMAX.
- Abhishek Sharma, 2005, Summer Intern, Motorola Inc., Distributed resource management with applications to WiMAX.
- Juan Alvarez, 2000, Summer Intern, Motorola Inc., Scheduling for GPRS/EDGE.

EXPERIENCE AT MOTOROLA INC.

Design and analysis of wireless scheduling algorithms
Description: Opportunistic scheduling algorithms were developed using a fairly general mathematical abstraction such that specific implementations could be tailored to GPRS/EGPRS, CDMA 1X, 1xEV-DV, UMTS, HSDPA and WiMAX/802.16 product solutions by Motorola Inc. These were then converted to algorithms implemented in Motorola Inc. product solutions.

Design and analysis of radio resource management algorithms
Description: Algorithms for admission control of new traffic (best-effort and real-time) were devised for UMTS and WiMAX/802.16e Motorola Inc. product offerings. The UMTS algorithm used a combination of (new) capacity checks based upon power control mechanisms, time-slot allocation mechanisms and carrier selection algorithms to ensure that the system operated in a regime of maximum capacity. The WiMAX/802.16e proposal was a distributed algorithm that also determined the metrics to be communicated with neighbour stations to perform admission control.

Distributed Architectures for 802.16e/WiMAX
Description: Proposed and analysed a host of procedures in the context of distributed network architectures for 802.16e/WiMAX - distributed algorithms for load- balancing and handover determination, distributed context back-up algorithms as well as methods to indicate this while mobile is in motion (handover and idle mode), procedures over the air to speed-up network re-entry, security of network re-entry, assessment of bearer and control traffic generated owing to mobility procedures, distributed interference management schemes.

Standards Participation, IPR Generation, Customer Interaction
Description: Participated in WiMAX/802.16e standards, especially in handover and network control aspects discussions. Many patents issued and applied for in the process of introducing cutting-edge ideas into Motorola product offerings. Participated and presented in many customer Requests For Proposal and Requests For Information.

System Simulation Platform Design
Description: Detailed simulation models developed for GPRS/EGPRS, 1xEV-DV, UMTS, HSDPA and OFDM-based systems (802.16e) to assess performance and capacity resulting from incorporation of advanced scheduling algorithms. Models incorporated details of propagation characteristics of wireless medium (at relevant frequencies) including effects of multi-path fading, propagation loss and shadowing. Details of the air-interface technology (modulation, coding schemes, transmission methodology) were also incorporated into the simulation models. Care was taken to have a flexible and extensible frame-work where additional features such as motion could be added in later.

MISCELLANEOUS

- **Project Reviewing**: Reviewer for an EU FP7 Project.

- **Reviewing**: IEEE Trans. on Information Theory, IEEE Trans. on Communications, IEEE/ACM Trans. on Networking, IEEE INFOCOM, IEEE JSAC, Operations Research, Performance Analysis, Queueing Systems, ACM SIGMETRICS, ISIT, IEEE Trans. on Vehicular Technology, IEEE PIMRC, EURASIP, ACM SIGCOMM, IEEE JSAC, Mathematical Reviews, IEEE Trans. Mobile Computing, IEEE Trans. Wireless Communications.
- **Technical Program Committee**: BroadWim2004, WCNC 2006, RAWNET2006, Wireless Networks Symposium of GLOBECOM 2008, WICON 2008, MACOM 2009, COMSNETS 2010, INFOCOM 2010 WIP Session.

HONORS

- Recipient of the National Talent Scholarship - given by the Govt. of India for high school students through their college education.
- Motorola Industrial Fellowship - for the academic year 1998-99.