

RCA 2020 Virtual Technical Symposium, Saturday November 21st Final Agenda

9:00	9:05*	Welcome & Introductions	John Facella, P.E.
9:05	09:50	“Recent Progress in Observing Large Scale Traveling Ionospheric Disturbances Using Amateur Radio”	Dr. Nathaniel Frissell, (Univ. of Scranton)
09:50	10:35	“The KDKA Tower”	Mike Rhodes, P.E. (Cavell Mertz)
10:35	10:50	Break, sponsor activity	
10:50	11:35	“The Modified Franklin Tower – A Look Back at the Past 20 Years”	Chris Hudak (Station KDKA)
11:35	11:50	“Listen to What We Started”	Jim Graci (Station KDKA)
11:50	12:20	Lunch Break- with sponsors	
12:20	12:45	Progress Report on RCA’s Youth Initiatives	Carole Perry (RCA)
12:45	1:30	Youth Presentation: “Stranger Things”	Francis Bonte, student at Case Western Reserve Univ.
1:30	2:15	“Modern AM Modulation Techniques”	Geoff Mendenhall, P.E. (Mendenhall Engineering LLC)
2:15	2:30	Break, sponsor activity	
2:30	3:15	“Near Field Drone Measurements of Broadcast Antennas”	Nicole Starrett (Dielectric Corp.)
3:15	4:00	“Next Gen Interactive TV & Advanced Emergency Alerting & Informing”	Fred Baumgartner (One Media 3.0)
4:00	4:45	“Rail Wireless Communications – What’s Next?”	Barry Einsig (Econolite) Umberto Malesci (Fluidmesh Networks)
4:45	5:30	“History of Westinghouse Radio & TV Manufacturing on the 100 th Anniversary Of KDKA”	Mike Molnar
5:30	5:45**	Wrap up	Dr. Jim Breakall

* Note: All presentation times include audience Q&A at the end of each presentation.

**** After 5:45, viewers should switch to a NEW Zoom link to view the RCA Awards Event at 6 PM ET:**

<https://us02web.zoom.us/j/85280653104?pwd=Nno4V0lyckRGRWxWVWZjQTJachZqZz09>

Meeting ID: 852 8065 3104, Passcode: RCA2020

Abstracts, Speaker Biographies

RCA 2020 Virtual Technical Symposium, November 21st

“Recent Progress in Observing Large Scale Traveling Ionospheric Disturbances Using Amateur Radio”

Dr. Nathaniel Frissell, Univ. of Scranton

Abstract

Large Scale Traveling Ionospheric Disturbances (LSTIDs) are quasi-periodic variations in F region electron density with horizontal wavelengths > 1000 km and periods between 30 to 180 min. On 3 November 2017, LSTID signatures were detected at 7 and 14 MHz in observations made by amateur radio reporting networks for the first time. These networks provide data to the Ham Radio Science Citizen Investigation (HamSCI) community. The LSTIDs are detected by observing changes in average propagation path length with time. Simultaneous LSTID signatures were present in ham radio observations over the continental United States, the Atlantic Ocean, and Europe. LSTIDs observed with amateur radio were consistent with observations by the Blackstone SuperDARN HF radar and in differential GNSS Total Electron Content (TEC) measurements. The LSTID signatures were observed throughout the day following ~ 800 nT surges in the Auroral Electrojet (AE) index at 00 and 12 UT. We will discuss potential generation hypotheses for the observed LSTIDs, including atmospheric gravity wave (AGW) sources triggered by auroral electrojet intensifications and associated Joule heating.

Speaker Biography

Dr. Nathaniel Frissell is a Space Physicist and Electrical Engineer with a passion for radio science and remote sensing of the ionosphere. Currently, he serves as an Assistant Professor of Physics and Engineering at The University of Scranton. Previously, he was a research professor at New Jersey Institute of Technology, earned his Ph.D. in Electrical Engineering from Virginia Tech working in the SuperDARN laboratory, and earned his B.S. in Physics and Music Education from Montclair State University (2007).



“The KDKA Tower”

Mike Rhodes, P.E., Cavell Mertz

Abstract

The original 1938 KDKA AM tower was a sectionalized “Franklin” - a $3/4$ wavelength tower insulated and fed in the center (a $3/4 \lambda$ vertical dipole). This configuration produces a large amount of high angle vertical radiation that, at night, generated a skywave signal which caused significant interference within the station’s own nighttime groundwave coverage area. In 1994 the original tower had to be replaced due to structural concerns and a new design was proposed which would maintain the ground-wave efficiency of a $3/4 \lambda$ tower but reduce the vertical radiation. This “modified Franklin” is a half-wave over a quarter-wave, still insulated and fed in the middle but was enhanced by remotely adjustable circuits and with phase monitoring at the feed point and at the base to modify the phase relationship of the two sections.

This presentation is in memory of Bix Bixby, the primary design engineer involved with this project, and will broadly cover the original antenna system design and the design and construction challenges of the current tower built in 1994.

Speaker Biography

Michael D. Rhodes, P.E., has spent the last 22 years at Cavell Mertz & Associates as a Senior Engineer working on radio and television allocation, coverage, and interference analysis. He has been involved in all aspects of studio, transmitter and antenna system, design, installation and repair. For the last several years he has been a lead Subject Matter Expert for the FCC’s television repack fund administrator. Other interesting projects include ongoing maintenance of FCCInfo.com, monitoring and troubleshooting a 750-mile microwave system, satellite radio interference prediction, and serving as a fully cleared, subject matter expert on Full Motion Video for the US Intelligence Community.

Prior to joining Cavell Mertz in 1998, Mike spent four years with Moffet, Larson and Johnson, Inc. (MLJ) where his work included the rebuilding of the KDKA(AM) and WINS(AM) antenna systems as well as the design and build-out of the first GSM cellular system in Houston, TX. Mike began his consulting career as a staff engineer with Jules Cohen & Associates, in Washington, DC. He is a member of SBE and SMPTE and a past president of AFCCE.



“The Modified Franklin Tower – A Look Back at the Past 20 Years”

Chris Hudak, Chief Engineer, RF Systems, Station KDKA

Abstract

Since the work that Mike Rhodes has just presented, which led KDKA to a modified Franklin tower, the station has continued to do work on their tower. 50 KW of energy can have a significant impact on conductors, insulators, and matching circuits. As a result, KDKA has had to do multiple modifications to the installation, and this presentation will highlight what we did and what we learned, working at 270 feet on a 720 ft. tower.

Speaker Biography

Chris Hudak is a graduate of Penn Technical Institute, an avid amateur radio operator (WA3PBL). He began his broadcast career in the early 1970's, working for several stations in and around the Pittsburgh market. He has been with the former CBS Radio (now Entercom) cluster of stations, including KDKA-AM/FM, WDSY-FM and WBZZ-FM for the past 36 years.



“Listen to What We Started”

Jim Graci, Brand Manager & Programming, Station KDKA

Abstract

This presentation will be a historical look at radio station KDKA, including its early history, key dates, some of the radio personalities of KDKA, and our centennial celebration.

Speaker Biography

Jim Graci has spent a lifetime in radio. Starting at 16, he worked his way through various stations in various formats in Central Pennsylvania. He moved to Atlanta in 1984 to work at legendary Z-93 as a disc jockey and production director. His radio career crossed the country with stints in Seattle, Phoenix, Dallas and Pittsburgh. He has programmed legendary stations over the last 20 years including Sportstalk WEAE in Pittsburgh and News Talk KLIF-AM Dallas. He returned to Pittsburgh in 2012 to take over the programming at News Radio 1020 KDKA. In 2015, he added Sports Radio 93.7 The Fan (KDKA-FM) to his programming responsibility. Graci also served as public address announcer for 14 seasons, four with the Atlanta Hawks and ten in Seattle for the now defunct SuperSonics. Graci’s wife is a 25 year veteran of music radio and record promotion as well.



“Progress Report on RCA’s Youth Presentation” Carole Perry, RCA Director

Abstract

This presentation will highlight the latest RCA activities and work with youth and students to encourage them to pursue STEM-based (science, technology, engineering, mathematics) careers. Carole and RCA have been assisting youth to discover the fun of STEM and wireless for over 30 years. In August Carole was invited to moderate a Youth Forum for the QSO Today Virtual Ham Expo. She chose seven very technically talented and creative RCA Young Achievers as presenters. She will describe each presenter and their topics, and the follow up we all experienced from the live Q and A following our Forum.

Speaker Biography

Carole Perry is an RCA Director and Fellow, and Chairperson of RCA Youth Activities. She is also a Director of QCWA (the Quarter Century Wireless Association) and Chairperson of its Youth Activities. She was recently elevated to the status of Fellow of the AWA (Antique Wireless Association).

Carole Perry is the recipient of many national and international awards. Amongst them is the prestigious 1987 Dayton Hamvention Ham of the Year, the 1993 QCWA President’s Award, the 2009 and 2012 RCA President’s Award, the RCA Barry Goldwater Award, the RCA Vivian Carr Award, the YASME Foundation Award, and she was inducted into the 2018 CQ Amateur Radio Hall of Fame.

In 2019 Carole was the first recipient of the Carole Perry Educator of the Year Award. The Florida Hamcation is the sponsor of this award, given to other deserving educators of radio technology each year.

Eleven years ago, Carole created the RCA Youth Activities Program which supports and showcases technically talented and creative young ham radio operators. She travels across the country sponsoring youngsters to give presentations at her Youth Forums. She has also been an invited speaker in Friedrichshafen, Germany, and Hyderabad, India. Carole has moderated the Dayton Hamvention Youth Forum and Instructors’ Forums for 32 years, showcasing our RCA Young Achievers. She moderated the recent QSO Today Virtual Ham Expo, showcasing 7 RCA Young Achievers. To date we have awarded 141 young people with the honor of receiving the RCA Young Achiever’s Patch and certificate. One of these Young Achievers is chosen each year to give a presentation at the RCA Technical Symposium. Another is chosen to receive the IWCE RCA Young Achiever Award.



“Stranger Things: A Young Person’s Look at Space Weather and the Effects on Radio Communications”

Francis Bonte, student at Case Western Reserve University

Abstract

In the recent Netflix television series *Stranger Things*, many amateur radio operators got excited when the star Dustin got his radio license and used it to contact his long-distance girlfriend. In my mind, I was more excited about the strange phenomena occurring in the show due to the Upside Down. The effects of the Upside Down, although a fictional dimension, are similar to the impacts of real life space weather on our world.

Space weather due to the sun and the ionosphere can affect a variety of space and ground technological systems. Space weather can distort GPS readings, allow us to communicate (or not) on certain frequencies, and affect Doppler Shift. The organization HamSCI is developing a Personal Space Weather Station, with the involvement of scientists and citizens, to uncover more patterns about space weather. This presentation will explain the Personal Space Weather Station Project, whose purpose is to develop a ground magnetometer used to measure the Earth’s magnetic field. It will also explain the involvement of young people in radio technologies so that they learn more about the strange things of space weather.

Speaker Biography

Frances “Frankie” Bonte, KE8HPA, is a recent high school graduate from Columbus, Ohio. At her high school, she was involved in theatre, student government as the treasurer, and the chemistry and math clubs. She enjoys being involved in science research and ham radio. In addition to working with the citizen science organization HamSCI, she completed a capstone project on 5G antenna siting, and is involved in the WWV Doppler Shift study with the team from W8EDU. She now attends Case Western Reserve University and is studying both engineering and dance.



“Modern AM Modulation Techniques”

Geoff Mendenhall, P.E., Mendenhall Engineering LLC

Abstract

Four of the most important advances in amplitude modulation (AM) were developed at the Harris Corporation Broadcast Division. Pulse Duration Modulation (PDM), Progressive Series Modulation (PSM), DX Direct Digital Modulation, and 3DX Rotational Digital Modulation were all developed to greatly improve the efficiency, fidelity, and digital radio capability of AM broadcast transmitters. 3DX is currently in use for KDKA's 50 kW transmitter.

This presentation provides a technical explanation of how each of these modulation technologies work and the benefits to both broadcasters and listeners.

Speaker Biography

Geoff Mendenhall is an RF engineering consultant and technology advisor. He has spent most of his 50 year career in the broadcast industry. He has always had a passion for radio broadcasting, where his many technical contributions have made him one of the industry's best known experts on FM transmission.

Geoff has authored over 50 technical papers including the chapter on FM / HD Radio transmitters in the NAB Engineering Handbook. He was recognized with the 2010 NAB Best Paper Award, and the 2011 Matti S. Siukola memorial award for best IEEE Broadcast Symposium technical paper. Geoff received the 1999 National Association of Broadcasters Radio Engineering Achievement Award, recognizing his many innovations and contributions to the broadcast industry. He was named an Engineering Fellow by Harris Corporation in 2008. Geoff retired from Harris Broadcast Communications in 2013 to form Mendenhall Engineering, LLC, an RF engineering consulting firm.

He earned his electrical engineering degree from the Georgia Institute of Technology and is the inventor of nine U.S. patents for broadcast equipment. Mr. Mendenhall is a registered Professional Engineer. He is a member of the Association of Federal Communications Consulting Engineers (AFCCE), a former member of the FCC Technological Advisory Council (FCC-TAC), a contributor to the National Radio Systems Committee, a Life Member of the IEEE, and a member of the Radio Club of America.



“Near Field Drone Measurements of Broadcast Antennas”

Nicole Starrett, Engineering Manager, Dielectric Corporation

Abstract

There are many reasons to verify the radiation characteristics of a broadcast antenna once it is on a tower. It is currently a reimbursable item for re-packed broadcasters so they can ensure their new antenna is radiating as predicted and oriented in the correct direction. Another scenario might involve the diagnosing of an older antenna that does not seem to be performing as it did originally. Whatever reason drives the need for field pattern verification, there is a growing appeal to use drones to take the measurements, making the process quick and cost effective. The current drone measurement procedure is to fly an azimuth and elevation radiation pattern cut of the broadcast antenna in the far field. The radiating far field in the elevation plane is typically about one mile for a high-power UHF broadcast antenna.

Drone flights at this distance from the tower require special FAA authorization and the signal strength measurements at this distance are subject to reflections. To overcome these two drawbacks, a method to measure the antenna at a much closer distance is proposed. This paper will discuss how the near-field magnitude vs. elevation angle can be predicted with knowledge of the antenna design. Comparison of this known value to a measured value is enough to prove certain performance characteristics of the antenna.

Speaker Biography

Nicole Starrett joined Dielectric as an Electrical Engineer in 2014 upon her graduation from University of Maine with dual Bachelor’s degrees in Electrical Engineering and Mathematics. She has played an instrumental role in transitioning the company to more efficient design and production processes. Her implementation of modernized, software-based antenna design methods has accelerated production and delivery schedules and increased operational efficiencies – both of which paid dividends through the busy TV broadcast spectrum repack period. These experiences made her a natural fit to champion the new technology of utilizing drones for near field measurements of broadcast antennas.

Nicole primarily focuses on TV antenna design and testing at Dielectric’s Raymond and Lewiston Maine facilities, with a secondary concentration on the R&D roadmap for future products. Nicole is also responsible for some of Dielectric’s most recent cutting-edge innovations, including the original pattern work and modeling for Dielectric’s highly popular WB line of auxiliary antennas. She was also active in the simulation and development of two unique Dielectric products: the DCRU high-power, multi-station FM antenna; and the APT panel TV antenna with its unusual, variable vertical component. All three innovations help Dielectric remain competitive and forward-looking in a rapidly changing industry.



“Next Gen Interactive TV & Advanced Emergency Alerting & Informing” Fred Baumgartner, Director of Next Gen TV Implementation, One Media 3.0

Abstract

Next Gen TV is a lot of things, but mostly it’s “Broadcast Internet” in that it delivers IP in a highly resilient manner. The center of Next Gen TV is the “Broadcaster Application.” The early versions of the “BA” simply handle linear TV, albeit this supports 4K, immersive audio, and other content distribution formats that current DTV cannot. As the BA develops, it handles Advanced Emergency Alerting and Informing (AEA&I) next. AEA&I is completely different from the earlier Emergency Alerting System (EAS). AEA&I leaves the alerting up to the emergency community and the informing to the broadcaster. AEA&I lets the emergency community target alerts, and the user to determine what alerts they wish to receive. AEA&I is different from the “one-size-fits-all” of EAS. Also it’s not just alerts for the public – AEA&I is designed to be used for alerting first responders privately. Broadcasters aggregate, validate, curate, prepare and distribute information. With AEA&I, broadcasters don’t vet alerts; alerts pass through the system instantly and go directly to the user who determines if and how the alert and follow on information is presented. While AEA&I does everything EAS did and much more, it does not replace EAS – however AEA&I can change how we use EAS and Wireless Emergency Alerts.

The AEA&I pilot is being conducted at WJLA-TV in Washington D.C. Fred will address some of the improvements Next Gen TV make, the progress toward conversion to Next Gen TV (ATSC 3.0) which is slated to be available to 90% of the population by spring, and the why of reinventing broadcast. EAS was based on the best technology of the time – an acoustic modem – and represents the first digital anything broadcast. AEA&I is an opportunity to move forward with a digital era broadcast system.

Speaker Biography

Fred Baumgartner, CPBE, CBNT is a fellow of the Society of Broadcast Engineers, and past trustee of its Ennes Foundation; fellow of the Radio Club of America and recipient of the Lee DeForest Lifetime Achievement Award; and 2020 TVT Technology Leadership Award. Currently, Fred is working on Advanced Emergency Alerting and Informing, the first interactive use of Next Gen TV on behalf of Sinclair/ONEMedia 3.0. Previously, Fred was Director of Broadcast Engineering for Qualcomm’s MediaFLO project. He also directed Leitch/Harris’ Systems Engineering group. Up to that time, he served as Director of Engineering for the Comcast Media Center in Denver, its Director of New Product Development through the center’s AT&T ownership, and Director of Broadcast Satellite Operations during its TCI ownership era. Before joining the satellite and cable origination world, he held the position of Chief Engineer at KDVR-TV and KFCT-TV, Denver; WTTV-TV, WTTK-TV, Indianapolis; KHOW AM & FM, Denver; WIBA AM & FM, Madison, Wisconsin; operations manager at KWGN-TV, Denver; and others beginning with the overnight gig and a newly minted FCC 1st Class license at WBIZ AM & FM, Eau Claire, Wisconsin in 1972. He is a University of Wisconsin graduate. Fred was also heavily involved with the development of EAS and has authored several hundred articles and a few books on Radio and TV engineering.



“Rail Wireless Communications – What’s Next?”

Barry Einsig, Principal of Econolite

Umberto Malesci, CEO and Co-Founder of Fluidmesh Networks

Abstract

Autonomous vehicles are becoming an integral part of the operations of many cities and industrial sites. For example, autonomous trains have been used in metro lines across the globe for twenty years, autonomous trucks are becoming common in open pits and underground mines, autonomous cranes are getting traction in ports, and autonomous vehicles are a critical component in the most popular attractions in amusement parks. This presentation will review the challenges of these autonomous applications in terms of wireless communications and connectivity. The discussion will include how wireless multiprotocol label switching (MPLS) technology uses tailored communications protocols to overcome some of the limitations of both 4G/LTE and Wi-Fi.

Speaker Biography

Barry Einsig is a Principal of Econolite/CAVita Consulting, responsible for business development and execution of the strategic advisory programs for nations, states, cities, local governments and private corporations.

He joins Econolite/CAVita following six years with Cisco Systems, Inc., where he was an executive responsible for global automotive and transportation solution development. Barry helped launch Cisco’s leading innovative solutions in several new markets, including connected and automated vehicle, rail, roadways, and mass transit. Prior to Cisco Systems, Einsig was the Director of Transportation/Strategic Development for Harris Corp. (Washington D.C.) where he was one of the founding members of the Broadband team which led the company into the LTE market. While at Harris, Einsig received a patent for the use of video over LTE networks.

He is a previous 4 year member of the Singapore CARTS Committee focused on Connected and Highly Automated vehicle systems. He is a published authority on intelligent transportation systems (ITS), infrastructure systems, and connected vehicle applications. He holds a Bachelor of Science from Juniata College.



Umberto Malesci is co-founder and CEO of Fluidmesh Networks, a wireless technology company headquartered in Brooklyn, NY with customers in more than 25 different countries. Fluidmesh was acquired by Cisco in July 2020, and Umberto currently leads the integration of Fluidmesh within Cisco. Moreover, Umberto has been serving on the board of the Italian Institute of Technology (IIT) since 2014.

Umberto Malesci has been Vice-Chairman of AvrioRms Group and Pantascene, two technology companies acquired by Hitachi in 2014. Umberto obtained a Bachelor of Science and a Master of Engineering from the Massachusetts Institute of Technology (MIT). During his career, he also worked as a research assistant at MIT

Computer Science and Artificial Intelligence Laboratory (CSAIL), and as a management consultant at McKinsey & Company. Umberto Malesci has authored multiple academic publications in the field of wireless networking and is co-inventor in seven international patents and patent applications.



“History of Westinghouse Radio & TV Manufacturing on the 100th Anniversary of KDKA”

Mike Molnar

Abstract

For most of the 20th century Westinghouse was a household name in radio and then television. From producing the earliest home radios to color television sets, when customers were told “You can be sure...if it’s Westinghouse”, the company was a leader. But it was not along a straight path. Westinghouse was not only a pioneer in the technology, but also a pioneer in outsourcing.

The 100th anniversary of Westinghouse radio broadcasting at KDKA, Pittsburgh, PA marked just the beginning of a large broadcasting business. Few people today are aware of the fact that the old Westinghouse company still exists in broadcasting, after a corporate takeover and changing the company name to CBS, the Columbia Broadcasting System.

Speaker Biography

Mike Molnar started his company, Diagnostic Services Inc., over 36 years ago providing equipment and service for nuclear medicine systems. Over the last 20 years Mike’s design of large gamma cameras for equine medicine, and smaller versions for cats and dogs, have found a niche in private veterinary practices and universities around the country. Mike’s interest in the history of electronic technology goes even further back, resulting in a 50-year collection of radio, television, electrical and medical equipment. Now much of Mike’s spare time is spent sharing that history through a website (www.electronicfossil.org) , and via articles, presentations, as well as his museum display.



Technical Symposium Host Biographies

Dr. James K. Breakall, WA3FET

Dr. James K. Breakall received degrees in Electrical Engineering and Applied Physics from Penn State University and Case Western Reserve University. He has over 45 years of experience in numerical electromagnetics and antennas. He was a Project Engineer at the Lawrence Livermore National Laboratory (LLNL), Livermore, CA, and an Associate Professor at the Naval Postgraduate School (NPGS), Monterey, CA. Presently he is a Full Professor of Electrical Engineering at Penn State. Dr. Breakall began his career as a graduate student at the Arecibo Observatory in Puerto Rico working on antenna analysis and radar probing of the ionosphere. At LLNL, he and his group worked on the development of the Numerical Electromagnetics Code (NEC), the first sophisticated antenna modeling program. Other significant projects that he has worked on were the designs of the HAARP facility in Alaska, both HF facilities at Arecibo, and the Kinstar low profile AM broadcast antenna. Dr. Breakall (working on the electrical) and Tim Duffy (working on the mechanical) designed the very popular Ham Radio Skyhawk Yagi antenna. He is also the inventor of the Optimized Wideband Antenna (OWA).

Dr. Breakall is a Senior Member of the IEEE Antennas and Propagation Society, IEEE Broadcast Technology Society, Eta Kappa Nu, International Union of Radio Science Commission B, IEEE Wave Propagation and Standards Committee, has been an Associate Editor for the Radio Science journal, and served as an Arecibo Observatory Users and Scientific Advising Committee Member. In 2017, Dr. Breakall was awarded the prestigious Sarnoff Citation from the RCA. He was elected as a Director to the Board in 2018 and is the Co-Chairman of the 2020 Technical Symposium. He also serves on the RCA Scholarship Committee.



John Facella, P.E.

John Facella is a Principal at Panther Pines Consulting, LLC, specializing in public safety communications consulting, and general management consulting. He has over 30 years in the wireless industry working for both Motorola and Harris, and as a senior vice president with a national consulting company. Mr. Facella has been a frequent presenter at wireless industry trade shows, and written numerous articles. He was a 10 year member of the International Assoc. of Chiefs of Police Communications Committee, a 9 year member of the International Assoc. of Fire Chiefs Communications Committee. As a member of the NPSTC Broadband EMS Working Group he wrote a white paper on the impact of broadband wireless on rural emergency medical services. He currently serves on the National Fire Protection Association 1221/1225 and 1802 committees. He has a BSEE from Georgia Tech, an MBA in marketing, and is a registered professional engineer. Mr. Facella served overseas in the U.S. Army Signal Corps as a platoon leader. He is a life member of the IEEE, and is a Fellow, Life Member, and Executive Vice President of the Radio Club of America, and he received RCA's President's award

in 2014. He also has over 30 years of experience as a part-time fire fighter and EMT. He is a life member of the ARRL, the Quarter Century Wireless Association, and the Antique Wireless Association. He has been the Chair or Co-Chair of the RCA Technical Symposium since 2013.

