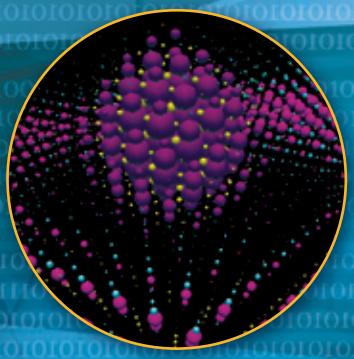
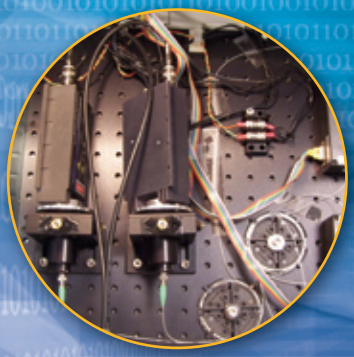
Information Technology Laboratory





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

LETTER FROM THE DIRECTOR

Welcome to the Information Technology Laboratory (ITL). As one of the major research components of the National Institute of Standards and Technology, ITL accelerates the development and deployment of information and communication systems that are reliable, usable, interoperable, and secure; advances measurement science through innovations in mathematics, statistics, and computer science; and conducts research to develop the measurements and standards infrastructure for emerging information technologies and applications. We accomplish these goals through collaborative partnerships with our customers and stakeholders in industry, government, academia, and consortia. Based on input from these customers and stakeholders, we have focused our R&D agenda on eight broad program areas: complex systems; cyber and network security; enabling scientific discovery; identity management systems; information discovery, use and sharing; pervasive information technologies; trustworthy information systems; and virtual measurement systems. Many of our vital programs impact national security, such as improving the accuracy and interoperability of biometrics recognition systems and facilitating communications among first responders. The combination of our mission and mandates such as the Federal Information Security Management Act, the Computer Security Research and Development Act, the USA PATRIOT Act, the Enhanced Border Security Act, and the Help America Vote Act lead to rich programmatic diversity. 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.

Cita M. Furlani

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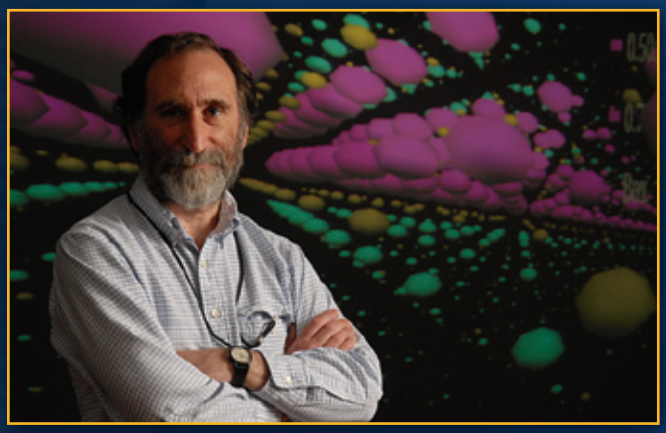
ITL PROGRAMS

Complex Systems: Complex Systems are composed of large interrelated, interacting entities which taken together, exhibit a macroscopic behavior which is not predictable by examination of the individual entities. The Complex Systems Program seeks to understand the fundamental science of these systems and develop rigorous descriptions (analytic, statistical, or semantic) that enable prediction and control of their behavior. Initially focused on the Internet and Grid Computing, this Program will facilitate predictability and reliability in these areas and other complex systems such as biotechnology, nanotechnology, semiconductors, and complex engineering.



John Hagedorn of ITL stands in front of an immersive display that allows researchers to visualize atoms, molecules, nanotechnology structures and other data in three dimensions. *© Peter Cutts*

Cyber and Network Security: Cyber and network security is focused on ensuring three security objectives of information technology systems: confidentiality, integrity, and availability. The Cyber and Network Security Program addresses NIST's statutory responsibilities in the domain and the near- and long-term scientific issues in some of the building blocks of IT and network security - cryptography, security testing and evaluation, access control, internetworking services and protocols (Domain Name System, Border Gateway Protocol, IPv6, Wi-Max, etc.), security metrics, vulnerability analysis, security automation, and security properties. These efforts will provide a more scientific foundation for cybersecurity, while maintaining a focus on near-term security issues in emerging technologies.

Enabling Scientific Discovery: Modern scientific research has become more and more dependent on mathematical, statistical, and computational tools for enabling discovery. The Enabling Scientific Discovery Program promotes the use of these tools to dramatically advance our ability to predict the behavior of a broad range of complex scientific and engineering systems and enhance our ability to explore fundamental scientific processes. This Program focuses on interdisciplinary scientific projects that involve novel computational statistics and the development of simulation methods and software. These efforts will have a foundational impact on scientific discovery throughout U.S. industry, government, and academia.

Identity Management Systems: Identity management systems are responsible for the creation, use, and termination of electronic identities which are routinely used to access logical and physical resources, and have become a ubiquitous part of our national infrastructure. The Identity Management Systems Program is pursuing the development of common models and metrics for identity management, critical standards, and interoperability of electronic identities. These efforts will improve the quality, usability, and consistency of identity management systems while protecting privacy.

ITL computer scientist Ross Micheals demonstrates an ITL-developed system for studying the performance of facial recognition software programs. The research supports ITL's mandate under the USA PATRIOT Act to certify the use of biometrics in national entry-exit systems such as US-VISIT. *© Robert Rathe*

ITL researchers John Roberts (right) and Oliver Slattery demonstrate a new device designed to allow people who are blind or visually impaired to feel images. *© Robert Rathe*

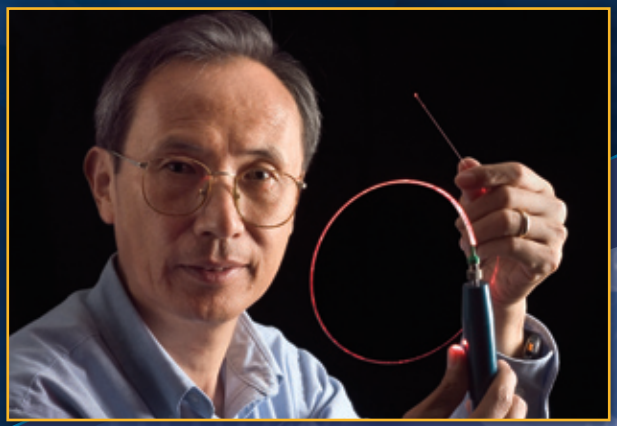
Information Discovery, Use, and Sharing: Society is awash in data - our ability to amass data has outpaced our ability to use it. Extracting knowledge, information, and relationships from this data is one of the greatest challenges faced by the scientists in the twenty-first century. The data can be as diverse as biological research data, medical images, automated newswire, speech, or video. The Information Discovery, Use, and Sharing Program fosters innovation throughout the information life cycle by developing the measurement infrastructure to enhance knowledge discovery, information exchange, and information usability. The Program enables novel computational approaches to data collection and analysis to be combined with improved interoperability techniques to effectively extract needed information from the wealth of available data.

Pervasive Information Technologies: Pervasive information technology is the trend towards increasingly ubiquitous connected computing sensors, devices, and networks that monitor and respond transparently to human needs. The Pervasive Information Technologies Program facilitates the creation of standards for sensor communication, networking interoperability, and sensor information security. The Program enables the use of pervasive information technologies to enhance personal and professional productivity and quality of life.

Trustworthy Information Systems: A trustworthy system is one that performs as intended for a specific purpose, when needed, with operational resiliency and without unwanted side effects, behaviors, or exploitable vulnerabilities. The Trustworthy Information Systems (TIS) Program conducts research, development, and testing to improve the ability to model, build, test, measure, and assess information system trustworthiness through the development and application of new and innovative technologies, models, measurement methods, and tools. The aim of the TIS program is to reduce the risk and uncertainty associated with information systems that must be trusted, and to improve the ability to build in and evaluate trustworthiness in information applications and systems.

Virtual Measurement Systems: A virtual measurement is a quantitative result and its uncertainty, obtained primarily by a nontrivial computer simulation or computer-assisted measurements. Examples of virtual measurements include computational models of physical systems and visualizations of the results. The Virtual Measurement Systems Program introduces metrology constructs - standard references, uncertainty characterization and propagation, and traceability - into scientific computation and computer-assisted measurement technologies. As with physical measurement systems, development of a virtual metrology infrastructure will result in predictive computing with quantified reliability. In turn, this will enable improved decision-making contingent on virtual measurement systems.

Xiao Tang and colleagues focus on advanced networking techniques by conducting research on quantum communications over optical fiber channels. *© Robert Rathe*



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 analyses for measurement science
- Modeling and simulation for measurement science
- IT standards development and deployment

Our Resources

- Highly qualified professional and support staff of 329 and 136 guest researchers
- Fiscal year (FY) 2008 budget of $97.9M
- 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

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

"Intelligent" building systems may someday allow firefighters and other first responders to better respond to emergencies by providing information such as building floor plans and real-time data from motion, heat, biochemical and other sensors and video cameras. *Illustration by: Tim McEvoy*

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 FY 2008 resources of $931.5 million, NIST employs about 2,900 scientists, engineers, technicians, and administrative personnel at its headquarters in Gaithersburg, Maryland, and its laboratories in Boulder, Colorado. See *http://www.nist.gov.*

Visit our Web site:
http://www.itl.nist.gov

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COVER CAPTIONS

Circle top right: *Snapshot from an immersive visualization of a quantum dot. The spheres represent s orbitals, which also are representative of the atoms in the structure. In a collaboration with the NIST Physics Laboratory, ITL contributed the parallel algorithms needed to be able to compute the structure in a reasonable time and the immersive visualization techniques to facilitate an understanding of the landscape of the nano structure.*

Circle left center: *ITL has been conducting fingerprint research for more than 35 years.*

Circle lower right: *Detection stage of the NIST prototype quantum key distribution (QKD) system: Incoming photons already have been sorted into one of two quantum states. Photons are "up-converted" from 1310 to 710 nm by one of the two NIST-designed converters at right, then sent to one of two commercial silicon avalanche photo diode units to the left.*

Writer/Editor: Elizabeth Lennon; Design: Michael James, The DesignPond *January 2009*