

VIJAY G. SUBRAMANIAN

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EDUCATION

Ph.D. Electrical Engineering, University of Illinois at Urbana-Champaign – October 1999.

Dissertation: Broadband Fading Channels: Signal Burstiness and Capacity.

Master of Science (Engineering) (M.Sc.(Eng)), Electrical Communication Engineering, Indian Institute of Science (IISc), Bangalore, India – October 1995.

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

PROFESSIONAL EXPERIENCE

EMPLOYMENT

- **Research Assistant Professor**, Electrical Engineering & Computer Science Dept, Northwestern University, Evanston, IL, USA. Nov 2011–present.
Research topics: Economics and game theory-based analysis of spectrum markets and social networks, Inference in network games, Delay analysis of completely distributed load management algorithms in large-scale networks, Convergence of point processes, Applied probability.
- **Senior Research Associate**, Electrical Engr. & Computer Science Dept, Northwestern University, Evanston, IL, USA. Nov 2010–Oct 2011.
Research topics: Delay analysis of completely distributed load management algorithms in large-scale networks, Analysis of fractional frequency reuse in cellular systems.
- **Research Fellow**, Hamilton Institute, National University of Ireland, Maynooth, Co. Kildare, Ireland. May 2006–Nov 2010.
Research topics: Analysis of distributed wireless scheduling and load management algorithms, Analysis of 802.11-based mesh networks, Information theory of queueing systems, Mathematical immunology.
- **Distinguished Member of Technical Staff**, Performance Analysis and Availability Department, Networks Business, Motorola Inc., Arlington Heights, IL, USA. Oct 2004–May 2006.
Description of work/responsibilities: Opportunistic scheduling algorithms for implementation in 802.16e/ WiMAX and LTE product solutions, Distributed network architectures for 802.16e/ WiMAX/ LTE, Distributed interference management and admission control for WiMAX/LTE, Standards participation (802.16e/ WiMAX, lead for mobility management), IPR generation, Customer interaction (RFP and RFI presentations), Led team to develop detailed simulation models for OFDM-based systems (802.16e, LTE).
- **Senior Staff Engineer**, Mathematics of Communication Networks, Global Telecommunications Solutions Sector, Motorola Inc., Arlington Heights, IL, USA. Jan 2001–Sept 2004.
Description of work/responsibilities: Opportunistic scheduling algorithms for implementation in 1xEV-DV and HSDPA product solutions, Distributed admission control for UMTS, IPR generation, Detailed simulation models developed for 1xEV-DV and HSDPA.
- **Lead Engineer**, Mathematics of Communication Networks, Global Telecommunications Solutions Sector, Motorola Inc., Arlington Heights, IL, USA. Nov 1999–Dec 2000.
Description of work/responsibilities: Opportunistic scheduling algorithms for implementation in GPRS/ EGPRS & UMTS product solutions; Detailed simulation models developed for GPRS/ EGPRS & UMTS.

CONSULTANCY

- **Visiting Professor**, NJRC, QFT, Qualcomm, Bedminster, NJ. July–Dec 2012.

HONORARY POSITIONS

- **Visiting Researcher**, Laboratory for Information & Decision Sciences (LIDS), Massachusetts Institute of Technology, Cambridge, MA, USA. Aug–Nov 2010.
Research topics: Analysis of distributed large-scale stochastic switched networks, Delay analysis of completely distributed load management algorithms in large-scale networks.

RESEARCH GRANTS

PENDING:

- NSF EARS: Spectrum Sharing in the Shadow of Uncertainty: Risk, Incentives and Investment, (Co-applicants R. Berry, M. Honig & R. Vohra), 2013.
- NSF SaTC SBE: Security dynamics in a networked world, (Co-applicant R. Berry), 2012.

GRANTED:

- NSF-SES EARS-Market Structures for Efficient Spectrum Sharing (Co-PIs R. Berry, M. Honig & R. Vohra), USD 141,489.00, Aug 2012-July 2013.
- NSF-IIS III: Inferring first movers in large-scale socio-technical networks (Co-PI R. Berry), USD 500,000.00, Aug 2012-July 2015.

PAST APPLICATIONS:

- Cisco RFP: Network effects in technology adoption, (Co-applicants R. Berry, D. Guo), 2012.
- NSF-CNS NeTS: The price of externalities in wireless spectrum sharing, (Co-applicants R. Berry, M. Honig, R. Vohra), 2012.
- NSF-CNS NeTS: Delay scaling in dense wireless deployment: From interacting particle systems to wireless networks, (Co-applicant M. Alanyali), 2011.
- Science Foundation of Ireland RFP: Power efficiency at the MAC, transport and application layers in wireless mesh networks, (Co-applicant K. Duffy), 2009.
- Ulysses Grant for Franco-Irish Cooperation: Analysis of belief propagation and its variations, (Co-applicants M. Lelarge, K. Duffy), 2008.

TRAVEL GRANTS

- 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

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, April 2010.

ARTICLES IN REFEREED JOURNALS:

1. V. G. Subramanian and D. J. Leith, "Convexity conditions for 802.11 WLANs," accepted to *IEEE Trans. Info. Theory*, Dec 2012.
2. X. Chen, V. G. Subramanian and D. J. Leith, "PHY modulation/rate control for fountain codes in 802.11 WLANs," accepted to *Elsevier Journal on Physical Communication*, October 2012.
3. R. Berry, M. Honig, T. Nguyen, V. Subramanian, H. Zhou and R. Vohra, "Newsvendor model of capacity sharing," *ACM SIGMETRICS Performance Evaluation Review* 40 (2), 26-29, Sept 2012. (Also see corresponding conference entry.)
4. D. J. Leith, Q. Cao and V. G. Subramanian, "Max-min fairness in 802.11 mesh networks," *IEEE/ACM Trans. on Networking*, 20(3), 756–769 June 2012.
5. V. G. Subramanian, S. Kittipiyakul and T. Javidi, "Many-sources large deviations of Max-Weight scheduling," *IEEE Trans. on Info. Theory*, 57(4), 2151–2168, April 2011.
6. V. G. Subramanian, "LDP for Max-Weight scheduling over convex compact rate-regions," *Mathematics of Operations Research*, 35(4), 881–910, Nov 2010.
7. V. G. Subramanian, R. A. Berry and R. Agrawal, "Joint scheduling and resource allocation in DL of CDMA systems," *IEEE Transactions on Information Theory*, 56(5), 2416–2432, 2010.
8. D. J. Leith, V. G. Subramanian and K. R. Duffy, "Log convexity of rate region in 802.11e WLANs," *IEEE Comm. Letters*, 14(1), 57–59, 2010.
9. V. Badarla, V. G. Subramanian and D. J. Leith, "Low-delay dynamic routing using fountain codes," *IEEE Comm. Letters*, 13(7), 552–554, 2009.
10. 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.
11. 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), 226–234, 2009.
12. J. Huang, V. G. Subramanian, R. Agrawal and R. Berry, "Downlink scheduling and resource allocation for OFDM systems," *IEEE Transactions on Wireless Communications*, 8(1), 288–296, 2009.
13. 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.
14. 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.
15. B. Hajek and V. G. Subramanian, "Capacity and reliability function for small signal constraints," *IEEE Transactions on Information Theory*, 48(4), 828–839, April 2002.
16. V. G. Subramanian and B. Hajek, "Broadband fading channels: Signal burstiness and capacity," *IEEE Transactions on Information Theory*, 48(4), 809–827, April 2002.
17. 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), pp. 215–236, 2000.

REFEREED CONFERENCE PAPERS:

1. R. Agrawal, N. Arulselvan, S. Kalyanasundaram, B. Natarajan, H. Xu, V. Subramanian, "Interference Penalty Algorithm (IPA)- A novel algorithm for uplink inter-cell interference co-ordination in LTE," accepted to *IEEE WCNC 2013*.
2. R. Berry, M. Honig, T. Nguyen, V. Subramanian, H. Zhou and R. Vohra, "On the nature of revenue-sharing contracts to incentivize spectrum-sharing," accepted to *INFOCOM 2013*.
3. X. Chen, V. Subramanian and D. Leith, "An Upper Bound on the Packet Error Rate of 802.11a/g Viterbi Soft Decision Decoding in the AWGN Channel", to appear in *Proc. of IFIP Wireless Days 2012*, Dublin.
4. K.-H. Hui, V. Subramanian, D. Guo and R. Berry, "Diffusion of innovation in two-sided markets," in *Proc. of Allerton Conference*, 2012.
5. R. Berry, M. Honig, T. Nguyen, V. Subramanian, H. Zhou and R. Vohra, "Newsvendor model of capacity sharing," in *Proc. of W-PIN 2012* (1st Workshop on Pricing and Incentives in Networks), June, 2012, in conjunction with ACM SIGMETRICS/Performance 2012 (London, UK). (Also see corresponding journal entry.)
6. V. G. Subramanian and M. Alanyali, "Delay performance of CSMA in networks with bounded degree conflict graphs," in *Proc. of IEEE ISIT 2011*, St. Petersburg, Russia.
7. X. Chen, V. G. Subramanian and D. J. Leith, "Binary Symmetric Channel Based Aggregation with Coding for 802.11n WLANs," in *Proc. of IEEE Broadnets 2010*, Athens, Greece.
8. D. Vasudevan, V. G. Subramanian and D. J. Leith, "Scheduling jobs with hard deadlines over Multiple Access and Degraded Broadcast Channels," in *Proc. of IEEE ISIT 2010*, Austin, TX, USA.
9. D. Vasudevan, V. G. Subramanian and D. J. Leith, "On ARQ for Packet Erasure Channels with Bernoulli Arrivals," in *Proc. of IEEE ISIT 2010*, Austin, TX, USA.
10. H. Qi, D. Malone and V. G. Subramanian, "Does every bit need the same power? An investigation on unequal power allocation for irregular LDPC codes," in *Proc. of International Conference on Wireless Communications and Signal Processing 2009*, Nanjing, China.
11. A. Nedich, V. G. Subramanian, "Approximately Optimal Utility Maximization," in *Proc. of IT Workshop 2009*, Volos, Greece.
12. V. G. Subramanian and D. J. Leith, "On a class of optimal rateless codes," in *Proceedings of Allerton Conference 2008*, Monticello, IL.
13. S. Bodas, S. Viswanath and V. G. Subramanian, "Random access over multiple access channels: A queueing perspective," in *Proc. of CISS 2008*, Princeton, NJ.
14. T. Coleman, N. Kiyavash and V. G. Subramanian, "Alternate proof of rate-distortion function of a Poisson Process," in *Proceedings of DCC 2008*, Snowbird, Utah.
15. J. Huang, V. G. Subramanian, R. Agrawal and R. Berry, "Scheduling and resource allocation for DL of OFDM systems," in *Proc. of CISS 2006*.
16. R. Agrawal, V. Subramanian, and R. Berry, "Joint Scheduling and Resource Allocation in CDMA Systems," in *Proc. of WiOpt 2004*.
17. R. Agrawal, A. Bedekar, R. La, and V. Subramanian, "A Class and Channel-Condition based Weighted Proportionally Fair Scheduler," in *Proc. of ITC 2001*.
18. V. G. Subramanian and B. Hajek, "Capacity and reliability function for small signal constraints," in *Proc. of CISS 2000*.
19. B. Hajek and V. G. Subramanian, "Capacity and reliability function per fourth moment cost for WSSUS fading channels," in *Proc. of ITW June 1999*.
20. V. G. Subramanian and B. Hajek, "Capacity and reliability function per unit cost for WSSUS fading channels," in *Proc. of CISS 1999*.

21. V. Subramanian and R. Srikant, "Tail probabilities of queuelengths, workloads and waiting times," in *Proc. of IEEE CDC 1997*.
22. V. G. Subramanian and U. Madhow, "Blind demodulation of direct-sequence CDMA signals using an antenna array," in *Proc. of CISS 1996*.

INVITED CONFERENCE PAPERS:

1. R. Berry and V. Subramanian, "Spotting trendsetters: Inference in network games," in *Proc. of Allerton Conference*, 2012.
2. D. J. Leith and V. G. Subramanian, "Utility Fairness in 802.11-Based Wireless Mesh Networks," in *Proc. of Allerton Conference 2010*, Monticello, IL, USA.
3. D. J. Leith, Q. Cao and V. G. Subramanian, "Realising Max-min Fairness in 802.11e Mesh Networks," in *Proc. of IEEE International Symposium on Wireless Pervasive Computing 2010*, Modena, Italy.
4. S. Kittipiyakul, T. Javidi and V. G. Subramanian, "Many sources large deviations of max-weight scheduling," appeared in *Proc. of Allerton Conference 2008*, Monticello, IL.
5. V. G. Subramanian, "Large deviations of max-weight scheduling policies on convex rate regions," appeared in *Proc. of ITA 2008*, UCSD, SD.
6. V. G. Subramanian and D. J. Leith, "Draining-time based scheduling algorithm," appeared in *Proc. of CDC 2007*, New Orleans, LA.
7. J. Huang, V. G. Subramanian, R. Berry and R. Agrawal, "Scheduling and resource allocation for UL of OFDM systems," appeared in *Proc. of Asilomar 2007*.
8. R. Agrawal, R. Berry, J. Huang and V. G. Subramanian, "Scheduling and resource allocation for DL of OFDM systems," appeared in *Proc. of Asilomar 2006*.
9. R. Agrawal and V. Subramanian, "Optimality of Certain Channel Aware Scheduling Policies," in *Proc. of the Allerton Conference 2002*.
10. 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 *Proc. of ITCOM'01*.

REFEREED POSTERS:

1. R. Berry , T. Nguyen and V. Subramanian, "The role of search friction in networked markets stationarity," Interdisciplinary Workshop on Information and Decision in Social Networks, LIDS, MIT, 2012.

WORKING PAPERS

1. K.-H. Hui, V. Subramanian, D. Guo and R. Berry, "Diffusion of innovation in two-sided markets," document in preparation.
2. T. Nguyen, V. G. Subramanian and R. Berry, "Bargaining with middlemen," document in preparation.
3. V. G. Subramanian and R. Berry, "Spotting trendsetters: Inference in network games," document in preparation.
4. V. G. Subramanian, R. Berry and R. Vohra, "Spectrum sharing: Revenue sharing contracts to incentivize sharing," document in preparation.
5. V. G. Subramanian and M. Honig, "Comparative statics on the allocation of new spectrum," document in preparation.
6. D. Shah and V. G. Subramanian, "Large deviations of the max-weight α scheduling policy," document in preparation.

PRESENTATIONS

RECENT PRESENTATIONS:

1. ITA Workshop 2012, UCSD, Feb. 2012.
2. CSL Communication Group Seminar, UIUC, March 2012.
3. CommNetS Seminar, USC, April 2012.
4. RSRG Seminar, Caltech, April 2012.
5. Group Seminar, ECE Dept, Princeton, July 2012.
6. CS Dept Seminar, Univ. of Illinois, Chicago, October 2012.
7. ITA Workshop 2013, UCSD, Feb. 2013.
8. BIRS Workshop on Asymptotics of Large-Scale Interacting Networks, Banff, Feb. 2013.
9. Group Seminar, ECE Dept, OSU, Columbus, March 2013.
10. IIT Chicago, Applied Mathematics Colloquium, March 2013.
11. Group Seminar, ECE Dept, UMD, College-Park, March 2013.
12. DYOGEN Seminar, INRIA, Paris, April 2013.
13. SPASWIN Workshop, Japan, May 2013.
14. Information Engg Dept Seminar, CUHK, ShaTin, Hong Kong, May 2013.

UPCOMING PRESENTATIONS:

1. MOBIHOC Workshop, India, July 2013.

TUTORIALS

1. Tutorial at IEEE VTC Fall 2005, Scheduling in Wireless Networks, Dallas, TX, USA.

TEACHING

- **Instructor and course designer**, *Stochastic Models for Web2.0*, Electrical Eng & Computer Science Dept, Northwestern University, Evanston, IL, USA. Spring Quarter 2011. Graduate Course.
- **Co-Instructor**, *Advanced Communication Networks*, Electrical Eng & Computer Science Dept, Northwestern University, Evanston, IL, USA. Spring Quarter 2013, Graduate Course.

GRADUATE STUDENTS/SUMMER INTERNS

- Lan Xing, 2012-2013 (M. Eng.), Northwestern University, Capacity of cellular systems with random base-station placement.
- Xiaochen Zhang, 2012-2013 (M. Eng.), Northwestern University, Inference of early adopters.
- Mack Lee, 2012-2013 (High-school), Illinois Math & Science Academy, Student Inquiry and Research, Capacity of cellular systems with random base-station placement.
- Matt Dzugan, 2010-2011 (BS-MS), Northwestern University, Capston Project, Capacity of cellular systems with regular base-station placement.
- Xiaomin Chen, 2008-2012 (Ph.D. Eng), National University of Ireland Maynooth, Co-supervised with Prof. Doug J. Leith, Coding solutions to improve WiFi throughput..

- 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.

MISCELLANEOUS/SERVICE

- **NSF Review Panels:** CCF (March 2013) & IIS (May 2013).
- **Session Organizer:** Information Theory & Applications Workshop, University of California, San Diego, 2009 & 2010.
- **Editorial Board:** Multimedia Communications Technical Committee IEEE Communications Society E-Letter, 2010.
- **Conference Organizing Committee:**
 - Publicity Chair, COMSNETS 2014, Bangalore, India.
 - Posters Chair, IEEE Communication Theory Workshop, Hawaii, May 2012.
- **Technical Program Committee:** BroadWim2004, WCNC 2006, RAWNET2006, Wireless Networks Symposium of GLOBECOM 2008, WICON 2008, MACOM 2009, COMSNETS 2010, INFOCOM 2010 WIP Session, NETWORKING 2011, COMSNETS 2011, ACM MobiHoc 2011, COMSNETS 2012, ACM MobiHoc 2012, COMSNETS 2013, WiOpt 2013, ICCCN-MRTM 2013.
- **Ph.D. Thesis Committee:**
 - Ka-Hung Hui, EECS Dept, Northwestern University, Dec 2012.
 - Chayant Tantipathananandh, CS Dept, University of Illinois Chicago, April 2013.
 - Habiba, CS Dept, University of Illinois Chicago, May 2013.
- **Project Technical Reviewer:** Reviewer for an EU FP7 project in 2009 and two projects in 2011
Projects: OPNEX (1.43 million Euros) & CONECT (1.94 million Euros)
- **Reviewing:**
 - IEEE Journals and Conferences:* Trans. on Information Theory, Trans. on Communications, Trans. on Networking, Journal on Special Areas in Communication (JSAC) , Trans. on Vehicular Technology, Trans. on Mobile Computing, Trans. on Wireless Communications, Trans. on Automatic Control, INFOCOM, International Symposium on Information Theory (ISIT), Personal Indoor and Mobile Radio Conference (PIMRC).
 - International Journals and Conferences:* Operations Research, Performance Analysis, Queueing Systems, EURASIP, ACM SIGMETRICS, ACM SIGCOMM, AMS Mathematical Reviews, Nature Communications, PloS ONE.

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.
11. US Patent, Method and apparatus for spreading channel code selection, #8009637, Aug. 2011.
12. US Patent, Method and apparatus for decreasing latencies during handover, #8175600, May 2012.

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 systems," August 2005.

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.

PAST HONORS

- Recipient of the National Talent Scholarship - Govt. of India, 1987.
- Motorola Industrial Fellowship - for year 1998-99.

PERSONAL INFORMATION

Immigration Status: Permanent Resident of USA

REFERENCES

1. Prof. Bruce E. Hajek, University of Illinois at Urbana-Champaign, Coordinated Sciences Lab, 1308 W. Main, Urbana, IL 61801, USA. Ph - +1-217-333-3605. Email - b-hajek@illinois.edu.
2. Prof. Doug J. Leith, Director, Hamilton Institute, National University of Ireland, Maynooth, Co. Kildare, Ireland. Ph - +353-1-7086063. Email - doug.leith@nuim.ie.
3. Dr. Rajeev Agrawal, Nokia-Seimens Networks, 1501 W. Shure Drive, Arlington Heights, IL 60004, USA. Ph - +1-847-6323221. Email - Rajeev.Agrawal@nsn.com.
4. Prof. Prakash Narayan, Dept of ECE, 2353 A. V. Williams Building, University of Maryland, College Park, MD 20742, USA. Ph - +1-301-4053661. Email - prakash@umd.edu.

5. Prof. Rayadurgam Srikant, Univ. of Illinois at Urbana-Champaign, CSL,1308 W. Main St., Urbana, IL 61801, USA. Ph - +1-217-333-2457, Email - rsrikant@illinois.edu.