

2014 YEAR IN REVIEW

# GTRI

# Georgia Tech Research Institute

# 2014 YEAR IN REVIEW

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The Georgia Tech Research Institute (GTRI) is a highly regarded research and development organization solving engineering problems for the federal government and industry sponsors. GTRI is an integral part of the Georgia Institute of Technology, one of the world's top-ranked research universities.

With more than 2,000 scientists, engineers, support professionals and students, GTRI tackles difficult component and systems engineering problems in electronics, electromagnetics, electro-optics, cybersecurity, information systems, threat systems and more. Our work encompasses elements of electronic warfare, radars, antennas, electro-optics, secure information and communications systems, prototyping, robotics, unmanned and autonomous systems, test and evaluation, modeling and simulation, and human factors engineering.

This report contains examples of GTRI's applied expertise in these areas, along with notable facts and figures from the past fiscal year.

## MESSAGE FROM THE DIRECTOR



*Thanks to the innovation and hard work of our entire team, the scope and impact of GTRI's technical contributions have continued to expand at a significant pace. This annual report provides brief snapshots of a few of our most notable engineering solutions and contributions to science during the past year. As our financial statements clearly demonstrate, GTRI is also growing in revenue, size and capability.*

*GTRI is one of the government's largest University Affiliated Research Centers (UARC), serving as a trusted agent to the Department of Defense (DoD) and the U.S. intelligence community. We provide innovative applied research, development and engineering solutions for the DoD, continuing professional education to the DoD's active duty and civilian workforces, and hands-on training for students from Georgia and across the nation to develop the DoD's research and technology workforce of the future. We are also leveraging our core capabilities and systems engineering expertise developed for defense and national security in support of other government agencies and a growing base of industrial partners.*

*From applied electromagnetics to cybersecurity and from systems engineering and development to threat systems, GTRI continues to solve some of the world's most complex problems. With each passing year, our reputation for providing innovative solutions grows, giving us more opportunities to make a difference in the world. We are increasingly being sought out as a thought leader with researchers called upon to serve in key leadership roles in government and industry groups.*

*I hope you find this year's stories as exciting and inspiring as I do. There is certainly so much more to be accomplished. Thank you for reading our report, and let us know if you have a problem we can solve.*

Robert T. McGrath, Ph.D.  
Director, Georgia Tech Research Institute  
Senior Vice President, Georgia Institute of Technology

# Georgia Tech Research Institute

# 2014 CHALLENGES AND SOLUTIONS



## GTRI Cybersecurity Solutions Making an Impact

BlackForest is a new open source intelligence gathering system developed by GTRI cybersecurity specialists to track and analyze the activities of hackers as they coordinate attacks, display new malware or sell stolen data. The system uses information from hacker forums and other public sources to create a threat picture designed to alert corporations, government agencies and nonprofit organizations to developing concerns. For attacks that have already occurred, BlackForest can help

identify the source and mechanism to guide security improvements. The latest in a series of innovative cybersecurity solutions such as Apiary and Phalanx, BlackForest coordinates with other GTRI information security systems aimed at sharing information and thwarting email attacks.

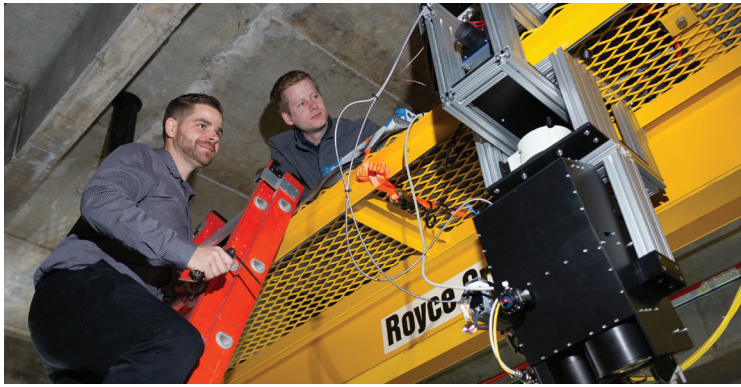
## Agile Aperture Antenna Tested on Aircraft

GTRI's software-defined, electronically reconfigurable Agile Aperture Antenna (A3) has now been tested on the land, sea and air. Department of Defense representatives attended a recent event in which two of the low-power devices, which can change beam directions in a thousandth of a second, were demonstrated in aircraft flight tests. One antenna, looking up, maintained a satellite data connection as the aircraft changed headings, banked and rolled, while the other antenna looked down to track electromagnetic emitters on the ground. In addition to rapidly altering its beam direction, the antenna's frequency and polarization can also be changed by switching active components.



## Ion Traps Advance Quantum Computing Systems

Working with university and industry partners, GTRI recently demonstrated two new ion traps that address major challenges of quantum computing systems based on trapped ions. The first trap advanced concepts for integrating electronics needed to control the traps, replacing external electronics with a small, in-vacuum system adjacent to the ion trap. The second trap uses diffractive mirrors integrated into electrodes to image single ions at multiple sites in the ion trap. The research is sponsored by the Intelligence Advanced Research Projects Activity (IARPA) through the Army Research Office (ARO) and the Space and Naval Warfare Systems Command (SPAWAR).



## New LIDARs Will Evaluate Atmosphere for Laser Weapons, Provide Underwater Imaging for UAVs

Future Navy ships will use lasers to defend themselves, but atmospheric conditions may not always be favorable for these weapons. To help commanders decide whether to fire a defensive laser or a missile, GTRI has designed a Light Detection and Ranging (LIDAR) system to scan the sea air for haze-creating aerosol particles that may affect laser performance. When completed, the Department of Defense-sponsored project may represent the first use of a LIDAR on a Navy ship. GTRI has completed design and computer simulations for the LIDAR, which is expected to be tested in 2016.

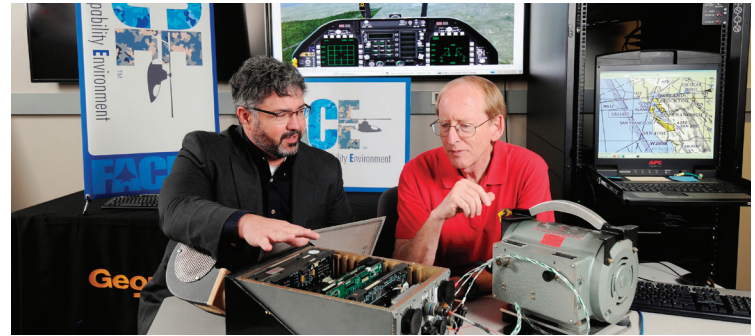
Known as a world-class LIDAR solutions provider for more than 20 years, GTRI also has a team developing a bathymetric LIDAR, half the size of current airborne LIDARs, capable of underwater imaging. The Active Electro-Optical Intelligence, Surveillance and Reconnaissance (AEO-ISR) system could be used on mid-sized unmanned aerial vehicles (UAVs) to support nautical charting and anti-mine and anti-submarine intelligence, as well as civilian mapping. The AEO-ISR approach uses high-power computing to gather and transmit data in real time, producing undersea imagery with much greater speed and efficiency than current systems. A prototype has successfully demonstrated the techniques in the laboratory, and researchers have designed a fully deployable device.



## Army Collaboration Produces New Test Station for Missile Warning System

The AN/AAR-57 Common Missile Warning System (CMWS) helps protect Army aircraft from attack by shoulder-launched missiles and other threats. To keep this defensive system operating at maximum effectiveness, the Army periodically updates the software on the more than 1,000 units in use around the world. Before new updates are fielded, however, they must be thoroughly tested to make sure the software performs as expected. To facilitate this, researchers from GTRI and the Army Reprogramming Analysis Team (ARAT) have developed and built a new integrated support

station that runs the software through its paces under conditions simulating actual aircraft operation. The ISS development was part of a multi-phase program that transferred sustainment of AN/AAR-57 software from the system's original equipment manufacturer to the Army.

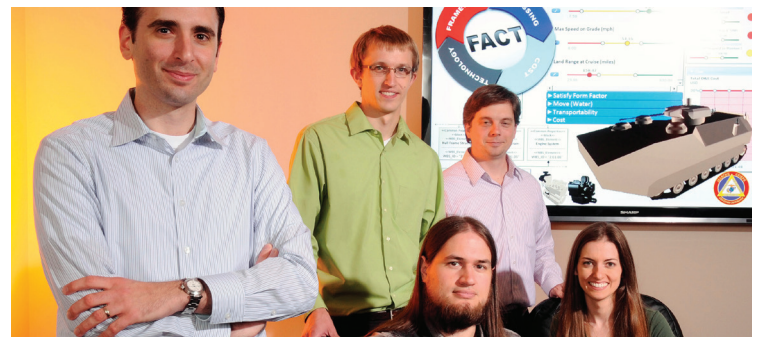


## Supporting Open Architecture Avionics Software

GTRI researchers are supporting U.S. military efforts to modify the way in which avionics software interfaces with an aircraft's hardware and other software. Part of the U.S. Navy's Future Airborne Capability Environment (FACE™) project, the work involves the FACE™ consortium, a government, industry and academia consortium managed by The Open Group® to develop a new technical standard governing how avionics software communicates with other avionics software and with hardware. GTRI is involved in validating and maturing the FACE™ Technical Standard by producing reference software built according to the new FACE™ standards. The project is funded by the Naval Air Systems Command Air Combat Electronics Program Office and the U.S. Army Aviation and Missile Research Development and Engineering Center.

## Testing Materials in a Simulation Environment

Accurately measuring how radio signals propagate in electromagnetic materials is difficult, especially at lower radio frequencies where long wavelengths are difficult to study as they propagate through the small samples typical of experimental materials. In work sponsored by the Air Force Research Laboratory, GTRI researchers have developed a computer-based simulation technique that permits the characterization of complex natural and engineered materials. The new software tools allow investigators to modify traditional approaches, and also to explicitly simulate the experimental apparatus, including the specimen under test, using a computer-based simulation and parameter extraction tool suite.



## Collaborative Software Links Performance and Cost

Today's modeling and simulation software provides indispensable tools for systems engineering challenges, allowing investigators to experiment with "what-ifs" by adjusting design parameters and examining potential

outcomes. A GTRI research team has produced an advanced web-based tool that allows physically separated participants to collaborate on model-based systems engineering projects. Known as the Framework for Assessing Cost and Technology (FACT), the program utilizes open-source software components to help users visualize a system's potential expense alongside its performance, reliability and other factors. The research is sponsored by the U.S. Marine Corps Systems Command.



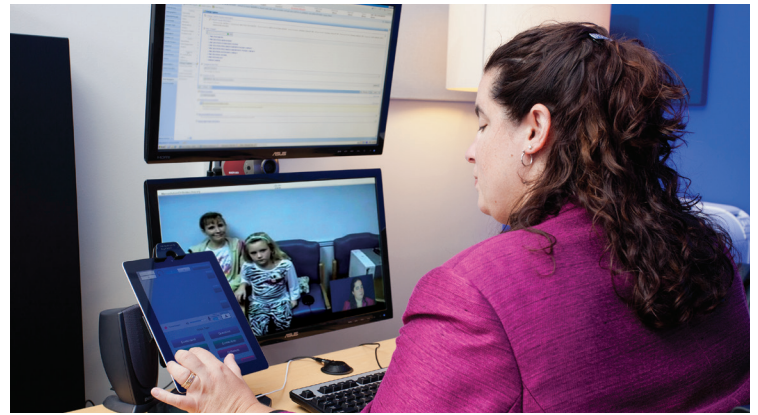
### Major Upgrades Mark FalconView's 20th Year

FalconView® mapping software, a geospatial program that already has an estimated 80,000 users, will soon be available in two new versions. The framework for the military's Portable Flight Planning System and Special Operations Execution Planner, FalconView ties together many mission planning and navigational tools. New are a 3-D version that better supports the missions of ground units, ships and others, and a mobile version that extends core functionality to tablet computers and smartphones. The versions will run on Windows, Android or Apple iOS operating systems. First released in 1994, FalconView's development is now supported by the U.S. Special Operations Command, the U.S. Air Force and U.S. Army.



### Three UAVs Perform Autonomous Formation Flight

Coordinated autonomous operation is important for allowing small unmanned aerial vehicles to optimize camera and sensor use in agricultural, military, forest fire monitoring, and search-and-rescue missions. GTRI researchers have successfully flown three fully autonomous and collaborating UAVs in formation at the same altitude through a series of maneuvers, including figure-eight patterns. A single UAV served as the leader, sending commands to follower aircraft, which adjusted flight controls and throttles as needed. The aircraft were separated by about 50 meters, demonstrating a high level of collaboration and autonomy.



### Medical Innovations Improve Hospital Hand Hygiene Practices, Rural Autism Patient Services

A GTRI-developed system that reminds hospital workers to sanitize their hands and monitors how well they comply with hygiene rules has the potential to significantly reduce the more than 2 million infections hospital patients get each year. The battery-operated device works with wall-mounted hand sanitizing stations already used by hospitals, adding to them a low-power wireless communications technology that connects to hospital networks. The device reminds workers to sanitize their hands as they enter patient rooms – and monitors who doesn't. The device is being evaluated at Emory Healthcare in Atlanta.

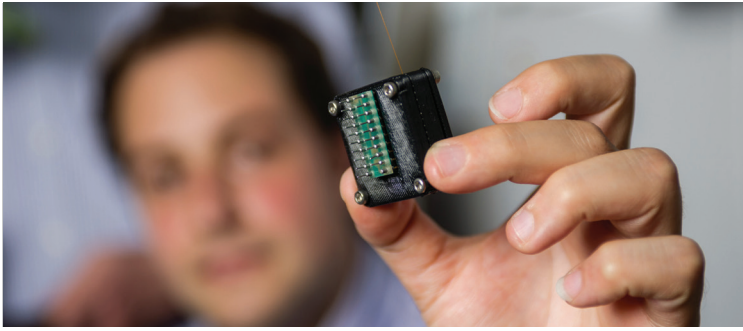
GTRI scientists have also helped develop a state-of-the-art telemedicine system that allows autism patients from rural areas of Georgia to meet face-to-face with doctors at the Marcus Autism Center – without traveling to Atlanta. The system creates telepresence, clinical workflow, and diagnostic processes that enable clinicians to identify children with autism spectrum disorders when they are as young as 18 months old. GTRI's telemedicine efforts are supported by a donation from Allen Ecker, a Georgia Tech alum and former executive vice president of Scientific Atlanta. Cisco Systems Inc., as a provider of telemedicine equipment at Children's Healthcare of Atlanta (CHOA), also donated equipment and software toward telemedicine enhancements at both the Marcus Autism Center and CHOA.



### Supporting BP's Cybersecurity Initiatives

GTRI information security researchers are working with BP to support the company in anticipating potential threats, protecting its information and networks, and providing specialized staff training. The agreement between Georgia Tech and BP enables GTRI to provide targeted support as required and leverages GTRI's expertise in threat intelligence and information security issues.

To learn more about any of these projects, please visit the case studies page at [www.gtri.gatech.edu](http://www.gtri.gatech.edu).



## Agriculture Advances Help Farmers Detect Crop Diseases Earlier, Increase Poultry Yield

GTRI researchers are developing a micro gas chromatograph for early detection of diseases in crops. About the size of a 9-volt battery, the technology's portability could give farmers a better way to evaluate the health of their crops and potentially provide an earlier warning of threats, allowing more rapid intervention to reduce crop losses. Farmers now look for physical symptoms of disease or pests, but by the time these symptoms become visible, the plants may already be dead or dying. The device would detect changes in gases emitted by the crops, disease organisms and harmful insects.

GTRI's Poultry Deboning Line Screening System is one step closer to processing plants thanks to testing done by Gainesville, Ga.-based Gainco Inc. Yield detection involves measuring the amount of meat removed from a chicken frame during deboning, as well as the amount of meat left on the frame – both issues important to a poultry processor's bottom line. The GTRI system employs a special illuminated cone and sophisticated software algorithms to estimate the amount of meat left on the frame, known as yield loss. Gainco develops equipment for the poultry, meat, and seafood processing industries, and will incorporate the GTRI automated vision-based system into its YieldScan™ Rapid Yield Analyzer.

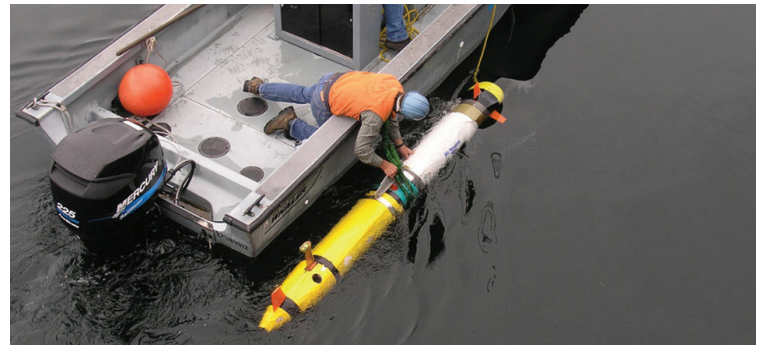


## MINT Program Helps Pinpoint Security Threats

GTRI researchers are helping improve the capabilities of the Multi-disciplinary Intelligence (Multi-INT) system, which monitors data collected by intelligence, surveillance and reconnaissance sensors. GTRI's MINT software has been installed on the Air Force's Forward Processing, Exploitation, and Dissemination system. Funded in part by the Air Force Lifecycle Management Center, MINT brings "actionable intelligence" – information requiring immediate response – to human analysts' attention. MINT uses automated algorithms to extract lean metadata from massive amounts of raw data, and converts that metadata into a single format. Machine-learning algorithms and concurrent-computing techniques then find and compare related pieces of information to perform data fusion, pinpointing those with the strongest relationships.

## New Approach Improves Missile Test Simulations

GTRI researchers are working with a company in Huntsville, Ala., U.S. and the U.S. Missile Defense Agency (MDA) to test high-altitude missiles without ever firing a shot. Aegis Technologies, specialists in modeling and simulation, contracted GTRI to collaborate with MDA on testing high-altitude air defense missiles. The work is the second phase of a multi-year project utilizing "hardware-in-the-loop" testing to enable more accurate modeling and simulation for its customer. Hardware-in-the-loop simulations use portions of the real missile hardware, such as the seeker, with any missing pieces made up by simulated components.



## Synthetic Aperture Sonar Will Hunt Sea Mines

New sonar research being performed by GTRI researchers could improve the Navy's ability to find sea mines deep under water. The underlying technology, known as synthetic aperture sonar (SAS), uses advanced computing and signal processing power to create fine resolution images of the sea floor based on reflected sound waves. Funded by the Office of Naval Research and conducted in collaboration with the Applied Research Laboratory at the Pennsylvania State University, the research on SAS technology could dramatically improve the Navy's ability to carry out its mine countermeasures mission.



## Controlling Hostile or Illegal Cell Phones

Cellular phones can present serious problems when used to remotely detonate explosive devices, perform corporate espionage or enable unchecked illicit communications in prison facilities. GTRI has developed a system called Mobile Soap that controls cell phone use by implementing a radio frequency and communication umbrella throughout a facility. It can detect, collect or deny cell phone transmissions, and use advanced analytics to create intelligence from collected data – while ensuring service for correctional officers and the public. GTRI has tested a range of interdiction techniques in a large prison, and demonstrated the ability to fully control inmate use of smuggled phones for illicit activities.

# ABOUT US

## OUR MISSION

We solve complex problems through innovative and customer-focused research and education.

## OUR VISION

To be the world's premier applied research and development organization.

# RESEARCH FOCUS AREAS

### Applied Electromagnetics

- Electronic Warfare
- Radars
- Antennas
- Electro-Optics

### Cybersecurity

- Secure Information Systems
- Secure Communication Systems

### Systems Engineering & Development

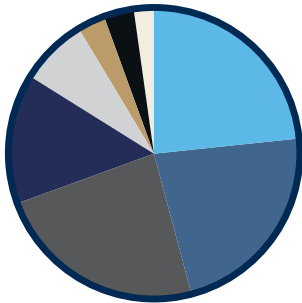
- Electronic Systems
- Prototyping
- Robotics & Unmanned Systems

### Threat Systems

- Test & Evaluation
- Modeling & Simulation
- Human Factors Engineering

# FINANCIAL STATEMENT

During the fiscal year that ended June 30, 2014, GTRI recorded revenue from contracts, grants, and other sources totaling \$305 million, compared with \$300 million for the previous fiscal year. Contract awards for the fiscal year reached \$363 million, surpassing the previous year's total of \$305 million. GTRI is a non-profit applied research and development organization.



# OUR CUSTOMERS

## Sponsored Research Revenues by Customer Type FY 2014

<span style="color: #0070C0;">■</span> Air Force . . . . .	\$68M	<span style="color: #808000;">■</span> Other Non-DoD Federal Agencies . . .	\$10M
<span style="color: #000080;">■</span> Army . . . . .	\$71M	<span style="color: #000000;">■</span> State and Local Governments . . . .	\$10M
<span style="color: #808080;">■</span> Other DoD . . . . .	\$72M	<span style="color: #D2B48C;">■</span> Private (Universities, Businesses) . . .	\$6M
<span style="color: #000080;">■</span> Navy . . . . .	\$44M		
<span style="color: #A9A9A9;">■</span> Federal Pass-Throughs . . . . .	\$22M		
			<b>Total: \$303 Million</b>

# Professional Education



GTRI fulfills an educational mission in addition to research and development. GTRI delivers short courses and certificate programs in defense technology, cybersecurity, problem solving, and occupational safety and health through Georgia Tech Professional Education. There are more than 124 defense technology courses and 60 safety and health courses. The number of professional certificates continues to grow, with 13 defense technology certificates and 8 safety and health certificates. The recently established Professional Master's in Applied Systems Engineering has graduated 81 students with another 56 currently enrolled. In the last fiscal year, GTRI's programs had 5,328 students.

**430 percent growth in the number of applicants to the Professional Master's in Applied Systems Engineering (PMASE) since FY 2010**

# GTRI LEADERSHIP

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## R&D LEADERSHIP

GTRI's eight laboratories are organized into three research and development directorates. Complete laboratory descriptions and contact information are available at [www.gtri.gatech.edu/labs](http://www.gtri.gatech.edu/labs).

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#### Barry Bullard, Ph.D.

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## LOCATIONS

Aberdeen (MD) Field Office  
Atlanta (GA) Headquarters  
Cobb County (GA) Research Facility  
Dayton (OH) Field Office  
Hampton Roads (VA) Field Office  
Huntsville (AL) Research Center

Orlando (FL) Field Office  
Patuxent River (MD) Field Office  
Panama City (FL) Field Office  
Pearl City (HI) Field Office  
Quantico (VA) Field Office

San Antonio (TX) Field Office  
San Diego (CA) Field Office  
Shalimar (FL) Field Office  
Tucson (AZ) Field Office  
Warner Robins (GA) Field Office  
Washington (DC) Field Office



Problem. Solved.

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