

R. Michael Buehrer, FIEEE

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Education

June 1996	Virginia Polytechnic Institute and State University, The Bradley Department of Electrical and Computer Engineering, Bradley Fellowship, Ph.D.
August 1993	The University of Toledo, Department of Electrical Engineering and Computer Science, M.S.
June 1991	The University of Toledo, Department of Electrical Engineering and Computer Science, B.S. <i>cum laude</i> .

Employment

Aug. 2012 - Present	Professor, Virginia Polytechnic Institute and State University, Bradley Department of Electrical and Computer Engineering, Director of <i>Wireless @ Virginia Tech</i>
Aug. 2006 – Aug. 2012	Associate Professor, Virginia Polytechnic Institute and State University, Bradley Department of Electrical and Computer Engineering, Mobile and Portable Radio Research Group.
Aug. 2009 – Dec. 2009	Visiting Researcher at the Laboratory for Telecommunication Sciences (LTS) a federal research lab which focuses on telecommunication challenges for national defense.
Aug. 2001 – Aug. 2006	Assistant Professor, Virginia Polytechnic Institute and State University, Bradley Department of Electrical and Computer Engineering, Mobile and Portable Radio Research Group.
Aug. 2001 – Present	Independent Consultant, self-employed.
Aug. 1996 – Aug. 2001	Member Technical Staff, Bell Laboratories, Lucent Technologies, promoted to Distinguished Member of Technical Staff in September 2000.
Sep. 1993 – Jun. 1996	Graduate Research Assistant, Virginia Polytechnic Institute and State University, Bradley Department of Electrical and Computer Engineering, Mobile and Portable Radio Research Group.
May 1994 – Aug. 1994	Senior Engineer, Stanford Telecommunications, Advanced Programs.
Sep. 1991 – Aug. 1993	Graduate Research Assistant, The University of Toledo, Department of Electrical Engineering and Computer Science, Communications Research Group.

Honors and Recognitions

- Fellow of the IEEE (So named “for contributions to wideband signal processing in communications and geolocation”)
- Ellersick Best Paper Award in the Unclassified Technical Program, *IEEE Military Communications Conference (MILCOM)* 2010.
- SDR Forum Best Paper Award, 2007.
- Outstanding Paper Award, SDR Forum, 2008.
- Dean’s Award for Teaching Excellence - April 2014.
- Dean’s Award for Outstanding New Assistant Professor, College of Engineering, 2003.
- Dean’s List for Teaching Effectiveness (teaching evaluation greater than 3.6) 16 out of 18 semesters.
- Nominated for Teaching Certificate, College of Engineering, Spring 2004 and Spring 2005.
- Bell Labs President’s Silver Award for outstanding research contributions.
- 1999 Best Paper Award for *Bell Labs Technical Journal*.

Patents

- S. D. Gordon, R.M. Vaghefi, and R.M. Buehrer, “Estimating the Location of a Wireless Terminal Based on Cooperative Measurements,” *US Patent No. 10,527,708*, January 7, 2020.
- S. D. Gordon, R.M. Vaghefi, and R.M. Buehrer, “Estimating the Location of a Wireless Terminal Based on Radio-Frequency Pattern Matching and Cooperative Measurements,” *US Patent No. 9,989,620 B1*, June 5, 2018.
- S. D. Gordon, R.M. Vaghefi, and R.M. Buehrer, “Estimating the Location of a Wireless Terminal Based on Radio-Frequency Pattern Matching and Cooperative Measurements,” *US Patent No. 9,596,571 B1*, March 14, 2017.
- R.M. Buehrer, R.A. Soni, and J.A. Tsai, “Methods and Apparatus for Downlink Diversity in CDMA Using Walsh Codes,” *U.S. Patent No. 7,400,614 B2*, July 15, 2008.
- R. D. Benning, R. M. Buehrer, Mark H Kramlm, and P. A. Polakos, “Space-Time Spreading and Phase Sweep Transmit Diversity”, *US Patent No. 7,042,955 B2*, May 9, 2006.
- R.D. Benning, R.M. Buehrer, and R.A. Soni, “Biased Phase Sweep Transmit Diversity”, *US Patent No. 7,035,599 B2*, April 25, 2006.
- R. D. Benning, R. M. Buehrer, P. A. Polakos, and R. A. Soni, “Split Shift Phase Sweep Transmit Diversity, ” *US Patent No. 6,980,778 B2*, December 27, 2005.
- R.D. Benning, R.M. Buehrer, and R.A. Soni, “Symmetric Sweep Phase Sweep Transmit Diversity”, *US Patent No. 6,920,314*, July 19, 2005.
- R.M. Buehrer, S.P. Nicoloso, R.A. Soni, and D. Uptegrove, “Cellular Communications System And Related Methods”, *US Patent No. 6,801,791*, October 5, 2004.
- R.M. Buehrer, S.-C. Liu, S.P. Nicoloso, and D. Uptegrove, “Method of channel estimation and compensation based thereon,” *U.S. Patent No. 6,542,560*, April 1, 2003.

- R.M. Buehrer and S.-C. Liu, “Code division multiple access system and method of operation with improved signal acquisition and processing,” *U.S. Patent No. 6,549,565*, April 15, 2003.
- R.D. Benning, R.M. Buehrer, and R.A. Soni, “Apparatus and method of enhancing transmit diversity,” *U.S. Patent No. 6,594,226*, July 15, 2003.
- R.M. Buehrer, S.-C. Liu, S.P. Nicoloso, and D. Uptegrove, “Iterative channel estimation and compensation based thereon,” *U.S. Patent No. 6,614,857*, September 2, 2003.
- R.M. Buehrer and R.A. Soni, “Methods And Apparatus For Downlink Diversity In CDMA Using Walsh Codes”, *U.S. Patent No. 6,515,978*, February 4, 2003.
- R.M. Buehrer, S. Gollamudi, and S.P. Nicoloso, “Multistage interference cancellation for CDMA applications using M-ary orthogonal modulation,” *US Patent No. 6,363,103*, March 26, 2002.
- S.A. Allpress, R.M. Buehrer, and R.A. Soni, “Receiver Architecture Employing Space Time Spreading and Orthogonal Transmit Diversity Techniques,” *US Patent No. 6,317,410 B1*, November 13, 2001.
- S.A. Allpress, R.M. Buehrer, Quinn Li, Ramesh Nallepilli, and R.A. Soni, “Transmitter Architecture Employing Space Time Spreading and Orthogonal Transmit Diversity Techniques,” *US Patent No. 6,392,988*, May 21, 2001.
- R.M. Buehrer, M.D. Hahm, S.C. Liu, and S.P. Nicoloso, “Base Station System Including Parallel Interference Cancellation Processor,” *US Patent No. 6,157,847*, December 5, 2000.

Teaching

Undergraduate Courses

- Engineering Exploration
- Electric Circuits
- Signals and Systems
- Introduction to Communications
- Digital Communications
- Analog and Digital Communication Laboratory – *developed this course with \$70k grant from the State of Virginia.*

Graduate Courses

- Spread Spectrum Communications – *developed this course for the ECE department. It is now a permanent offering.*
- Advanced Digital Communications
- Multi-Channel Communications (Course covers the fundamentals of OFDM and MIMO techniques the underlying technologies for 4G cellular communications) – *developed this course for the ECE dept.*
- Information Theory
- Machine Learning for Communication Systems

Teaching Evaluations (through Spring 2011)

- Average student evaluation – 3.8/4.0 (17 courses, 450 students)
- Dean’s List (student evaluation > 3.6) in 16 of 18 semesters of teaching

Short Courses Given

- Position Location
- Position Location using Ultra-Wideband Signals
- Radio Resource Management in CDMA Systems
- WiFi – An introduction to WLANs
- OFDM – Multicarrier transmission for high data rate systems; Application to 4G (LTE) cellular and Wi-Fi
- Ultra Wideband Communications
- Multi-Input Multi-Output (MIMO) Communication Systems; Application to 4G (LTE/LTE-Advanced) cellular and Wi-Fi

Advising

Current

- Jianyuan Yu, “The Application of Machine Learning to Dynamic Spectrum Access,” Ph.D. candidate, expected graduation, May 2020.
- Yue Xu, “ Deep Learning in Wireless Communication Systems,” Ph.D. candidate, expected graduation, May 2020.
- Charlie Thornton, “ Distributed Cognitive Radar,” Ph.D. candidate, expected graduation May 2023.
- William Howard, “ Distributed Learning Approached for Cognitive Radar and Radio,” Ph.D. candidate, expected graduation May 2023.
- Don-Roberts Emenonye, ” Machine Learning Approaches to Remote Rehabilitation,” Ph.D. candidate, expected graduation May 2023.
- Sam Shebert, ”Automatically Classifying Modern Communication Waveforms,” Ph.D. candidate, expected graduation May 2024.
- C. Tanner Fredieu, ”Classification Approaches for Electronic Warfare,” M.S. candidate, expected graduation May 2022.
- Sebastian Rodriguez, ”Advanced Signal Processing for Cognitive Radar,” M.S. candidate, expected graduation May 2022.

Former

- Chris O’Lone, “Statistical Analysis of Geolocation Fundamentals Using Stochastic Geometry,” Ph.D. December 2020.
- Jeff Poston, “ILoViT: Indoor Localization via Vibration Tracking,” Ph.D. March 2018.
- Mahi Abdelbar, “Applications of Sensor Fusion in Classification, Localization and Mapping,” Ph.D. February 2018.
- Mico Woolward, “SUPPLEMENTING LOCALIZATION ALGORITHMS FOR INDOOR FOOTSTEPS,” Ph.D., July 2017.
- Daniel Jakubisin, “Advances in Iterative Probabilistic Processing for Communication Receivers,” Ph.D., April, 2016, *currently employed by McGuire-Woods.*
- Jeannette Nounagnon “Using Kullback-Leibler Divergence to Analyze the Performance of Collaborative Positioning,” Ph.D., April, 2016, *currently employed by ComSat.*
- SaiDhiraj Amuru, “Intelligent Approaches for Communication Denial,” Ph.D., September, 2015, *currently employed by Samsung.*
- Javier Schloemann, “Fundamental Analyses of Collaborative and Noncollaborative Positioning,” Ph.D., August, 2015, *currently employed by Northrup-Grumman.*
- Reza Vaghefi, “Cooperative Positioning in Wireless Sensor Networks Using Semidefinite Programming,” Ph.D., December 2014, *currently employed by Blue Danube Labs.*
- Jeong-heon Lee, “Physical Layer Security for Wireless Position Location in the Presence of Location Spoofing,” Ph.D., March 2011, *currently employed by Samsung.*
- Haris I. Volos, “Cognitive Radio Engine Design For Link Adaptation,” Ph.D., September 2010, *currently employed by the University of Arizona.*
- Tao Jia, “Collaborative Position Location for Wireless Networks in Harsh Environments,” Ph.D., March 2010, *currently employed by Qualcomm, Inc.*
- Heba Shaban, “A Novel Highly Accurate Wireless Wearable Human Locomotion,” Ph.D., April 2010, *currently employed by Arab Academy of Science and Technology.*
- Haesoo Kim, “Cooperative Communications,” Ph.D., August 2008, *currently employed by LG Electronics.*
- Rekha Menon, - “Interference Avoidance based Underlay Techniques for Dynamic Spectrum Sharing,” Ph.D., April 2007, *currently employed by Tyco Electronics.*
- Swaroop Ventkatesh, “The Design and Modeling of Ultra-Wideband Position-Location Networks,” Ph.D., February 2007, *currently employed by Marvel Semiconductor.*
- Jihad Ibrahim, “Algorithms and Architectures for UWB Receiver Design,” Ph.D. January 2007, *currently employed by MathWorks.*
- Chris Anderson, “A Software Defined Ultra Wideband Transceiver Testbed for Communications, Ranging, or Imaging,” Ph.D., September 2006, *currently an Associate Professor at the US Naval Academy.*
- Samir Al-Ghadhban - “ Multi-layered Space Frequency Time Codes,” Ph.D. October, 2005, *currently an associate professor at King Fahd University.*
- Jing Jiang – “Increasing the Capacity of Wireless Data Systems - A Cross Layer Perspective,” Ph.D., July 2004, *currently employed by Texas Instruments.*
- Jiann-An Tsai – “Overloaded Array Processing Using Interference Cancellation,” Ph.D., May 2002. *Currently employed by Samsung.*

- Daniel Tait, “Electromagnetic Vector-Sensor Direction-of-Arrival Estimation in the Presence of Interference,” M.S. August 2020.
- Don-Roberts Emenonye, “Application of Machine Learning to Multi-Antenna Transmission and Machine Type Resource Allocation,” M.S. July 2020.
- Charlie Thornton, “Learning Schemes for Adaptive Spectrum Sharing Radar,” M.S. May 2020.
- Mark Kozy, “Creation of a Cognitive Radar with Machine Learning: Simulation and Implementation,” M.S., May 2019.
- Bryse Flowers, “Adversarial RFML: Evading Deep Learning Enabled Signal Classification,” M.S., June 2019.
- Parker White, “Constrained Clustering for Frequency Hopping Spread Spectrum Signal Separation,” M.S., August 2019.
- Ersin Selvi, “Cognitive Radar Applied To Target Tracking Using Markov Decision Processes,” M.S. December 2017, *currently employed by Raytheon.*
- Ali Gaber Mohamed, “Navigating via Discrete Astronomical Radio Sources: Geolocation Using Fringe Rates,” M.S. April 2017, *currently employed by Alexandria University.*
- Eric Sollenberger, “Iterative Leakage-Based Precoding for Multiuser-MIMO Systems,” M.S., May, 2016, *currently employed by Qualcomm, Inc..*
- Kevin McDermott, “On the Improvement of Positioning in LTE with Collaboration and Pressure Sensors,” M.S., May, 2015, *currently employed by Northrup Grumman*
- Tori Jewell, “Use of GIS in Radio Frequency and Positioning Applications,” M.S. June 2014.
- Jacob Overfield, “The Impact of MIMO on Signal Localization,” MS, May 2013, *currently employed by n-ask, inc.*
- Zachary Biskaduros, “Collaborative GPS,” MS, June 2013, *currently employed by n-ask, inc.*
- Hunter DeJarnette, “Measuring Noise in the VHF Band and Its Effect On Low SNR Signal Detection,” MS Thesis, September 26, 2012, *currently employed by Johns Hopkins Applied Physics Lab.*
- Benton Thompson, “Characterization and Improvement of the Collaborative and Non-Collaborative Position Location Problems,” MS, August 2011, *currently employed by G3, Inc.*
- Corey Cooke, “Attenuation Field Estimation using Radio Tomography,” MS, August 2011, *currently a Ph.D. student at Georgia Tech.*
- Harpreet Dhillon, “The Optimal Sum-Rate of Multi-Band MIMO Interference Channel,” MS, July 2010, *currently an Assistant Professor at Virginia Tech.*
- Justin Kelly, “The Value of Collaboration in Dynamic Spectrum Access,” MS, July 2009, *currently employed by the Department of Energy.*
- Matthew Roney, “Dual-Channel Direction Finding in Multipath Channels,” M.S. candidate, *currently employed by DRS Signal Solutions.*
- Jesse Reed, “Approaches to Multiple-source Localization and Signal Classification,” MS, May, 2009, *currently employed by Arinc, Inc.*
- Chang Li, “Non-contact Estimation of Respiration and Heartbeat Rate using Ultra Wideband,” MS, August 20, 2008, *currently employed by Qualcomm, Inc.*
- Arjun Bhupathi Raju, “Characterization of Uplink Transmit Power and Talk-Time in WCDMA Networks,” MS, July 15, 2008, *currently employed by Qualcomm, Inc.*

- Rajaraman Parameswaran – “Effects of user and spatial diversity on high data rate wireless systems,” M.S., August 2005, *currently employed by Qualcomm Inc.*
- Nathan Harter, “Single Channel Direction Finding in Multipath Channels,” M.S., April 2007, *currently employed by IO-Max.*
- John Keaveny – “The Implementation of Single-Channel Direction Finding,” M.S., February 2005. *Currently employed by Boeing.*
- Brian Donlan, “Ultra-wideband Narrowband Interference Cancellation and Channel Modeling for Communications,” M.S., January 2005, *currently employed by IOMAX USA.*
- Vivek Baradwaj, “Ultra-Wideband for Communications: Spatial Characteristics and Interference Suppression,” M.S., April 2005. *Currently employed by Qualcomm, Inc.*
- Liu Yang, “On the Applicability of the Tap-delay Line Model to UWB Channel Modeling,” M.S., August 2004, *currently employed by Microsoft.*
- Dan Hibbard, “The Impact of Bandwidth on Indoor Communication System Performance,” M.S., May 2004. *Currently employed by Raytheon.*
- Nishant Kumar – “MAC and Physical Layer Design for Ultra-Wideband Communications,” M.S., May 2004. *Currently employed by Staccato Communicaitons.*
- Samir Ginde – “A Game-theoretic Analysis of Link Adaptation in Cellular Radio Networks,” M.S., May 2003. *Currently employed by Qualcomm, Inc.*
- Rahul Mahajan – “Cross Layer Optimization: System Design and Simulation Methodologies,” M.S., December, 2003. *Currently employed by Qualcomm, Inc.*
- Aaron Orndorf, “Transceiver Design for Ultra Wideband Communications,” M.S., completed May 2004.
- David McKinstry – “Channel Models and Receivers for Ultra Wideband Communications,” M.S., May 2003. *Currently employed by Johns Hopkins Applied Physics Lab.*
- Venkatasubramanian Ramasamy – “MC-CDMA/OFDM and Adaptive Antennas,” M.S., June 2002. *Currently employed by Apple.*
- Ray Chan – “Link Adaptation for Public Safety Wireless Information Networks,” M.S., June 2003. *Currently employed by Northrup Grummond Corp.*
- Payal Jain – “Software Radio Implementation of Adjustable High Data Rate Receivers,” M.S., November 2002. *Currently employed by Digital Receiver Technology, Germantown, MD.*

Funded Research

1. Title: “SWIFT: SMALL: Interference Canceling for Improved Coexistence for Passive and Active Radio Systems,”
Sponsor: National Science Foundation,
Funding: \$499,999,
Period of Performance January 2021 January 2024.
Percent: 50%.
2. Title: “SCH:INT: Collaborative Research: Semi-Automated Rehabilitation in the Home,”
Sponsor: National Science Foundation,
Funding: \$1.1M
Period of Performance: August 2020 July 2024,
Percent: 10%

3. Title: "Vector Sensor Processing in the Presence of Multipath"
Sponsor: Applied Signals Intelligence
Funding: \$170,000
Period of Performance: April 2020 - April 2021.
Percent: 90%
4. Title: "Machine Learning Approaches to Optimize Army Radar, Communication and EW Systems"
Sponsor: Army Research Lab
Funding: \$975,000
Period of Performance: May 11, 2020 - May 10, 2024.
Percent: 100%
5. Title: "Vector Sensor Processing in the Presence of Interference"
Sponsor: Applied Signals Intelligence
Funding: \$232,193
Period of Performance: December 20, 2018 - April 30, 2019.
Percent: 60%
6. Title: "Digital Beamforming and Interference Mitigation for MIMO Systems "
Sponsor: GIRD Systems
Funding: \$1,575,398
Period of Performance: October 17, 2018 - October 16, 2021.
Percent: 50%
7. Title: "Cognitive Radar for C-SCoRE: Enhancing Radar Functionality through Interference Analysis and Avoidance,"
Sponsor: Georgia Tech Research Institute (AFRL)
Funding: \$121,758
Period of Performance: December 15, 2018 - June 30, 2020
Percent: 100%
8. Title: "Collaborative Learning for Harmonious Coexistence of Heterogeneous Wireless Networks"
Sponsor: Defense Advanced Research Agency
Funding: \$1,999,994
Period of Performance: January 1, 2017 - December 30, 2019.
Percent: 25%
9. Title: "MU-MIMO Channel Characterization"
Sponsor: GIRD Systems
Funding: \$117,712
Period of Performance: April 1, 2017 - March 31, 2019.
Percent: 100%
10. Title: "Cognitive Radio Approaches to Optimize Army Radar Systems"
Sponsor: Army Research Lab
Funding: \$250,000
Period of Performance: January 1, 2018 - December 30, 2020.
Percent: 100%
11. Title: "Cognitive Radio Approaches to Optimize Army Radar and Communication Systems"
Sponsor: Army Research Lab
Funding: \$190,282
Period of Performance: January 1, 2017 - December 30, 2017.
Percent: 50%
12. Title: "Hyper-wideband Communications"
Sponsor: Defense Advanced Research Projects Agency

- Funding: \$182,451
Period of Performance: May 1, 2015 - April 30, 2016.
Percent: 50%
13. Title: "IUSE: Gamification of Wireless Communication Testbeds for Authentic STEM Learning"
Sponsor: National Science Foundation
Funding: \$626,665
Period of Performance: Sept. 1, 2014 - Aug. 31, 2017.
Percent: 20%
14. Title: "Advanced Cognitive Radio Design using SDRs"
Sponsor: Lockheed Martin Advanced Technologies
Funding: \$494,600
Period of Performance: April 1, 2014 – Sept. 30, 2015
Percent: 100%
15. Title: "SDR Technology Development Support"
Sponsor: DoD
Funding: \$375,000
Period of Performance: 5/1/14 – 4/30/14
P.I.: J.H. Reed
Percent: 30%
16. Title: "Improving Cellular Positioning through Collaboration"
Sponsor: Polaris Wireless
Funding: \$82,813
Period of Performance: 11/01/2013 - 10/31/2014
Percent: 100%
17. Title: "Advanced Wireless Systems and Technologies"
Sponsor: DoD
Funding: \$3,883,320
Period of Performance: 07/01/2012 - 06/30/2014
P.I. R.W. McGwier
Percent: 10%
18. Title: "Cognitive Radio Development"
Sponsor: Lockheed Martin – Advanced Technologies Lab
Funding: \$325,000
Period of Performance: 7/1/2012 – 12/31/2013
P.I. R.M. Buehrer
Percent: 50%
19. Title: "Next Generation Secure, Scalable Communication Network for the Smart Grid"
Sponsor: Oak Ridge National Labs
Funding: \$626,671
Period of Performance: 1/1/2011-10/31/2012
PI – R.M. Buehrer
Co-PI: J.H. Reed
Percent: 50%
20. Title: "Software Defined Radio Waveform and Device Development And Component Deployment Using Ossie"
Sponsor – DoD (Maryland Procurement Office)
PI – RM Buehrer
Period of Performance: Aug. 1, 2010 – July 31, 2013
Funding: \$299,227
Percent: 100%

21. Title: "SDR Technology Development Support"
Sponsor: DoD (Maryland Procurement Office)
PI: R.M. Buehrer and J.H. Reed
Funding: \$638,653
Period of Performance: 9/30/2010 4/30/2014
Percent: 75%
22. Title: "Signal Processing Research"
Sponsor: Aerospace Corp.
PI: T.C. Clancy
Co-PI: R.M. Buehrer
Period of Performance: 1/1/2011 10/31/2011
Funding: \$130k
Percent: 50%
23. Title: "IHCS: Proactive Cross-Layer Adversary Localization for Hostile or Harsh Wireless Environments"
Sponsor: NSF
Funding: \$494,788
Period of Performance: 5/1/08 4/30/11
PI: Y. Yang
Co-PIs: R.M. Buehrer and J.M. Park
Percent: 33%
24. Title: "A Fundamental Analysis of Spectrum Sharing"
Sponsor: Qualcomm, Inc.
Funding: \$120,000
Period of Performance: 5/1/08 4/30/10
PI: Buehrer
Co-PIs: Y. Yang
Percent: 85%
25. Title: "Reasoning and Learning in Adaptive Wireless Networks"
Sponsor: BBN/DARPA
Funding: \$605,000
Period of Performance: 10/1/07 3/31/10
PI: L. DaSilva
Co-PIs: R.M. Buehrer, C. Bostian, A. MacKenzie, and J.H. Reed
Percent: 25%
26. Title: DRS Graduate Fellowship
Sponsor: DRS Signal Solutions
Funding: \$76,000
Period of Performance: 9/01/07 8/30/09
PI: R.M. Buehrer
Percent: 100%
27. Title: U-PoLo Nets Position Location in Harsh Environments
Sponsor: National Science Foundation
Funding: \$175k
Period of Performance: 8/1/05 7/30/08
PI: R.M. Buehrer
Percent: 100%
28. Title: NeTS ProWiN: An Open Systems Approach for Rapid Prototyping Waveforms for Software Defined Radio
Sponsor: National Science Foundation
Funding: \$1M

Period of Performance: 8/1/05 7/30/09
PI: J.H. Reed (lead), R.M. Buehrer, and W.H. Tranter
Percent: 33%

29. Title: Node and Network Benefits of Improved RF Characteristics in CDMA Cellular Networks
Sponsor: ParkerVision
Funding: \$131,474
Period of Performance: 11/1/07 10/31/08
PI: R. M. Buehrer
Percent: 100%
30. Title: UWB Propagation in Office Environments
Sponsor: Freescale Semiconductor
Funding: \$35,000
Period of Performance: 5/1/05 4/30/06
PI: R. M. Buehrer
Percent: 100%
31. Title: Networking Issues for Peer-to-Peer VoIP Link for Radio Interoperability, Fire Management and Security
Sponsor: Catalyst Communications
Funding: \$67,500
Period of Performance: 1/1/05 5/15/05
PI: S.M. Midkiff (lead) and R.M. Buehrer
Percent: 33%
32. Title: AWINN: Advanced Wireless Networking for the Navy
Sponsor: ONR
Funding: \$3M
Period of Performance: 12/20/04 6/19/06
PI: Warren Stutzman
Co-PIs: J.H. Reed, Scott Midkiff, R. M. Buehrer, W.H. Tranter, Peter Athanas, Tom Hou, Binoy Ravindran, Rick Habayeb
Percent: 10%
33. Title: Ultra Wideband Communications Systems
Sponsor: ASPIRES
Funding: \$118,360
Period of Performance: 7/1/03 6/30/04
PI: R. M. Buehrer
Percent: 100%
34. Title: UWB Communications
Sponsor: Motorola
Period of Performance: 12/15/03 12/14/04
Funding: \$35,000
PI: Buehrer
Percentage: 100%
35. Title: Simulation of Ultra Wideband Communications
Sponsor: ITRI
Funding: \$10,000
Period of Performance: 9/1/03 12/31/03
PI: R.M. Buehrer
Percent: 100%
36. Title: Receiver Design for Ultra Wideband Communications
Sponsor: ITRI

- Funding: \$15,000
Period of Performance: 9/1/03 12/31/03
PI: R.M. Buehrer
Percent: 100%
37. Title: Indoor Propagation
Sponsor: Qualcomm, Inc.
Funding: \$14,000
Period of Performance: 12/1/03 5/15/04
PI: R.M. Buehrer
Percent: 100%
38. Title: Single Channel Direction Finding
Sponsor: DRS Technologies
Funding: \$91,000
Period of Performance: 10/18/02 10/17/05
PI: R. M. Buehrer
Percent: 100%
39. Title: Flexible High Data Rate Transmission for Wireless Data Applications
Sponsor: BAE Systems
Funding: \$29,000
Period of Performance: 10/18/01 10/17/02
PI: R. M. Buehrer
Percent: 100%
40. Title: UWB Propagation Measurements, Modeling, and Communication System Enhancements
Sponsor: DARPA
Funding: \$688,620
Period of Performance: 5/13/02-5/12/03
PI: R.M. Buehrer
Co-PI: A.S. Safaai-Jazi, W. Davis, D. Sweeney
Percentage: 35%
41. Title: Modeling and Simulation for the FCS Development Environment
Sponsor: Boeing
Funding: \$127,022
Period of Performance: 5/1/02 - 4/1/03
PI: W. H. Tranter
Co-PI: R. M. Buehrer, A. Annamalai
Percentage: 33%
42. Title: The Benefits of Multiple Antennas at the Handset for Cellular CDMA
Sponsor: e-Tenna Corporation
Funding: \$15,000
Period of Performance: 5/15/02 8/14/02
PI: R. M. Buehrer
Percent: 100%
43. Title: MPRG Affiliates Program
Sponsor: Analog Devices, ARO, Cingular, DRS Technologies, General Motors, General Dynamics, Huawei Technologies, Hughes, Lucent Technologies, Motorola, Qualcomm, Raytheon, Samsung, SW Bell, Texas Instruments, et. al.
Funding: \$2M
Period of Performance: 8/25/01 5/15/11
PI: J.H. Reed

Co-PIs: R.M. Buehrer, W.H. Tranter, S.W. Ellingson, others
Percent: 20%

Book Publications

S. Zekavat and R.M. Buehrer, editors, Position Location - Theory, Practice and Advances, Second Ed., Wiley-IEEE, 2019.

S. Zekavat and R.M. Buehrer, editors, Position Location - Theory, Practice and Advances, Wiley-IEEE, 2011.

J.H. Lee and R.M. Buehrer, "Security Issues in Position Location," Chapter 3 in Position Location - Theory, Practice and Advances, Wiley-IEEE, 2011.

R. M. Buehrer and S. Venkatesh, "Fundamentals of Time-of-Arrival-based Position Location," Chapter 6 in Position Location - Theory, Practice and Advances, Wiley-IEEE, 2011.

J.H. Lee and R.M. Buehrer, "Fundamentals of Received Signal Strength Based Position Location," Chapter 11 in Position Location - Theory, Practice and Advances, Wiley-IEEE, 2011.

T. Jia and R.M. Buehrer, "Collaborative Position Location," Chapter 23 in Position Location - Theory, Practice and Advances, Wiley-IEEE, 2011.

R.M. Buehrer, An Introduction to Code Division Multiple Access (CDMA), Morgan-Claypool Publishers, 2007.

R.A. Soni and R.M. Buehrer, "Multiple Antenna Techniques in 3G Wireless Systems," Chapter 25 in Space-Time Wireless Systems: From Array Processing to MIMO Communications, H. Bolecskei, D. Gesbert, C. Papadias, and A.J. vander Veen, editors, Cambridge University Press, 2005.

R.M. Buehrer, "Channel Modeling," Chapter 3 in An Introduction to Ultra Wideband Communication Systems, Jeff Reed, editor, pp. 73-158, Prentice-Hall, 2005.

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J. Jiang, R.M. Buehrer, and W.H. Tranter, "Spatial T-H Precoding for Packet Data Systems with Scheduling," *Fall 2003 Vehicular Technology Conference*, pp. 537-541, Orlando, FL, October 6-9, 2003.

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- R.M. Buehrer, "On the Usefulness of Outer-loop Power Control with Successive Interference Cancellation," *IEEE Vehicular Technology Conference – Fall 2002*, Vancouver, British Columbia, Canada, pp. 1897-1901, September 24-29, 2002.
- R.M. Buehrer, "The Impact of Angular Energy Distribution on Spatial Correlation," *IEEE Vehicular Technology Conference – Fall 2002*, Vancouver, British Columbia, Canada, pp. 1173-1177, September 24-29, 2002.
- J. Tsai, R.M. Buehrer, and B.D. Woerner, "BER Analysis of Orthogonal Transmit Waveform with Space-Time Diversity for MIMO CDMA Systems," *IEEE Vehicular Technology Conference – Fall 2002*, Vancouver, British Columbia, Canada, pp. 1051-1055, September 24-29, 2002.
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- N.A. Kumar and R.M. Buehrer, "Application of Layered Space-Time Processing to Ultra-Wideband Communication," *45th IEEE Midwest Symposium on Circuits and Systems*, Tulsa, OK, pp. 597-600, August 4-7, 2002.
- P. Jain and R.M. Buehrer, "Implementation of Adaptive Modulation on Sunrise Software Radios," *45th IEEE Midwest Symposium on Circuits and Systems*, Tulsa, OK, pp. 405-408, August 4-7, 2002.
- R. Venkatasubramanian, J. Tsai, and R. M. Buehrer, "Beamforming for MC-CDMA," *45th IEEE Midwest Symposium on Circuits and Systems*, Tulsa, OK, pp. 441-444, August 4-7, 2002.
- D.R. McKinstry and R.M. Buehrer, "Issues in the Performance and Covertness of UWB Communications Systems," *45th IEEE Midwest Symposium on Circuits and Systems*, Tulsa, OK, pp. 601-604, August 4-7, 2002.
- J. Neel, R.M. Buehrer, J.H. Reed, and R.P. Gilles, "Game theoretic analysis of a network of cognitive radios," *45th IEEE Midwest Symposium on Circuits and Systems*, Tulsa, OK, pp. 409-412, August 4-7, 2002.
- J.A. Tsai, R.M. Buehrer, and B.D. Woerner, "The Impact of AOA Energy Distribution on the Spatial Fading Correlation of Linear Antenna Array," *55th IEEE Vehicular Technology Conference – VTC Spring 2002*, Birmingham, AL, vol. 2, pp. 933-937, May 2002.
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- R.M. Buehrer, "Generalized Equations for Spatial Correlation for Low to Moderate Angle Spread," *10th Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, pp. 101-108, June 2000.
- S.P. Nicoloso, M. Metke, and R.M. Buehrer, "Frame-Quality-Based vs. Eb/No-Based Forward Power Control Methods for cdma2000," *10th Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, pp. 239-248,

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R.M. Buehrer, "On the Convergence of Multistage Interference Cancellation," *33rd IEEE Conference on Signals, Systems and Computers - Asilomar*, Pacific Grove, CA, vol. 1, pp. 634-638, October 1999.

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J.-A. Tsai, R.M. Buehrer, and D. Uptegrove, "Performance Comparisons of Adaptive Antenna Arrays with Fixed Multibeam Systems for TDMA Systems," *49th IEEE Vehicular Technology Conference – VTC Spring 99*, Houston, TX, vol. 2, pp. 1079-1083, May 1999.

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J.-A. Tsai and R.M. Buehrer, "Frequency Reuse Reduction for IS-136 Using a Four Element Adaptive Array," *8th Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, pp. 11-22, June 10-12, 1998.

N.S. Correal, R.M. Buehrer, and B.D. Woerner, "Real-Time DSP Implementation of a Coherent Partial Interference Cancellation Multiuser Receiver for DS-CDMA," *IEEE International Conference on Communications - ICC*, Atlanta, GA, vol. 3, pp. 1536-1540, May 1998.

R.M. Buehrer and B.D. Woerner, "The Asymptotic Multiuser Efficiency of M -Stage Interference Cancellation Receivers," *8th IEEE International Symposium on Personal, Mobile, and Indoor Radio Conference*, Helsinki, Finland, vol. 2, pp. 570-574, September 1997.

N. Correal, R.M. Buehrer, and B.D. Woerner, "Improved CDMA Performance Through Bias Reduction for Parallel Interference Cancellation," *International Conference on Personal, Mobile, and Indoor Radio Conference*, Helsinki, Finland, vol. 2, pp. 565-569, September 1997.

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R.M. Buehrer, N.S. Correal, and B.D. Woerner, "A Comparison of Multiuser Receivers for Cellular CDMA," *IEEE Global Telecommunications Conference '96*, London, England, pp. 1571-1577, November 11-18, 1996.

J. Feil, L. Ippolito, M. Buehrer, G. Feldhake, and S. Horan, "The First Two Years of Experimental Results from the New Mexico ACTS Propagation Terminal at 20.185 and 27.505 GHz," *1996 IEEE International Symposium on Antennas and Propagation*, Baltimore, MD, vol. 3, pp. 1868-1871, July 21-26, 1996.

J. Feil, L. Ippolito, M. Buehrer, G. Feldhake, and S. Horan, "First Year Propagation Experiment Results from the New Mexico ACTS Receiver Terminal at 20.185 and 27.505 GHz," *16th AIAA International Communications Satellite Systems Conference*, Washington, D.C. pp. 1-11, February 1996.

R.M. Buehrer and B.D. Woerner, "Performance of CDMA Multistage Interference Cancellation with Phase and Timing Errors," *1995 IEEE Conference on Universal Personal Communications – UPC'95*, Tokyo, Japan, pp. 153-157, November 6-9, 1995.

R.M. Buehrer and B.D. Woerner, "Analysis of Adaptive Multistage Interference Cancellation for CDMA Using an Improved Gaussian Approximation," *1995 IEEE Military Communications Conference*, San Diego, CA, vol. 3, pp. 1195-1199, November 5-8, 1995.

A. Park, R.M. Buehrer, and B.D. Woerner, "Throughput Performance for a FHMA System with Variable Rate Coding," *1995 IEEE Military Communications Conference*, San Diego, CA, vol. 1, pp. 320-324, November 5-8, 1995.

R.M. Buehrer and B.D. Woerner, "Spread Spectrum for Wireless Communications," *4th Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, pp. 3-1 – 3-20, June 1994.

R.M. Buehrer, S.C. Kwatra, and J. Kim, "A Satellite/Terrestrial Hybrid System for the National Research and Education Network," *15th AIAA International Communications Satellite Systems Conference*, San Diego, CA, March 1994.

M. Keaton, R.M. Buehrer, S.C. Kwatra, and J. Kim, "A Wideband Communications Satellite for the National Research and Education Network," *1993 IEEE Global Communications Conference*, Houston, TX, vol. 3, 1644-1648, December 1993.

M. Keaton, R.M. Buehrer, S.C. Kwatra, and J. Kim, "Network Requirements for a Satellite Based National Research and Education Network," *1993 IEEE Military Communications Conference*, Boston, MA, vol. 3, pp. 993-997, November 1993.

Technical Reports

National Research Council. 2009. "Toward a Universal Radio Frequency System for Special Operations Forces", Washington, D.C.: The National Academies Press.

R. M. Buehrer, W.A. Davis, A. Saffai-Jazi, and D. Sweeney, "Ultra-wideband Propagation Measurements and Modeling - Final Report," submitted to DARPA as part of the NETEX Program.

R. M. Buehrer, A. Saffai-Jazi, W. A. Davis, D. Sweeney, "Path Loss Calculations for Ultra-wideband Signals in Indoor Environments," invited contribution to the International Telecommunications Union, Document Number USWP 3K-1, October 26, 2003.

15 technical memoranda in the areas of multiuser detection, intelligent antennas, and OFDM for Bell Labs – Lucent Technologies. Titles and abstracts are proprietary information.

Professional Affiliations

- *Fellow*, Institute of Electrical and Electronics Engineers (IEEE)
- Member, IEEE Communications Society
- Member, IEEE Vehicular Technologies Society
- Member, IEEE Signal Processing Society
- Member, Eta Kappa Nu
- Member, Tau Beta Pi
- Member, Pi Mu Epsilon

Selected Professional Activities

- Area Editor, *IEEE Transactions on Wireless Communications*, 2017 - present.

- Guest Lead Editor, *IEEE Journal on Special Topics in Signal Processing*, special issue on non-cooperative position location networks.
- Guest Editor, *Proceedings of the IEEE*, special issue on cooperative localization.
- Associate Editor, *IEEE Wireless Communications Letters*, 2010 - 2014
- Associate Editor, *IEEE Transactions on Communications*, 2009 - 2014
- Associate Editor, *IEEE Transactions on Wireless Communications*, 2005 - 2012, 2015 - 2017
- Associate Editor, *IEEE Transactions on Vehicular Technologies*, 2005 - 2009
- Associate Editor, *IEEE Transactions on Signal Processing*, 2006-2007
- Associate Editor, *IEEE Transactions on Education*, 1997-2000
- Organizer and Technical Co-Chair, 2015 IEEE Global Communications Conference Workshop on Localization and Tracking: Indoors, Outdoors and Emerging Networks (GC - LION 15), December 6, 2015. Signal Processing for Communications symposium co-chair for IEEE ICC 2017 i
- Symposium co-chair for IEEE ICC 2017 Signal Processing for Communications Symposium
- Technical Program Co-Chair, WPNC 2013.
- Technical Program Chair for UWBST2003.
- Technical Program Committee, 2008-2016 IEEE Global Communications Conference
- Technical Program Committee, 2007-2016 IEEE International Conference on Communications
- Technical Program Committee, IEEE RWS 2006
- Technical Program Committee, IEEE 2006 International Conference on Ultra Wideband
- Technical Program Committee, IEEE Vehicular Technology Conference 2006 - Fall
- Technical Program Committee, 2004 IEEE International Workshop on Ultra Wideband Systems / Ultra Wideband Systems and Technologies.
- Technical Program Committee, 2004 IEEE Radio and Wireless Conference (RAWCON), September 2004.
- Technical Program Committee, 2005 Wireless Communications and Networking Conference.
- Reviewer for *IEEE Journal on Selected Areas in Communications*, *IEEE Transactions on Communications*, *IEEE Transactions on Vehicular Technology*, *IEEE Communications Letters*, *IEEE Transactions on Signal Processing*, *ETRI Research Journal*, *Army Research Office*, *State of Tennessee*
- Session Chair, IEEE Vehicular Technology Conference – Fall 2002

Selected Consulting

- Lutron Electronics
 - Provided recommendations on the design and testing of indoor wireless networks, August - Sept. 2019.
 - Evaluated RF coexistence plan, March 2020.
- Polaris Wireless - Provided an evaluation of Z-axis estimation algorithm, Sept-Oct 2018.
- ENSCO, Inc. – Provided an evaluation of spread spectrum ranging system. March 2011.
- FCC – Delivered short courses on various topics in wireless communications including WiFi, spread spectrum, and 3G technologies. Summer 2004, Summer 2005.

Expert Witness Experience

- Tesla, Inc.
 - Law firm: Munger, Tolles, & Olson
 - Served as testifying expert witness
 - Technology: Control channels/information in cellular systems
 - Dates: November 2020 - present
- Apple, Inc.
 - Law firm: Wilmer-Hale
 - Wrote declaration in support of request for ex parte reexamination
 - Technology: Control information in cellular systems
 - Dates: November 2020 - January 2021
- Phillips vs. Garmin
 - Law firm: Alston-Bird
 - Represented: Garmin (defendant)
 - Served as testifying expert witness for Federal Trade Commission proceedings
 - Technology: Local and Cellular Wireless Connections in Personal Emergency Response Systems
 - District: FTC
 - Dates: June - July 2020
- ZTE vs. Sisvel International
 - Law firm: Banner-Witcoff
 - Represented: ZTE (Petitioner)
 - Served as expert in Inter Partes Review proceedings. Wrote declaration supporting petitioner.
 - Technology: Cell selection and reselection in Radio Resource Control
 - Dates: April 2020 - June 2020
- Apple, Inc. vs. Optis
 - Law firm: Wilmer-Hale
 - Represented: Apple (Plaintiff)
 - Served as testifying expert witness for litigation
 - Technology: Control information in cellular systems
 - District: Eastern District of Texas
 - Dates: July 2019 - August 2020.
- Apple, Inc. vs. Wi-LAN
 - Law firm: DLA Piper
 - Represented: Apple (Plaintiff)
 - Served as testifying expert witness for litigation
 - Technology: Resource Allocation in Wireless Systems
 - District: Southern District of California
 - Dates: January '19 - January '20

- TELUS Communications, Bell Mobility, and Rogers Communications vs. WiLAN, Inc.
 - Law firm: Torys, LLP.
 - Represented: TELUS Communications, Bell Mobility, and Rogers Communications
 - Served as testifying expert. Analyzed certain patents (and the prior art) and provided technical reports on sufficiency, validity and potential double-patenting.
 - Technology: Resource allocation in wireless networks
 - Dates: January 2019 - November 2019
- Samsung vs. Sharp
 - Law firm: Fish and Richardson
 - Represented: Samsung
 - Analyzed technical aspects of patent to aid validity/invalidity analysis.
 - Technology: Feedback in MIMO-OFDM systems
 - Dates: April 2019 - July 2019
- American Patents, LLC vs. HP, Inc.
 - Law firm: DLA Piper
 - Represented: HP, Inc.
 - Analyzed technical aspects of two patents to aid validity/invalidity analysis.
 - Technology: MIMO/OFDM synchronization in cellular systems
 - Dates: June 2019
- Blackberry vs. Uniloc, LLC.
 - Law firm: Oblon
 - Represented: Blackberry (Petitioner)
 - Wrote declaration to the USPTO concerning the disclosure of certain features of two patents in previous references.
 - Technology: Traffic mapping between logical channels and transport channels in wireless systems
 - Dates: June 2019.
- Apple, Inc. vs. Wi-LAN
 - Law firm: DLA Piper
 - Represented: Apple (Plaintiff)
 - Served as testifying expert witness for litigation (non-infringing alternatives)
 - Technology: Resource Allocation in Wireless Systems
 - District: Southern District of California
 - Dates: November '17 - July '18
- Apple, Inc., LG Electronics Inc., Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. vs. Uniloc, LLC.
 - Law firm: Fish and Richardson
 - Represented: Apple, Inc., LG Electronics Inc., Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. (Petitioner)
 - Wrote declarations to the USPTO concerning the disclosure of certain features of two patents in previous references.

- Technology: Traffic mapping between logical channels and transport channels in Wireless Systems; Multi-mode transceivers
 - Dates: September 2018 - November 2019.
- Apple, Inc. vs. Wi-LAN
 - Law firm: DLA Piper
 - Represented: Apple (Plaintiff)
 - Served as testifying expert witness for litigation (infringement analysis and non-infringing alternatives)
 - Technology: Resource Allocation in Wireless Systems
 - District: Southern District of California
 - Dates: Fall 2017 - July 2018
- CCE vs. Apple, Inc.
 - Law firm: DLA Piper
 - Represented: Apple (Defendant)
 - Served as testifying expert witness for litigation (infringement analysis)
 - Technology: Power Headroom Reporting in Cellular Systems
 - District: Eastern District of Texas
 - Dates: January 2017 - July 2017
- Nokia Technologies vs. Apple, Inc.
 - Law firm: Wilmer-Hale
 - Represented: Apple (Defendant)
 - Served as testifying expert witness for litigation (infringement analysis)
 - Technology: antennas for handheld mobile devices
 - District: Eastern District of Texas
 - Dates: January 2017 - June 2017
- Core Wireless vs. Apple, Inc.
 - Law Firm: Wilmer-Hale
 - Represented: Apple (Defendant)
 - Role: Served as testifying expert witness for litigation (infringement and validity analysis).
 - Technology: Control Channels and Frame Stealing in 2G (GSM) cellular networks.
 - District: The US District Court for the Northern District of California
 - Dates: May 2015 - December 2016.
- AMERICAN SYSTEMS vs. US Navy
 - Law Firm: Miles and Stockbridge
 - Represented: AMERICAN SYSTEMS (Plaintiff)
 - Role: Served as testifying expert witness for litigation (case settled prior to expert reports being filed).
 - Technology: Wireless mesh networks.
 - Dates: Nov. 2014 - June 2015.
- TruPosition, Inc. vs. LM Ericsson Telephone Company, et. al.
 - Law Firm: Constantine-Cannon LLP

- Represented: TruePosition (Plaintiff)
- Role: Served as testifying expert witness for litigation. Case settled prior to depositions being taken.
- Technology: Cellular-based geolocation for 4G (LTE) cellular networks.
- District: The US District Court for the Eastern District of Pennsylvania
- Dates: March 2013 - July 2014.
- Andrew, LLC vs TruPosition, Inc.
 - Law Firm: Patterson Belknap Webb & Tyler LLP
 - Represented: Andrew, LLC (Plaintiff)
 - Role: Served as testifying expert witness for patent litigation. Case settled before trial, but after depositions were taken.
 - Technology: Cellular-based (2G, 3G) geolocation.
 - District: The US District Court for the District of Delaware
 - Dates: Nov. 2009 - March 2010.
- TCL vs. Ericsson
 - Law Firm: Sheppard Mullin
 - Provided Services for: TCL (Plaintiff)
 - Role: Served as consulting expert witness for essentiality analysis.
 - Technology: digital communications in 2G, 3G, and 4G cellular systems.
 - District: The US District Court for the Central District of California
 - Dates: March 2015 - December 2015.
- Univ. of Minnesota vs. Sprint
 - Law Firm: McGuire-Woods
 - Provided Services for: Sprint (Defendant)
 - Role: Served as consulting expert for validity analysis.
 - Technology: 4G cellular networks.
 - Dates: October 2015 - January 2016.
- Eon Corp, IP Holdings, LLC vs Research In Motion Corporation, et. al.
 - Law Firm: Sidley-Austin
 - Provided Services for: Research in Motion Corporation (Defendant)
 - Served as consulting expert for patent litigation
 - Technology: Cellular technologies
 - Dates: March 2012
- InterDigital vs. Nokia
 - Law Firm: Alston-Bird LLP
 - Provided Services for: Nokia
 - Served as a consulting expert
 - Technology: Cellular CDMA and power control
 - Date: Oct. 2011 - Dec. 2011.
- SPH America, LLC vs Acer, Inc.

- Law Firm: Spotts Fain PC
- Provided Services for: UT Starcomm
- Role: Served as a consulting expert for patent litigation
- Technology: CDMA (spread spectrum) and 3G cellular technologies.
- Dates: Jan. 2011 - March 2011

References

Available upon request.