

Richard D. Gitlin

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Education

- Eng. Sc. D., Electrical Engineering, Columbia University, 1969.
- M.S., Electrical Engineering, Columbia University, 1965.
- B.E.E., The City College of New York, 1964 [with honors].

Employment

- **2020:** Consultant specializing in expert witness for intellectual property litigation.
- **2007-2019 (retired):** State of Florida 21st Century Scholar, Distinguished University Professor, and Agere Systems Chair of Electrical Engineering, University of South Florida. Research in wireless communications and networking for biomedical systems and 5G wireless systems. Teaching graduate courses in wireless networking, digital communications, and random processes. Retired, August 2019 and became Distinguished University Professor, Emeritus.
 - Research Grants: 4 NSF, QNRF (Qatar), 2 Jabil, NSA, and Innovatia Medical Systems
 - Supervised graduate student research in the above areas.
 - 7 Ph.D. graduates and 5 M.S. graduates [Two more Ph.D. graduates expected in 2020].
 - PhD graduates (employment):
 - Gabriel Arrobo (INTEL)
 - Chao He (Samsung Research)
 - Yang Liu (Nirveda Cognition)
 - Calvin Perumalla (Vectra Networks)
 - Nabeel Sulieman (Iraqi Telecom)
 - Mohamed Elkourdi (Qualcomm)
 - Asim Mazin (Moffitt Cancer Center)
 - PhD expected graduates
 - Faeik Al-Rabee (May, 2020)
 - Chetana Murudkar (Sprint, Summer 2020)
 - USF Service
 - University
 - Faculty Advisory Committee to USF Board of Trustees, 20015-2016
 - Faculty, USF Institute for Advanced Discovery and Innovation, 2015-present
 - Distinguished University Professor Recommending Committee, 2017-present
 - COE and EE Department Service
 - Chair, EE Department Academic Affairs Committee 2011-present
 - Chair, EE Department Research and Innovation Committee 2016-present
 - Created new EE Department Doctoral Qualifying Exam (DQE) 2015-present

¹USF Institute for Advanced Discovery & Innovation
<https://www.usf.edu/research-innovation/institute-adv-discovery/>

- Chair, EE Department Head Search Committee 2010-2011
 - Member, COE Dean search committee, 2014-2015
- **2010-2017: Founder and CTO, Innovatia Medical Systems LLC** ---a medical device start up in Tampa, FL that used advanced wireless networking technologies to create a new paradigm for minimally invasive robotic surgery.
- **2003-2007: Chief Technology Officer, Hammerhead Systems.**
A Silicon Valley startup that raised >\$100M and provided innovative data networking solutions for wireline, wireless, and cable service providers. Responsible for developing a product line vision, developing core technology, representing product technology and directions with customers, partners, and standards bodies, and management of intellectual property. Personal research contributions in application-aware networking and network architecture.
- **2001-2003: Vice President Technology, NEC Laboratories America**
Responsible for research in Broadband/IP and Mobile Networking, System LSI, Secure Systems, and Quantum IT. Initiated many systems projects in wireless networks, 4G communications, system LSI, and secure and reliable systems.
- **2000-2001: Visiting Professor of Electrical Engineering, Columbia University**
 - Courses taught: EE 6712x: Communication Theory I ---graduate course
EE 6713y: Communication Theory II --- graduate course
EE 6950x: Wireless Networking --- graduate course
 - Research: Wireless Networking and Communications
 - Major professor for two Ph.D. students [see below] and several M.S. students.
- **2001- 2003 Adjunct Professor of Electrical Engineering, Columbia University**
Major Professor for two Ph.D. students:
 - Eunsoo Shim (2003): SVP, Samsung Research
 - Hung-yu Wei (2003): Professor, National Taiwan University

1969-2001: Bell Labs, Lucent Technologies

- **1998-2001: Senior Vice President R&D and CTO Data Networking Systems Group**
Responsible for applied research, system architecture, standards, and network performance for IP/ATM data networking business unit. Commercialization initiatives that I started include Globespan (DSL) the Bell Labs high-speed router (Packetstar), Cable Modem Termination System (CMTS), and BLAST (first wireless MIMO system).
- **1995-1998: Senior Research Vice President, Communications Sciences Research [Bell Labs]**
Responsible for leading and managing a broad range of research programs in broadband (IP/ATM) and computer networking, wireless communications, multimedia systems, and system LSI. Managed ~500 people in 5 research labs, in multiple locations and continents [initiated labs in The Netherlands and the UK --- the first Bell Labs research locations outside the US]. Maintained personal research agenda in wireless and networking and significantly influenced the IS-95B (CDMA) multicode standard. Made significant personal contributions to the R&D of WiFi and CDMA wireless systems.
- **1992-1995: Vice President, Communications Systems Research [Bell Labs]**
Led and managed ~100 research staff lab in communications, broadband networking, and access.

Accomplishments: BLAST [MIMO space time coding], Packetstar IP Router/Switch, Atlanta ATM chip set, and the DoCSIS cable protocol

- **1987-1992: Director, Network Systems Research [Bell Labs]**
Initiated smart antenna research program, co-inventor of multicode CDMA, 20 Gbps ATM switch, LuckyNet Gigabit testbed, Diversity Coding, and Optical Equalization. Made strong personal contributions to smart antenna research (today referred to as MIMO) and multi-code CDMA that use in contemporary 3G/4G wireless systems.
- **1986-1987: Director, Data Communications Research**
Co-inventor DSL, initiated 56K modem development, and helped create Globespan (AT&T DSL spinoff).
- **1969-1986: Director, Supervisor and Member of Staff in Advanced Data Communications**
Co-inventor of the passband equalizer used in generations of modems, and many contributions to QAM systems, coded modulation, echo cancellation, and V.32/V.34 modems.
- **1990-1991: Adjunct Professor of Electrical Engineering, Princeton University:** taught EE526, graduate course in Communication Theory.
- **1973: Adjunct Assistant Professor of Electrical Engineering, Columbia University:** taught EE6712, a graduate course in Communication Theory.

Awards and Honors

- Academy of Science, Engineering, and Medicine -Florida (2019)
- Florida Inventors Hall of Fame (2017)
- Distinguished University Professor-University of South Florida (2013)
- Faculty, USF Institute for Advanced Discovery & Innovation (2013)
- Charter Fellow of the National Academy of Inventors (NAI) (2012)
- State of Florida 21st Century Scholar (at USF -2007)
- Agere Endowed Chair in EE (at USF - 2007)
- National Academy of Engineering (NAE), for “contributions to communications systems and networking” (2005)
- Thomas Alva Edison award for “innovations in wireless networking” (2005)
- IEEE Communications Society Steven O. Rice Award for the best original paper published in the *IEEE Transactions on Communications* (1995)
- IEEE Communications Society Frederick Ellersick Award for the best paper published in *IEEE Communications* (1994)
- AT&T Bell Labs Fellow, for “contributions to data communications” (1987)
- IEEE Fellow for “contributions to data communications techniques” (1986)
- *Bell System Technical Journal Award* (1982) for the best paper in communications science.
- Honor Societies: Tau Beta Pi, Eta Kappa Nu, and Sigma Xi (The City College of New York and Columbia University).

Short Courses: Presented state-of-the art short courses at various major conferences [Globecom, ICC, SIGCOMM, and OFC] and universities in the areas of

- Wireless Communications and Networks
- Broadband Networks
- Digital Communications
- Adaptive Signal Processing

Selected Keynote Speeches

- COMCAS 2019
- WAMICON 2016
- WTSI 2015
- WCNC 2015
- WTSI 2010
- MPLS 2006
- Mobicom 2004
- WCNC 2003
- APOC [Asian Pacific Optical and Wireless Conference] 2002
- Globecom 1998
- Merlin Lecture at the Technion (Israel) 1998

Selected Accomplishments (industry)

Below are selected highlights of my personal *research* accomplishments [as opposed to my managerial accomplishments] that have had a significant impact on communications networks. Throughout my career, I have maintained a personal research agenda ---even during my years in management. I have tried to list only those contributions that are fundamental and have had significant impact on the research and commercial communities over the years.

Modems and Signal Processing

1. 1973: Co-invention of the **passband equalizer**. This remains the standard equalization structure for Quadrature Amplitude Modulation [QAM]-based systems used in modems, wireless, DSL, cable modems etc.
2. 1973: Provided the first fundamental understanding and design guidance for the level of precision needed in **adaptive digital (finite precision) equalization algorithms** [in contrast to the lower levels of precision needed for non-adaptive equalization or digital filtering].
3. 1982: Provided a fundamental understanding of the **fractionally spaced adaptive equalizer** and invented new adjustment algorithms to ensure proper operation [**BSTJ prize paper**].
4. 1985: Co-invention of **DSL** --- which created an industry [independently, and unknown to us, similar work was also done at Bellcore by J. Lechleider]. Described in US Patent 4924492.

Optical Communications and Networking

1. 1993: Provided fundamental understanding necessary to realize the world's **first adaptive equalizer to compensate for polarization mode dispersion** [**Ellersick prize paper**]. This led to a prototype gigabit per sec equalizer chip. Several research groups and companies are now incorporating these ideas in their next-generation gigabit LANs.
2. 1990: Invented **diversity coding** (the application of forward error/erasure coding across diverse network links ---could be different wavelengths or network paths--- awarded the **Rice prize paper**). This technique is being considered for rapid fault recovery in commercial DWDM systems. [Original invention in 1975 for reliable operation of microwave radio in severe fading]. This work has led to the contemporary work on **network coding**.

Wireless Communications and Networking

1. 1994: Provided fundamental understanding of the benefits of **adaptive (“smart) antenna arrays** in increasing the capacity of wireless systems. **Today, 3G systems have standardized this technology (now known as MIMO).**
2. 1995: Proposed and implemented the first **asymmetric wireless network protocol** (AIRMAIL) to minimize power consumption at the mobile, while not compromising performance.
3. 1995: Invented **multi-code CDMA**-based wireless systems. This technology permits user to efficiently burst at rates approaching the system capacity. **Standardized in 3G CDMA wireless.**
4. 2001: Co-inventor of wireless IP-layer fast handoff procedure that became an **IETF RFC.**

Selected Accomplishments at USF

Since joining USF in 2008, initially focused on the intersection of communications with medicine and created an interdisciplinary team that is focused on wireless networking of *in vivo* miniature wirelessly controlled devices to create a paradigm shift in minimally invasive surgery (MARVEL), an integrated vectorcardiogram (*i*VCG) that has the potential to provide 24x7 diagnostic information and to indicate and potentially predict cardiac events, and related cyber-physical health care systems. Fundamental patents have been obtained for the MARVEL and *i*VCG systems. This research has involved extensive collaboration with USF, Tampa General, Florida Hospital and Duke University physicians, private companies, and the creation of a startup company, to commercialize MARVEL.

Most recently, research directed towards advancing wireless 4G/5G/6G cellular systems by increasing their reliability, capacity, and achieving very low latency for emerging applications such as autonomous vehicles and remote cyberphysical systems (such as remote surgery). Extensive research on the application of Machine Learning to next-generation wireless systems.

Professional Service

- NAE Nominating committees for the Electronics and Computer Science sections
- Chair, Communication Theory Group, IEEE Communications Society [1988-1992]
- Member, IEEE Communications Society Board of Governors [1988-1991]
- Member, IEEE Communications Society Awards Board [1991-1994]
- Chair, Communication Theory Workshop [1992]
- Member, Advisory Board for Computer Science and Engineering [CISE], National Science Foundation [1995-1998]
- Member, Industrial Advisory Board, Department of Electrical Engineering and Computer Science, University of California, Berkeley [1995-1996].
- Advisory/Editorial Board Member
- Editor, Communication Theory, the *IEEE Transactions on Communications* [1977-1986]
- *Bell Labs Technical Journal* [founding member: 1996 -2000]
- *Journal of Communications Networks* [1998-2007]
- *Mobile Networks and Applications* [1996-2005]
- Editor of several special issues of communications and networking journals.

Book

Data Communications Principles, Gitlin, Hayes, and Weinstein, Plenum Press (1992).

Peer-Reviewed Publications

At USF

1. F. T. Al Rabee and R. D. Gitlin, " Uplink Power-Domain Non-Orthogonal Multiple Access (NOMA): Bit Error Rate Performance with Channel Estimation Errors," in International Journal of Interdisciplinary Telecommunications and Networking, vol. 12, no. 4, 2020. [PDF](#)
2. Chetana Murudkar and Richard D. Gitlin, "User-Centric Approaches for Next-Generation Self-Organizing Wireless Communication Networks Using Machine Learning", IEEE International Conference on Microwaves, Communications, Antennas, and Electronic Systems (COMCAS), Tel Aviv, Israel, November 4-6, 2019. [PDF](#)
3. Chetana V. Murudkar and R. D. Gitlin, "Machine Learning for QoE Prediction and Anomaly Detection in Self-Organizing Mobile Networking Systems," International Journal of Wireless & Mobile Networks (IJWMN), April 2019 [PDF](#).
4. Chetana V. Murudkar and R. D. Gitlin, "Optimal-Capacity, Shortest Path Routing in Self-Organizing 5G Networks using Machine Learning," 20th annual IEEE Wireless and Microwave Technology Conference (WAMICON), Cocoa Beach, FL, USA, April 8-9, 2019. [PDF](#).
5. N. I. Sulieman and R. D. Gitlin, "Near-Instant Fault Recovery and Ultra-Reliable Multi-Hop Wireless Sensor Networks," IEEE SoutheastCon 2019 Conference, Huntsville, AL, USA, April 11-14, 2019 [PDF](#).
6. Chetana V. Murudkar and R. D. Gitlin, "QoE-driven Anomaly Detection in Self-Organizing Mobile Networks using Machine Learning," the 18th annual Wireless Telecommunications Symposium (WTS 2019), New York City, NY, USA, April 9-12, 2019. [PDF](#).
7. Mohamed Elkourdi, Asim Mazin and R. D. Gitlin, "Performance Analysis for Virtual-Cell Based CoMP 5G Networks Using Deep Recurrent Neural Nets," the 18th annual Wireless Telecommunications Symposium (WTS 2019), New York City, NY, USA, April 9-12, 2019. [PDF](#).
8. F. Al Rabee and R. D. Gitlin, "Performance of Uplink Non-Orthogonal Multiple Access (NOMA) in the Presence of Channel Estimation Errors," the 18th annual Wireless Telecommunications Symposium (WTS 2019), New York City, NY, USA, April 9-12, 2019. [PDF](#).
9. Asim Mazin, Mohamed Elkourdi and R. D. Gitlin, "SAN- Slotted Aloha-NOMA a MAC Protocol for M2M Communications ," Information Theory and Applications (ITA 2019), February 2019. [Invited paper](#). [PDF](#) .
10. Eren Balevi and R. D. Gitlin, "An Inherent Fog Network Brain-Spinal Cord-Nerve Networks," IEEE Access, Dec 2018, DOI: [10.1109/ACCESS.2018.2800679](#).
11. F. Al Rabee, Ashraf Al-Rimawi, and R. D. Gitlin, "Channel Capacity in a Dynamic Random Waypoint Mobility Model," 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) 2018, New York City, NY, USA, November 8-9, 2018. [PDF](#).
12. Asim Mazin, Mohamed Elkourdi and R. D. Gitlin, "Comparative Performance Analysis of Beam Sweeping Using a Deep Neural Net and Random Starting Point in mmWave 5G New Radio," 9th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON) 2018, New York City, NY, USA, November 8-9, 2018. [PDF](#)
13. Mohamed Elkourdi, Asim Mazin and R. D. Gitlin, "Optimization of 5G Virtual Cell Based Coordinated Multipoint Networks Using Deep Machine Learning," International Journal of Wireless & Mobile Networks (IJWMN) Vol. 10, No. 4, August 2018 [PDF](#).
14. N. I. Sulieman, Eren Balevi and R. D. Gitlin, "Enhanced Diversity and Network Coded 5G Wireless Fog-Based-Fronthaul Networks," IEEE 88th Vehicular Technology Conference (VTC2018-Fall), Chicago, IL, USA, August 27-30, 2018. [PDF](#).
15. Asim Mazin, Mohamed Elkourdi and R. D. Gitlin, "Accelerating Beam Sweeping in mmWave Standalone 5G New Radios using Recurrent Neural Networks," IEEE 88th Vehicular Technology Conference (VTC2018-Fall), Chicago, IL, USA, August 27-30, 2018. [PDF](#).

16. Asim Mazin, Mohamed Elkourdi and R. D. Gitlin, "Comparison of Slotted Aloha-NOMA and CSMA/CA for M2M Communications in IoT Networks," IEEE 88th Vehicular Technology Conference (VTC2018-Fall), Chicago, IL, USA, August 27-30, 2018. [PDF](#).
17. Mohamed Elkourdi, Asim Mazin and R. D. Gitlin, "Slotted Aloha-NOMA with MIMO Beamforming for Massive M2M Communication in IoT Networks," IEEE 88th Vehicular Technology Conference (VTC2018-Fall), Chicago, IL, USA, August 27-30, 2018. [PDF](#).
18. Mohamed Elkourdi, Asim Mazin and R. D. Gitlin, "Towards Low Latency in 5G HetNets: A Bayesian Cell Selection / User Association Approach," IEEE 5G World Forum (5GWF'18) July 9-11, 2018 in Santa Clara, CA, USA, [PDF](#).
19. N. I. Sulieman and R. D. Gitlin, "Efficiently Secure Broadcasting in 5G Wireless Fog-Based-Fronthaul Networks," International Journal of Wireless & Mobile Networks (IJWMN) Vol. 10, No. 3, June 2018 [PDF](#).
20. Eren Balevi and R. D. Gitlin, "A Clustering Algorithm That Maximizes Throughput in 5G Heterogeneous F-RAN Networks," IEEE International Conference on Communications (ICC), 2018, Kansas City, MO, May 2018, [PDF](#).
21. Eren Balevi, F. Al Rabee and R. D. Gitlin, "ALOHA-NOMA for Massive Machine-to-Machine IoT Communication," IEEE International Conference on Communications (ICC), 2018, Kansas City, MO, May 2018, [PDF](#).
22. Eren Balevi and R. D. Gitlin, "Pareto Optimization for NOMA Power Control," IEEE Wireless Telecommunications Symposium (WTS), 2018, Phoenix, AR, April 2018, [PDF](#).
23. N. Sulieman, Eren Balevi and R. D. Gitlin, "Near-Instant Link Failure Recovery in 5G Wireless F-RANs," IEEE Wireless Telecommunications Symposium (WTS), 2018, Phoenix, AR, April 2018, [PDF](#).
24. Mohamed Elkourdi, Asim Mazin and R. D. Gitlin, "Enabling Slotted Aloha-NOMA for Massive M2M Communication in IoT Networks," IEEE 19th Wireless and Microwave Technology Conference (WAMICON), April 2018, [PDF](#).
25. Nazli Siasi, N. Sulieman and R. D. Gitlin, "Ultra-Reliable NFV-Based 5G Networks Using DC-NC," IEEE 19th Wireless and Microwave Technology Conference (WAMICON), April 2018, [PDF](#).
26. N. Sulieman and R. D. Gitlin, "Ultra-Reliable and Energy Efficient Wireless Sensor Networks," IEEE 19th Wireless and Microwave Technology Conference (WAMICON), April 2018, [PDF](#).
27. N. Sulieman, Eren Balevi and R. D. Gitlin, "Reliable and Resilient Coordinated Multi Point Fronthaul Networks," IEEE 19th Wireless and Microwave Technology Conference (WAMICON), April 2018, [PDF](#).
28. Eren Balevi and R. D. Gitlin, "Stochastic geometry analysis of IEEE 802.15.6," IEEE 19th Wireless and Microwave Technology Conference (WAMICON), April 2018, [PDF](#).
29. Eren Balevi and R. D. Gitlin, "Optimizing the Number of Fog Nodes for Cloud-Fog-Thing Networks," IEEE Access, February 2018, San Diego, CA. DOI: [10.1109/ACCESS.2018.2808598](#).
30. Eren Balevi and R. D. Gitlin, "An Inherent Fog Network Brain-Spinal Cord-Nerve Networks," IEEE Access, Dec 2018, DOI: [10.1109/ACCESS.2018.2800679](#).
31. Eren Balevi and R. D. Gitlin, "Synergies between Cloud-Fog-Thing and Brain-Spinal Cord-Nerve Networks," Information Theory and Applications Workshop (ITA), 2018, San Diego, CA, February 2018, [PDF](#). [Invited paper](#).
32. Eren Balevi and R. D. Gitlin, "Unsupervised Machine Learning in 5G Networks for Low Latency Communications," IEEE International Performance Computing and Communications Conference-IPCCC-2017, December 2017, San Diego, CA. [PDF](#).
33. Eren Balevi and R. D. Gitlin, "Performance Analysis of Local Anchor Based 5G HetNets Using Stochastic Geometry," International Journal of Wireless & Mobile Networks (IJWMN) Vol. 9, No. 5, October 2017 [PDF](#).
34. N. Sulieman, Eren Balevi, K. Davaslioglu, and R. D. Gitlin, "Diversity and Network Coded 5G Fronthaul Wireless Networks for Ultra Reliable and Low Latency Communications," IEEE

- International Symposium on Personal, Indoor and Mobile Radio Communications 2017, Montreal, QC, Canada, Oct 2017, [PDF](#).
35. N. Sulieman, K. Davaslioglu, and R. D. Gitlin, "Diversity Coded 5G Fronthaul Wireless Networks," IEEE Wireless Telecommunications Symposium (WTS), 2017, Chicago, IL, April 2017, [PDF](#).
 36. D. S. Wickramasuriya, C. A. Perumalla, K. Davaslioglu, and R. D. Gitlin, "Base Station Prediction and Proactive Mobility Management in Virtual Cells using Recurrent Neural Networks," IEEE 18th Wireless and Microwave Technology Conference (WAMICON), April 2017, [PDF](#).
 37. F. Al Rabee, K. Davaslioglu, and R. D. Gitlin, "The Optimum Received Power Levels of Uplink Non- Orthogonal Multiple Access (NOMA) Signals," IEEE 18th Wireless and Microwave Technology Conference (WAMICON), April 2017, [PDF](#).
 38. A. Mazin, K. Davaslioglu, and R. D. Gitlin, "Secure Key Management for 5G Physical Layer Security," IEEE 18th Wireless and Microwave Technology Conference (WAMICON), April 2017, [PDF](#).
 39. N. Sulieman, K. Davaslioglu, and R. D. Gitlin, "Link Failure Recovery via Diversity Coding in 5G Fronthaul Wireless Networks," IEEE 18th Wireless and Microwave Technology Conference (WAMICON), April 2017, [PDF](#).
 40. Y. Liu, K. Davaslioglu, and R. D. Gitlin, "Energy Efficiency Optimization of Channel Access Probabilities in IEEE 802.15.6 UWB WBANs," IEEE Wireless Communications and Networking Conference (WCNC), 2017, San Francisco, CA, March 2017, [PDF](#).
 41. D. S. Wickramasuriya, C. A. Perumalla, and R. D. Gitlin, "Predicting Episodes of Atrial Fibrillation using RR-Intervals and Ectopic Beats," IEEE/EMB joint International Conference on Biomedical and Health Informatics (BHI), Orlando, FL, February 2017, [PDF](#).
 42. Y. Liu, K. Davaslioglu, and R. D. Gitlin, "Energy Efficiency and Resource Allocation of IEEE 802.15.6 IR-UWB WBANs: Current State-of-the-Art and Future Directions," Information Theory and Applications Workshop (ITA), 2017, San Diego, CA, February 2017, [PDF](#). [Invited paper](#).
 43. K. Davaslioglu, Y. Liu and R. D. Gitlin, "CLOEE - Cross-Layer Optimization for Energy Efficiency of IEEE 802.15.6 IR-UWB WBANs," IEEE GLOBECOM 2016, December 2016, [PDF](#).
 44. A. F. Demir, Z. E. Ankaral, Q. H. Abbasi, Y. Liu, K. Qaraqe, E. Serpedin, H. Arslan and R. D. Gitlin: Steps Toward the Next Generation of Implantable Devices, " IEEE Vehicular Technology Magazine (Volume: 11, Issue: 2), pp. 32-42, June 2016, DOI: [10.1109/MVT.2016.2520492](#).
 45. A. F. Demir, Z. E. Ankaral, Q. H. Abbasi, K. Qaraqe, E. Serpedin, H. Arslan and R. D. Gitlin, *In Vivo* Wireless Channel Modeling, book chapter in *Advances in Body-Centric Wireless Communication: Applications and State-of-the-art*, IET, 2016, ISBN: 978-1-84919-989-6.
 46. K. Davaslioglu and R. D. Gitlin, "5G Green Networking - Enabling Technologies, Potentials, and Challenges," IEEE 17th Wireless and Microwave Technology Conference (WAMICON), April 2016, DOI: [10.1109/WAMICON.2016.7483860](#).
 47. C. He and R. D. Gitlin, "System performance of cooperative massive MIMO downlink 5G cellular systems," IEEE 17th Wireless and Microwave Technology Conference (WAMICON), April 2016, DOI: [10.1109/WAMICON.2016.7483862](#).
 48. C. He and R. D. Gitlin, "Limiting Performance of Massive MIMO Downlink Cellular Systems," Information Theory and Applications Workshop (ITA), 2016, San Diego, CA, February 2016, [PDF](#).
 49. C. A. Perumalla, T. P. Ketterl, R. D. Gitlin, and P. J. Fabri, "Integrated Vectorcardiogram (*i*VCG) Rotation Modeling and Compensation, " 20th IEEE International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), September 2015.
 50. Z. E. Ankaral, A. F. Demir, M. Qaraqe, Q. H. Abbasi, E. Serpedin, H. Arslan and R. D. Gitlin, "Physical Layer Security for Wireless Implantable Medical Devices, " 20th IEEE International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), September 2015.
 51. C. He and R. D. Gitlin, "User-Specific QoS Aware Scheduling and Implementation in Wireless Systems," 2015 IEEE Wireless Telecommunications Symposium (WTS), April 2015.

52. C. A. Perumalla, T. P. Ketterl, G. E. Arrobo, R. D. Gitlin and P. J. Fabri, "Wireless iVCG Optimization Using A Least-Squares Fit," IEEE 16th Wireless and Microwave Technology Conference (WAMICON), April 2015.
53. Y. Liu and R. D. Gitlin, "A Phenomenological Path Loss Model of the In Vivo Wireless Channel," IEEE 16th Wireless and Microwave Technology Conference (WAMICON), April 2015.
54. C. He, G. E. Arrobo, and R. D. Gitlin, "Improving System Capacity Based upon User-Specific QoS for Heterogeneous Networks," IEEE Wireless Communications and Networking Conference (WCNC), March 2015.
55. Chao He, Yang Liu, Gabriel E. Arrobo, Thomas P. Ketterl and Richard D. Gitlin, "In Vivo Wireless Communications and Networking", ITA 2015, February 2015.
56. C. A. Perumalla, G. E. Arrobo, T. P. Ketterl, R. D. Gitlin and P. J. Fabri, "Wireless Vectorcardiogram System Optimization using Adaptive Signal Processing," IEEE International Microwave Workshop Series on RF and Wireless Technologies for Biomedical and Healthcare Applications (IMWS-BIO), December 2014.
57. C. He, Y. Liu, T. P. Ketterl, G. E. Arrobo, and R. D. Gitlin, "Performance Evaluation for MIMO In Vivo WBAN Systems," IEEE International Microwave Workshop Series on RF and Wireless Technologies for Biomedical and Healthcare Applications (IMWS-BIO), December, 2014.
58. Yang Liu, Thomas P. Ketterl, Gabriel E. Arrobo, and Richard D. Gitlin, "Modeling the In vivo Wireless Path Loss," IEEE International Microwave Workshop Series on RF and Wireless Technologies for Biomedical and Healthcare Applications (IMWS-BIO), December, 2014.
59. Calvin A. Perumalla, Gabriel E. Arrobo, Thomas P. Ketterl Richard D. Gitlin and Peter J. Fabri "Wireless Vectorcardiogram System Optimization using Adaptive Signal Processing," IEEE International Microwave Workshop Series on RF and Wireless Technologies for Biomedical and Healthcare Applications (IMWS-BIO), December, 2014.
60. C. He and R. D. Gitlin, "Application-Specific and QoS-Aware Scheduling for Wireless Systems," IEEE 25th International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), September 2014.
61. C. He and R. D. Gitlin, "User Specific QoS and its Application in Resources Scheduling for Wireless System," the 14th International Conference on Algorithms and Architectures for Parallel Processing (ICA3PP), Springer International Publishing, 2014, pp. 809–821
62. C. He, Y. Liu, T. P. Ketterl, G. E. Arrobo, and R. D. Gitlin, "MIMO in vivo," IEEE 15th Annual Wireless and Microwave Technology Conference (WAMICON), June 2014, Tampa, FL.
63. G. E. Arrobo, C. A. Perumalla, S. B. Hanke, T. P. Ketterl, P. J. Fabri, and R. D. Gitlin, "An Innovative Wireless Cardiac Rhythm Management (*iCRM*) System," Wireless Telecommunication Symposium 2014, April 9-11, 2014.
64. G. E. Arrobo and R. D. Gitlin, "Minimizing Energy Consumption for Cooperative Network and Diversity Coded Sensor Networks," Wireless Telecommunication Symposium 2014, April 9-11, 2014.
65. G. E. Arrobo and R. D. Gitlin, "Improving the Reliability of In Vivo Video Wireless Communications," National Academy of Inventors: Journal of Technology and Innovation, December 2013, pp. 227–236.
66. C. A. Castro, S. Smith, A. Alqassis, T. P. Ketterl, Yu Sun, S. Ross, A. Rosemurgy, P. P. Savage, and R. D. Gitlin, "A Wireless Miniature Robot for Networked Expedited Laparoscopy," IEEE Transactions on Biomedical Engineering (TBME), April 2013, pp. 930-936.
67. G. E. Arrobo and R. D. Gitlin, "Improving the Performance of OFDM-based Vehicular Systems through Diversity Coding," Journal of Communications and Networks, April 2013, pp. 132–141.
68. C. A. Castro, S. Smith, A. Alqassis, T. P. Ketterl, Yu Sun, S. Ross, A. Rosemurgy, P. P. Savage, and R. D. Gitlin, "A Wireless Miniature Robot for Networked Expedited Laparoscopy," IEEE Transactions on Biomedical Engineering (TBME), April 2013, pp. 930-936.

69. T. P. Ketterl, G. E. Arrobo, and R. D. Gitlin, "SAR and BER Evaluation Using a Simulation Test Bench for *In Vivo* Communication at 2.4 GHz." IEEE 14th Annual Wireless and Microwave Technology Conference (WAMICON), April 2013, Orlando, FL.
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Patents

Patent Number	Title
1 10,735,320	Application wire
2 10,587,999	Enabling slotted Aloha-NOMA for massive machine-to-machine (M2M) communication in internet of thing (IoT) networks
3 10,411,999	Application wire
4 10,327,123	System and method for machine-to-machine communication in an internet-of-things network
5 10,278,152	Method and apparatus for registering wireless device in wireless communication system
6 10,076,228	Minimally invasive networked surgical system and method
7 9,843,509	Application wire
8 9,832,042	Mapping PBT and PBB-TE traffic to VPLS and other services
9 9,826,541	System and method for user-specific quality of service scheduling in wireless systems
10 9,788,705	Minimally invasive networked surgical system and method
11 9,749,086	Physical layer security for wireless implantable medical devices
12 9,743,823	Minimally invasive networked surgical system and method

- 13 [9,649,120](#) [Minimally invasive surgery platform attachment apparatus](#)
- 14 [9,485,176](#) [Global IP-based service-oriented network architecture](#)
- 15 [9,451,890](#) [Integrated vectorcardiogram system and method of use](#)
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- 17 [9,264,354](#) [Mapping PBT and PBB-TE traffic to VPLS and other services](#)
- 18 [9,197,675](#) [Application wire](#)
- 19 [9,172,638](#) [Global IP-based service-oriented network architecture](#)
- 20 [9,020,059](#) [System and method for diversity coded orthogonal frequency division multiplexing \(OFDM\)](#)
- 21 [8,923,773](#) [Minimally invasive networked surgical system and method](#)
- 22 [8,908,089](#) [Implantable imaging device](#)
- 23 [8,848,711](#) [Global IP-based service-oriented network architecture](#)
- 24 [8,619,784](#) [Mapping PBT and PBB-TE traffic to VPLS and other services](#)
- 25 [8,588,061](#) [Application wire](#)
- 26 [8,504,136](#) [See-through abdomen display for minimally invasive surgery](#)
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- 30 [8,213,311](#) [Control plane to data plane binding](#)
- 31 [8,018,880](#) [Layer 2 virtual private network over PBB-TE/PBT and seamless interworking with VPLS](#)
- 32 [7,376,101](#) [Secure candidate access router discovery method and system](#)
- 33 [6,968,737](#) [Position determining system using transmitted position information](#)

- 34 [6,438,379](#) [Power control and cell site location technique for CDMA systems with hierarchical architecture](#)
- 35 [6,198,941](#) [Method of operating a portable communication device](#)
- 36 [6,188,718](#) [Methods and apparatus for reducing cochannel interference in a mixed-rate communication system](#)
- 37 [6,064,662](#) [System and method for optimizing spectral efficiency using time-frequency-code slicing](#)
- 38 [6,018,528](#) [System and method for optimizing spectral efficiency using time-frequency-code slicing](#)
- 39 [5,995,827](#) [Method of muting a non-speaking cellular telephone caller participating in a conference call](#)
- 40 [5,953,331](#) [Wireless packet system for efficient wide area bandwidth utilization](#)
- 41 [5,856,971](#) [Code division multiple access system providing variable data rate access to a user](#)
- 42 [5,630,207](#) [Methods and apparatus for bandwidth reduction in a two-way paging system](#)
- 43 [5,625,884](#) [Global paging with reverse virtual call setup in wireless personal communications](#)
- 44 [5,600,663](#) [Adaptive forward error correction system](#)
- 45 [5,570,367](#) [Asymmetric protocol for wireless communications](#)
- 46 [5,457,679](#) [Channel sharing and memory sharing in a packet switching system](#)
- 47 [5,442,625](#) [Code division multiple access system providing variable data rate access to a user](#)
- 48 [5,278,689](#) [Gigabit per-second optical packet switching with electronic control](#)
- 49 [5,278,681](#) [Combined color and monochrome display](#)
- 50 [5,243,413](#) [Color parallax-free camera and display](#)
- 51 [5,191,462](#) [Fiber optic transmission distortion compensation](#)
- 52 [5,175,640](#) [Interleaved receivers](#)
- 53 [5,159,445](#) [Teleconferencing video display system for improving eye contact](#)

54	5,119,196	Ghost cancellation of analog TV signals
55	5,107,493	High-speed packet data network using serially connected packet and circuit switches
56	5,056,117	Decision feedback equalization with trellis coding
57	5,048,013	Transmission congestion control method and apparatus
58	5,007,067	Diversity coding for transparent self-healing communications networks
59	4,995,104	Interference cancelling circuit and method
60	4,924,492	Method and apparatus for wideband transmission of digital signals between, for example, a telephone central office and customer premises
61	4,924,480	Codecs with suppression of multiple encoding/decodings across a connection
62	4,644,537	Inband coding of secondary data
63	4,615,038	Equalization of modulated data signals utilizing tentative and final decisions and replication of non-linear channel distortion
64	4,416,015	Timing acquisition in voiceband data sets
65	4,412,341	Interference cancellation method and apparatus
66	4,334,313	Timing recovery technique
67	4,320,526	Adaptive phase-jitter tracker
68	4,253,184	Phase-jitter compensation using periodic harmonically related components
69	4,245,345	Timing acquisition in voiceband data sets
70	4,237,554	Coefficient tap leakage for fractionally-spaced equalizers
71	4,072,830	Variable phase shifter for adaptive echo cancellers
72	4,057,696	Recursive-like adaptive echo canceller
73	4,021,738	Adaptive equalizer with fast convergence properties
74	3,755,738	PASSBAND EQUALIZER FOR PHASE-MODULATED DATA SIGNALS