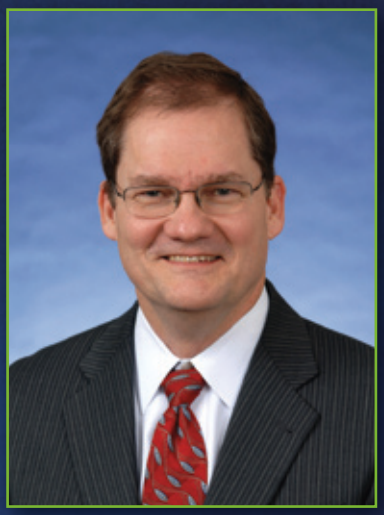
Information Technology Laboratory

National Institute of Standards and Technology
U.S. Department of Commerce

Letter from the Director



In November 2011, I became the Director of the Information Technology Laboratory (ITL), one of six research laboratories within the National Institute of Standards and Technology (NIST). ITL develops and deploys standards, tests, and metrics to make our information systems more secure, usable, interoperable, and reliable. As a world-class measurement and testing laboratory encompassing a wide range of areas of computer science, mathematics, statistics, and systems engineering, our research program supports NIST's mission to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

ITL collaborates with other NIST laboratories, the Department of Commerce, other government agencies, the U.S. private sector, standards development organizations, and other national and international stakeholders in both the development and application of new information technologies to help meet national priorities. For example, ITL cybersecurity experts collaborate to develop cybersecurity standards, guidelines, and associated methods and techniques for federal agencies (which are widely adopted by U.S. industry). ITL mathematicians and statisticians collaborate with measurement scientists across NIST to help ensure that NIST maintains and delivers the world's leading measurement capability. ITL computer scientists and other research staff provide technical expertise and development that underpins national priorities such as cloud computing, the Smart Grid, homeland security, information technology for improved health care, and electronic voting.

We invite you to learn more about how ITL is enabling the future of the nation's measurement and standards infrastructure for information technology and as always, we welcome your interest and comments.

Charles H. Romine

Charles H. Romine
Director, Information Technology Laboratory
itl_inquiries@nist.gov

Our Mission

To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology through research and development in information technology, mathematics, and statistics.

Our Core Competencies

- IT measurement and testing
- Mathematical and statistical analysis for measurement science
- Modeling and simulation for measurement science
- IT standards development and deployment

Our Resources

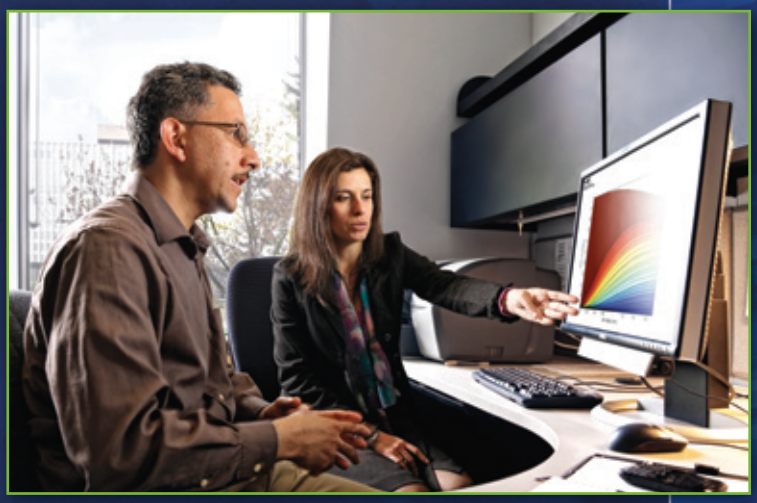
- Highly qualified professional and support staff of 369 employees and 173 guest researchers
- Annual budget of about $100 million
- State-of-the-art research facilities in Gaithersburg, Maryland, and Boulder, Colorado

Our Products

- Standards and guidelines
- Reference data sets and evaluation software
- Advanced software quality assessment tools
- Tests and test methodologies
- Proof-of-concept implementations
- Specialized databases
- Validation programs for cryptographic standards
- Mathematical and statistical consulting

Our Customers and Stakeholders

- U.S. industry and private sector organizations
- Federal, state, and local governments
- Academia
- Research laboratories
- IT users and providers
- Industry standards organizations
- Industry consortia
- NIST staff and collaborators



Electronics engineer Michael Souryal and computer engineer Nada Golmie discuss the network performance of mobile communication systems. NIST develops models for such systems to characterize their performance for applications such as public safety and Smart Grid communications.

ITL Programs

Cloud Computing

ITL plays a central role in defining and advancing standards, and collaborating with federal agency Chief Information Officers, private sector experts, and international bodies to identify and reach consensus on cloud computing technology and standardization priorities. Through its strategic efforts to collaboratively develop a U.S. government Cloud Computing Technology Roadmap, ITL is helping to translate mission requirements into technical portability, interoperability, reliability, maintainability, and security requirements. Focusing its efforts using these priorities, ITL is working with other stakeholders to develop the standards, guidance, and technology which must be in place to enable the secure and effective deployment of the cloud computing model.

Computer scientist Murugiah Souppaya investigates security techniques for protecting virtualized computing environments and cloud computing systems. His virtualization lab serves as a testbed to develop and implement controls that reduce security vulnerabilities and minimize exposure to cyber attacks, and also provides virtualized computing services for other ITL research projects. *© Nicholas McIntosh*

Complex Systems

Every week millions of users update their computers with new software. Could one of these monthly updates cause widespread Internet performance degradation? Using methods pioneered by the ITL Complex Systems program, researchers showed such a scenario could occur if computers received a revised Internet protocol intended to improve performance for individual users. The Internet is a complex system comprising a large collection of interconnected components whose interactions lead to global behaviors that are difficult to predict. ITL researchers are creating advanced modeling and analysis methods, enabling engineers to foresee when small changes could lead to global failure or widespread performance reduction.

Forensics

The methodologies of forensic science are used in solving crimes and presenting evidence in court. The kinds of evidence analyzed range from fingerprints and DNA found at crime scenes to call logs on cell phones to faces captured on surveillance video. It is imperative that the methods used in forensic science are reliable, accurate, and scientifically validated. The

Computer scientist Rick Ayers makes sure commercial forensics tools for cell phones conform to required specifications by testing them on a number of phone models. These tests provide a measure of assurance that the tools used in digital forensic investigations give accurate results.
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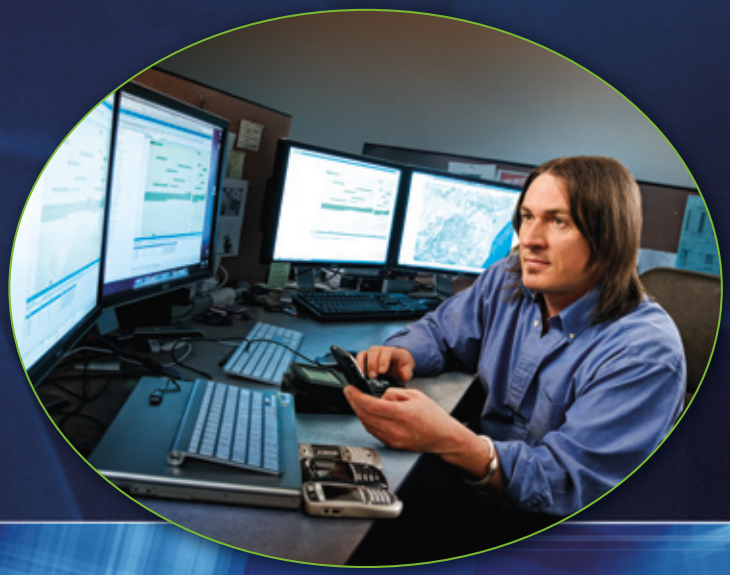


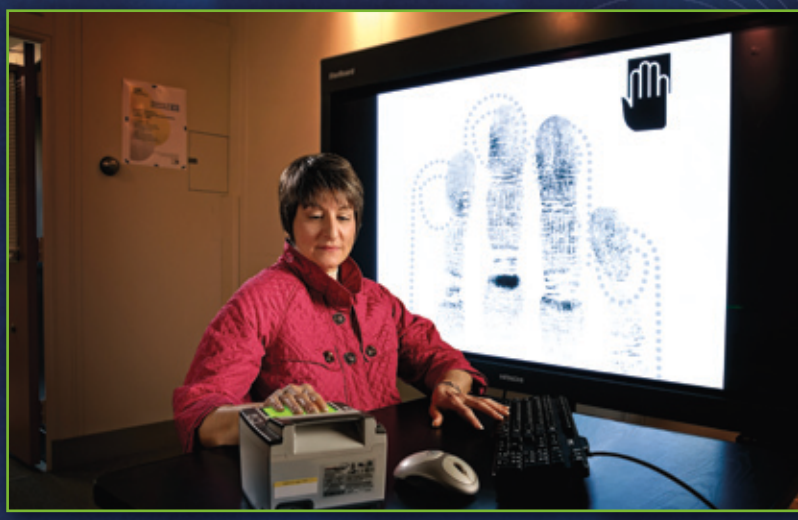
ITL Forensics program advances the measurements and standards infrastructure for forensic science through the application of computer science, mathematics, and statistics. We are working to better understand and improve the accuracy and reliability of forensic science; establish measures of uncertainty for forensic analyses; develop computational methods to help automate forensic analyses; and enhance the usability and interoperability of forensic systems.

Health Information Technology (IT)

As health IT has become a top priority around the nation, standards and interoperability are key to the fulfillment of the goals of health IT including higher-quality and more efficient care. In collaboration with industry, government, academia, and consortia, ITL researchers focus on standards, testing, certification, security and privacy, usability, and emerging technologies to enable health IT interoperability and adoption. We provide technical expertise to leverage industry-led, consensus-based standards development and harmonization as well as to develop a conformance testing infrastructure. We leverage security automation specifications and apply them within the context of healthcare. Our usability studies improve the effectiveness and efficiency of product use. Finally, we focus on emerging technologies such as medical device interoperability, telemedicine applications, the long-term preservation and management of electronic health records (EHRs), and the ubiquitous delivery of physiological signals to/from the human body via radio frequency-enabled wearable or implantable devices.

National Initiative for Cybersecurity Education (NICE)

The National Initiative for Cybersecurity Education (NICE), which is being led and coordinated by ITL, represents an excellent opportunity for NIST to coordinate not only the education, training, awareness, and professional development activities related to cybersecurity in general but also to work closely with the Smart Grid initiative, the National Strategy for Trusted Identities in Cyberspace (NSTIC), the Health IT effort, and other forward-looking programs and initiatives in which NIST has significant roles. The everyday lives of virtually every American will be affected by these activities and can clearly be seen reflected in the NICE vision, which is, ***"A secure digital nation capable of advancing America's economic prosperity and national security in the 21st century through innovative cybersecurity education, training, and awareness on a grand scale."***



Computer scientist Mary Theofanos demonstrates a NIST-developed system that visually guides users to correctly place their hands on a digital fingerprint scanner. The system improves image quality and speeds up the fingerprinting process by allowing a person to provide prints unassisted.
© Nicholas McIntosh

National Strategy for Trusted Identities in Cyberspace (NSTIC)

ITL staff leads the National Program Office (NPO) tasked with implementing the National Strategy for Trusted Identities in Cyberspace (NSTIC) — a White House initiative to work collaboratively with the private sector, advocacy groups, public sector agencies, and other organizations to improve the privacy, security, and convenience of sensitive online transactions. NSTIC calls for the development of interoperable technology standards and policies to enable an "Identity Ecosystem" — where individuals, organizations, and underlying infrastructure such as routers and servers can be authoritatively authenticated. The goals of the strategy are to protect individuals, businesses, and public agencies from the high costs of cyber crimes such as identity theft and fraud, while simultaneously helping to ensure that the Internet continues to support innovation and to be a thriving marketplace of products and ideas.

Pervasive Information Technology

The Pervasive Information Technology program is facilitating the development of standards and innovative measurement methodologies for reliable, interoperable, and ubiquitous communication and networking of personal and medical devices. From ultra-small wearable or implantable sensors to acute-care clinical devices, the program focuses on critical research issues such as measurement and modeling of radio frequency propagation, interference analysis, algorithms for network performance improvement, and semantic and architectural interoperability. The ability to pervasively monitor and respond to human health and well-being will result in an environment that can convey important information to and from individuals in need. This will ultimately lead to enhanced medical care and improved quality of life for many people.

Computer engineer Kamran Sayrafian uses NIST's Reconfigurable 3D Immersive Platform to study and model how radio frequency (RF) waves propagate through the human body. This research is being used to support the development of standards for implantable and wearable wireless medical devices. © Nicholas McIntosh

Quantum Information

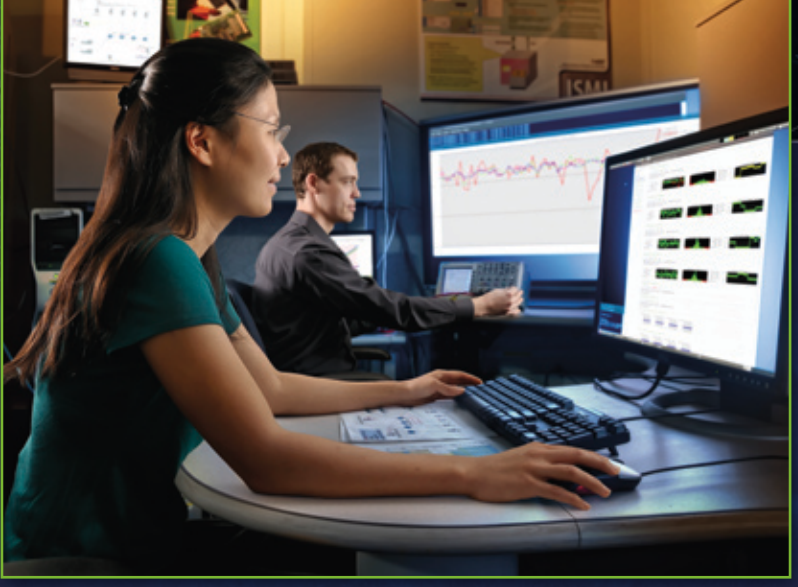
An emerging discipline at the intersection of physics and computer science, quantum information science is likely to revolutionize science and technology just as lasers, electronics, and computers did in the 20th century. By encoding information into quantum states of matter, one can, in theory, exploit the counter-intuitive behavior of quantum systems to enable phenomenal increases in information storage and processing capability, as well as communication channels with extremely high levels of security. Although many of the necessary physical manipulations of quantum states have been demonstrated experimentally, scaling these up to fully capable quantum computers remains a challenge. In ITL, we are engaged in theoretical studies aimed at revealing the true power of quantum computing, as well as in collaborative efforts with NIST experimentalists working to characterize and benchmark physical implementations of quantum information processing technologies and systems.

Security Automation

The security automation project within ITL has made important strides towards standardizing and automating critical information security elements such as software vulnerabilities and secure configurations. The National Vulnerability Database is the premier source of official software vulnerability information for the public and private sectors, ensuring that both software vendors and users have a common reference for this important data. The National Checklist Program provides a wide range of guides that aid users in ensuring that their operating systems and applications are configured as securely as possible. These resources, and the technical standards that support them, are critical components in ensuring that security management is effective and efficient.

Smart Grid

By linking information technologies with the electric power grid, the Smart Grid promises many benefits, including increased energy efficiency, reduced carbon emissions, and improved power reliability. As outlined in the Energy Independence and Security Act of 2007 (Public Law 110-140, often referred to as EISA), NIST has been given "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of Smart Grid devices and systems."



Computer scientist Ya-Shian Li-Baboud (foreground) and NIST associate Julien Amelot develop test methods to evaluate the performance of commercial tools in meeting network time-synchronization requirements. Precise timing is vital to the operation of the Smart Grid, a planned nationwide network that uses information technology to deliver electricity efficiently, reliably, and securely. © Nicholas McIntosh

ITL works both nationally and internationally with industry, other government agencies, academia, and other stakeholders on cybersecurity and communication requirements, measurement methods, and standards. ITL is leading NIST Smart Grid activity in cybersecurity and the use of wireless communications and Internet protocols in the Smart Grid, as well as the harmonization of power line carrier standards for appliance communications in the home. ITL also leads the Vehicle-to-Grid Working Group and provides technical expertise to the Smart Grid Architecture Committee.

Virtual Measurement Systems

ITL's Virtual Measurement Systems (VMS) program introduces metrology constructs — reference computations, uncertainty quantification, and traceability — into scientific computation. This infrastructure will result in predictive computing with quantified reliability, enabling improved decision making based on computer simulations. In 2010, VMS researchers collaborated with NIST's Fire Research Division to investigate uncertainty quantification of computational fire models applied to computational predictions of the temperature of the hot gas layer (HGL) in a compartment fire. Results contributed to the quantitative validation of computational predictions of HGL temperatures as compared with physical measurements performed under controlled burn conditions. This research is sponsored by the U.S. Nuclear Regulatory Commission through its program to develop a regulatory framework under which elements of nuclear power plant fire safety may be assessed using computational fire models.

Voting Standards

ITL plays a key role in ensuring that all Americans can vote independently and privately with ballots that are clear and understandable on voting systems that are secure and easy to navigate. The Help America Vote Act of 2002 directed ITL's Voting Standards program to develop voluntary voting system guidelines to improve voting systems for voters both in this country and overseas. These guidelines, which address reliability, usability, accessibility, and security, support the U.S. Election Assistance Commission and the Federal Voting Assistance Program, as well as election officials, industry, academia, and advocacy groups. To date, ITL has issued guidance for plain language in ballot instructions, color in voting systems, and clear instructions for voters and poll workers. We have also issued guidance on computer security considerations for voting equipment and remote systems. Finally, ITL has developed test procedures for evaluating equipment performance for compliance with the guidelines.

A controlled heptane pool fire conducted for the purpose of fire model validation. Courtesy Simo Hostikka, VTT Research Centre, Helsinki, Finland

About NIST

Founded in 1901, NIST is a non-regulatory federal agency within the U.S. Department of Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. With total Fiscal Year 2011 resources of approximately $934 million (includes NIST appropriations and reimbursable operations), NIST employs about 3,000 scientists, engineers, technicians, support, and administrative personnel at its headquarters in Gaithersburg, Maryland, and its laboratories in Boulder, Colorado. In addition, NIST hosts about 2,600 associates and facility users from academia, industry, and other government agencies. See *http://www.nist.gov.*

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Visit our Information Technology Laboratory Web site: *http://www.nist.gov/itl.*

Contact us:

National Institute of Standards and Technology
Information Technology Laboratory
Gaithersburg, MD 20899-8900
(301) 975-2900
E-mail: *itl_inquiries@nist.gov*

Writer/Editor: Elizabeth Lennon
Design: Michael James, The DesignPond
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