

THE PROBLEM SOLVERS

# GTRI

2011 ANNUAL REPORT





## MESSAGE FROM THE DIRECTOR

At the Georgia Tech Research Institute (GTRI), we're planning for the future. Our researchers are anticipating national and international needs in applied research, and are innovating new concepts that enhance our nation's defense, security and economic vitality. We are also developing the talented individuals and investing in the cutting-edge research capabilities that allow us to make valuable contributions today and to solve the problems of tomorrow.

As one of the world's premier applied research and development organizations, GTRI is a recognized leader in such areas as electronics, advanced radars, information and communications technologies, sensors, systems engineering, and testing and evaluation. At GTRI, we're not content to simply ask: "What's next?" Instead, we are working to define the future in cybersecurity and information utilization; defense intelligence, surveillance and reconnaissance (ISR) technologies; robotics and unmanned systems for our armed forces; agricultural technology for Georgia industry; and much more.

This past year, we extensively modernized a large portion of our research infrastructure. For example, we completely renovated our Cobb County Research Facility, and built an all-new compact radar range at our midtown Atlanta campus. In parallel, our administrative support staff has been relentlessly pursuing organizational effectiveness by regularly reviewing administrative efficiency metrics and benchmarking against best practices at other institutions.

During 2011, we continued our aggressive investment in new talent, hiring 122 of the world's best engineers, scientists and professional support staff. Being an integral part of the Georgia Institute of Technology allowed us to provide unique and challenging internships and research opportunities for more than 300 of our best and brightest undergraduate and graduate students.

Collectively, our entire GTRI team strives to deliver outstanding applied technology solutions for all of our sponsors. You will see that goal represented in the projects described in this brief report on our accomplishments in 2011.

*Robert T. McGrath*

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

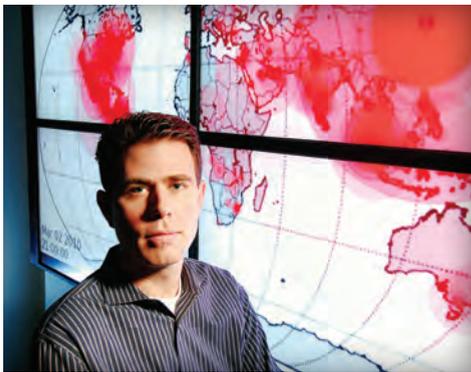
# 2011 GTRI

## ANNUAL REPORT

The Georgia Tech Research Institute (GTRI) is a highly regarded applied research and development organization that is part of the Georgia Institute of Technology, one of the world's top-ranked research universities. With nearly 1,600 scientists, engineers and other professionals, GTRI helps solve the most difficult problems facing government and industry across the nation and around the world.

In this annual report are examples of how GTRI researchers have applied their expertise, creativity and innovation to solve important challenges.

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



### 1. Report Forecasts Cyber Threats for 2012

Cybersecurity challenges in the year ahead will include new and increasingly sophisticated means of capturing and exploiting user data, as well as escalating battles over the control of online information that will threaten to compromise content and erode public trust and privacy. Those were among the findings contained in the Georgia Tech Emerging Cyber Threats Report for 2012, produced by researchers from GTRI and the Georgia Tech Information Security Center (GTISC).

Among specific threats, the researchers identified three areas of high concern: (1) search poisoning, in which attackers use search-engine optimization techniques to raise the visibility of malicious links; (2) attacks focused on the Web browsers of mobile devices, exploiting the compromise between usability and security imposed by device constraints; and (3) increased exploitation of private user information stolen by networks of botnets. The report was released at the annual Georgia Tech Cyber Security Summit.

### 2. Simulator Provides Realistic Electronic Warfare Training

Realistic in-flight training on the protective electronic warfare (EW) equipment built into U.S. military aircraft is essential to ensuring readiness of flight crews. As part of its broad-based EW research program, GTRI recently completed development of a mobile radar air defense simulator that reproduces the behavior of hostile ground-based radar and missile installations. The simulator provides flight crews with a realistic environment that activates on-board EW equipment.

The transportable test and evaluation system, known as the XM-15S threat simulator, was fielded at Eielson Air Force Base in Alaska, where it is used by the U.S. Pacific Air Forces (PACAF) – which supported its development. Flight crews from the United States and allied nations are now using the system at the Joint Pacific Alaska Range Complex to simulate interaction with hostile radars and to practice countermeasures against simulated ground-to-air missile launches. The system also tracks how well crews respond to the threats.



### 3. Inexpensive Wireless Sensor Detects Explosives

A prototype wireless sensor capable of detecting trace amounts of ammonia, a key ingredient of many explosives, has been developed by GTRI researchers in collaboration with colleagues from Georgia Tech's School of Electrical and Computer Engineering. The device, which employs carbon nanotubes and is printed on paper or paper-like material using inkjet technology, could be deployed in large numbers to help alert authorities to the presence of explosives.

The sensor includes a communications device integrated into a small and low-cost package designed to operate almost anywhere. The components, circuits and antennas are printed using "inks" that contain silver nanoparticles in an emulsion. The new device could offer advantages over conventional gas sensors, which require costly semiconductor fabrication or gas chromatography and lack integrated communications devices.





## 4. Study Evaluates Open Source Security Solutions

GTRI researchers are evaluating open source and open cybersecurity methods, models and technologies as part of the \$10 million Homeland Open Security Technology (HOST) program funded by the U.S. Department of Homeland Security's Science and Technology Directorate. The goal of the project is to identify viable and sustainable open source approaches that support national cybersecurity objectives.

As part of the five-year project, researchers will reach out to government, industry, academic

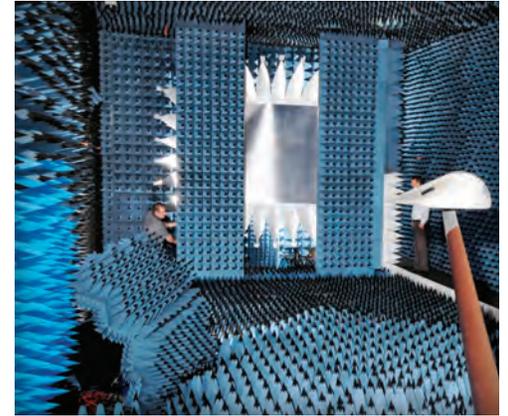
and open source community representatives to learn where and how open source technologies have been successfully adopted within public and private systems – and where challenges remain. GTRI is leading the HOST initiative in conjunction with the Open Technology Research Consortium (OTRC), a collaborative network of leading academic research institutions, industry partners and open source community organizations that promote the advancement of open source software within government agencies.

## 5. New Compact Range Boosts Research Options

GTRI opened a new compact range that will be used for radar cross section measurements and antenna testing. The facility, which is also fully shielded against electromagnetic interference, will be used for evaluating small prototypes or portions of larger defense-related systems.

Located on GTRI's midtown Atlanta campus, the new range has a test zone approximately 6 feet wide, 4 feet tall and 6 feet deep. It can test at frequencies ranging from 2 gigahertz (GHz) to 100 GHz, and that range can be extended down to 800 megahertz. Overall, the facility is 18 feet high, 24 feet wide and 60 feet long. The range was designed with a novel integrated mobile absorber wall that can be deployed to cover the compact range reflector, allowing the facility to be operated as an anechoic chamber.

The new compact range complements the wide array of radar and test facilities already operated by GTRI, including its Electromagnetic Test and Evaluation Facility (EMTEF) located on the Smyrna, Ga. campus.



## 6. Collaboration Focuses on Better Vision Measurement

With research and development assistance from GTRI and seed funding from the Georgia Research Alliance (GRA), an Atlanta-based company is developing what may be the next-generation instrument for optimizing eyesight for the hundreds of millions of people who wear glasses or contact lenses.

To be used by optometrists and ophthalmologists, the instrument – known as the VisionOptimizer – is intended to provide more accurate vision measurements, along with more patient-friendly and engaging vision tests. The company, DigitalVision LLC, believes its system will facilitate

the custom-manufacturing of spectacles and contact lenses that provide better eyesight and improved wearing comfort, compared to vision correction done with conventional methods.

As part of the project, GTRI researchers are helping the company update a vision measurement system designed during the 1970s, and have developed a patent-pending head-and-eye-tracking system to improve the accuracy of vision tests.



## 7. High School Students Develop Weather Instrument

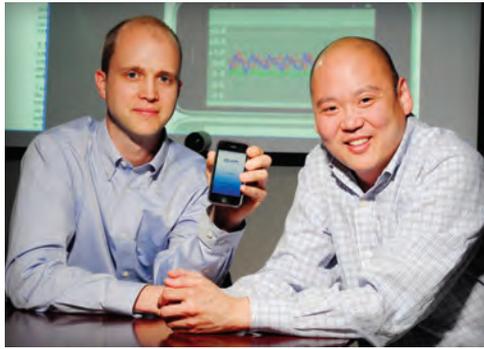
Under the guidance of GTRI researchers, a group of Atlanta-area high school students has designed, built and tested a low-cost version of a device that monitors the buildup of electrical charge in clouds. A network of such devices, known as field mills, could be used to learn more about the lightning that accompanies severe weather – while providing real-world engineering experience for the students.

As part of GTRI's Severe Storms Research Center, the project involved a succession of five student interns who designed a prototype, analyzed and improved its design, produced plans for commercially manufactured circuit boards, and built and tested multiple devices. Performance of the low-cost field mill is now being compared to that of commercial units. Researchers ultimately hope to have as many as 25 of the instruments at high schools around Georgia to monitor the development of lightning.

## 8. Listening to Chickens May Improve Flock Health

The poultry industry contributes \$20 billion to Georgia's economy each year, so keeping flocks healthy and growing is important. Poultry farmers currently rely on sensor systems and their own long-term knowledge of chickens to determine if flocks are under stress from environmental or other factors.

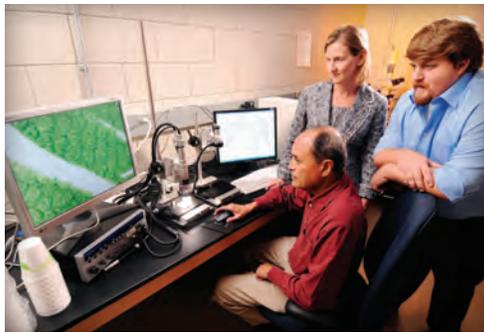
A project being conducted by GTRI, collaborators in the Georgia Tech School of Electrical and Computer Engineering and partners at the University of Georgia may ultimately help improve growing conditions by simply listening to the chickens. The researchers are using sophisticated digital signal processing to identify aspects of chicken vocalizations – squawks, clucks and other sounds – that may indicate non-optimal conditions. The work is funded by the Agricultural Technology Research Program, a state-supported effort to assist Georgia's food processing industry.



## 9. Application for iPhone May Help Parkinson's Patients

GTRI researchers have developed an iPhone application that may enable persons with Parkinson's disease, essential tremor and certain other neurological conditions to use the ubiquitous devices to collect data on hand tremors. That information could be relayed to medical personnel, potentially providing a more representative view of a patient's experience with tremor by allowing more frequent monitoring to assess the progress of the disease.

Known as iTrem, the program utilizes the iPhone's built-in accelerometer to directly measure the tremors that are part of the disease. The researchers ultimately hope to make the program available through the popular iTunes store, but before that happens, iTrem will have to undergo a clinical study and receive any necessary regulatory approvals.



## 10. Research Supports Landfill Biodegradation of Plastics

Researchers at Georgia Tech and North Carolina State University are working together with the Plastics Environmental Council (PEC) to expand the use of chemical additives that cause petroleum-based plastic packaging such as water bottles and Styrofoam cups to biodegrade in landfills. The additives encourage anaerobic bacteria and fungi found naturally in landfills to degrade the plastics into methane gas, carbon dioxide and humus.

GTRI researchers and colleagues in the Georgia Tech School of Chemical and Biomolecular Engineering are conducting research to help the PEC and ASTM develop a set of standard specifications that would ensure accuracy and consistency in determining and communicating the biodegradation performance of plastics made with the additives. The additives do not affect the performance of plastic containers while they are in use or limit their ability to be recycled in current systems.

## 11. Online Environment Facilitates Military Vehicle Design

With funding from the Defense Advanced Research Projects Agency (DARPA), GTRI researchers are creating an online environment that would allow multiple design teams to work together to develop new military vehicles. The goals of the VehicleForge project are to create a secure central website and other Web-based tools and methods that would facilitate such collaborative development.

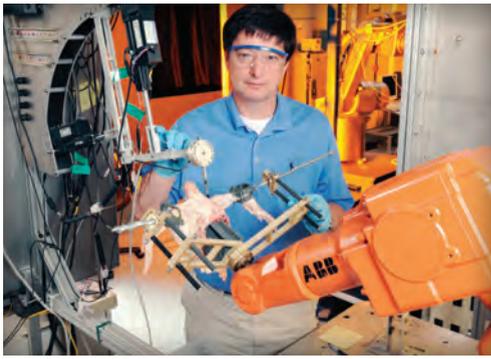
By allowing many designers in varied locations to work together in a distributed manner, the project aims to accelerate development of future vehicles, fundamentally changing the way complex systems move from concept to reality. Two companies, Red Hat Inc. and RadiantBlue Technologies, are working with GTRI on the project, which will draw on collaboration technology already being used to develop open source software for the U.S. Department of Homeland Security.



## 12. Data Visualization Tool Finds "Unknown Unknowns"

A new software tool developed by a GTRI research team enables users to perform in-depth analysis of modeling and simulation data, and then visualize the results on-screen. The new data analysis and visualization tool offers improved ease of use compared to similar tools, and could be readily adapted for existing data sets in a variety of disciplines.

The new software is a subset of the Text Matrix Tool (TMT), a multi-component system developed by GTRI for designing, executing and analyzing large-scale modeling and simulation data sets. The visualization capability offers a graphical user interface that provides both on-screen data-manipulation features such as filters and the ability to see query results in the form of graphical images. Reviewing information in graphical format may reveal patterns not apparent from purely numerical results.



### 13. System Facilitates Automated Chicken Deboning

GTRI researchers are combining image processing, modeling of biomaterials, statistical modeling and high-speed force control to help bring automated chicken deboning to poultry processors. The Intelligent Deboning System, developed with support from Georgia's Agricultural Technology Research Program, aims to match or exceed the efficiency of existing manual processes.

Initial tests of the deboning prototype system, including cutting experiments, have shown the system's ability to recognize bone during a cut and thus avoid bone chips. Systems designed to automate manual cutting processes must simultaneously address two key concerns: avoiding the production of bone chips – which are a major concern for the processors of breast fillets – and minimizing wasted meat. A 1 percent loss of breast meat represents about \$2.5 million a year to each of Georgia's 20 chicken processing plants.

### 14. Novel Technologies Developed for Factory of the Future

A GTRI research team is working with the General Motors Co. to develop novel sensor and computer technologies for manufacturing. The project, known as Factory of the Future, seeks to establish a manufacturing model based on approaches and techniques largely new to factory design and processes. Among other approaches, the researchers are investigating the use of biologically inspired software algorithms to improve factory-floor efficiency.

At the heart of the process improvement approach is a robust combination of sensor and intelligent algorithm technologies. The project's algorithms would utilize asset visibility of supplies, machines and vehicle assembly status to optimize the manufacturing process.

### 15. Research Focuses on Plasma-Container Interactions

With support from the Air Force Office of Scientific Research, scientists and engineers have begun a fundamental study into the ways in which plasmas – a state of matter that contains ionized particles – interact with the walls of the structures containing them. The research could lead to improvements in a broad range of areas, including higher-performance satellite thrusters, improved tubes for Department of Defense radar and communications systems, more efficient high-intensity lamps, and new spray-coating processes.

The research team – from GTRI, the Georgia Tech School of Aerospace Engineering and the University of Alabama – will use new analysis techniques, including a terahertz-frequency



laser for non-intrusively studying the plasma sheath, which is the portion of the plasma that interacts with the wall.

### 16. Project Aims to Cut the Cost of Photovoltaic Systems

As the price of photovoltaic (PV) modules continues to decline, the costs involved in the remainder of solar photovoltaic systems – including installation hardware and labor – are becoming more important. Through a new U.S. Department of Energy project, GTRI is leading a consortium of researchers, students and industry partners in an effort to cut these “balance of system” costs in half.

Beyond GTRI researchers, the three-year project includes students and faculty from the Georgia Tech College of Architecture and School of Mechanical Engineering, along with PV manufacturer Suniva and Radiance Solar – a major integrator of PV systems. Also involved are scientists from the Georgia Tech Center for Biologically Inspired Design, whose expertise in adapting natural solutions to man-made systems may lead to new system design approaches.

### 17. GTRI Connects to Key Defense Networks

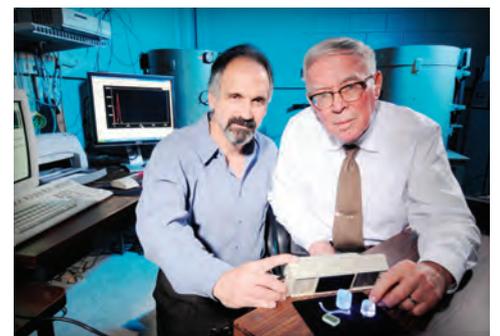
GTRI is now connected to the Defense Research and Engineering Network (DREN) and to the Secret Defense Research and Engineering Network (SDREN). The connectivity will enhance the ability of GTRI researchers to collaborate with others, share large files and participate in events such as the recent AGILE Fire V exercise, which provided the inaugural event for the SDREN connection.

As part of the AGILE Fire V demonstration, GTRI utilized the Joint Mission Environment Test Capability (JMETC), a classified enterprise-level virtual distributed test capability that uses a common infrastructure over the SDREN. During the past four years, GTRI has invested more than \$1 million in secure connectivity for its internal networks, and is the first university-based organization to be connected to the SDREN.

### 18. Nanoscale Materials Enable Improved Radiation Detector

Using novel materials and nanotechnology techniques, GTRI researchers have developed the Nano-photon Composite Scintillation Detector, a prototype radiation detector that combines rare-earth elements and other materials at the nanoscale for improved sensitivity, accuracy and robustness. The technology could be used at ports, border crossings, airports and other locations to detect radioactive materials hidden in shipping containers.

Existing approaches for detecting radioactive materials, including scintillation detectors and solid-state detectors, have disadvantages related to their underlying technology. With funding from the Domestic Nuclear Defense Office of the U.S. Department of Homeland Security and the National Science Foundation, GTRI scientists overcame those issues by using nanoparticles to detect the gamma rays and subatomic particles that indicate the presence of radioactive materials.



# OUR MISSION

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

# OUR VISION

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

# OUR NUMBERS

2011 Research Revenue: ..... **\$221M**  
Internal Research & Development Investment: ... **\$8.2 M**  
Total Number of Employees: ..... **1,521**  
Students Employed by GTRI: ..... **300**

# STATEWIDE IMPACT

Amount of Funding Generated by GTRI for Every Dollar Provided by Georgia: ..... **\$30**  
Estimated Annual Economic Impact on Georgia: **\$400+M**

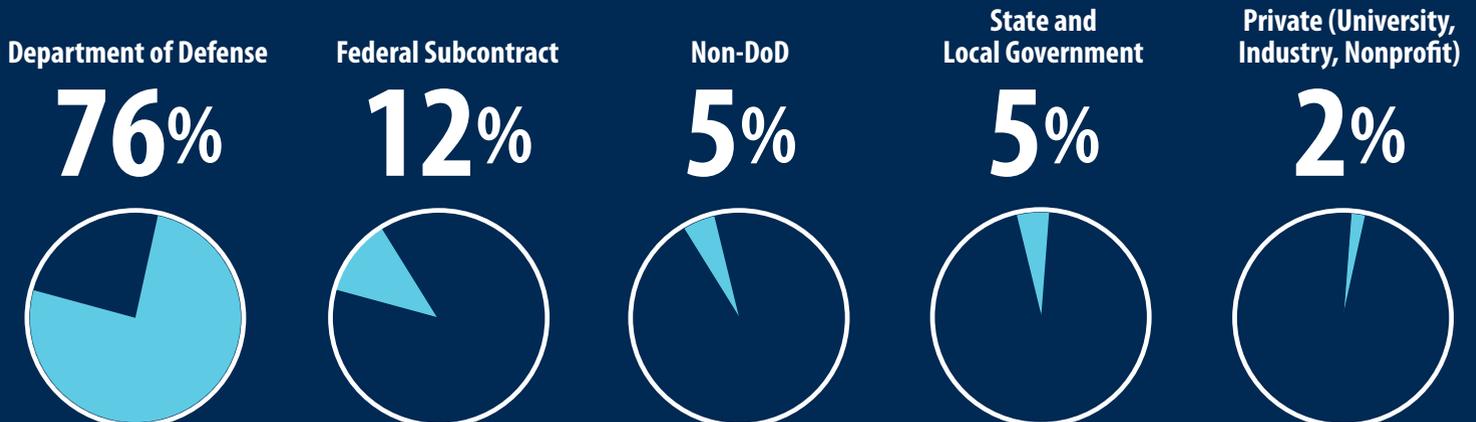
# RESEARCH FOCUS AREAS

**Core Research Areas**

- SYSTEMS ENGINEERING
- SENSORS
- INFORMATION
- TEST & EVALUATION
- ELECTRONIC WARFARE
- MODELING & SIMULATION
- CYBERSECURITY
- RADAR
- ANTENNAS
- OPTICS
- MEDIA, HEALTH & EDUCATION
- ROBOTICS & UNMANNED SYSTEMS
- AEROSPACE TECHNOLOGIES
- COMMUNICATIONS
- ADVANCED COMPUTING
- MATERIALS

**GTRI ALSO PROVIDES PROFESSIONAL EDUCATION IN THESE RESEARCH AREAS.**

# OUR CUSTOMERS



# GTRI LEADERSHIP

**Robert T. McGrath, Ph.D.**

Director, GTRI  
Vice President, Georgia Institute  
of Technology  
404.407.7401  
robert.mcgrath@gtri.gatech.edu

**Thomas A. McDermott, Jr.**

Deputy Director, GTRI  
Director, Research  
404.407.7369  
tom.mcdermott@gtri.gatech.edu

**Lisa C. Sills**

Deputy Director, GTRI  
Director, Support Operations  
404.407.8957  
lisa.sills@gtri.gatech.edu

**Tom Horton**

Chief of Staff, GTRI  
Director, Government Relations  
404.407.8110  
tom.horton@gtri.gatech.edu

**Rebecca V. Caravati**

Associate Director, GTRI  
Director, Financial Administration  
404.407.7818  
rebecca.caravati@gtri.gatech.edu

**George B. Harrison**

Major General, USAF (Ret)  
Associate Director, GTRI  
404.407.7136  
george.harrison@gtri.gatech.edu

**Dennis J. Folds, Ph.D.**

Chief Scientist, GTRI  
404.407.7262  
dennis.folds@gtri.gatech.edu

**Jeff Moulton**

Director, Program Development, GTRI  
404.694.2742  
jeff.moulton@gtri.gatech.edu

# LABORATORY DIRECTORS

Complete laboratory descriptions and contact information are available at [www.gtri.gatech.edu/labs](http://www.gtri.gatech.edu/labs)

**Rusty Roberts**

Aerospace, Transportation and  
Advanced Systems Laboratory  
404.407.7856  
rusty.roberts@gtri.gatech.edu

**Bo Rotoloni**

Cyber Technology and Information  
Security Laboratory  
404.407.6534  
bo.rotoloni@gtri.gatech.edu

**Gisele Bennett**

Electro-Optical Systems Laboratory  
404.407.6100  
gisele.bennett@gtri.gatech.edu

**Bill Melvin**

Sensors and Electromagnetic  
Applications Laboratory  
404.407.8274  
bill.melvin@gtri.gatech.edu

**Barry Bullard**

Applied Systems Laboratory at  
Huntsville  
256.716.2150  
barry.bullard@gtri.gatech.edu

**Joe Brooks**

Electronic Systems Laboratory  
404.407.7144  
joe.brooks@gtri.gatech.edu

**Jim McGarrah**

Information and Communications  
Laboratory  
404.407.6858  
james.mcgarrah@gtri.gatech.edu

**Lon Pringle**

Signature Technology Laboratory  
404.407.6995  
lon.pringle@gtri.gatech.edu

