



Wireless Research Center Overview

Organization Snapshot

Wireless Research Center

www.wirelesscenter-nc.org

www.ncriot.org

Nonprofit research center advancing global innovation with engineering and testing for wireless technologies from in-body sensors and implanted medical devices to satellites and space exploration. The WRC fosters global collaboration among companies, industry groups, academic institutions and other research organizations.

The WRC's novel approach to intellectual property does not require a share of jointly developed inventions, unique among research organizations globally.

WRC's RIoT is an economic development initiative focused on Internet of Things.

Market Sectors

Include consumer, business enterprise, industrial, medical, public safety, aviation, defense, agriculture.

Wireless connectivity expertise in development, standardization and harmonization including medical and wearable devices, sensor networks, 5G and next generation, aviation, defense sensor systems, public safety and rural broadband.

Core Services

Antenna and RF devices and system design, simulation, prototyping, fabrication, test and measurement, including regulatory approval and IP development guidance.

Supported standards include: ANSI, CISPR, IEEE, MIL-STD, SAE

Earned certifications include: ISO 17025:2005, CTIA, Verizon

President and CEO

Gerard James Hayes, PhD

- Founded 2010
- Headquarters – Wake Forest, N.C.
- Team of wireless experts with more than 125 issued patents

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The Wireless Research Center is an independent, private nonprofit research center dedicated to applied research and engineering. The WRC helps clients from around the world develop products and services that advance wireless technology innovation. Success is fostered by building a community of collaboration in public and private sectors, accelerating development of ideas from initial concept through commercial production.

Innovation at the WRC is engineered to solve complex scientific challenges for specific, practical solutions for new solutions and to improve products and services across virtually all industries – from wireless network infrastructure to connected devices. The WRC nurtures collaboration among companies, academic institutions, industry associations and other research organizations.

The WRC's approach to intellectual property (IP) is unique among research organizations globally. The WRC was founded on a strategic principle of not requiring an ownership share of IP developed through research and engineering services. The WRC's novel IP strategy is a cornerstone of the relationship of trust and true collaboration with customers and partners. The strategy is an ethical commitment to customers that inventions developed jointly will fully benefit their company and customers.

The WRC helps companies and organizations of all sizes around the world, from Fortune 100 to start-up companies, develop and enhance intellectual property. This includes using the WRC teams' knowledge and experience across many industries to help customers broaden patent portfolios to address needs in other industries to expand their market strategy. For start-ups and small companies, this approach also helps attract capital financing to bridge the gap from innovative idea to commercialization.

Market Landscape

Wireless communications impacts our lives and daily habits, and drives businesses across virtually all industries. Younger generations may not identify with many of society's communication needs prior to the Internet and ubiquitous mobile phones. The WRC looks forward to help shape future breakthroughs in wireless communications.

Most common wireless devices use radio waves that require antennas. Transmitters turn electrical signals into radio waves that can travel short distances, such as implanted medical devices and Wi-Fi networks in our home, or millions of miles into deep space. Today, the market for wireless voice and data applications include mobile phones for wireless voice and data, Wi-Fi and Bluetooth for local area networks, mesh networks, satellite communications and wireless sensor networks. Wireless energy transfer networks power devices ranging from electric cars and drones to mobile phones and biomedical devices such as pacemakers. Wireless body sensor networks monitor blood pressure, heart rate, oxygen level and body

temperature – the genesis for the latest generation of fitness trackers, smartwatches and smart clothing. Military applications range from satellite communications to wireless mesh networks and sensor networks to support mission critical communications in open terrain and complex, obstructed urban environments.

For many applications, the next generation in wireless will be driven by innovation in the way wireless networks operate, including the radio frequencies and how antennas handle radio signals and exchange data. The next evolution to 5G wireless networks will advance connected devices with Internet of Things (IoT) initiatives. 5G will be a catalyst for the continued evolution of wireless communications to support applications across many industries and markets, from drones, autonomous cars and smart cities to connected homes, improved healthcare and medical devices. Industrial applications include industrial robots, connected vehicle fleets, predictive maintenance, factory automation, and workforce training. Mobile Internet speeds will enable mobile phones to download entire movies in seconds.

Transforming Competition into Collaboration

The WRC is uniquely created to transform competition into collaboration with its private, nonprofit organizational structure and novel approach to intellectual property development. These elements build relationships of trust with customers and partners to develop better and products and services, and advance innovation that benefits all.

The WRC has developed extensive partnerships beyond the wireless community to include scientists and engineers across disciplines in industry and academia. The WRC builds relationships and provides engineering expertise

The Foundation for Research on Information Technologies in Society (IT²IS) in Zurich, Switzerland in partnership with WRC are now testing and validating a POPEYE (human model) in WRC's anechoic chamber. "We believe the relationship with the WRC allows us to be proactive in understanding the challenge of testing these devices, and more importantly, better understanding the performance of these devices across multiple market segments," states Dr. Niels Kuster, director of the IT²IS Foundation and professor at ETH Zurich. **TechRepublic Magazine, "IOT manufacturers must get wireless right: This North Carolina nonprofit can help"**

for success. Other test labs churn through device tests with pass/fail results and move on to the next test in the queue. If a customer device fails a test, the WRC doesn't simply provide results, instead addressing issues and testing until it can pass. The WRC complements services of other testing, engineering and product design firms, partnering with customers to navigate a strategy to ensure successful launches. Instead of competition, the WRC fosters partnerships and collaboration by building a relationship of trust with customers and partners.

History of Innovation and Collaboration: Create Companies and Jobs

Founder Gerry Hayes conducted research and developed new products at Ericsson and later Sony Ericsson. The global telecommunications giant was closing its research and development campus for wireless technology in North Carolina's Research Triangle Park (RTP) around the same time that other global companies were closing or downsizing R&D operations. These included Alcatel Lucent, Nortel Networks and Cisco. Part of his vision behind forming the WRC was to take advantage of retaining world-class engineering talent and equipment found in only a few locations in the world in North Carolina to help local and global businesses.

Discovery and innovation at the WRC is a catalyst in today's technology-driven economy to improve lives of people worldwide and in North Carolina. Economic development includes helping entrepreneurs create new companies and jobs in the companies and communities they serve. The Town of Wake Forest, N.C., located in the RTP region, shared the vision to help build the WRC as a nonprofit, shared resource where companies can share office space and collaborate with the WRC's team of experts. As a commitment to boost economic development through investments in technology, the Town of Wake Forest provided financing to support operational costs to launch the WRC. Grants from the Golden LEAF Foundation helped purchase equipment. The WRC includes a commercialization center with shared business incubator office space. Companies have access to the WRC's equipment, engineering and strategic business services that through 2018 have helped 21 start-up companies in Wake Forest and 60 companies at RIoT locations in Raleigh. The WRC has partnered with organizations secure \$5.8 million in regional grants. Startup companies that have worked with WRC and RIoT have collectively raised over \$350 million in investment capital.



WRC's RIoT

RIoT was adopted in 2015 by the Wireless Research Center as an economic development initiative to establish partnerships and collaboration for the Internet of Things (IoT) – how devices connect, interact and exchange data. Connecting equipment, supplies, products, and infrastructure to a centralized system is transforming business and industry. RIoT has grown to include more than 6,000 members and 80 company sponsors throughout the nation.

As part of a new partnership between UNC-TV Public Media North Carolina, the N.C. Department of Information Technology and the Wireless Research Center for a public safety research center, new products and services will be developed from ATSC 3.0/Next Gen TV applications for first responders and public safety response.
TV Technology Magazine: "UNC-TV Using Next Gen TV Tools To Assist First Responders"

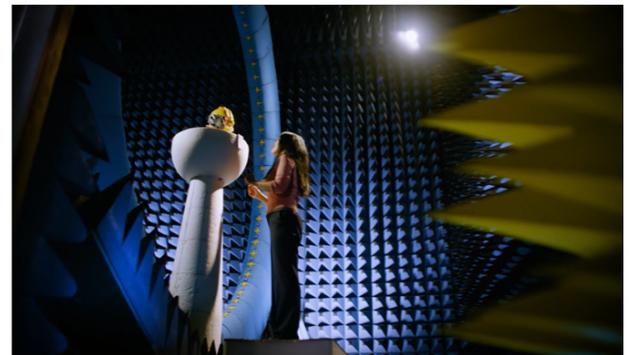
RIoT is a community of technologists, engineers, business leaders, academics, policy makers and entrepreneurs who have a role in the Internet of Things of connected devices. RIoT operates an accelerator program (RAP) to support early stage startups. RIoT also provides consulting services for corporate innovation teams. In addition, RIoT facilitates

collaboration among companies of all sizes through networking and educational events, coworking offices and prototype labs at HQ Raleigh and N.C. State University. RIoT helps connect entrepreneurs with the venture capital community to create and grow companies.

WRC Core Testing and Engineering Services

The WRC offers engineering, testing and strategic business services to support and accelerate the commercialization of wireless products from initial concept through high-volume production. The WRC also collaborates and supports a wide range of business, academic and regulatory research and certification projects.

- Internal Organization for Standardization (ISO 17025) accredited facility for testing and calibration globally.
- Certified Cellular Telecommunications Industry Association (CTIA) Test Lab for over-the-air (OTA) testing of cellular devices on networks including AT&T and other national carrier networks.
- Verizon approved third-party test lab to certify devices for the Verizon network.
- AT&T certification for IoT devices recognizing RF consulting and design service for hardware and software.
- Passive antenna testing to IEEE Standard 149.
- American Association for Laboratory Accreditation (A2LA) for wireless tests on mobile devices.



Satimo SG-64 chamber is the most accurate equipment to test antennas and wireless devices

"Next Gen TV is kind of the digital evolution of broadcast TV," said Gerry Hayes, CEO and founder of the Wireless Research Center. ...With Next Gen TV, the transmission is simultaneous, and specific data, including weather mapping and video content, could be targeted to certain receivers."
Government Technology Magazine
"Next Gen TV Could Be Another Tool in Public Safety Arsenal"

Antenna Testing – The WRC's Satimo SG-64 chamber for antenna testing is one of only five other chambers in the world representing an investment of millions of dollars. Other organizations that host this equipment do not make it available to the public. As a nonprofit research center, the WRC offers access to the chamber in half-hour increments with significant pricing discounts for universities, research and nonprofit organizations. Antenna testing includes prototype testing, final product testing for regulatory approval and competitive analysis measuring performance against other products on the market. The WRC has added equipment for field testing with mobile towers and testing wearables on human bodies. The WRC also offers electrostatic discharge (ESD) testing as well as anechoic for radio frequency (RF) tests and acoustic chambers for additional services.

Engineering Services – The heart of every wireless device is the radio and antenna. Maximum range and battery life are achieved when the radio and antenna are optimized for the device and application. The WRC has the expertise, tools and capabilities to design, simulate, test and evaluate products to optimize RF designs and antennas for specific applications. From early concept to mass production, the WRC assists clients with development throughout the entire design cycle.

Leadership

CEO and Founder, Gerard James Hayes, Ph.D. – More than two decades of experience in government and commercial electromagnetic research and design. Previously, he was director of engineering at GreenWave Scientific where he led the development of antenna and RF circuit designs for U.S. Department of Defense applications. He served in global leadership positions with Ericsson and Sony Ericsson Mobile Communications in the technology and research organization, and at Lockheed Martin for research and development for space-based, phased array applications. He holds more than 75 U.S. patents.

Asokan Ram, senior architect – Leadership experience spanning the evolution of wireless technology over three decades, including satellite and aviation communication systems. Asokan has 25 patents and was recognized with Sony Ericsson's Distinguished Inventor Award, Ixia Engineering Master Award, and Ixia Technical Excellence Award. As architect at Ixia Communications, he led wireless test system design and development and mentored the engineering team. This leadership included the development, from definition to commercialization, of the 4G LTE Multi UE sector simulator and its evolution for LTE-A to 5G-NR technologies. At Ericsson, he led the Technology Working Group for radio access, 3GPP standardization and served in product development and engineering roles. He was a key player in architecting the ACeS GMR-2 geo-mobile satellite system based on GSM/EDGE, and led the standardization of GMR-2 air interface in ETSI. He worked on the development of multiple mobile platforms, terminals and advanced receiver algorithms for 2G GSM/EDGE and 3G WCDMA/HSPA technologies.

Koichiro Takamizawa, Ph.D, technical manager of research and engineering – More than two decades of experience in the design and manufacturing of antennas and RF systems development for broad spectrum of industries including consumer electronics, aerospace, medical, and industrial instrumentation. He has worked with antenna systems design and development for mobile handsets and machine-to-machine applications at Sony Ericsson and HTC, and geostationary communication satellite antennas and NASA deep space spacecraft communication antennas design and development.

John Swartz, Ph.D, senior staff engineer – More than 30 years of experience in electrical engineering and project management performing research and development in industrial, medical, university, and defense labs. He has designed and built RF and laser labs and developed RF and antenna systems and instrumentation for wireless sensor networks, CubeSat satellites for space research, novel DoD satellite applications, and medical imaging systems.

Shruthi Soora, senior staff engineer – More than 15 years of experience in RF and antenna engineering in the commercial, defense and medical device markets and has developed products from early concept to production. Previously, she has held technical positions at RFMD, HTC, Sony Ericsson and Harris Corporation.

Mike Barts, Ph.D, senior staff engineer – More than two decades of experience in the design and manufacturing of antennas and RF systems. He has developed antennas for commercial and government applications. As one of the founders and CTO of Mohu, he developed a paper thin antenna for over-the-air TV reception which became a best seller on Amazon and in major retailers such as Walmart and Best Buy. He has worked with satellite systems, designing commercial ground station antennas and RF propagation modeling and measurements for mobile satellite system for NASA, which were later used in developing Iridium and SiriusXM satellite systems.

Scott Vance, senior staff engineer – Designing antennas for Sony Ericsson, he developed a new, more efficient method of testing for certification measurements which was adopted into the CTIA OTA testing standard 3.6. Scott is an inventor on more than 30 patents in a variety of fields including antenna design, mechanics, and medical implants.

Paul Allan Sadowski, senior staff engineer – Extensive public safety experience in government and the U.S. Department of Defense. He is a co-inventor for Paging Plus which was recognized by the National Association of Broadcasters for TV Broadcast Innovation, and a system for a drone-powered communications and sensor system. He served as the director of infrastructure planning for the N.C. Department of Information Technology's Broadband Infrastructure office leading the First Responder Network, and he led communications infrastructure technology initiatives for the N.C. State Highway Patrol. He also served as a communications advisor for the Pentagon and as a major in the U.S. Air Force.

Tom Snyder, RIoT executive director – More than 25 years in product and technology development in consumer and industrial electronics, healthcare and Internet of Things. Experience in multi-national corporations including HTC, Ericsson and Sony Ericsson, and small business consulting, teaching, startup acceleration and entrepreneurship. Tom has been awarded more than 30 patents. He leads RIoT Labs at HQ Raleigh and co-instructs Product Innovation Lab, a Forbes award winning multi-disciplinary course in innovation and entrepreneurship at NC State University. Previously he served an executive leadership role at the ASSIST Center, a National Science Foundation sponsored effort to create wearable electronics for healthcare monitoring.