WRC Technologies Overview

WRC Technologies Snapshot

www.wrc-nc.org

Independent, private nonprofit creates communities for innovation and technology-led economic development to create jobs and improve communities.

Catalyst for collaboration globally among companies, industry groups, government agencies, academic institutions and other research organizations.

Bridging the gap between research and commercialization with applied research, engineering services and ISO accredited, certified testing services for wireless technologies. Engineers support design, simulation, prototyping and fabrication.

IP Neutral – Unique approach to intellectual property does not require a share of jointly developed inventions.

Other WRC Initiatives

RIoT - building communities of entrepreneurs for Internet of Things innovation across the nation. More than 12,000 members and 90 company sponsors.

Connected Communities – bridging the digital divide with high-speed, open-access broadband networks and digital skills job training to close the digital divide and foster digital equity.

WRC Technologies Projects

Government and Public Safety - applied research and development for government agencies and public safety initiatives.

AERPAW 5G Innovation - testbeds for drones and unmanned aerial systems supported by an industry consortium and $24 million NSF grant.

Founder, CEO Gerard James Hayes, PhD

- Founded 2010 in Wake Forest, N.C.
- Team with more than 125 issued patents

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Flying cars are nearly visible on the horizon. Drones deliver medical supplies. Autonomous vehicles are at work on farms and factories. Wireless connectivity undergirds innovative products and services, many shaped by the Wireless Research Center. The WRC Technologies initiative bridges the gap between research and commercialization with applied research, engineering services and certified testing. As an extension of client teams around the world, engineers support all facets of development including design, simulation, prototyping and fabrication.

The WRC is an independent, unique nonprofit empowering collaboration for innovation. The WRC has expanded from the roots of WRC Technologies, adding two other strategic initiatives. RIoT is a catalyst forming communities of entrepreneurs to build companies and create jobs. Connected Communities cultivates public and private partnerships to deploy broadband connectivity infrastructure and digital workforce job training programs.

WRC Technologies fosters collaborative innovation around the world – a partner with companies, industry groups, government agencies and academic institutions. At the core of WRC Technologies is a team of visionary and highly-accomplished engineers. Communications expertise spans from implanted medical device sensors to satellites and space exploration.

WRC Technologies is a trusted partner for applied research, engineering and certified wireless testing using the best equipment in the world typically found only in the R&D labs at the largest companies. Customers span all industry sectors seeking expertise from the design of new concepts to certification and commercialization.

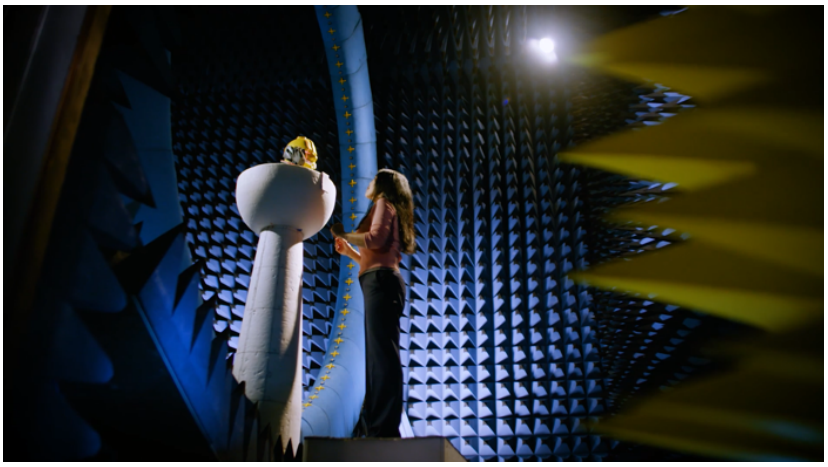
Founded on Visionary Innovation

The vision that birthed the WRC in 2010 began with founder Gerard “Gerry” Hayes, who holds more than 75 patents. After working at Lockheed developing satellite communications, Hayes led global advanced technology and new concept initiatives in research and development for Sony Ericsson for more than 15 years.

Innovation was rooted in the R&D culture at Sony Ericsson, thinking three to five years ahead about complex problems and inventions needed to solve challenges and seize market opportunities. Collaborating worldwide with academic researchers, industry standards groups and certification organizations, Hayes and his team worked to develop concept prototypes focused on commercialization. The focus was on solutions for the marketplace, not research alone.

Hayes and the R&D team worked on the connectivity challenges of smartphones years before the iPhone, streaming music years before iTunes, and Internet-of-Things possibilities when the world was still using dial-up modems. Being a visionary futurist was the most important aspect of the job which shaped a unique view of the world. Driven by an inherent and zealous curiosity, Hayes and his team were focused on applied research and commercial development to address challenges on the horizon.

His vision for the WRC was a place where new technologies could be developed and tested using the best equipment in the world and a team of exceptional engineers and mentors to help companies and entrepreneurs invent new products and services, create new companies and jobs. The WRC was born with a culture for collaboration and visionary innovation that Hayes and team enjoyed at Sony Ericsson with ***two important exceptions*** – **a nonprofit and founding principle of not requiring a share of intellectual property.** All jointly developed inventions for new and better products and services are owned by customers and partners.



Satimo SG-64 chamber for antenna testing was one of only three in the world when installed at the WRC.

The culture has inspired many experts to join his team who share a passion for wireless connectivity engineering and collaboration with other experts to shape the vision of communications and connectivity. The engineering team received more than 125 issued patents before joining WRC Technologies at companies including Ericsson, Sony Ericsson, HTC, RFMD, Ixia Communications, Mohu, Lockheed Martin, GreenWave Scientific, U.S. Department of Defense, Booz Allen Hamilton, SDI Corporation, RTI International, Orbital Sciences, and Harris Corporation.

Engineering and Testing Services

WRC Technologies uses applied research to help clients improve existing products and develop new products and services. Collaboration includes helping develop business plans and making introductions to build relationships that lead to business and investment partnerships, customers and product launches.

WRC Technologies engineers become an extension of a company's or partner's team. This is why the identity of customers typically is confidential. Customers and partners range from the world's largest communications equipment and network providers, other Fortune 100 companies, the world's leading research institutions, national, state and local government agencies, global standard development organizations including the IEEE to startup entrepreneurs with dreams to launch a company.

A team of engineers is exploring the possibility of using data found in 5G wireless signals to measure a key factor in the early detection of tornadoes. The group is part of a nonprofit test lab and engineering consulting firm called the Wireless Research Center**.** **"How 5G May Improve Early Warnings of Severe Weather,"** **Wall Street Journal**

The Satimo SG-64 chamber for antenna testing was one of only three in the world when it was installed. Other organizations with this equipment do not make it available to the public.

WRC Technologies' engineers support design, simulation, prototyping, fabrication and certified testing for clients in many sectors. For example, engineers help clients pass certifications for Verizon and the Cellular Telecommunications Industry Association (CTIA), which represents the U.S. wireless industry including carriers

R&D Engineering Services

Applied research and development for design, simulation, prototyping, fabrication and certified testing.

- AT&T, Verizon and CTIA authorized lab
- Pre-compliance testing and mitigation
- Field testing and propagation modeling
- Antenna and RF design, test and simulation with HFSS, CST, MatLab
- IoT and wearable design support
- Wireless architecture

Market Advantages

- Broad range of wireless connectivity expertise including 5G, LTE, WCDMA, 802.11, Cat M1, NB-IoT, Bluetooth, LoRa, and legacy technologies.
- Complete antenna and RF design and simulation using CST and HFSS
- Test and measurement using Satimo SG-64 in 5 meter anechoic chamber from 400 MHz to 18 GHz.
- Mobile towers support field testing.
- Industry standard RF phantoms for testing portable and wearable RF devices.

Earned certifications include:

- ISO 17025:2005
- CTIA Authorized Test Lab,
- Verizon Approved Test Facility
- AT&T IoT RF Consultants & Design

Supported standards include:

ANSI, CISPR, IEEE, MIL-STD, SAE

and equipment manufacturers. The test and certification lab is accredited by the International Organization for Standardization (ISO), the most important global standard for accurate test and measurement data. WRC Technologies is an approved partner for AT&T for RF consulting and design. Success is fostered by building communities of collaboration in public and private sectors, accelerating development of ideas from initial concept through commercial production. Innovation is engineered to solve complex scientific challenges for specific, practical solutions across virtually all industries – from wireless network infrastructure to connected devices.

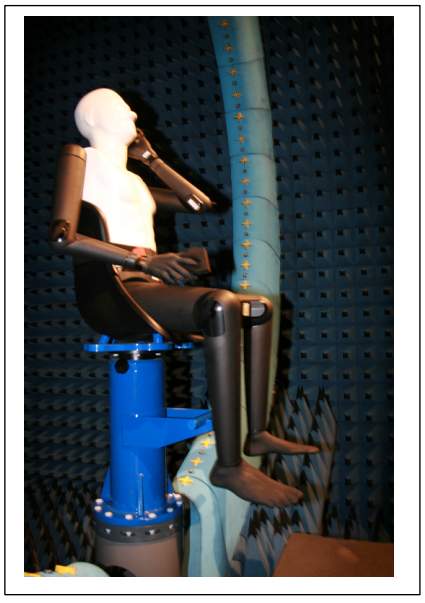
Antenna Development, Testing and Certification

WRC Technologies hosts multiple types of equipment for testing antenna platforms certifying performance on carrier networks and predicting performance before they go into the field.

- Complete antenna patterning and wireless system characterization from 400 MHz to 18 GHz.
- Three anechoic chambers provide RF high shielding / isolation. Simulate the cellular environment of any location in the world.
- Pre-certification testing to check wireless device antenna performance integrated into the overall system often saves clients' money and time to market.

RF and Antenna Engineering

WRC Technologies engineers can model and simulate devices and platforms to guide design and development. Off-the-shelf RF modules and antennas can sometimes provide acceptable performance, but that often is not ideal for many clients.



WRC Technologies engineers and design tools can quickly model, simulate and design RF system and antenna solution to meet specific product requirement, including body worn device testing.

WRC engineers add value for clients during all phases of development, from concept to late stage production and commercialization. The WRC also assists clients with hardware and software prototyping.

Field Testing and Training

WRC Technologies' portable towers enable temporary cellular networks ("cell on wheels"-COWs) or other short-term communications installations. The towers are quickly deployed, self-contained and easily transported. Integrated 5.5kW diesel generators provide off-grid operation of radios and electronics in weatherproof cabinets. The towers have industry standard antenna, sector array, camera mounting hardware and options for addition of rotors and platforms.

WRC Technologies Projects

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 engineering team assists clients with development throughout the development cycle. The broad ranges of devices includes development, standardization and harmonization of medical and wearable devices, sensor networks, autonomous vehicles and drones, defense sensor systems, public safety, IoT, and rural broadband.

Wide Range of Product Types

- Network design and system architecture
- Carrier network device optimization and certification
- Small form factor devices (asset tracking, sensors, etc.)
- Wearable devices (consumer, medical, first responder, etc.)
- Consumer devices (smart home, retail, device charging, pet care, etc.)
- Smart City (public safety, infrastructure, metering, environment, security, buildings, etc.)
- Large form factor IoT devices (stationary objects such as home appliances, etc.)
- Mobile platforms (avionic, marine, vehicle, etc.)
- Other unique form factors and novel applications

WRC Technologies is leading the deployment and operation of advanced wireless 5G testbeds in Raleigh and Cary as part of the Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW). The testbeds for drones and unmanned aerial systems is one of four national testbeds for advanced wireless research. AERPAW is supported by an industry consortium and a $24 million grant from the National Science Foundation awarded to N.C. State University and the WRC to collaborate with other universities and communities. WRC Senior Staff Engineer Mike Barts serves as the AERPAW deployment and operations manager. WRC Senior Architect Asokan Ram serves as the AERPAW senior deployment engineer.

Government and Public Safety

WRC Technologies' Government and Public Safety community supports wireless innovation and applied research, accelerating development through design, simulation, testing and certification of antenna, radio frequency (RF), and wireless technologies. The WRC partners with customers to apply for federal grants, including Small Business Innovation Research (SBIR) through the Small Business Administration and Small Business Technology Transfer (STTR).

Public safety work includes developing a prototype digital paging system for first responders in the state of North Carolina using the public television broadcast network's ATSC 3.0 / NextGen TV technology. A Small Business Innovation Research (SBIR) grant from the U.S. Department of Homeland Security awarded to engineering firm Device Solutions supports the applied research through the Wireless Research Center, PBS North Carolina (formerly UNC-TV) and the N.C. Department of Information Technology (NCDIT).

> The new digital paging capabilities would provide responders with improved pager coverage, more rapid dispatching, and overall improved situational awareness with additional information including maps and videos. New services can also enhance notifications for the public through on-screen notifications for weather, fire, earthquake, Amber Alerts and other emergencies.
> **North Carolina Deploys Statewide Paging System Using Next-Generation TV**
> **MissionCritical Communications, Radio Resource International**

Other WRC Technologies public safety community initiatives include collaboration with The Center of Excellence for Advanced Technology Aerial Firefighting (CoE) created by the state of Colorado to lead development and testing for aerial firefighting technology. In a project featured in the Wall Street Journal, the WRC is also collaborating with the NOAA National Severe Storms Laboratory to develop a new way to measure humidity using 4G and 5G cell signals, potentially improving public broadcast warnings for severe weather.