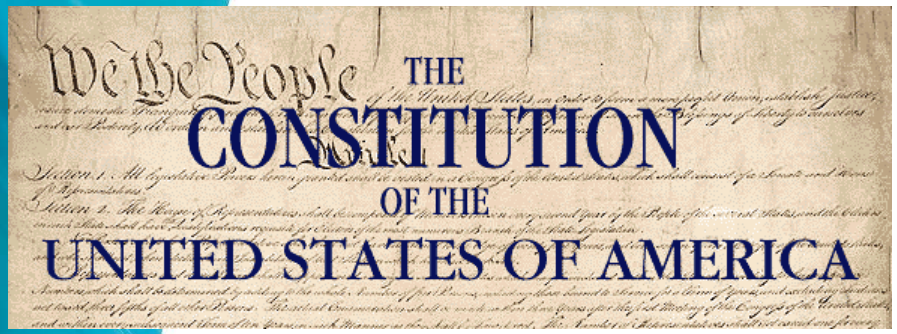
Information and Software Quality, Integrity and Usability from the Viewpoint of NIST

Cita M. Furlani, Director,
Information Technology Laboratory

November 13, 2010

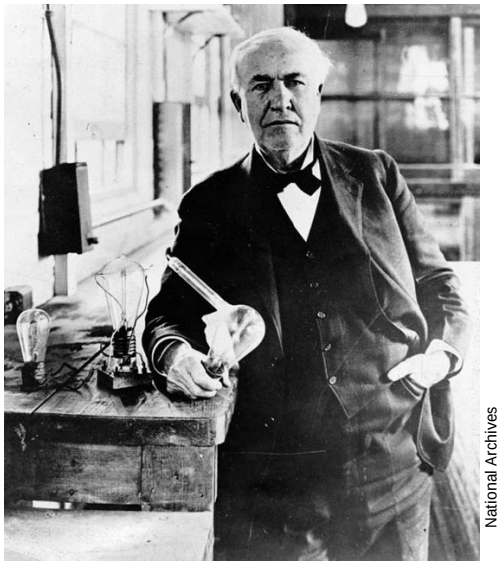
NIST
National Institute of Standards and Technology
U.S. Department of Commerce

The Importance of Standards



Article I, Section 8: The Congress shall have the power to…*fix the standard of weights and measures*

- National Bureau of Standards established by Congress in 1901
- Eight different "authoritative" values for the gallon
- Electrical industry needed standards
- American instruments sent abroad for calibration
- Consumer products and construction materials uneven in quality and unreliable


National Archives

Estimated that 80% of global merchandise trade is influenced by testing and other measurement-related requirements of regulations and standards

NIST Mission and Programs

"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"

NIST Laboratories

- Create critical measurement solutions and promote equitable standards to stimulate innovation, foster industrial competitiveness, and improve the quality of life.

Hollings Manufacturing Extension Partnership

- Nationwide network of resources helping smaller manufacturers compete globally

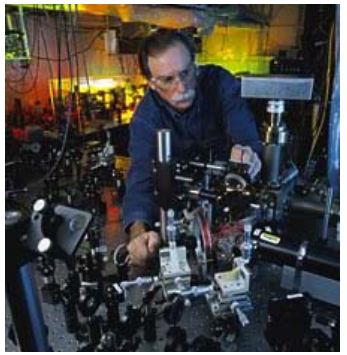
Baldrige Performance Excellence Program

- Promoting and recognizing performance excellence via information and Presidential awards in manufacturing, service, small business, education, health care, and the nonprofit sector

Technology Innovation Program

- Supports development of cutting edge technologies by the private sector and universities to address critical national needs and key societal challenges

NIST is the nation's innovation agency



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Courtesy Stoner Inc.

Courtesy Steuben

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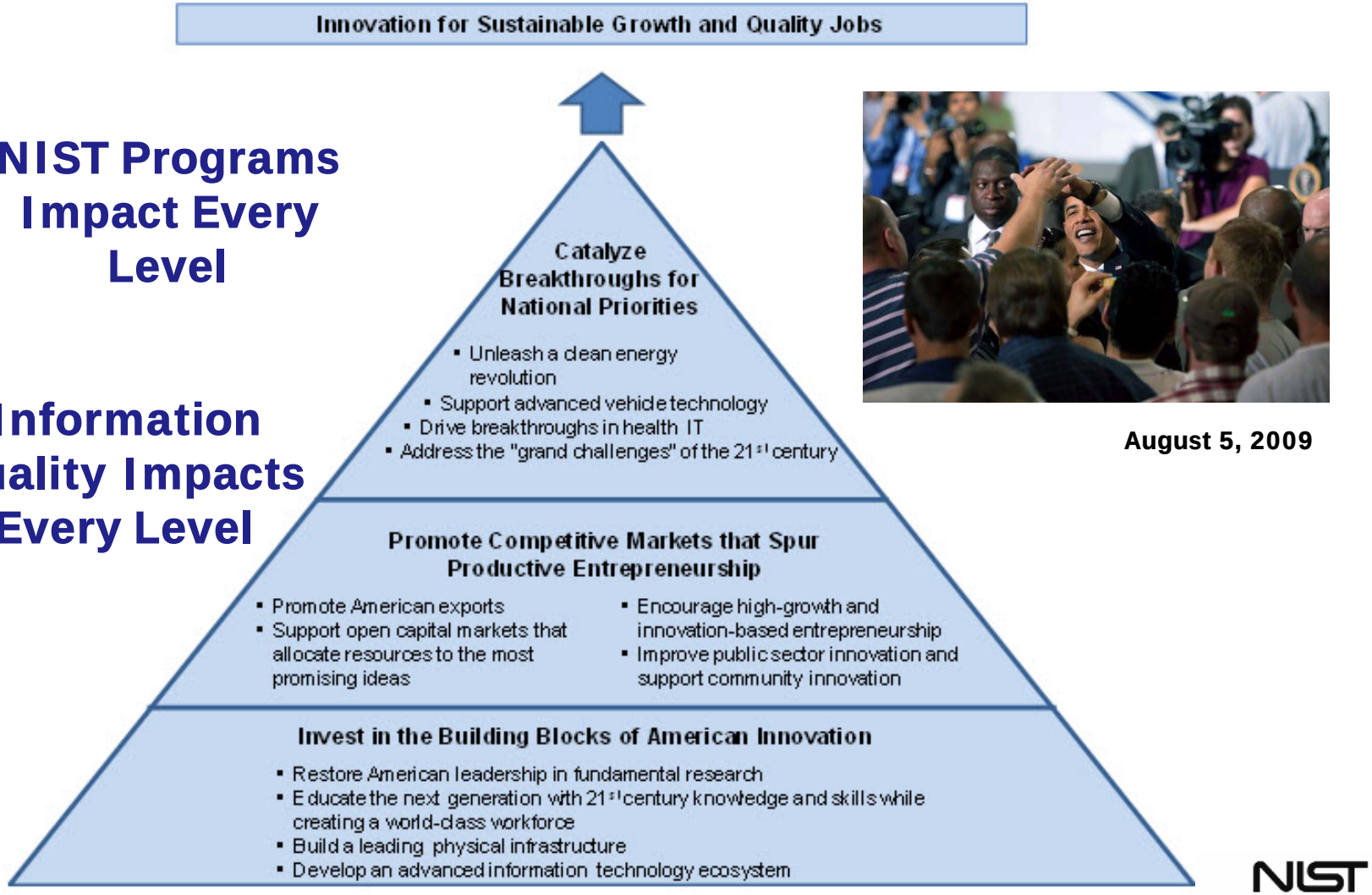
President's Innovation Strategy:
Driving Towards Sustainable Growth and Quality Jobs

NIST Programs Impact Every Level

Information Quality Impacts Every Level



August 5, 2009

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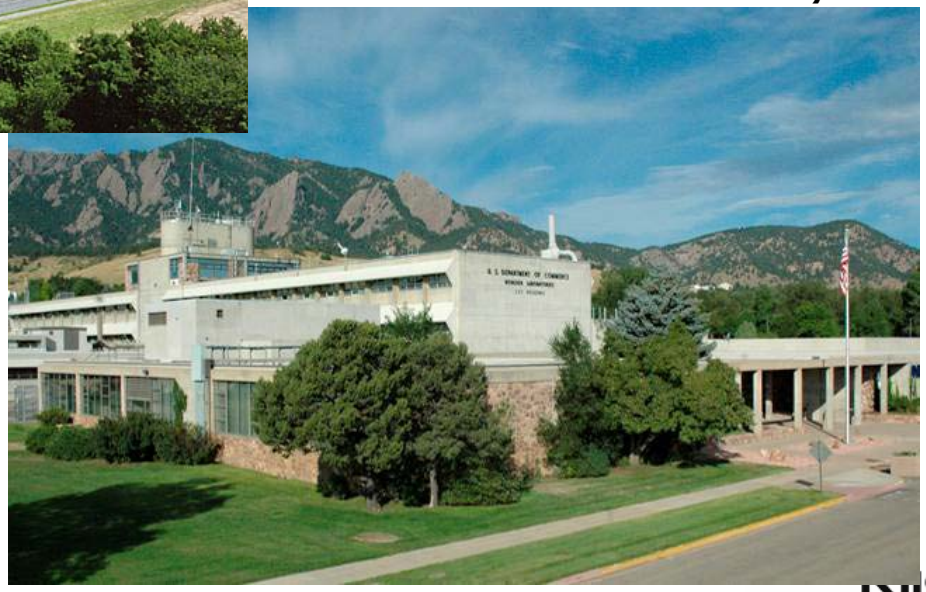
NIST has... ... two main campuses

Gaithersburg, MD

Courtesy HDR Architecture, Inc./Steve Hall © Hedrich Blessing

Boulder, CO



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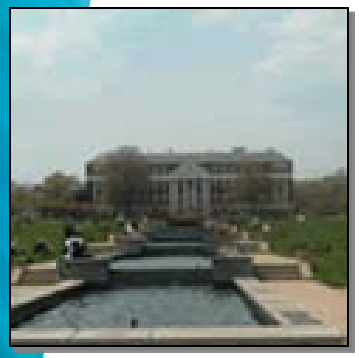
NIST has... ...four joint institutes

JILA
NIST + University of Colorado

University of Maryland Biotechnology Institute



Joint Quantum Institute
NIST + University of Maryland + NSA

Hollings Marine Laboratory
NIST + NOAA + South Carolina
+ College of Charleston
+ Medical University of South Carolina

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NIST Products and Services

Measurement Research

- ~ 2,200 publications per year

Standard Reference Data

- ~ 100 different types
- ~ 6,000 units sold per year
- ~ 226 million data downloads per year

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Standard Reference Materials

- ~ 1,300 products available
- ~ 30,000 units sold per year

Calibration Tests

- ~ 18,000 tests per year

Laboratory Accreditation

- ~ 800 accreditations of testing and calibration laboratories

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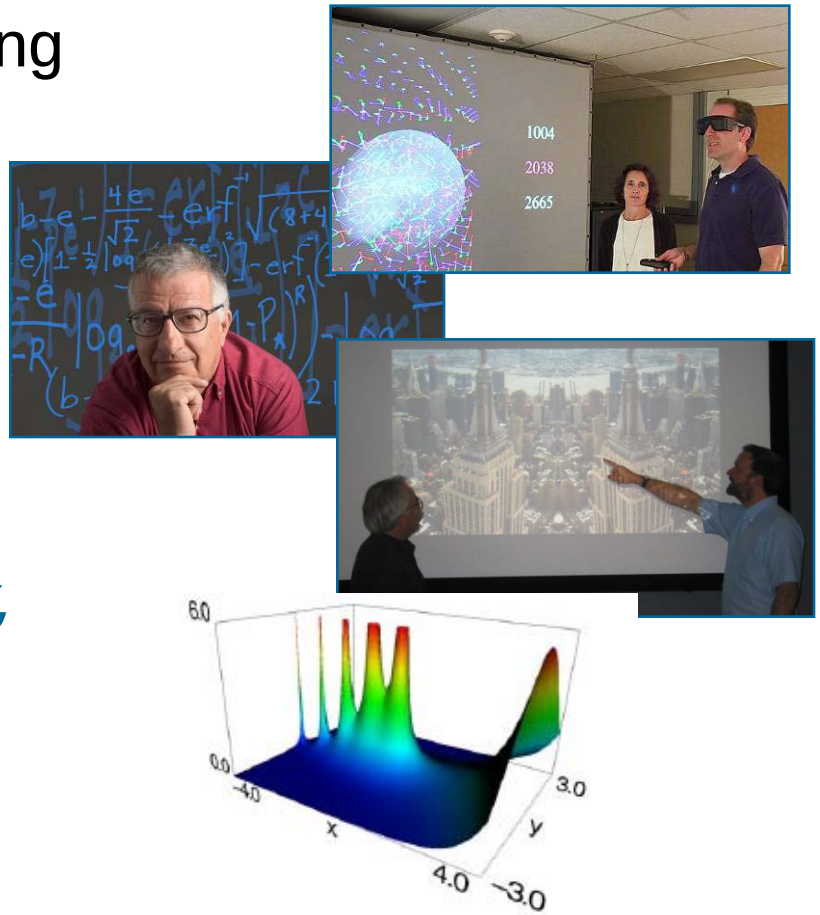
ITL Mission

To promote US innovation and industrial competitiveness by advancing

measurement science, standards, and technology

through research and development in

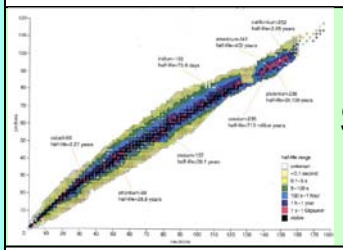
information technology, mathematics, and statistics.



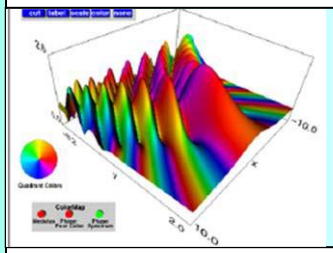
Core Competencies

Technology Development

IT Measurement and Testing



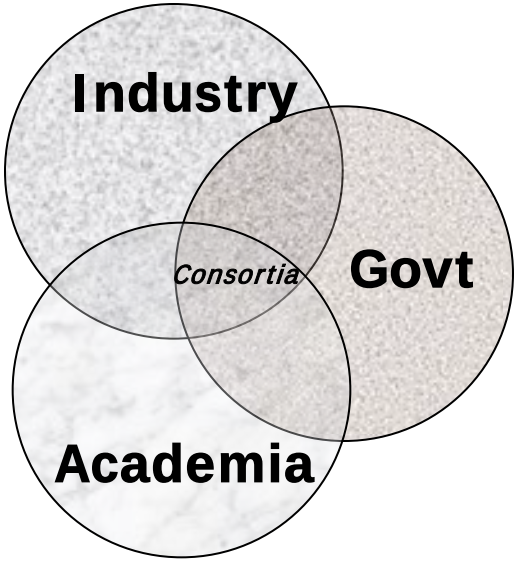
Mathematical and Statistical Analyses for Measurement Science



Modeling and Simulation for Measurement Science

IT Standards Development and Deployment

Customers

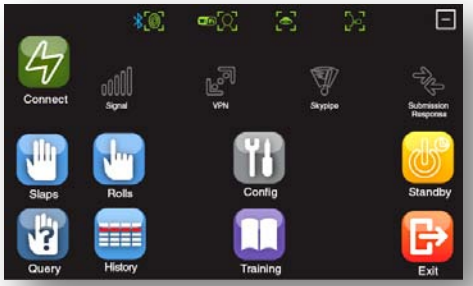


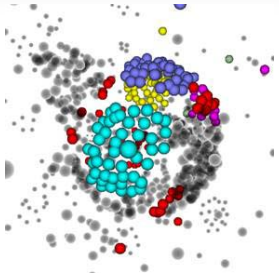
ITL Goals

- Accelerate the development and deployment of reliable, secure, usable, and interoperable information and communication systems.
- Catalyze the development of particular applications of national importance that have significant IT requirements.
- Enable world-class measurement and testing through innovations in mathematics, statistics, and computer science.

NIST addressing critical national needs – Infrastructural Technologies

- Software Quality
- Usability
- Foundations of Measurement Science for Information Systems
- Math Knowledge Management
- Statistics for Uncertainty
- Digital Data Preservation





SAMATE

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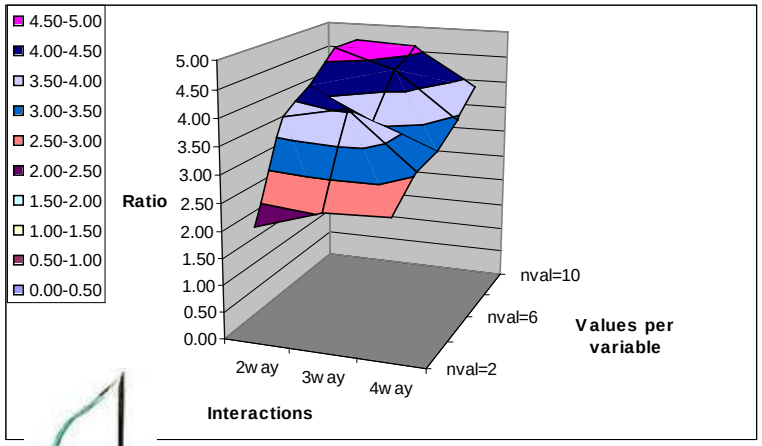
NIST addressing critical national needs – Software Quality

- Accelerate the development and adoption of correct, reliable, testable software, leading to increased trust and confidence in deployed software
  - Automated Combinatorial Testing for Software
  - Software Assurance Metrics
  - Static Analysis Tool Exposition
  - National Checklist Program



SAMATE

NIST Security Configuration CHECKLISTS http://checklists.nist.gov CSD

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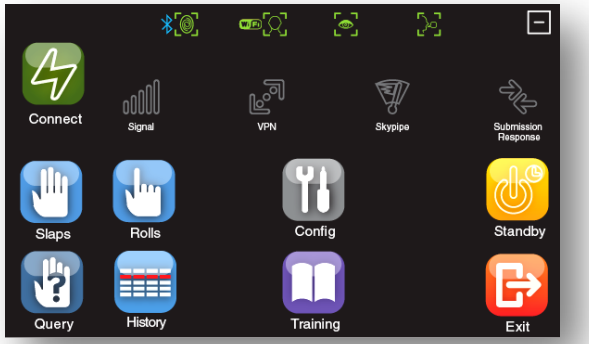
NIST addressing critical national needs – Usability

- User-centered research in human-system interaction by applying human factors scientific principles and methodologies to national priorities in the field of information technology
  - Usability Metrics & Measurements
  - Usability for Biometric Systems
  - Usability in Health IT
  - Usability and Accessibility of Voting Systems



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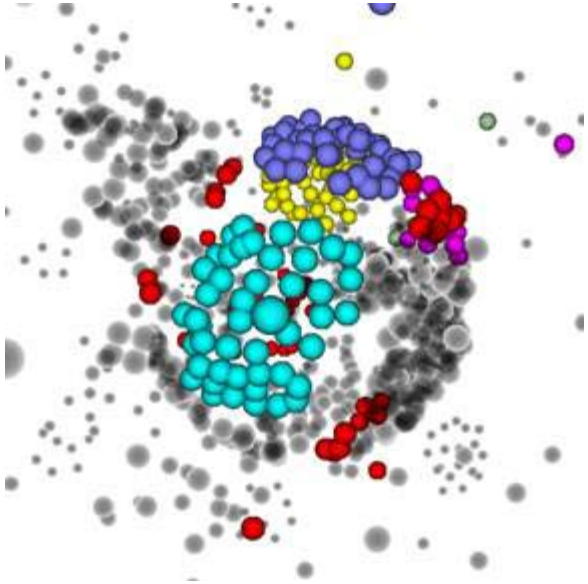
NIST addressing critical national needs – Foundations of Measurement Science for Information Systems

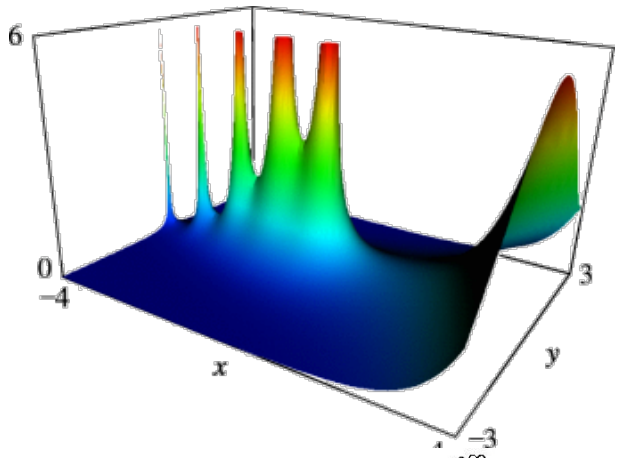
- Develop metrics for assessing critical properties of information systems that can be used to both design more reliable and secure systems, as well as to enable effective real-time control of deployed systems.
  - Macro-scale structure and dynamics of large-scale interconnected systems
  - Identify and characterize fundamental measurable properties of complex information systems that are indicators of the systems' inherent level of security and reliability
  - Complex Networks Data Sets



NIST addressing critical national needs – Math Knowledge Management

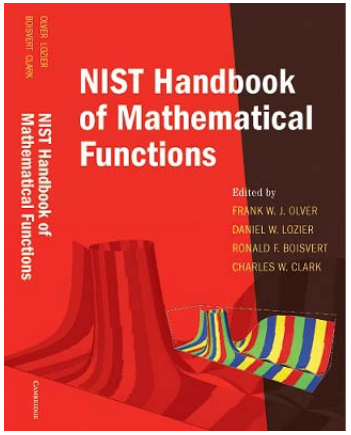
- Develop approaches, methods, algorithms, and prototype software tools for production of searchable math repositories with full semantics, and for upgrading existing math repositories to endow them with these same capabilities
  - Digital Library of Mathematical Functions
  - Math Metadata
  - Enhancing mathematical markup
  - Indexing of math content
  - Heuristic algorithms

  =>Techniques and tools for online math documents



$$\Gamma(z) = \int_0^\infty e^{-t} t^{z-1} dt,$$

$$\Gamma(z) = \lim_{k \to \infty} \frac{k!k^z}{z(z+1)\cdots(z+k)},$$



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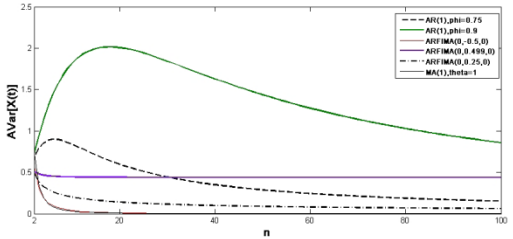
NIST addressing critical national needs – Statistics for Uncertainty

- Develop metrics for assessing critical properties of information systems that can be used to both design more reliable and secure systems, as well as to enable effective real-time control of deployed systems.
  - Best practices for the characterization of measurement uncertainty
  - Uncertainty Quantification in Scientific Computing
  - NIST/SEMATECH e-Handbook of Statistical Methods

ENGINEERING STATISTICS HANDBOOK



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NIST addressing critical national needs – Digital Data Preservation

- Develop, and analyze the effectiveness of basic metrology and standards to improve the reliability, interoperability, and quality of diverse, complex, robust, and resilient current and future archival systems.
  - Digital Preservation Roadmap and Interoperability Framework
  - Foundational Digital Data Preservation Standards
  - Preservation of Electronic Health Records

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NIST addressing critical national needs – Applications

- Healthcare
- Cyber Security
- Smart Grid
- BioImaging
- Voting Systems
- Computer Forensics
- Identity Management

NIST Addressing Critical National Needs
Healthcare

Standards for National Priority Critical Infrastructures: Health Information Technology

- Support progress toward a nationwide healthcare information infrastructure by
  - Developing and harmonizing usable standards for health IT technologies
  - Creating a health IT technology testing infrastructure

Biomedical Measurements to Support Disease Diagnosis and Treatment

- Develop the measurement science and reference materials to improve the accuracy, reproducibility, and efficacy of measurements used in medical diagnostics and imaging
- Develop the measurement science and standards to support manufacturing and regulatory approval of biologic drugs

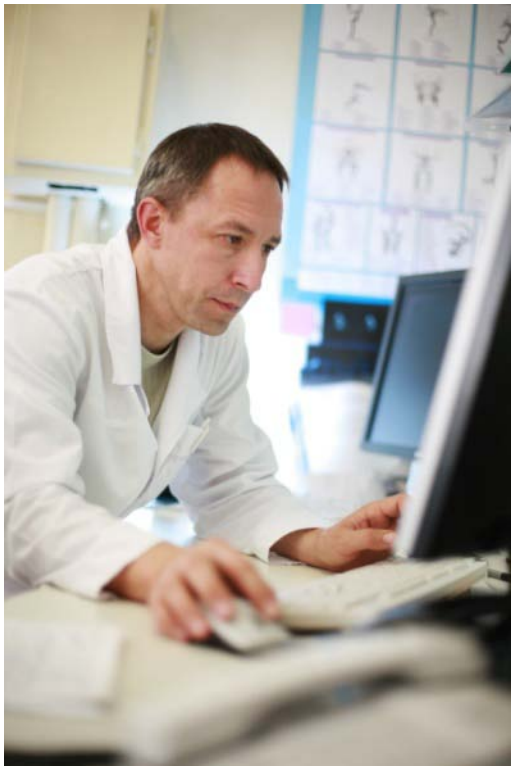
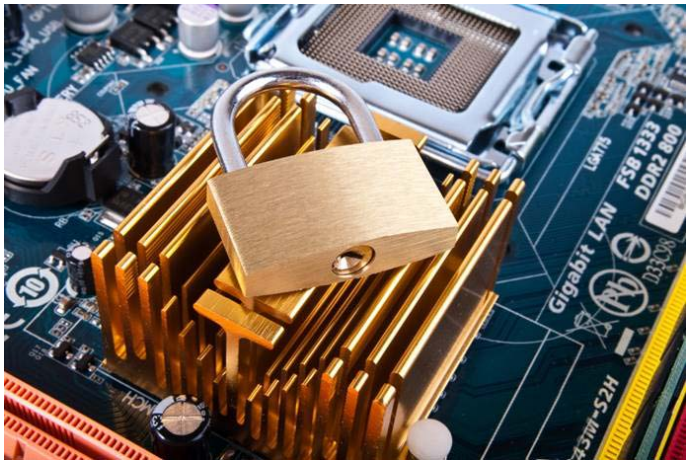


Image: Shutterstock, ©Konstantin Sutyagin

NIST addressing critical national needs – Cyber Security

- Scalable cybersecurity for emerging technologies and threats
  - Improved cryptographic capabilities
  - Stronger assurance of online user identities
  - Easier-to-use security mechanisms
  - Increased use of security automation technology
  - Security measurement for large-scale systems
  - Secure adoption of emerging virtual technologies
  - Critical infrastructure testbed development



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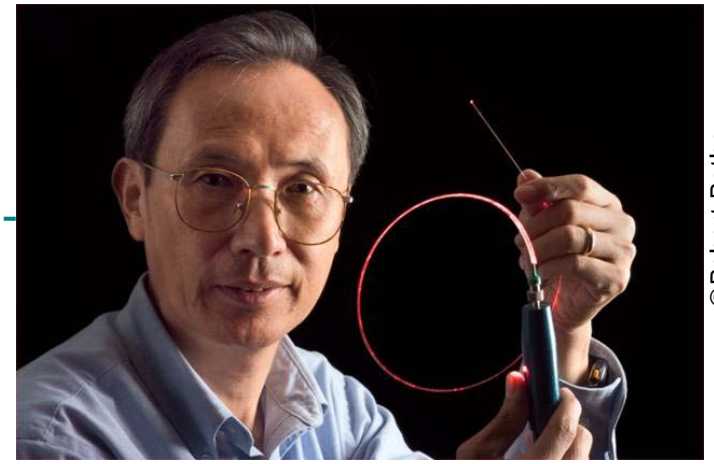

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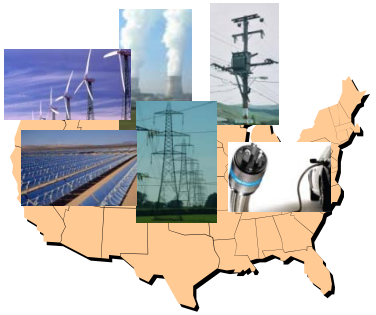
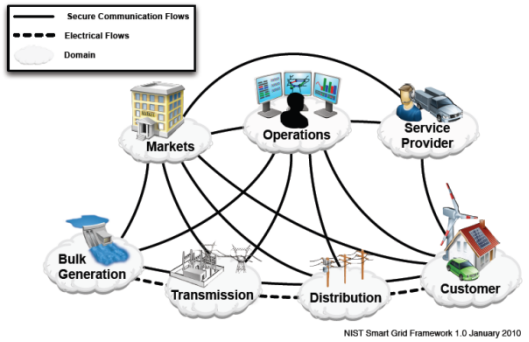
NIST addressing critical national needs – Smart Grid Interoperability

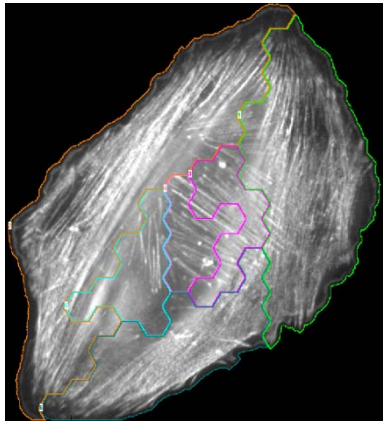
- Working collaboratively, develop a framework and measurement tools for interoperability of Smart Grid devices and systems.
  - Foundational Smart Grid Standards
  - Cyber Security for Smart Grid
  - Networking Standards for Smart Grid
  - Electric Power Metrology and the Smart Grid

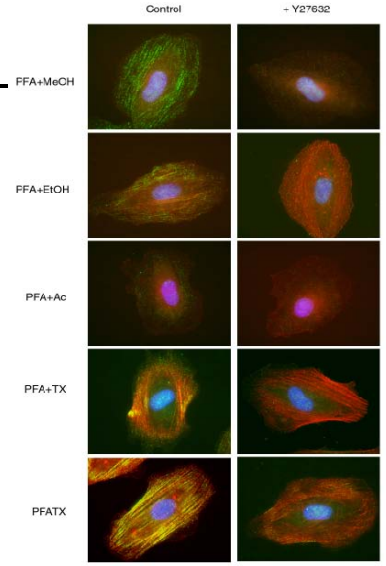


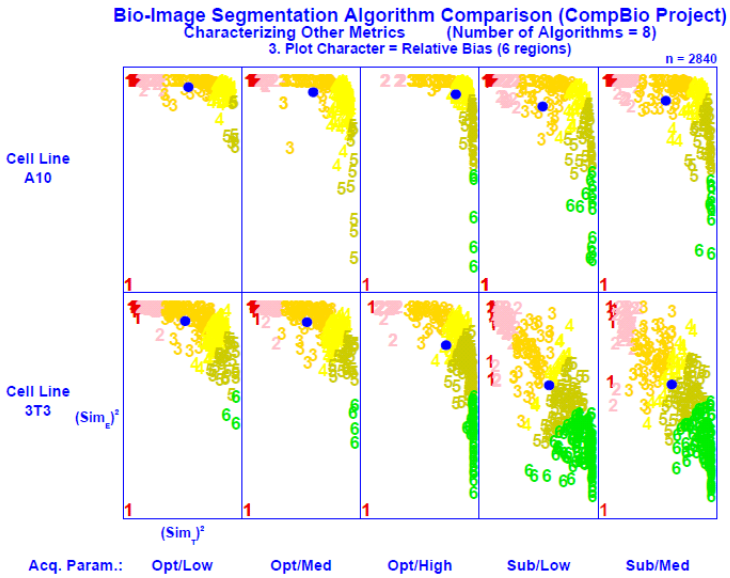


NIST addressing critical national needs – BioImaging

- Lead the development and rigorous evaluation of new computational approaches supporting multidisciplinary research, particularly at the convergence of bio- and information technologies.
  - Cell Segmentation
  - Live Cell Tracking
  - Subcellular Feature Extraction
  - Medical Imaging







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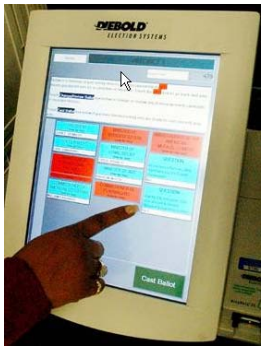
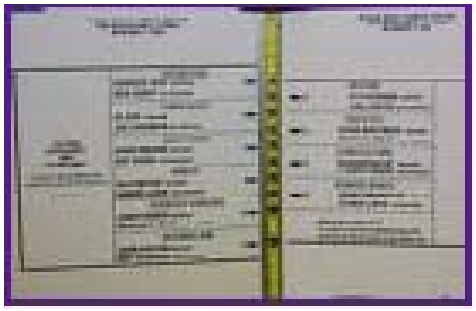
NIST addressing critical national needs – Voting Systems

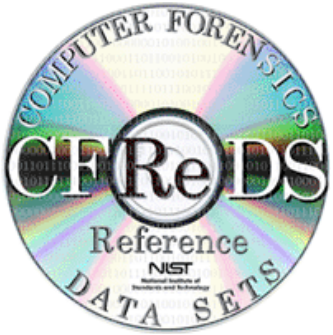
- Develop approaches, methods, algorithms, and prototype software tools for production of searchable math repositories with full semantics, and for upgrading existing math repositories to endow them with these same capabilities
  - Standards and Conformance Testing of Voting Systems
  - Usability and Accessibility of Voting Systems
  - Voting System Security





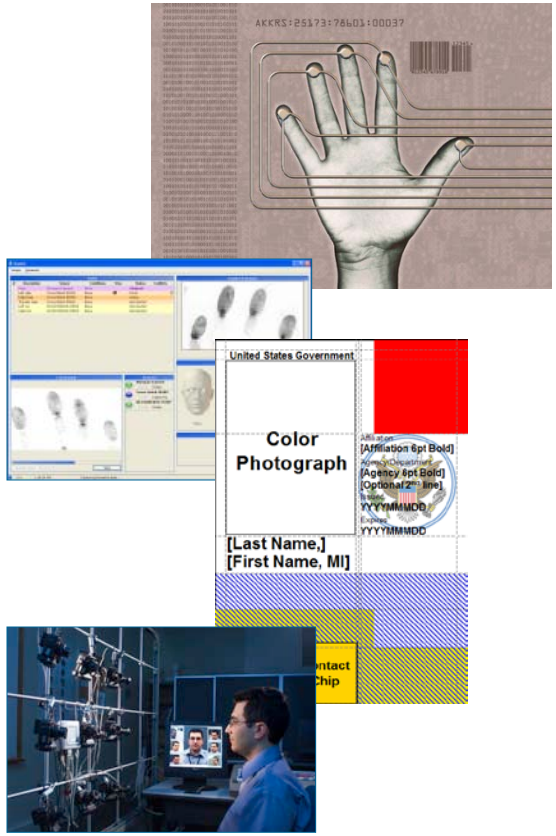
NIST addressing critical national needs – Computer Forensics

- Provide infrastructure necessary for automated processing in computer forensic investigations with scientific rigor necessary to support introduction of evidence
  - National Software Reference Library
  - Computer Forensics Tool Testing
  - Computer Forensics Tool Testing for Mobile Devices
  - Computer Forensics Reference Data Sets



NIST addressing critical national needs – Identity Management

- Advance Identity Management Systems technologies to ensure security, cost effectiveness and interoperability
  - Face & Iris Testing
  - Fingerprint Technology Testing for Identity Management
  - Identity Credential Interoperability
  - IDMS Research & Development
  - IDMS Standards Activities
  - Multimodal Biometrics
  - Research for Next Generation Biometric Measurements & Standards (NGBMS) for Identity Management
  - Usability of Biometric Systems

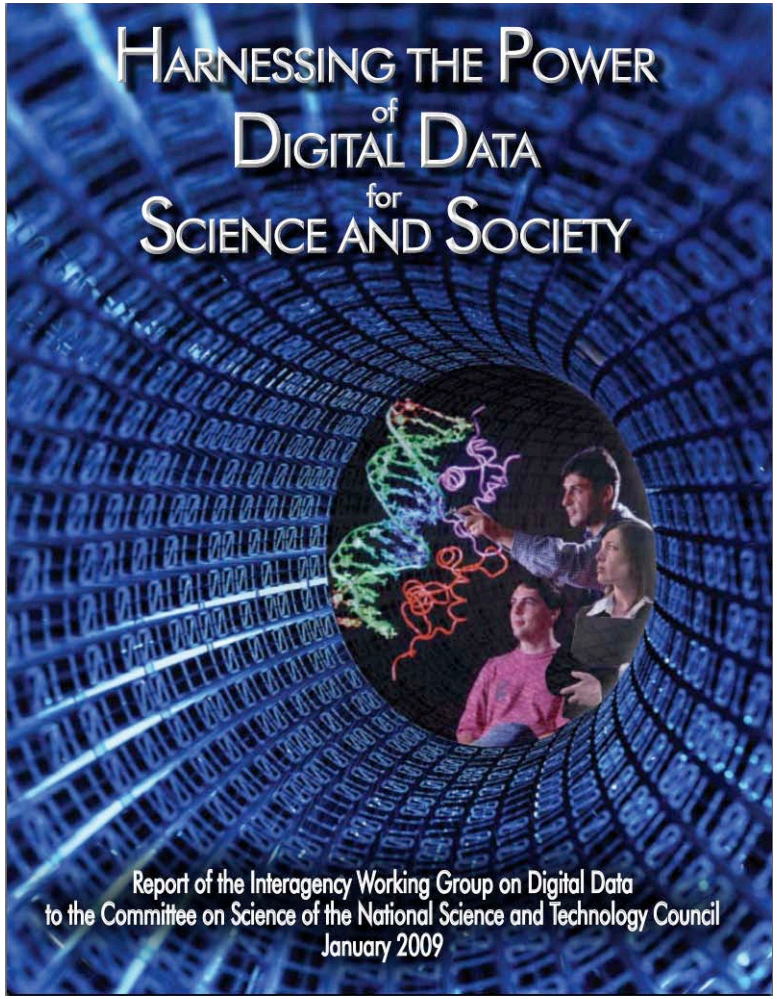


Interagency Working Group on Digital Data

- **22+** active participating agencies
- **CHARGE:** To *develop* and *promote* the implementation of a strategic plan for the Federal government to cultivate an *open interoperable framework* to ensure *reliable preservation* and *effective access* to digital data for research, development, and education in science, technology, and engineering.

IWGDD Report (January 2009)

http://www.nitrd.gov/About/Harnessing_Power.aspx



www.itl.nist.gov

Background material

Specific Mandates

- Biometrics
  - USA PATRIOT Act
  - Enhanced Border Security and Visa Entry Reform Act
  - Homeland Security Presidential Directive #12: Policy for a Common Identification Standard for Federal Employees and contractors
  - 10-Print Transition: mandated by Homeland Security Council Deputies Committee
  - National Security Presidential Directive/Homeland Security Presidential Directive (NSPD-59/ HSPD-24), Biometrics for Identification and Screening to Enhance National Security
- Cloud Computing
  - Federal CIO direction to NIST on cloud security and standards
- Cyber Security
  - National Security Presidential Directive 54 / Homeland Security Presidential Directive 23 (NSPD-54/HSPD-23): Comprehensive National Cybersecurity Initiative
  - Section 5131 of the Information Technology Management Reform Act of 1996 (Public Law 104-106) [supersedes Computer Security Act of 1987 (Public Law 100-235)]
  - Federal Information Security Management Act (FISMA) of 2002 (Title III of the E-Government Act), including Information Security and Privacy Advisory Board (ISPAB) mandate amended.
  - Computer Security Research and Development Act of 2002
  - Homeland Security Presidential Directive #12
  - Conference Report on House Resolution 5441, Department of Homeland Security Appropriations Act, 2007: Title V - General Provisions (WHTI Certification effort)
  - OMB M04-04 E-Authentication Guidance for Federal Agencies
  - Information Technology Management Reform Act of 1996, Public Law 104-106
  - OMB Circular A-130 and OMB Directive 05-24

Specific Mandates, continued

- DNSSEC
  - OMB mandate M-08-23
- Emergency Alert for wireless mobile devices
  - Warning, Alert, and Response Network Act
- Healthcare
  - American Recovery and Reinvestment Act of 2009
- Identity Management
  - National Strategy for Trusted Identities in Cyberspace
- Internet Protocol version 6 (IPv6)
  - OMB memo
  - OMB memo M-05-22 on Transition Planning for IPv6 (August 2, 2005)
- Smart Grid
  - Energy Independence Security Act (EISA) of 2007
  - American Recovery and Reinvestment Act of 2009
- Statistical methods for evaluating and expressing the uncertainty of NIST measurement results
  - NIST Administrative Manual Subchapter 4.09, Appendix E, 3b
- Voluntary Voting System Standards
  - Help America Vote Act

Program Portfolio

- National Priorities
  - Biometrics
  - Cloud Computing
  - Cyber Security
  - Domain Name System Security (DNSSec)
  - Health Information Technology
  - Identity Management
  - Internet Protocol Version 6 (IPv6)
  - Smartgrid
  - Statistics for Uncertainty (e.g., Gulf Oil Spill Response)
  - Voting Systems
- Emerging Technologies
  - Complex Systems
  - Pervasive Information Technology
  - Quantum Information
  - Virtual Measurement Systems
- Enabling Scientific Discovery
  - Digital Library of Mathematical Functions