Robert A. Scholtz

Fred H. Cole Professor of Engineering
University of Southern California

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Robert A. Scholtz was born in Lebanon, OH, on January 26, 1936. He is a Distinguished Alumnus of the University of Cincinnati, where, as a Sheffield Scholar, he received the Degree in Electrical Engineer in 1958. He was a Hughes Masters and Doctoral Fellow while obtaining his MS and PhD degrees in Electrical Engineering from USC in 1960 and Stanford University in 1964 respectively.

Dr. Scholtz, working on missile radar signal processing problems, remained part-time at Hughes Aircraft Co. until 1978. In 1963, Dr. Scholtz joined the faculty of the University of Southern California, where he is now the Fred H. Cole Professor of Engineering. From 1984 through 1989, he served as Director of USC's Communication Sciences Institute, and from 1994 to 2000 he was Chairman of the Electrical Engineering Systems Department. In 1996, Dr. Scholtz formed the Ultrawideband Radio Laboratory (UltRa Lab) to provide facilities for the design and test of impulse radio systems and other novel high-bandwidth high-data-rate wireless mobile communication links. He has served as a consultant to several corporations and government agencies.

His research interests include communication theory, synchronization, signal design, coding, adaptive processing, and pseudonoise generation, and their application to communications and radar systems. He has co-authored the books *Spread Spectrum Communications*, the *Spread Spectrum Communications Handbook*, and *Basic Concepts in Information Theory and Coding*.

Dr. Scholtz is a Fellow of the IEEE and a member of the National Academy of Engineering. He has received several best paper awards, including the 1984 Donald G. Fink Prize, 1992 Senior Award and the 2012 Best Paper Award of the IEEE Signal Processing Society, the 2003 S. A. Schelkunoff Prize from the IEEE Antennas and Propagation Society. Dr. Scholtz is a co-recipient of the 2006 Eric E. Sumner Medal from the IEEE "for pioneering contributions to ultra-wide band communications science and technology."

Dr. Scholtz has been an active member of the IEEE for many years, manning several organizational posts, including Finance Chairman for the 1977 National Telecommunications Conference, Program Chairman for the 1981 International Symposium on Information Theory, and Board of Governors positions for the Information Theory Group and the Communications Society. He has been General Chairman of seven workshops in the area of communications, including most recently three ultrawideband radio workshops.

Education

B.S.: Electrical Engineering, 1958, University of Cincinnati

M.S.: Electrical Engineering, 1960, University of Southern California

Ph.D.: Electrical Engineering, 1964, Stanford University

Positions

1954-1958: Electrical Technician and Designer, Sheffield Corporation, Dayton, Ohio

1958-1963: Master's and Doctoral Fellow, Hughes Aircraft Company

1963-1965: Research Associate, USC

1963-1968: Staff Engineer, Hughes Aircraft Company

1965-1968: Assistant Professor, Department of Electrical Engineering, USC

1969-1970: Sabbatical Leave — Visiting Assistant Professor, Information Sciences Program, University of Hawaii

1968-1975: Associate Professor, Department of Electrical Engineering, USC

1968-1978: Senior Staff Engineer, Hughes Aircraft Company

1975- : Professor, Department of Electrical Engineering, USC

1975-1980: Consultant, LinCom Corporation

1978: Sabbatical Leave — Visiting Professor, Electrical Engineering Department, University of Hawaii

1979-1986: Consultant, Axiomatix, Inc.

1984-1989: Director, Communication Sciences Institute, USC.

1985-1986: Sabbatical Leave

1986: Consultant, JPL

1987-1989: Consultant, Technology Group

1989: Consultant, TRW

1992:Sabbatical Leave (fall semester)

1992-2001: Consultant, Pulson Communications, now Time Domain Corporation.

1993-1994: Consultant, Cooley, Godward, Castro, Huddleson & Tatum (for Qualcomm)

1994-2000: Chairman, Electrical Engineering - Systems Dept., USC

2000-2001: Sabbatical Leave, Time Domain Corporation

2003- : Fred H. Cole Professor of Engineering, USC

2007-2008: Sabbatical Leave

2008-2009: Consultant, Science and Engineering Research Council, Singapore

2012: Mini-Sabbatical Leave (spring semester)

Research Support

Contracts and Grants as Principal Investigator or Co-Principal Investigator:

- "Development of Measurement and Testing Equipment for Distributed Wireless Communications and Localization Systems," with A. Molisch, H. Hashemi, and A. Willner, $475,000, *Major Research Instrumentation Program, National Science Foundation*, September 1, 2011 – August 31, 2014.
- "Ultra-wideband MIMO Channel Sounder for Distributed Electronic Warfare Applications," with A. Molisch, H. Hashemi, and A. Willner, $500,000 (plus cost sharing), *Defense University Research Instrumentation Program, Office of Naval Research Program*, December 1, 2010 – December 1, 2012.
- "Short-Range Ultra-Wideband Systems," $6,031,195, *Department of Defense MURI Program*, (team of eight investigators from USC, UC Berkeley, and University of Massachusetts, Amherst) May 1, 2001 – April 30, 2006.
- "Anechoic Chamber," $200,000 gift from Paul Allen through *Vulcan Ventures*, Summer 2000.
- "Ultrawideband Radio Ranging Studies," $282,996.00, *Office of Naval Research*, January 1, 2000 – December 31, 2002.
- "Fundamental Experimental and Analytical Studies in Ultra Wideband Radio with Application to Wireless Multimedia Communication," with K. Chugg, A. Otrega, A. Prata, $700,000.00, *National Science Foundation*, September 1, 1998 – August 31, 2001.
- "Request for Research Instrumentation for the UltRa Lab," with Keith Chugg, $54,165, *U.S. Army Research Office*, April 1, 1998 – March 31, 1999.
- "A Proposal to the Army Research Office for Support of a Workshop on Ultra-Wideband Radio Techniques," $11,000.00, *U.S. Army Research Office*, May 15, 1998 – May 14, 1999.
- "A Proposal to the AASERT Program for Research on Impulse Radio for Battlefield Communications," $186,500, *U.S. Army Research Office*, June 1, 1997 – May 31, 2000.
- "Acquisition of Instrumentation for Testing of Ultra-Wideband Wireless and Wired Communications and Design of Enabling Instrumentation," with A. Willner and J. Choma, $403,952 *National Science Foundation*, September 1, 1996 – August 31, 1998.

- "Mobile Communications Networks with Directive/Adaptive Antennas," $274,487, *U.S. Army Research Office*, July 1, 1996 – June 30, 1999.

- "Research on Common-Code Spread-Spectrum Communications," *National Science Foundation,* (NCR-9400628), January 1, 1994 – December 31, 1994, $50,000.

- "Communication Techniques in Stressed Environments" (Task: Multiple-Rate Communication Link Design), with A. Polydoros and four senior investigators, *U.S. Army Research Office* (DAAL03-88-K-0059), 15 July 1988 – 14 July 1991, $1,117,315.

- "Engineering Research Equipment Grant: VLSI Design and Test," with I. S. Reed, *National Science Foundation* (CDA-8905938), 15 August 1989 – 30 July 1990, $35,732.

- "Cryptographic Implications of the Symmetric Group's Action on Reed-Muller Codes," with one senior investigator, *Faculty Research and Innovation Fund*, 1 January 1989 – 1 January 1990, $15,000.

- "Advanced Communication Techniques," with L. R. Welch and six senior investigators, *U.S. Army Research Office* (DAAG29-85-K-0116), 1 June 1985 – 31 May 1988, $773,008.

- "Workshop on Advanced Communication Processing Techniques," *U.S. Army Research Office* (DAAL03-89-G-0016), 13 February 1989 – 30 June 1990, $10,822.

- "Adaptive Channel Coding Using Hidden Markov Chains," with R. E. Peile, *U.S. Army Research Office* (DAAL03-88-K-0169), 1 July 1988 – 31 December 1988, $20,000.

- "Workshop on Advanced Communication System Engineering," *U.S. Army Research Office* (DAAL03-87-G-0101), 16 March 1987 – 15 March 1988, $16,028.

- "Engineering Research Center for Advanced Communication System Engineering," *USC Provost (proposal fund)*, June 1986 – December 1986, $10,000.

- "Principles of Spread Spectrum Systems," with C. L. Weber and one senior investigator, *Office of Naval Research* (N00014-82-K-0328), 1 September 1982 – 31 December 1985, $311,000.

- "Advanced Digital Communication Research," with L. Silverman and five senior investigators, *U.S. Army Research Office* (DAAG29-83-M-0065), 1 September 1982 – 31 May 1985, $810,000.

- "Spread Spectrum Signal Studies," with S. W. Golomb and L. R. Welch, *National Security Agency* (MDA904-83-H-0004), 1 November 1982 – 31 November 1985, $338,000.

- "Workshop on Research Trends in Military Communications," with C. L. Weber, *U.S. Army Research Office* (DAAG29-82-K-0142), November 1982 – October 1983, $14,000.

- "Research in Digital Communications," with L. M. Silverman and seven senior investigators, *U.S. Army Research Office* (DAAG29-79-C-0054), 15 March 1979 – 14 March 1982, $585,086; extension for March 1982 – June 1982, $75,000; extension for June 1982 – August 1982, $76,500.

- "Advanced Communication System Studies," with W. C. Lindsey and two senior investigators, *Air Force Office of Scientific Research* (AFOSR-80-0171), 15 May 1980 – 15 May 1982, $204,633.
- "Research in Communication Theory," with L. R. Welch, *U.S. Army Research Office* (DAAG29-76-G-0246), 16 June 1976 – 15 June 1979, $138,417.
- "Research in Communication Theory," with L. R. Welch, *U.S. Army Research Office* (DA-ARO-D-31-124-73-G153), 1 May 1973 – 30 April 1976, $108,700.
- "Coding, Synchronization, and Tracking Systems," with I. S. Reed and one senior investigator, *U.S. Army Research Office* (DA-ARO-D-31-124-70-G51, DA-ARO-D-31-124-72-G-43), 1 May 1970 – 30 April 1973, $46,558.
- "Transmitter Optimization in Digital Communications," with I. S. Reed, *U.S. Army Research Office* (DA-ARO-D-31-124-G929, DA-ARO-D-31-124-G1045), 1 June 1967 – 31 May 1970, $103,000 (est).
- Supplement to "Coding, Synchronization, and Tracking Systems," with I. S. Reed, *National Science Foundation* (GK33349), 1972 – 1973, $16,000.

Contract and Grant Participation as a Senior Investigator:

- UltRa Lab Support, $25,000 from NTT DoKoMo, via IMSC, Fall, 2001.
- UltRa Lab Support with Prata, $50,000 from Compaq via IMSC, Spring 1999.
- UltRa Lab Support, with Choma, Chugg, and Ortega, $150,000 from Advanced Micro Devices via IMSC, December 1996.
- "Integrated Media Systems Center," $12,475,000.00, Engineering Research Center Program of NSF, 5 years, beginning July 1, 1996.
- "Multimedia transmission in fiber-optic networks using optical CDMA," $581,454, with O. Moreno as principal investigator, ONR, subcontract to USC, $136,169 over 3 years.
- "Research in Electronics" (Task: Wideband Time-Hopping for Multiple-Access Communications), with W. Steier and ten senior investigators, *Joint Services Electronics Program*, 1 April 1994 – 31 March 1997.
- "Automatic Detection and Recognition in Infrared and SAR Using Multi-Dimensional Signal Features," with I. S. Reed and four senior investigators *DARPA*, 1 July 1993 – 30 June 1996, $1,696,585.
- "TCM Studies," Center for Applied Research in Signal Processing (CRASP), October 1, 1993 - September 30, 1994.
- "Communication Sequences," with S.W. Golomb and five senior investigators, *National Security Agency* (MDA904-87-H-2007), 1 November 1986 – 31 March 1990, $595,343.

- "Research in Electronics" (Task: Spread Spectrum Receiver Design for Intense Jamming Environments), with W. Steier and twelve senior investigators, *Joint Services Electronics Program* (F49620-88-C-0067), 1 April 1988 – 31 March 1991, $2,696,317.

- "Research in Electronics" (Task: Adaptive Channel/Code Matching), with W. Steier and twelve senior investigators, *Joint Services Electronics Program*, 1 April 1991 – 31 March 1994, $3,257,900.

- "TRW/USC Research Program" (Task: Analysis of Codeless GPS Navigation), with C. L. Weber and seven senior investigators, *TRW, Inc.*, 16 March 1987 – 15 March 1988, $13,003 (task share).

- "Advanced Communication Techniques II," with S. W. Golomb and senior investigators, *Natinoal Security Agency* (MDA904-86-H-0002), 26 December 1985 – 31 October 1986, $55,000.

- "," *Joint Services Electronics Program*, 1 April 1977 – 31 March 1978, $12,000 (task share).

- "Automata and Communications," with S. W. Golomb and I. S. Reed and five senior investigators, *Air Force Office of Scientific Research* (AF-AFOSR-874-65,...-66,...-67, AF-AFOSR-68-1555), 1 Mar 1965 – 28 February 1970, $260,000 (est.).

Ph.D. students

- Walter S. Cascell, "Tracking Loop for a Time-Varying Center Frequency of a Random Process," 1969.

- Robert M. Gray, "Information Rates of Autoregressive Processes," 1969.

- Robert M. Storwick, "Codes for Almost Sure Synchronization," 1969.

- Richard W.D. Booth, "Generalized Input Broadcast Channels," 1974.

- Jose R. Boisson de Marca, "Recursive Decoders for Convolutional Codes Transmitted over Burst Channels," 1977.

- John D. Olsen, "Nonlinear Binary Sequences with Asymptotically Optimum Periodic Cross-Correlation," 1977.

- Nagwa E. Bekir, "Bounds on the Distribution of Partial Correlation for PN and Gold Sequences," 1978.

- P. Vijay Kumar, "On Bent Sequences and Generalized Bent Functions," 1983.

- Seong Young Kang, "Frequency-Offset Retrodirective Arrays," 1983.

- Sabah A. Al-Quaddoomi, "Two-dimensional Binary Codes with Good Autocorrelation," 1983.

- Alex Netch, "Pairwise Phase-Locked Loop Coupling for Tracking Improvement in Non-Rigid Retrodirective Arrays," 1983.

- Samir Soliman, "Synchronization over Fading Dispersive Channels," 1983.
- Raimundo Sampaio-Neto, "Spread-Spectrum Code Tracking in the Presence of Interference," 1983.
- Arie Reichman, "Adaptive Spread Spectrum Using Least-Squares Lattice Algorithms," 1984.
- Wei-Chung Peng, "Some Communication Jamming Games," January 1986.
- Duncan Dlugos, "Acquisition of Spread Spectrum Signals by an Adaptive Array," March 1986.
- Christopher Miller, "Multiple Radio Source Location Using an Array of Moving Passive Sensors," May 1986.
- Tsern-Huei Lee, "Communications with Multiple Data Rates in a Hostile Environment," June 1987.
- Charles Franz, "The Calibration of Distorted Airborne Antenna Arrays Using Synthetic Aperture Radar Principles," May 1989.
- Yu-Cheun Jou, "Design of Switchable Pseudonoise Generator and its VLSI Implementation," May 1989.
- Seok-Ho Kim, "An Optimum Filter Design for a Cross-Spectrum Symbol-Rate Detector," May 1990.
- Dong-In Kim, "On the Performance of Common Spreading Code CDMA Packet Radio Systems with Multiple Capture Capability," December 1990.
- Inkyung Kim, "Performance of Unslotted Common Spreading-Code Packet-Radio Networks with Adaptive Header-Detection Schemes," January, 1992.
- Ranjan Mallik, "Link Jamming Games with Discrete Levels," January 1992.
- Haiping Tsou "On the Performance of Direct-Sequence Spread-Spectrum Code Tracking in the Presence of Cyclostationary Interference," March 1992.
- Narciso Tan, "Adaptive Channel/Code Matching," October 1993.
- Dennis M. Gottman, "Joint Decoding and Carrier Phase Estimation for Trellis Code Modulation," November, 1993.
- Wei-Chun Wang, "A New Pulse Compression Scheme Applied to Spread Aloha VSAT Networks," 1994.
- Gregory Mitchell, "Doppler Tolerant Waveforms in Pulse Compression Systems for Ranging and Timing Applications," 1994.
- Lin-Lang A. Yang, "Digital Algorithms for Multiuser Detector, Decision-Directed Phase Tracking Loop, and A/D and D/A Converter," May 1995.

- Qingchong (John) Liu, "Performance Analysis and Collision Resolution Algorithm for Random Access Multichannel CDMA Systems with Multiuser Detection," December 1996.
- Chi-Ping Nee, "Finite State Machine Model of Rotationally Invariant/Geometrically Uniform Trellis-Coded Modulation," 1997.
- Eduardo Esteves, "Efficient Orthogonal Multichannel DS-CDMA System with Low Complexity Multiuser Detection," September 1997.
- Moe Z. Win, "Ultra-Wide Bandwidth (UWB) System for Wireless Multiple Access Communications," October 1997.
- Tien-Yow Liu, "Link Acquisition Protocols for a Mobile Communication Network with Directive/Adaptive Antennas," December 1997.
- Fernando Ramirez-Mireles, "Multiple-Access with Ultra-Wideband Impulse Radio Modulation Using Spread-Spectrum Time-Hopping and Block Waveform Pulse-Position-Modulated Signals," March 1998.
- George Chrisikos, "Joint Sequence and Detector Optimization in CDMA Systems," September 1998.
- Jong-Heon Oh, "Sequential Detection of DOA in a Mobile Communication Network with Directive/Adaptive Antennas," December 1998.
- Robert Jean-Marc Cramer, "An Evaluation of Ultra-Wideband Propagation Channels," December 2000.
- Joon-Yong Lee, "UWB Ranging in Dense Multipath Environments," April 2002.
- Sangyoub Lee, "Design and Analysis of Ultra-Wide Bandwidth Impulse Radio Receiver," April 2002.
- Carlos J. Corrada-Bravo, "Sequence Designs for Applications in Ultra-Wideband Systems and Turbo Codes," August 2002.
- Eric A. Homier, "Synchronization of Ultra-Wideband Signals in the Dense Multipath Channel," June 2004.
- Yi-Ling Chao, "Ultra-wideband Radios with Transmitted Reference Methods," March 2005.
- Chee-Cheon Chui, "Synchronous Impulse Networks," May 3, 2005.
- Robert Wilson, "Characterization and Identification of Ultrawideband Radio Propagation Channels," October 2005.
- Meng-Hsuan Chung, "Receiver Design for Ultra-Wideband Radios with Efficient Multipath Diversity Utilization," May 2006.
- Ziba Ebrahimian, "Improvement in Hyperbolic Position Location Systems," June 2006.

- Majid Nemati-Anaraki, "UWB Indoor Diffusion Channel Model and Its Application to Receiver Design," January 13, 2007.
- Sanghyun Chang, "UWB Polarization Measurements in Multipath Channels," January 14, 2007.
- Yenming Chen, "Theoretical Models of Voltage-Controlled Oscillators and the Effects of Nonlinearity," September 13, 2007.
- Terry Lewis, An Ultrawideband Digital Signal Design with Power Spectral Density Constraints, " August 29, 2010.

Awards, Honors, and Miscellaneous Information

- Sheffield Scholar 1953-58.
- RCA Scholarship 1957-58.
- Honorary Membership in the Dayton Engineer's Club, given for receiving the top grade in the State of Ohio, Engineer-in-Training Exam, Spring 1958.
- Hughes Aircraft Company, Masters Fellowship 1958-60.
- Hughes Aircraft Company Doctoral Fellowship 1960-63.
- Paper with C.L. Weber, "Signal Design for Phase-Incoherent Communications," nominated by the IEEE Information Theory Group for the Browder J. Thompson Award. 1967.
- Chosen by the National Academy of Science to host the visit of S.I. Samoylenko to the United States. 1971. (An interesting experience !)
- Hughes Aircraft Company Invention Awards:

  (1) A Coherent Digital Range-Error Processor, 1972.

  (2) A Coherent Signal Detector, 1975.

⋆ 1980 Fellow of the Institute of Electrical and Electronic Engineers for "contributions to the theory and design of synchronizable codes for radar and communication systems."

⋆ 1982 Distinguished Alumnus Award, University of Cincinnati.

⋆ 1983 Recipient of the IEEE COMSOC's Leonard G. Abraham Prize Paper Award for "The Origins of Spread-Spectrum Communications," *IEEE Trans. on Communications*, May 1983.

- 1983 General Chairman (with C.L. Weber) of an Army Research Office sponsored workshop on "Research Trends in Military Communications."

⋆ 1984 Recipient of the IEEE Donald G. Fink Prize Award for "The Origins of Spread-Spectrum Communications."

- Honorable Mention in the Phi Kappa Phi Research Award Competition, 1985.

- 1987 General Chairman of an Army Research Office sponsored workshop on "Advanced Communication System Engineering".

- 1989 General Chairman of an Army Research Office sponsored workshop on "Advanced Communication Signal Processing Techniques," May 14-17, 1989.

- Member of the Advisory Board, EPSCoR Project on Computational Mathematics and the CISE Program, University of Puerto Rico, 1990- .

- Session Chairman, First International Symposium on Communication Theory and Application, Crieff, Scotland, September 9-13, 1991.

- Nominated for the 1992 USC Award for Excellence in Teaching.

⋆ Co-recipient with Duncan Dlugos of the 1992 Senior Award of the IEEE Signal Processing Society for the paper "Acquisition of Spread-Spectrum Signals by an Adaptive Array," *IEEE Transactions on Acoustics, Speech and Signal Processing*, August 1989.

⋆ Coauthor of "ATM Based Ultrawide Bandwidth (UWB) Multiple-Access Radio Network for Multimedia PCS," with M. Z. Win, J. H. Ju, X. Qiu, and V. O. K. Li, Fourth Annual Engineers Conference at NetWorld+Interop'97, that received the best student paper award from the conference program committee.

- Panel Chairman, "Open Research Issues and Tradeoffs," ARO/ARL Federated Laboratory Workshop on Spread Spectrum for Tactical Mobile Wireless Communications, College Park, MD, June 19, 1997.

- Session Chairman, PIMRC'97, Helsinki, Finland, September 1-4, 1997.

⋆ Co-recipient with J.-H. Oh of the Ellersick Award for the outstanding unclassified paper at Milcom'97, "Strategies for minimizing the intercept time in a mobile communication network with directive/adaptive antennas."

- Participant, Research Strategy Planning Workshop, U.S. Army Research Office, Electronics Division, Charleston, SC, January 5-8, 1998.

- General Chairman of the workshop on "Ultra-Wideband Radio Techniques," May 25-28, 1998.

- Speaker and Participant, NSF Networking Principal Investigators' Workshop, Washington, DC, January 21-23, 1999.

- Chair, Technical Papers Session, Ultra Wideband (UWB) Conference, Washington DC, September 28-30, 1999.

- Panelist, UWB Research Directions, Ultra Wideband (UWB) Conference, Washington DC, September 28-30, 1999.

⋆ Recipient of a $10,000 unrestricted grant from the Okawa Foundation, 2000.

⋆ Recipient of the Military Communications Conference Award for Technical Achievement, 2001.

• Consultant (gratis), Defense Science Board Task Force on Wideband Radio Frequency Systems, 2002.

• Workshop Organizer, "An Ultra-Wideband Technology Workshop: From Research to Reality" and Panel Chair "UWB Interference and Coexistence," jointly sponsored by Intel and the UWB MURI, October 3-4, 2002.

⋆ Co-recipient of the S. A. Schelkunoff Prize Paper Award, IEEE Antennas and Propagation Society, 2003 for the paper with Jean Marc Cramer and Moe Z. Win, "Evaluation of an Ultra-Wideband Propagation Channel," *IEEE Transactions on Antennas and Propagation,* May 2002.

⋆ Corecipient with Eric Homier of a Best Paper Award from the meeting organizers for the paper, "Hybrid Fixed-Dwell-Time Search Techniques for Rapid Acquisition of Ultra-Wideband Signals," *IWUWBS2003*, Oulu, Finland, June 2003.

⋆ Recipient of the Senior Research Award, USC School of Engineering, 2003.

⋆ Awarded the Fred H. Cole Professorship in Engineering by the USC School of Engineering, August 2003.

• International panelist, Thematic Strategic Research Program (TSRP) Workshop, "UWB & Pervasive Computing," Singapore, October 6-7, 2003.

⋆ Plenary Address: "Looking for the Ultrawideband Communications Niche." Joint meeting of the *IEEE Conference on Ultrawideband Systems and Technologies* and the *International Workshop on Ultrawideband Systems*, Kyoto, Japan, May 18-21, 2004.

⋆ Recipient (with Moe Win) of the 2006 Eric E. Sumner Medal and Award from the IEEE "for pioneering contributions to ultra-wide band communications science and technology."

• Organizer and General Chair, "Workshop on Short Range Ultra-Wideband Radio Systems," Santa Monica CA, April 11-12, 2006.

⋆ Plenary Address: "CDMA in Retrospect," ISCCSP'06, Marrakech, Morocco, March 14, 2006.

⋆ Plenary Address: "Recent Results and Challenges in Ultrawide Bandwidth Radio Systems," ICUWB 2006, Waltham MA, September 26, 2006.

⋆ 2007 Technical Recognition Award, given by the IEEE ComSoc Radio Communications Committee (RCC) for outstanding contributions to the technological advancement of radio communications.

• Member, External Review Committee, Science & Engineering Research Council, Singapore, 2008-2009.

⋆ 2009 Member of the National Academy of Engineering for "contributions to the fields of ultra-wideband and spread-spectrum communication"

⋆ 2010 USC Mellon Mentoring Award for mentoring graduate students.

⋆ Co-recipient with Robert Wilson and David Tse of the 2012 Best Paper Award, IEEE Signal Processing Society, for "Channel Identification: Secret Sharing Using Reciprocity in Ultra-wideband Channels" *IEEE Transactions on Information Forensics and Security*, Volume: 2, No. 3, September 2007.

⋆ Keynote Speaker: "How I Got into Impulse Radio – the Education of one Communication Theorist," *ICUWB'13*, Sydney, Australia, September 2013.

⋆ Inaugural Lecture: "Synchronization Dreams," *EE Pioneer Lecture Series*, Ming Hsieh Institute, May 2, 2014.

Who's Who Listings

- Who's Who in the West (18th ed. –)
- Who's Who in Engineering (5th ed. –)
- Who's Who in Frontiers of Science and Technology (2nd ed. –)
- Who's Who in Technology Today (2nd ed. –)
- International Who's Who in Education (3rd ed. –)
- Who's Who in Aviation and Aerospace, U.S. Edition (1st ed. –)
- American Men and Women of Science (15th ed. –)
- Personalities of America (4th ed. –)
- Personalities of the Americas (1st Commemorative eds. –)
- Men of Achievement (12th ed. –)
- Biography of the Year, 1986.
- Dictionary of International Biography (vol. 20 –)
- Who's Who in California (16th ed. –)
- Two Thousand Notable Americans (3rd ed. –)
- Five Thousand Personalities of the World (2nd ed. –)
- Who's Who in Society (2nd ed. –)
- Who's Who in America (45th ed. –)
- Community Leaders of America (14th ed.)
- Who's Who in Science and Engineering (1st ed.)
- Who's Who in American Education 1992-1993

Activities in the Institute of Electrical and Electronic Engineers

- Past Chairman and Secretary-Treasurer, Los Angeles Chapter, Group on Information Theory, 1965-1967.
- Member of the Communication Theory Committee, IEEE Communication Society for over two decades.
- IEEE Student Chapter Advisor, 1972-1976.
- General Chairman, Third Annual Communication Theory Workshop, 1973.
- Program Committee, International Communications Conference, 1974.
- Local Arrangements Chairman, Fifth Annual Communication Theory Workshop, 1975.
- Advisory Council, Communication Society, 1978-1979.
- Finance Chairman, National Telecommunications Conference, 1977.
- Secretary, Technical Affairs Council, Communication Society, 1980-1981.
- Program Chairman, International Symposium on Information Theory, 1981.
- Board of Governors, Communication Society, 1981-83.
- Board of Governors, Information Theory Group, 1981-86.
- Session Chairman, 1982 Communication Theory Workshop.
- Session Chairman, MILCOM '82.
- Advisory Board, MILCOM '84.
- Member of the IEEE Prize Papers Committee, 1984-85.
- Panel Chairman, 1984 Communication Theory Workshop.
- Program Committee, 1985 International Symposium on Information Theory.
- Session Organizer and Chairman, MILCOM '85.
- Member of the IEEE Awards Board, 1990-93.
- Chairman of the Simon Ramo Medal Award Committee, 1990-93.
- Session Chairman, 1990 International Symposium on Information Theory.
- Session Organizer and Session Chairman, Twenty-Fourth Asilomar Conference on Signals, Systems, and Computers, 1990.
- Session Organizer, 1992 IEEE Information Theory Workshop.
- Session Organizer and Chairman, MILCOM '93.

- Session Chairman, 1994 International Symposium on Information Theory.
- Session Organizer and Chairman, MILCOM '95.
- Member, IEEE Fellows Committee, 1/1/00 - 6/1/01.
- Session Chairman, Third IEEE Workshop on WLAN, Newton MA, Sept. 27-28, 2001.
- Session Chairman, 2002 IEEE Conference on Ultra Wideband Systems and Technologies, Baltimore MD, May 20-23, 2002.
- Guest Editor, IEEE Transactions on Vehicular Technology, special issue on Ultra-Wideband Radio, September 2005.
- Technical Program Co-Chairman and Session Organizer, 2007 International Conference on Ultra-WideBand, Singapore, September 24-26, 2007.
- Member, Eric E. Sumner Award Committee, 2007-2010 .

PUBLICATIONS

Books

[1] *Spread Spectrum Communications,* 3 volumes, with M.K. Simon, J.K. Omura, and B.K. Levitt, Computer Science Press, 1985.

[2] *Basic Concepts in Information Theory and Coding: The Adventures of Secret Agent 00111,* with S. W. Golomb and R. E. Peile, Plenum Publishing Corp., 1994.

[3] *Spread Spectrum Communications Handbook,* with M.K. Simon, J.K. Omura, and B.K. Levitt, revised edition of [1] in one volume, McGraw Hill, 1994.

[4] *Spread Spectrum Communications Handbook,* with M.K. Simon, J.K. Omura, and B.K. Levitt, electronic edition of [3], McGraw Hill, 2002.

Journal Papers

1. S.W. Golomb and R. A. Scholtz, "Generalized Barker Sequences," *IEEE Trans. on Information Theory*, Vol. IT-11, No. 4, 1965. Reprinted in *Multiple Access Communications*, N. M. Abramson, ed., IEEE Press, 1993.

2. R. A. Scholtz and C.L. Weber, "Signal Design for Phase-Incoherent Communications," *IEEE Trans. on Information Theory,* Vol IT-12 1966. (Nominated by IEEE Group on Information Theory for the Browder J. Thompson Award.)

3. I.S. Reed and R. A. Scholtz, "N-Orthogonal Phase-Modulated Codes," *IEEE Trans. on Information Theory,* Vol. IT-12, July 1966.

4. R. A. Scholtz, "Codes with Synchronization Capability," *IEEE Trans. on Information Theory*, Vol. IT-12, April 1966.

5. R. A. Scholtz, "Maximal and Variable Word-Length Comma-Free Codes," *IEEE Trans. on Information Theory*, Vol. IT-15, March 1969.

6. R. A. Scholtz and L. R. Welch, "The Mechanization of Codes with Bounded Synchronization Delays", *IEEE Trans. on Information Theory*, Vol. IT-16, July 1970.

7. R. A. Scholtz and R. M. Storwick, "Block Codes for Statistical Synchronization", with R.M. Storwick, *IEEE Trans. on Information Theory*, Vol. IT-16, July 1970.

8. R. A. Scholtz, "On the Passive Resolution of Broadcasting Targets with a Monopulse Antenna," *IEEE Trans. on Aerospace and Electronic Systems*, Vol. 9, No. 5, September 1973.

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92. Robert A. Scholtz, R. Jean-Marc Cramer, and Moe Z. Win, "Evaluation of the Propagation Characteristics of Ultra-Wideband Communication Channels," *1998 IEEE International Antennas and Propagation Symposium*, Atlanta GA, June 21-26, 1998, pp. 626-630.

93. Fernando Ramírez-Mireles and Robert A. Scholtz, "Time-Shift-Keyed Equicorrelated Signal Sets for Impulse Radio M-ary Modulation," *International Conf. on Wireless Communications (WIRELESS)*, Calgary, Canada, July 1998.

94. Ranjan K. Mallik and Robert A. Scholtz, "On the Existence of a Steady-State Solution to a Dynamic Jamming Game," *1998 IEEE International Symposium on Information Theory,* MIT,August 16-21, 1998. (copy not available)

95. Fernando Ramírez-Mireles and Robert A. Scholtz, "System Performance Analysis of Impulse Radio Modulation," *IEEE Radio and Wireless Conference (RAWCON)*, Colorado Springs, Colorado, August 1998.

96. R. Jean-Marc Cramer, Moe Z. Win and Robert A. Scholtz, "Evaluation of the Multipath Characteristics of the Impulse Radio Channel," *PIMRC'98*, Boston MA, September 8-11, 1998.

97. Fernando Ramírez-Mireles and Robert A. Scholtz, "Multiple-Access Performance Limits with Time Hopping and Pulse Position Modulation," *1998 IEEE Military Communications Conference,* October 1998.

98. Jung-Hyun Oh and Robert A. Scholtz, "Optimal Interception and Direction Finding of Signals in a Mobile Communication Network with Directive Antennas," *1998 IEEE Military Communications Conference,* October 1998.

99. Fernando Ramírez-Mireles and Robert A. Scholtz, "Wireless Multiple-Access Using SS Time-Hopping and Block Waveform Pulse Position Modulation, Part 1: Signal Design," with F. Ramirez-Mireles, *International Symposium on Information Theory and its Applications (ISITA)*, Mexico City, October 1998.

100. Fernando Ramírez-Mireles and Robert A. Scholtz, "Wireless Multiple-Access Using SS Time-Hopping and Block Waveform Pulse Position Modulation, Part 2: System Performance," with F. Ramirez-Mireles, *International Symposium on Information Theory and its Applications (ISITA)*, Mexico City, October 1998.

101. J. M. Cramer, M. Z. Win, and R. A. Scholtz "Spatio-Temporal Diversity in Ultra-Wideband Radio" *IEEE Wireless Communications and Networking Conference (WCNC)*, New Orleans, LA, September 21-24, 1999.

102. C. J. Corrada-Bravo, R. A. Scholtz, and P. V. Kumar, "Generating TH-SSMA sequences with good correlation and low PSD level," *1999 UWB Conference for Radio and Radar Technology,* Washington DC, Sept. 26-28, 1999.

103. R. Jean-Marc Cramer, Robert A. Scholtz, and Moe Z. Win, "Statistical models for indoor UWB signal propagation," *1999 UWB Conference for Radio and Radar Technology,* Washington DC, Sept. 26-28, 1999.

104. J. M. Cramer, R. A. Scholtz and M. Z. Win, "On the Analysis of UWB Communication Channels," *IEEE Military Communications Conference*, Atlantic City, NJ, Oct. 31-Nov. 3, 1999.

105. R. A. Scholtz, R. Weaver, E. Homier, J. Lee, P. Hilmes, A. Taha, and R. Wilson, "UWB Radio Deployment Challenges," *PIMRC 2000*, London, UK, September 18-21, 2000.

106. Joon-Yong Lee and Robert A. Scholtz, "Time of Arrival Estimation of the Direct Path Signal in UWB Communications," *National Radio Science Meeting*, Boulder CO, January 2001.

107. R. A. Scholtz, P. Vijay Kumar, and Carlos Corrada Bravo, "Signal Design for Ultra-Wideband Radio," *Sequences and Their Applications - SETA '01*, Bergen, Norway, May 13-17, 2001. Full papers published in book by Springer- Verlag, 2002.

108. R. D. Wilson, R. D. Weaver, M.-H. Chung, and R. A. Scholtz, "Ultra Wideband Interference Effects on an Amateur Radio Receiver," *2002 IEEE Conference on Ultra Wideband Systems and Technologies,* Baltimore MD, May 20-23, 2002.

109. Eric A. Homier and Robert A. Scholtz, "Rapid Acquisition of Ultra-Wideband Signals in the Dense Multipath Channel," *2002 IEEE Conference on Ultra Wideband Systems and Technologies,* Baltimore MD, May 20-23, 2002.

110. Robert A. Scholtz and Joon-Yong Lee, "Problems in Modeling Ultra-Wideband Channels," *Asilomar Conference on Signals, Systems, and Computers*, November 2002.

111. Eric A. Homier and Robert A. Scholtz, "Hybrid Fixed-Dwell-Time Search Techniques for Rapid Acquisition of Ultra-Wideband Signals," *IWUWBS2003*, Oulu, Finland, June 2003 (received best student paper award).

112. Chee-Cheon Chui and Robert A. Scholtz, "Tracking UWB monocycles in IEEE 802.15 Multipath Channels," *Asilomar Conference on Signals, Systems, and Computers*, November 2003.

113. Meng-Hsuan Chung and Robert A. Scholtz, "Optimization of Delay Tracking Loops for Binary Modulated Systems," *Asilomar Conference on Signals, Systems, and Computers*, November 2003.

114. R. D. Wison and R. A. Scholtz, "Template Estimation in Ultra-Wideband Radio," *Asilomar Conference on Signals, Systems, and Computers*, November 2003.

115. R. D. Wison and R. A. Scholtz, "Comparison of CDMA and Modulation Schemes for UWB Radio in a Multipath Environment," *Globecom*, December 2003.

116. Yi-Ling Chao and Robert A. Scholtz, "Optimal and Suboptimal Receivers for Ultra-Wideband Transmitted Reference Systems," *Globecom*, December 2003.

117. Chee-Cheon Chui and Robert A. Scholtz, "Optimizing Tracking Loops for UWB Monocycles," *Globecom*, December 2003.

118. Yi-Ling Chao and Robert A. Scholtz, "Multiple Access Performance of Ultra-Wideband Transmitted Reference Systems," *IEEE Wireless Communications and Networking Conference (WCNC 04)*, vol. 3, pp. 1788-1793, March 2004.

119. R. D. Wison and R. A. Scholtz, "On the Dependence of UWB Impulse Radio Link Performance on Channel Statistics," *IEEE International Conference on Communications*, Volume: 6, pp. 3566 – 3570, June 2004.

120. Chee-Cheon Chui and Robert A. Scholtz, "A Synchronizing Scheme for an Impulse Network," *IEEE Military Communications Conference*, Monterey CA, November 2004.

121. Majid A. Nemati and Robert A. Scholtz, "A Diffusion Model for UWB Indoor Propagation," *IEEE Military Communications Conference*, Monterey CA, November 2004.

122. Meng-Hsuan Chung and Robert A. Scholtz, "A Comparison of Transmitted- and Stored Reference Systems for Ultra-Wideband Communications." *IEEE Military Communications Conference*, Monterey CA, November 2004.

123. Sang-Hyun Chang and Robert A. Scholtz, "Polarization Measurements in a UWB Multipath Channel," *IEEE Military Communications Conference*, Monterey CA, November 2004.

124. Chee-Cheon Chui and Robert A. Scholtz, "Estimating Parameters of Received UWB Monocycles," *Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, November 2004.

125. Yi-Ling Chao and Robert A. Scholtz, "Novel Ultra-wideband Transmitted Reference Systems," *Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, November 2004.

126. Terry P. Lewis and Robert A. Scholtz, "An Ultrawideband Signal Design with Power Spectral Density Constraints," *Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, November 2004.

127. Yi-Ling Chao and Robert A. Scholtz, "Weighted Correlation Receivers for Ultra-Wideband Transmitted Reference Systems," *Global Telecommunications Conference*, December 2004.

128. Z. Ebrahimian and R. A. Scholtz, "Receiver Sites for Accurate Indoor Position Location Systems," *ACES Conference* (Applied Computational Electromagnetics Society), Honolulu HI, April 3-7, 2005.

129. Z. Ebrahimian and R. A. Scholtz, "Source Localization using Reflection Omission in the Near Field," *ACES Conference* (Applied Computational Electromagnetics Society), Honolulu HI, April 3-7, 2005.

130. Meng-Hsuan Chung and Robert A. Scholtz, "Receiver Improvement for Ultra-Wideband Transmitted-Reference Systems," *IEEE Wireless Communications & Networking Conference*, 2005.

131. Yenming Chen and Robert A. Scholtz, "A theoretical model of a voltage-controlled oscillator," *39th Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, Oct. 30-Nov. 2, 2005.

132. Majid A. Nemati and Robert A. Scholtz, "A parametric analytical diffusion model for indoor ultra-wideband received signal," *39th Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, Oct. 30- Nov. 2, 2005.

133. Sanghyun Chang and Robert A. Scholtz, "UWB Wave Polarization Measurements in Indoor Channels with a Hertzian Dipole Antenna Approximation," *2006 Antennas and Propagation Society International Symposium*, Albuquerque NM, July 9-14, 2006.

134. Majid A. Nemati, Urbashi Mitra, and Robert A. Scholtz, "Optimum Integration Time for UWB Transmitted Reference and Energy Detector Receivers," *MilCom 2006*, Washington, D.C., 23-25 Oct. 2006.

135. Robert Wilson, David Tse, and R. A. Scholtz, "Channel Identification: Secret Sharing Using Reciprocity in Ultrawideband Channels," *2007 IEEE International Conference on Ultra-Wideband*, Singapore, September 24-26, 2007.

136. Terry P. Lewis and Robert A. Scholtz, "The Search for Efficient Digitally Generated Impulse-Like Ultrawideband Signals," *Asilomar Conference on Circuits, Systems, and Computers*, November 5-7, 2007.

137. SangHyun Chang and Robert A. Scholtz, "UWB Wave Polarization Measurements in an Indoor Channel Using Array Sensors," *2008 IEEE International Symposium on Antennas and Propagation* and the *2008 USNC/URSI National Radio Science Meeting*, San Diego CA, July 5-12, 2008.

138. Yenming Chen and Robert A. Scholtz, "Theoretical Models of Oscillators, Phase Noise, and the Effects of Nonlinearity," *Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove CA, October 26-29, 2008.

Special Presentations

1. "Codes with Synchronization Capability," JPL Communications Research Seminar, Los Angeles, California, November 1967.

2. "A Review of Synchronizable Codes," San Francisco Bay Chapter IEEE Group on Information Theory, 1968.

3. "Transmitter Optimization in Digital Communications," Military Theme Review, Fort Monmouth, New Jersey, January 1969.

4. "Synchronizable Codes," Electronic Sciences Laboratory Research Review, University of Southern California, February 1969.

   Panelist: UCLA Conference on Education and System Sciences, Spring 1969.

5. "Elementary Cryptanalysis," USC Electrical Engineering Seminar, Spring 1969.

6. "Cryptanalysis - Science, Subterfuge, or Magic?" Information Sciences Seminar, University of Hawaii, October 1969.

7. "The Heritage of William F. Friedman," Information Sciences Seminar, University of Hawaii, November 1969.

8. "Synchronization - The Noiseless Case," Faculty Seminar, University of Hawaii, December 1969.

9. "Probabilistic Generation, Transmission, and Syntactical Decoding of Context-Free Programmed Languages," with C.R. Souza, Allerton Conference on Circuits and System Theory, University of Ilinois, October 7-9, 1970.

10. Panelist: Engineering Education, Tierra Verde Workshop on "Future Directions of Communication Theory," Sponsored by IEEE group on Communication Technology, April 1971.

11. "Coding for Synchronization," Los Angeles Chapter, IEEE Group on Information Theory, March 1971.

12. "Signals with Good Correlation Properties," Signal Analysis Section Seminar, Hughes Aircraft Company,November 1971.

13. "Coding, Synchronization, and Tracking Systems," Military Theme Review, White Sands Missile Range, December 1971.

14. "An On-Off Communication Study," with I.S. Reed, 1972 International Symposium on Information Theory, Pacific Grove, California, January 1972.

15. "Signal Design for Good Correlation," Electrical Engineering Seminar, Stanford University, March 1972.

16. Seminar Series, "Radar Signal Processing," Hughes Aircraft Company, Canoga Park, California, beginning Summer 1973.

17. "Research in Communication Theory," Military Theme Review, Fort Huachuca, Arizona, December 1973.

18. "Wideband Digital Signal Set Design," Electrical Engineering Seminar, Stanford University, February 1974.

19. "Wideband Digital Signal Set Design," San Francisco Bay Area Chapter, IEEE Group on Information Theory, February 1974.

20. "Communication Research," JSEP Research Review, USC, February 1977.

21. "Continued Fractions and Berlekamp's Algorithms," Los Angeles Chapter, IEEE Group on Information Theory, March 1977.

22. "A Survey for Synchronizable Codes," Seminar, University of Hawaii, March 1978.

23. "Spread Spectrum Communications," Seminar, University of Hawaii, April 1978.

24. "Radar Signal Design," Seminar, University of Hawaii, May 1978.

25. "Multiple Access Signal Sets," Seminar, University of Hawaii, May 1978.

26. "Unsolved Problems in the Design of Synchronizable Codes," USC Systems Seminar, February 1980.

27. "PN Spread Spectrum Code-Division Multiple-Access Signal Design," Los Angeles Chapter, IEEE Group on Information Theory, March 1980.

28. "Spread Spectrum Research," Fort Monmouth, New Jersey, May 1980.

29. "Spread Spectrum Communications," USC-ARO Communications Research Review, October 1980.

30. "What's New in Spread Spectrum?" Panel Moderator, Eleventh Annual Communication Theory Workshop, New Braunfels, Texas, April 1981.

31. "Bent Sequences," Spread Spectrum Seminar, Fort Monmouth, New Jersey, May 1981.

32. "Spread Spectrum Communications," South Bay Harbor Section of the IEEE, March 25, 1982.

33. "The Origins of Spread Spectrum Communications," Long Island NY branches of Aerospace and Electronic Systems Society and the Communications Society, May 18, 1982.

34. "Research in Digital Communications," Spread Spectrum Seminar, Fort Monmouth, NJ, May 19, 1982.

35. "Anecdotes from the History of Spread Spectrum Communications," Information Systems Seminar, Stanford University, November 18, 1982.

36. "Pseudonoise Generator Design Criteria," Los Angeles Chapter of the IEEE Information Theory Group, February 22, 1983.

37. "Research in the Communication Sciences Institute," Industrial Associates Research Review, USC, May 12, 1983.

38. "The Early Days of Spread Spectrum Communications," Naval Postgraduate School, June 28, 1983.

39. "Secure Communications," ARO Electronics Coordinating Group Workshop, Pingree Park, Colorado, Sept. 6-9, 1983.

40. "Pseudorandom Sequences in GF(q)," Seminar at CETUC, Pontificia Universidade Catolica, Rio de Janeiro, Brazil, August 31, 1984.

41. "Spread Spectrum Communications," (plenary talk), 2nd Brazilian Symposium on Telecommunications, Campinas, Brazil, Sept. 3-6, 1984.

42. "Spread Spectrum Codes," Course on Principles of Spread Spectrum Communications, sponsored by the South Bay Harbor Section of the IEEE, October 3, 1984.

43. "Flexible Arrays, Precorrelation Filtering, and Adaptive Spread Spectrum Systems," USC-ARO Research Review, USC, October 26, 1984.

44. "Nested, Retrodirective Array Processing," and "Precorrelation Filter Design for Spread Spectrum Systems," USC Electrical Engineering Research Review, April 1-2, 1985.

45. "Panelist at workshop on "Research Trends in Spread Spectrum Communications," Cowichan Bay, British Columbia, August 5-7, 1985.

46. "Comments on a Variety of Jamming Problems," CSI Research Review, February 6, 1986.

47. Participant at ARO-sponsored "Research Strategy Workshop," May 3-6, 1987, Quail Roost, N.C.

48. "A survey of Sequence Designs for Communications," Inaugural Lecture at the Internation Symposium on Information and Coding Theory, Campinas, SP, Brasil, July 27-August 1, 1987.

49. "Spread Spectrum Receiver Design for Intense Jamming Environments," Joint Services Program Review, September 23-27, 1987.

50. "History of Spread Spectrum Communications," Hughes Technical Colloquia, Hughes Ground Systems Group, October 28, 1987.

51. "A History of Early Spread Spectrum Communications," TRW Forum Colloquia, Space Park, June 16, 1988.

52. "Studies at the USC Communication Sciences Institute," University of Saskatchewan, November 29, 1988.

53. "Pseudonoise Sequence Design for Communications," Workshop on Applications of Algebraic Geometry, University of Puerto Rico, January 8-12, 1990.

54. "A History of Spread Spectrum Communications," Distinguised Visiting Scholar Lecture, California State Polytechnic University, Pomona, CA, April 11, 1990.

55. "The Use of Sequences in Communications," Plenary Invited Speaker, VI SIDIM (Seminario Interuniversitario de Investigacion Matematica), Universidad del Sagrado Corazón, Santurce, Puerto Rico, February 23, 1991.

56. "Common-Code Multiple-Access Spread-Spectrum Systems," Workshop: *Spread Spectrum — Potential Commercial Applications, Myth or Reality?,* (summary published), Montebello, Quebec, Canada, May 21-23,1991.

57. "Thoughts on the Management of Flexible Radios," CSI Research Review, February 13, 1992.

58. "Wideband Time-Hopping for Multiple-Access Communications," Joint Services Program Review, November 30, 1993.

59. "An Historical Commentary on Spread-Spectrum Techniques," The Rand Corp., March 15, 1994.

60. "Multiple Access with Time-Hopping Impulse Modulation," CSI Research Review, February 17, 1994.

61. "Spread-Spectrum Multiple-Access," Stanford Telecom, March 6,1995.

62. " PN Sequence Design for Time Hopping," Preliminary Design Review, Quantico VA, Nov. 30, 1995.

63. "The Potential of Impulse Radio," IEEE Communication Theory Workshop, Destin FL, April 14-17, 1996.

64. "The UltRa Lab Effort," Communication Sciences Institute Annual Research Review, February, 27, 1997.

65. Talk on "Impulse Radio" presented to the Santa Clara Valley chapter of the IEEE Microwave Theory and Techniques Society, February 13, 1997.

66. "A Quick Review of Direct Sequence and Frequency Hopping Spread Spectrum Communications," ARO/ARL Federated Laboratory Workshop on Spread Spectrum for Tactical Mobile Wireless Communications, College Park, MD, June 19, 1997.

67. "Ultrawideband Radio Laboratory," Ultrawideband Tactical Electronic Device Program, Demonstration and Review, Quantico VA, October 16, 1997.

68. "Ultrawideband Communications Systems," Workshop on Wireless Technologies and Information Networks (jointly sponsored by NSF,DARPA, ARO, NASA, ONR, and AFOSR), Airlie House, Warrenton VA, July 23-24, 1998.

69. "Ultrawideband Radio Laboratory," demonstration for the Communication Sciences Institute Annual Research Review, November 6, 1998.

70. "Ultra-Wideband Multiplexed Wireless Systems and Networks," IMSC Scientific Advisory Board, May 17, 1999; National Science Foundation Site Visit, May 19, 1999.

71. "Thoughts about Ultrawideband Radio," Hughes Research Laboratories, September 16, 1999.

72. "Ultra-Wideband Wireless Radio Update," Scientific Advisory Board, Integrated Media Systems Center, Palo Alto, CA, Oct. 22, 1999.

73. "Ultrawideband Wireless," Board of Councilors, USC School of Engineering, Nov. 19,1999.

74. "Ultrawideband Communication Systems," ARO MURI Program in Chaotic Communications, Winter School 2000, University of California, San Diego, Jan. 23-26, 2000.

75. "Multiple Access with Time-Hopping Impulse Modulation," Broadband Space-Time Seminar, Acorn Technologies, Inc., Pacific Palisades, February 11, 2000.

76. "Ultrawideband Radio," Workshop on Ultrawideband Communications (sponsored by the Office of Naval Research), Berkeley Wireless Research Center, May 16, 2000.

77. "Ultrawideband Radio," first speaker (invited) at the NSF Wireless Grantees Workshop, Washington DC, Feb. 20-21, 2001.

78. "Ultrawideband Radio Ranging Studies," first academic speaker, Marine Corps Science and Technology Program Review, Quantico, VA March 2, 2001.

79. "Ultrawideband Radio," opening technical speaker at the Intel Ultra-Wideband Technical Forum, Hillsboro, OR, October 11-12, 2001.

80. Speaker and Session Chairman at the Third IEEE Workshop on WLAN, Newton MA, Sept. 27-28, 2001.

81. "Remarks on Ultrawideband Radio," first academic speaker at the NETEX Program Industry Day, (a DARPA meeting), McLean VA, Sept. 10, 2001.

82. Seminar speaker, Information Sciences Institute, Marina del Rey, CA, September 6, 2001.

83. Seminar speaker, Time Domain Corporation, Huntsville, AL, June 7, 2001.

84. "Ultrawideband Radio," seminar speaker, Magis Networks, San Diego CA, February 15, 2002.

85. Panelist, "Ultra-wideband - The Future of Short and Medium Range Wireless Communications," WCNC 2002, Orlando, Florida, March 17-21, 2002.

86. Workshop Organizer "An Ultra-Wideband Technology Workshop: From Research to Reality," and Panel Chair "UWB Interference and Coexistence," (jointly sponsored by Intel and the UWB MURI) October 3-4, 2002.

87. "Ultrawideband Radio: Past, Present, and Future," Berkeley Wireless Research Center Winter Retreat, Monterey CA, January 13-14, 2003.

88. International Expert Panelist for a SERC sponsored workshop on "UWB and Pervasive Computing - Exploring Synergies," Singapore, October 6-7, 2003.

89. "Ultrawideband Promises and Problems," NSF Wireless Grantees Workshop, Honolulu HI, October 15-16, 2003 (associated with 2003 IEEE Topical Conference on Wireless Communication Technology).

90. "Looking for the Ultrawideband Communications Niche," Raytheon Corporation, Fullerton CA, April 2004.

91. The Plenary Address: "Looking for the Ultrawideband Communications Niche." Joint meeting of the *IEEE Conference on Ultrawideband Systems and Technologies* and the *International Workshop on Ultrawideband Systems*, Kyoto, Japan, May 18-21, 2004.

92. Workshop presentation: "Getting the Most out of UWB Propagation Measurements," RAWCON, Atlanta GA, September 19. 2004.

93. "CDMA in Retrospect," Viterbi Conference, University of Southern California, March 8-9, 2005.

94. "CDMA in Retrospect," EE-Systems Student Awards Program, University of Southern California, April 6, 2005.

95. "Ultra-Wideband Communications," EE Advisory Board Meeting, April 15, 2005.

96. Panelist, "Wireless Visionaries, 100Mbps anytime, anywhere?", 2005 Texas Wireless Symposium, Austin TX, October 27, 2005.

97. "Ultrawideband Radio – Realities and Promises," 2005 Texas Wireless Symposium, Austin TX, October 27, 2005.

98. "Ultrawideband Radio – Has It Arrived?" UCSD Symposium on Spectrally Efficient Wireless, San Diego CA, November 17, 2005.

99. "CDMA in Retrospect," (plenary address), ISCCSP'06, Marrakech, Morocco, March 14, 2006.

100. "Recent Results and Challenges in Ultrawide Bandwidth Radio Systems," (plenary address), ICUWB 2006, Waltham MA, September 26, 2006.

101. "A Commentary on the Origins of CDMA," MIT LIDS Colloquium, Boston MA, September 26, 2006.

102. Panelist,"Technical Challenges for Next and Future Generations of UWB Systems," 2007 IEEE International Conference on Ultra-Wideband, September 25, 2007.

103. "A Commentary on the History of CDMA Communications," Best Teaching Assistant and Best Research Paper Award Ceremony, USC, April 24, 2009.

104. "A UWB Walking Tour," iCORE Wireless Communications Laboratory Seminar, University of Alberta, July 21, 2010.

105. "The Origin of CDMA Communications," Spotlight Series, IEEE Student Chapter, USC, October 21, 2010.

106. "Communications at USC: A 20^{th} Century Retrospective" (with George Bekey), Communication Sciences Institute 30^{th} Anniversary Celebration, November 29, 2012.

107. Keynote Speaker, "How I Got into Impulse Radio – the Education of one Communication Theorist," *ICUWB'13*, Sydney, Australia, September 2013.

108. Inaugural Lecture: "Synchronization Dreams," EE Pioneer Lecture Series, Ming Hsieh Institute, May 2, 2014.

Miscellaneous publications

At Stanford University:

- "The Binary Coding Problem for a Random Channel," Stanford Electronics Laboratories Report No. 2004-7, January 1963.
- "Coding for Adaptive Capability in Random Channel Communications," Stanford Electronics Laboratories Report No. 6104-8, December 1963.

At USC:

- "Scatter Communication Models for Space Vehicles," USCEE Report No. 104, January 1964.
- "A Correlation Theory for Forward Scattering Processes," with I.S. Reed, USCEE Report No. 110, May 1964.
- "Synchronization," *USC Engineer*, May 1973, pp. 25-28.

At the University of Hawaii:

- "Syntactical Decoders and Backtracking S-Grammars," with C. de Renna e Souza, Aloha System Report, University of Hawaii, November 1969.

At Hughes Aircraft Co.:

- "A REAC Study of Average Missile Oil Consumption Rate with Flipper Angle Limiting (Problem No. 181)," with R.B. McGhee, 4312/587, February 16, 1959.
- "Simulation Study of the GAR-11 with 'On-Off' Jamming, REAC Problem No. 182", with M.M. Momoda, 4312/820, June 22, 1959.
- "Function Generation Using Turrets," 4312/918, August 26, 1959.
- "Recommendations Leading to Possible Improvement of Chaff Capability," 4216.5/31, April 19, 1960.
- "Simulation of the GAR-4A Using Model 150 Reticle Characteristics," with D.P. Sullivan, 4216.5/36, May 4, 1960.

- "Palmdale Chaff Test Recommendations," 4216.5/48, June 7, 1960.
- "Rear Reference Loop Noise Analysis for Internal-External Reference Switching," 2729.10/148, September 25, 1962.
- "Multiple Target Cross Sections and Reflected Waveforms for Pulsed-Doppler Radar Detection," 2145.5/137, October 10, 1963.
- "AWG-9 Elevation Angle Estimation," with W.J. Hurd, 2144/01/9, February 24, 1964.
- "Overmodulation Characteristics for the XAIM-54A Missile," with W.J. Hurd, 2144/ 01/23, July 17, 1964.
- "Angle Data Processing Simulation for XIAM-54A," with R. Makino, 2144.01/40, December 15, 1964.
- "A Comment on the Feasibility of a Medium PRF Doppler Radar," 2144.01/49, March 30, 1965.
- "Comments on Tracking the Center Frequency of a Random Process," 2142.06/26, February 20, 1967.
- "Analytical Investigation of ACM-76A Shrike Guidance Computer," 2142.06/40, February 22, 1967.
- "Tracking Noise Sources with a Silent Lobing System," 2142.06/58, June 8, 1967.
- "More on Tracking Center Frequencies," 2142.06/76, October 4, 1967.
- "Analysis of PCAM Signal Processor," 2142.06/101, January 23, 1968.
- "Range Gate Straddle Loss: FX. Air-to-Air Radar," 2142.06/127, April 30, 1968.
- "Computing the Output Spectral Density of a Hard Limiter; Special Cases," with L.O. Zimmerman, 2142.03/001, February 12, 1969.
- "Mechanization of Error Detecting and Correcting Codes," 2142.06/010, July 7, 1969.
- "Coherent Range-Error Processing," 2142.03/062, February 23, 1971.
- "Performance of Coherent Range-Error Processors," 2142.03/069, April 30, 1971.
- "Comments on Digital Angle Error Processing," 2142.03/085, August 11, 1971.
- "Angle Tracking a Pair of Broadband Noise Jammers," 2142.03/098, October 24, 1971.
- "Angle Tracking a Pair of Targets with a Monopulse Antenna," 2142.03/105, January 12, 1972.
- "Monopulse Antenna Resolution Characteristics," 2142.02/110, February 9, 1972.
- "Comments on the AIM-7F Killed Target Detector," 2143.31/28, September 27, 1972.
- "Detection of Rayleigh Scintillating Target," with N.E. Nahi, 2143.5/14, April 25, 1972.

- "Estimating Target Angle in Glint Situations," 2143.31/16, June 26, 1972.
- "On the Joint Density Signal Amplitude and Glint," 2143.31/6, June 1,, 1972.
- "Recursive Detection of Moderately Rayleigh Scintillating Targets," with J.J. Kappl, 212323.2/8, December 12, 1973.
- "Relative Performance of a Zero-Crossing Digital Processor," 2123.23/542, August 5, 1974.
- "Tracking Pairs of Jammers," 2123.23/557, November 21, 1974.
- "The TVM Concept," 2123.23/572, February 14, 1975.
- "Monopulse Antenna Patterns and the Sidelobe Jammer Threat," 2123.23/573, February 21, 1975.
- "A Comparison of Two Methods for the Detection of Moderately Fading Rayleigh Targets,", with J.J. Kappl, 5131.3/507, April 10, 1975.
- "Comment on TVM System Flaws," 5131.3/514, May 29, 1975.
- "A Possible CCM for Cooperative Blinking Jammers," 5131.3/519, August 17, 1975.
- "On the Detection of Broadband Noise Sources by a Monopulse Receiver," with R.E. Pavek, 5131.3/532, February 5, 1976 (C/CP).
- "Notes on GPS Communications Signal Processing," 5131.3/532, February 11, 1976.
- "Broadband Jammer Detection Algorithm for LWRM," 5131.3/542, May 14, 1976.
- "The Use of Charge-Coupled Devices in ATAAM," 5131.3/554, August 26, 1976.
- "Sequences with Good Correlation Properties," 5131.3/600, April 15, 1976.
- "Design of Prefilters for CCD Matched Filters," 5131.3/600, April 15, 1976.
- "Comment on a Sidelobe Signal Detection Scheme," 5131.3/614, July 6, 1977.
- "Design of Phase-coded High PRF Signal Processors," 5743.0/633, November 17, 1977.

<u>At LinCom Corporation</u>:

- "Cross-Correlation Detection of Multipath Parameters," LINCOM Report, 1976.
- "Spectral Computations for the Envelope of a Multipath Signal," LINCOM Report, 1976
- "Sync Word Recovery Study," LINCOM Report, 1977.
- "Communications Satellite Network Conceptual Design and Program Definition Study," LINCOM Report, December 1978.
- "Optimization of the Pilot SPS Signal Design - Task I Preliminary Study Report," with W.C. Lindsey, LINCOM Memo, March 1979.

- "Reviewers Comments on Solar Power Satellite (SPS) Pilot Beam and Communication Link Subsystem Investigation Study - Phase I," with C.M. Chie and W.C. Lindsey, LINCOM Memo, June 1979.

- "Alert Waveform Design for the Acoustic Channel," LINCOM Technical Report TR-0480-2179, April 1980.

At Axiomatix, Inc.:

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