NIST – Working with Industry To Accelerate Innovation

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Program Coordination Office
National Institute of Standards and Technology

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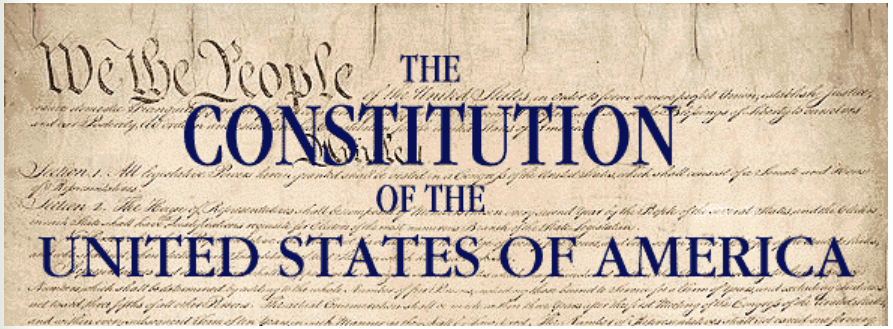
NIST Introduction and Background

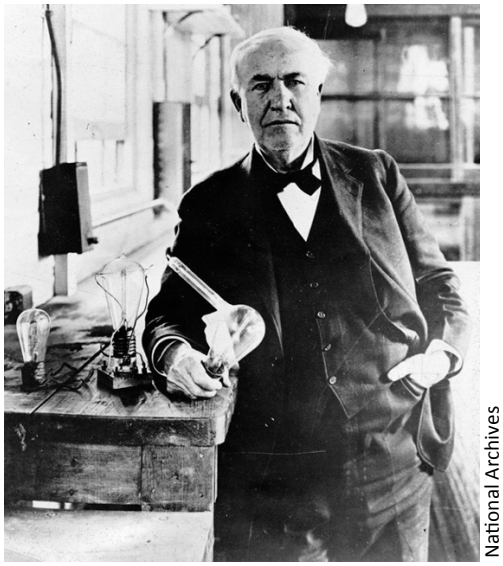
The Importance of Measurements and Standards



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'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.

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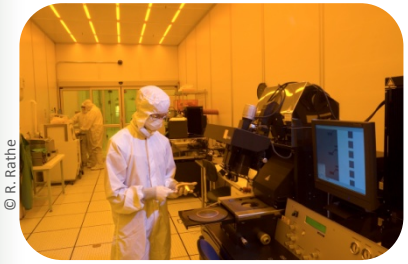
NIST Programs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NIST Laboratories

- Providing measurement solutions for industry and the nation


Texas Nameplate

Hollings Manufacturing Extension Partnership

- Nationwide network helping smaller manufacturers compete globally

Advanced Manufacturing Technology Consortia Program

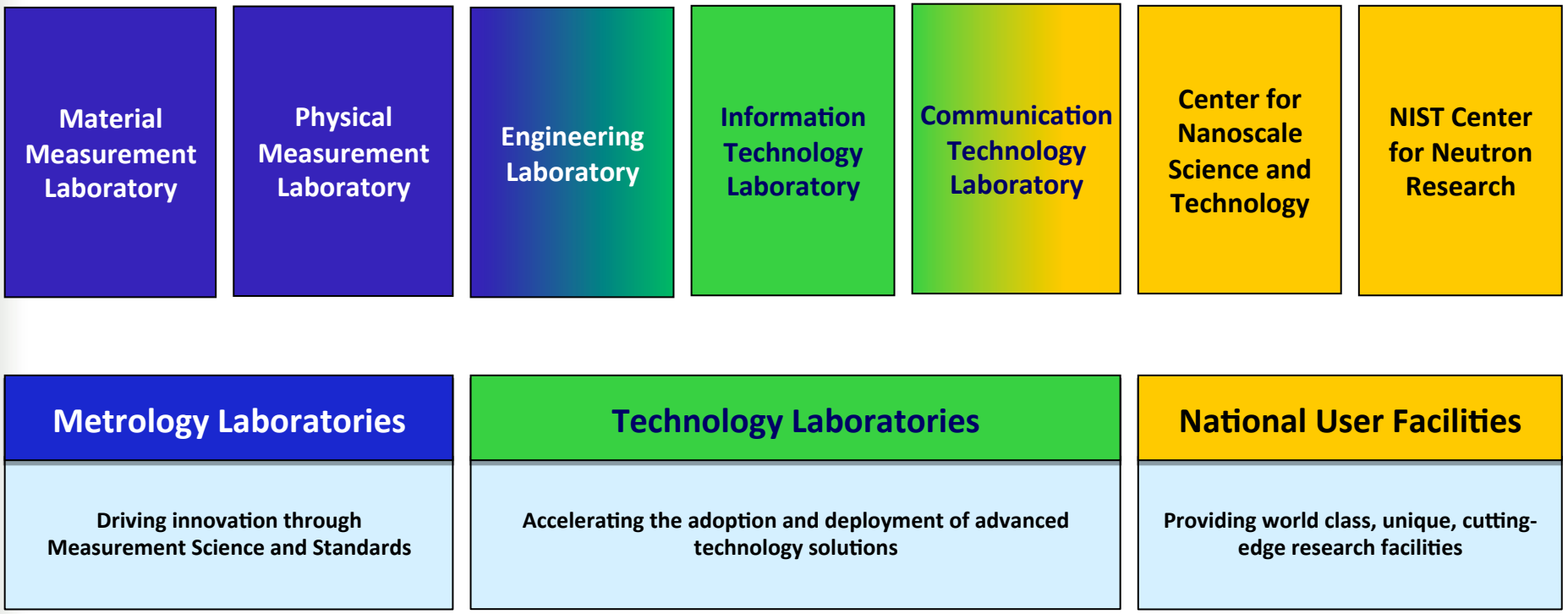
- Supporting industry-led consortia to develop common technological vision and accelerate innovation


Poudre

Baldrige Performance Excellence Program

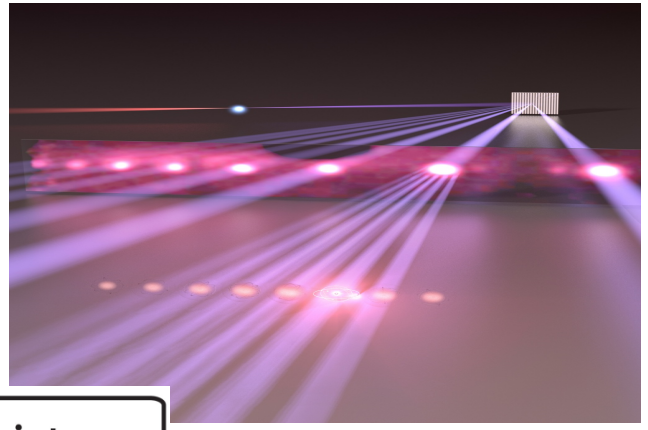
- Strengthening performance excellence in U.S. business

NIST Laboratories



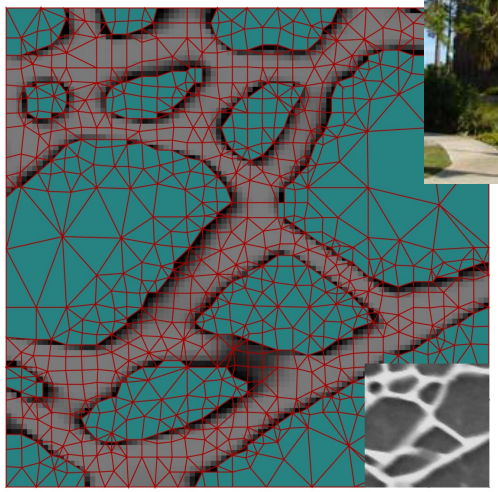
NIST Laboratory Programs – *Driving Innovation through Measurement*

- **The Material Measurement Laboratory** and the **Physical Measurement Laboratory** are responsible for NIST's metrology mission space
- **Core Functions Include:**
  - Maintenance of Fundamental Units
  - Applied measurements and dissemination of the SI
  - Quantum science and engineering
  - Calibrations
  - Characterization of material composition and properties
  - Production of validated methods and data
  - Development and dissemination of standard reference materials
  - Biotechnology and Healthcare measurements



Baxley/JILA

jqi Joint Quantum Institute



Langer/NIST

NIST Laboratory Programs – *Accelerating the adoption and deployment of advanced technology solutions*

- **ITL**, the **EL**, and **CTL** share responsibility for NIST's technology mission space
- **Core functions**
  - IT measurement, accreditation, and testing
  - Mathematical and statistical analysis
  - Modeling and simulation
  - Cybersecurity standards
  - Cloud computing
  - Identity management
  - Advanced manufacturing technolo and processes
  - Building technologies
  - Fire research
  - Smart grid and energy technologies
  - Advanced communications R&D
  - Spectrum sharing testing and evaluation

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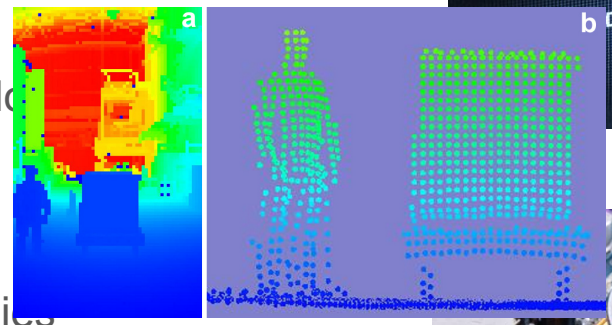
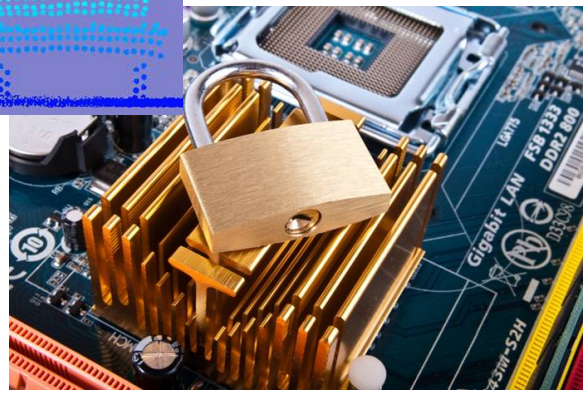


NIST



NIST Laboratory Programs – *World class, unique, cutting-edge research facilities*

The Center for Nanoscale Science and Technology (CNST) provides national access to world-class nanoscale measurement and fabrication methods and technology.

- Operates the rapid-access NanoFab
- Provides access to beyond state-of-the-art cutting-edge instrumentation \

The NIST Center for Neutron Research (NCNR) is a national resource for researchers from industry, university and other government agencies.

- Hosts more than 2,000 researchers annually

NIST Products and Services

Measurement Research

- ~ 2,200 publications per year

Standard Reference Data

- ~ 100 different types
- ~ 6,000 units sold per year
- ~ 25 million data downloads per year

© Robert Rathe

Standard Reference Materials

- ~ 1,300 products available
- ~ 33,000 units sold per year

Calibration Tests

- ~ 17,000 tests per year

Laboratory Accreditation

- ~ 800 accreditations of testing and calibration laboratories

Standards solutions for national priorities

Iadams/shutterstock

Smart grid

Johan_Swanepoel/shutterstock

Forensic science

Valerie_Potapova/shutterstock

Computer security

Kurhan/shutterstock

Health care

NIST Partners Include Industry, Academia, and Government

Industry

Agilent Technologies

IBM

Pfizer

intel

Dow

GM

Universities

University of Maryland

University of Colorado at Boulder

Penn — University of Pennsylvania

The University of Wisconsin Madison

Nonprofits

ASTM International — Standards Worldwide

USCAR

AdvaMed — Advanced Medical Technology

ITRS — International Technology Roadmap for Semiconductors

ADA

Government

NASA

NSF

National Institutes of Health

United States Environmental Protection Agency

Department of Defense — United States of America

Department of Justice

Homeland Security

Partnerships with Academia and Industry are Critical to the NIST Mission in Innovation

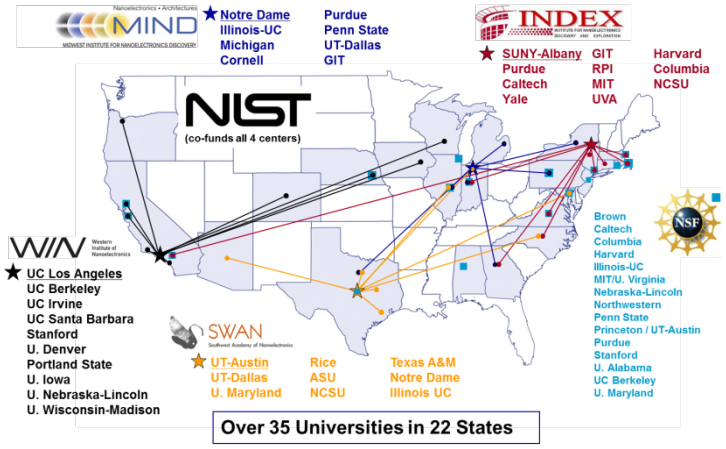
NIST – University Partnerships

Joint Quantum Institute

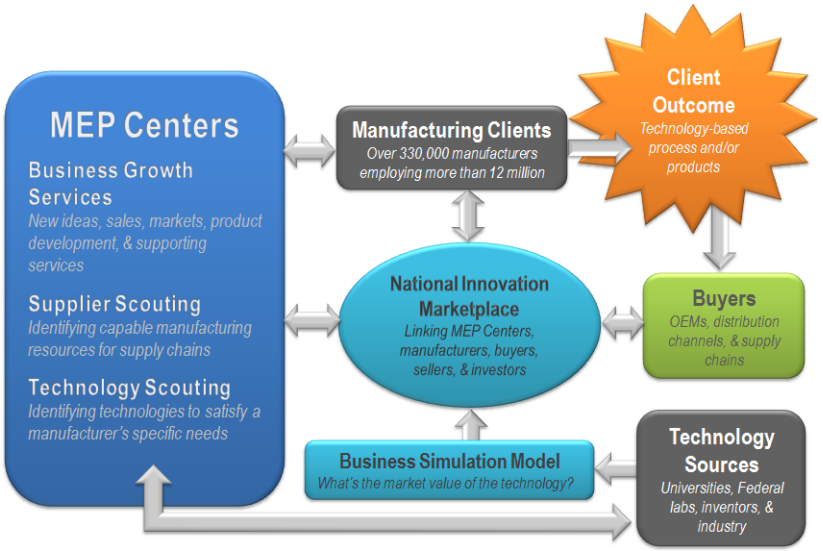
University of Maryland

Focus on quantum physics for information science and technology

Industry Driven Consortia

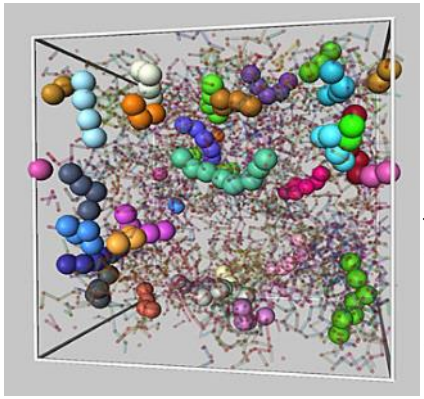


Manufacturing Extension Partnership

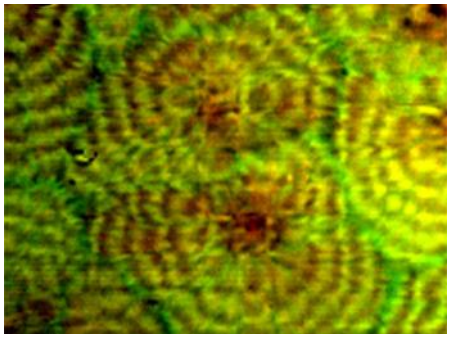


Program Update -- Center of Excellence on Advanced Materials

- RFP published June 27th, closed August 12th. NIST received many strong proposals
- Awarded to new Center for Hierarchical Materials Design (CHiMaD) Consortium lead by Northwestern
  - University of Chicago
  - Northwestern-Argonne Institute of Science and Engineering (partnership between Northwestern and DoE's Argonne National Lab)
  - The Computation Institute (partnership between University of Chicago and Argonne National Lab)
  - Fayetteville State
  - QuesTek
- $5 million NIST award with $4.65 million consortium contribution
- CHiMaD will focus on the discovery of novel hierarchical materials. Hierarchical materials exploit distinct structural details at various scales from the atomic on up to achieve special, enhanced properties.



Credit: Douglas/NIST



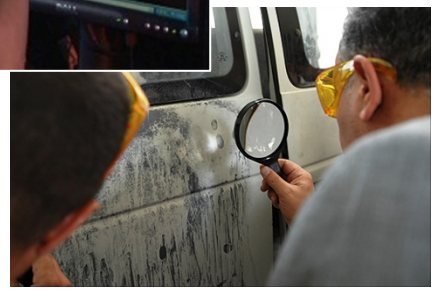
CHiMaD

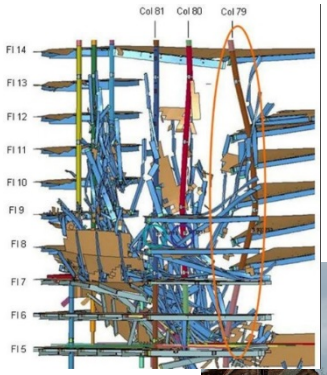
Program Update: NIST Centers of Excellence

NIST FY2014 appropriations include $8M to expand the Centers of Excellence program. We will establish new COEs in:

- **Disaster Resilience**
  - Develop integrated, systems-based computational models to assess community infrastructure resilience and guide community-level resilience investment decisions
  - Received strong response (closed Sept. 12, 2014)
  - Expect to make award in early 2015
- **Forensic Science**
  - Develop probabilistic methods to support the forensic science disciplines, focusing Pattern Evidence and Digital Evidence
  - Proposals due by December 13, 2014

Credit: NIST





Jace Anderson/FEMA

NIST Priorities

NIST Plays Key Roles in National Priorities

Advanced Manufacturing

- Precision Measurements
- Bio and Nanomanufacturing
- Smart Manufacturing
- Advanced Materials

Cybersecurity

Research in cryptography, privacy, biometrics

Advanced Communications

Enabling spectrum sharing and the development of next generation communications systems

Health Care and Bioscience

Measurement tools that will support multiplex analysis of proteins, genetic material, and metabolites.

Forensic Science

Enabling greater transparency and rigor in forensic evidence use

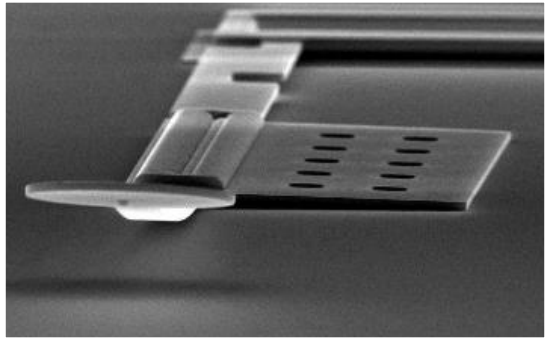
Climate Change and Clean Energy

Enabling sustainable and resilient buildings and communities

Advanced Manufacturing

Measurements, Standards, and Data for:

- Biomanufacturing
- Nanomanufacturing
- Sustainable Manufacturing
- Additive Manufacturing
- Robotics
- Smart Manufacturing



Example -- Uncertainties in Additive Manufacturing

Powder + **Process** = **Part**

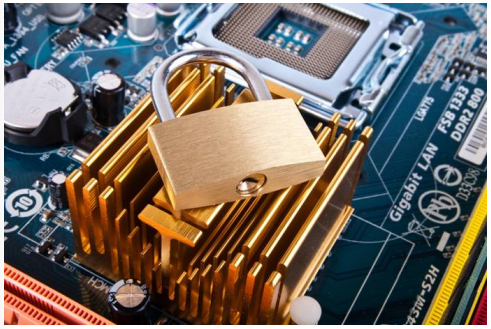
Uncertainties in the Input Materials

Uncertainties in Equipment and Process Performance

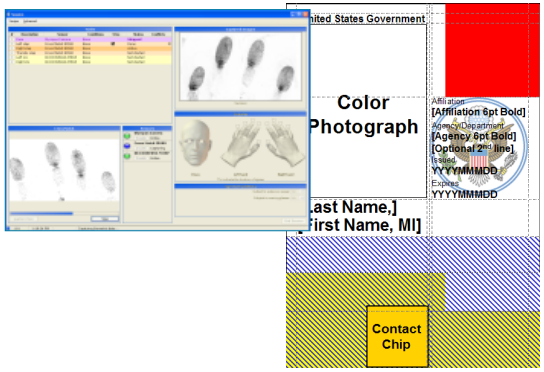
Uncertainties in the Final Parts

Measurement Science and Standards
Drive Innovation and Reduce Risk of Adoption

Cybersecurity



Validated over 3200 cryptographic modules used in weapon systems to everyday consumer electronics



Over 4 million secure credentials issued to federal employees and contractors are based on NIST standards

Major Activities

- Improving Cybersecurity infrastructure security and efficiency
  - Network security, biometrics, product assurance, metrics, cryptography, usability
  - Improved physical and logical access to government resources
- Supporting national priorities and stakeholders
  - Secure on-line transactions, health IT, smart-grid, voting
  - Federal agencies, CIO council, industry
- Cybersecurity research and standards
  - Leader in advancing stronger, hacker-resistant cryptography standards
  - Global harmonization through promotion of NIST standards with formal standards organizations

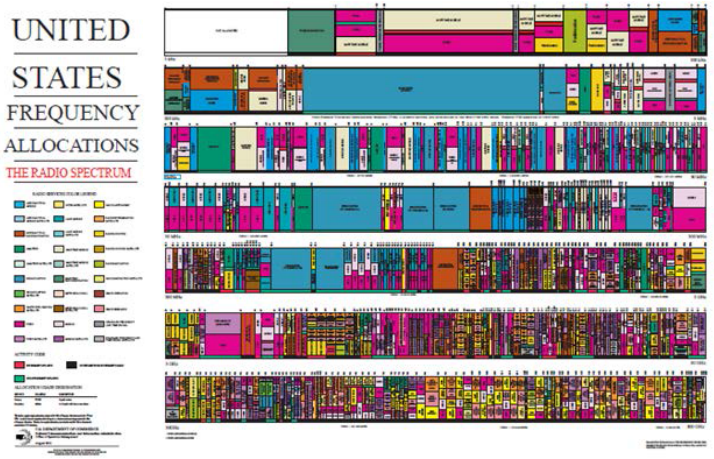
Advanced Communications

Through the development of appropriate measurements and standards:

1. Enable robust, mission-critical, interoperable **public safety communications**
2. Enable effective and efficient **spectrum use and sharing**
    - Center for Advanced Communications
    - National Advanced Spectrum and Communications Test Network (NASCTN)
3. Enable **advanced communications technologies**

PSCR

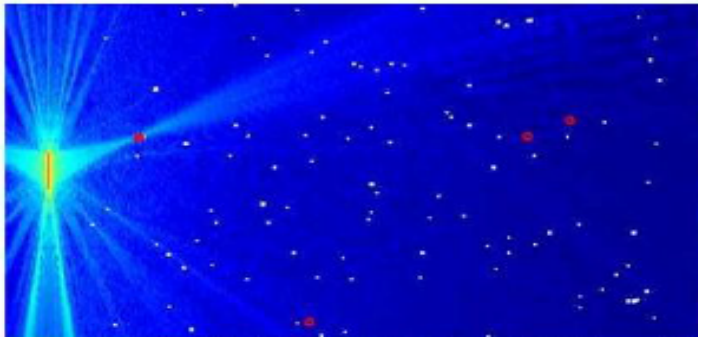
FirstNet™



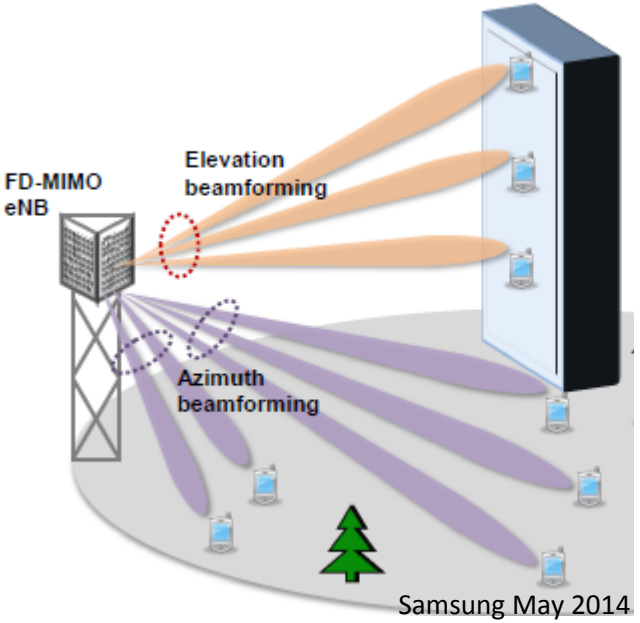
Example of Advanced Communications Technology R&D

Massive MIMO (multiple input multiple output) antennas

A key 5G technology for throughput



200 antenna MIMO simulation



- Requires entirely new antenna characterization methods

- Compare: Current LTE MIMO is 2x2; CTIA OTA test uses 8 transmitter cluster
  - Long calibration and test time (8 channels)
  - Test zone limited to ~0.7λ (small for M2M devices?)
  - Limited "sampling": 8 angles, azimuthal only
  - Uncertainties unknown; Test plan is not final
  - *Not scalable to 20, 50, or more antennas!*

Healthcare and the biosciences

Health IT

- Standards for EHRs, conformance testing

Clinical Diagnostics

- **Cholesterol, vitamin D, toxins, etc.**

Medical Imaging and Radiotherapy

- **Radiation, MRIs**

Vaccines

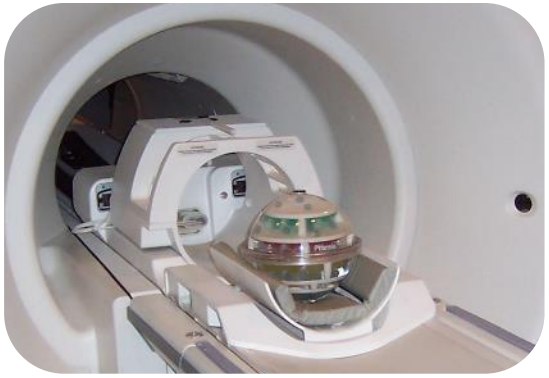
- **Storage, preservation, quality**

Disease assays

- Cellular imaging, single cell assay systems

Medical Technologies

- Bioreactors, tissue scaffolds, therapeutic nanoparticles



Forensic Science

NIST Forensic Science Research

DNA

- Reference Materials
- DNA mixture inter-laboratory studies

Ballistics

- Congruent Matching Cells
- Standard Bullets

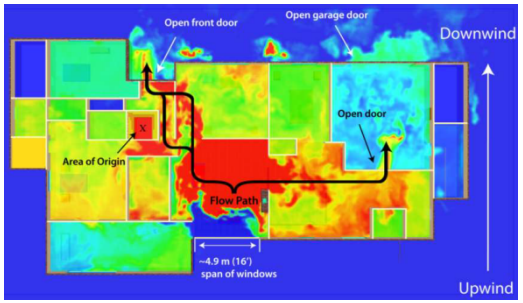
IT

- Databases
- Fingerprint matching

Statistical Methods

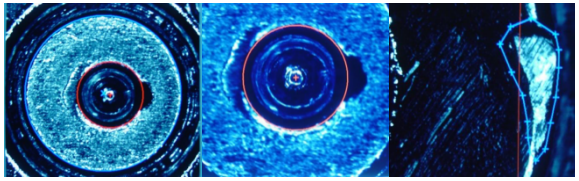
- Probabilistics
- Uncertainty assessment

Credit: DHS



Credit: Adam Barowy/NIST

Credit: Michael Indovina/NIST



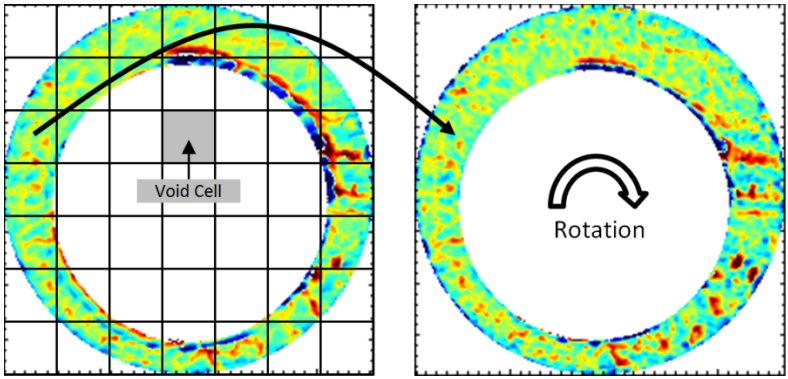
Credit: Theodore Vorbuger/NIST

Example Forensics R&D -- Congruent Matching Cells

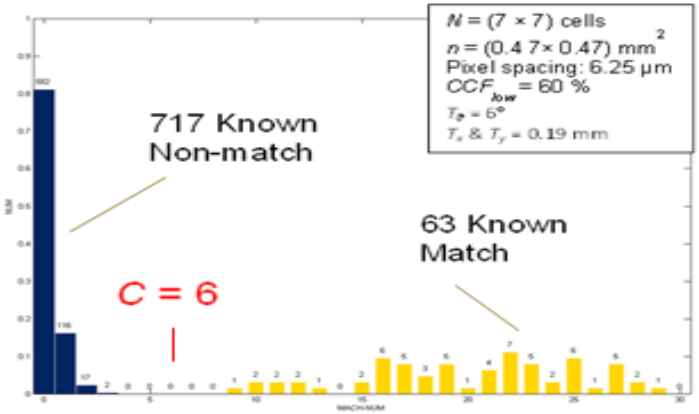
The newly developed Congruent Matching Cell (CMC) method relies on objective measurements and correlations that in turn facilitate error rate analyses for ballistics identifications.

The CMC method separates the ballistic surface into discrete cells that must exceed four similarity thresholds. Each pair of correlated surfaces require at least 6 CMCs to qualify as a match.

The CMC method has now been applied in a realistic blind validation study and was able to correctly identify all cartridge cases.



Example image (left) is divided into correlation cells. Each cell is scanned over the reference image (right) at each rotated position.

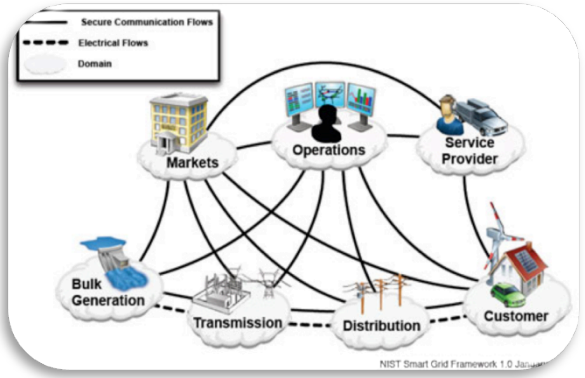


Example error rate analysis using the known matching and known non-matching distributions.

Climate Change and Energy

Fundamental Research -- NIST is accelerating the development and manufacture of next generation materials for thin-film and organic solar cells.

Technology Demonstartion – NIST's Net-Zero test facility will collect data on energy efficient construction methods and accelerate incorporation of energy saving technologies in to new construction



Interoperability – NIST's support for the development of technical standards is essential for the secure and efficient operation of a 21st Century power grid.

NIST Impacts from Lab to Market

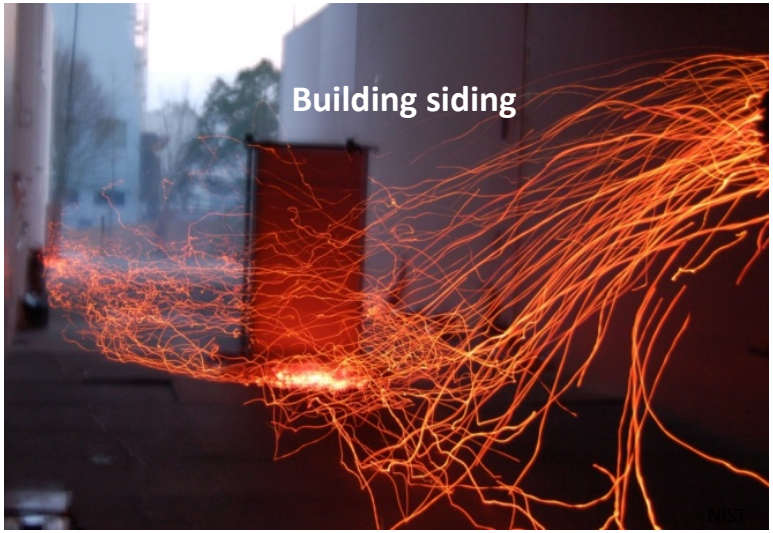
Example -- Hardening Vulnerable Building and Community Elements

Using laboratory tests to translate field study findings to standard test methods

- Ember generation
- Material performance

NIST

NIST



NIST

Program Update -- National Cybersecurity Center of Excellence (NCCoE)

- On Sept 23rd, NIST awarded FFRDC contract to MITRE, a not-for-profit company that operates multiple FFRDCs for DOD and FAA.
- MITRE has existing expertise in cybersecurity, as well as systems engineering and advanced technologies
- First task orders include:
  - Use Case Development and Implementation ($6M over 2 years)
  - Building Block Development and Demonstration ($5.5M over 2 years)
  - Operations Management and Facilities Planning Support ($17.6M over 5 years)

NCCoE
NATIONAL CYBERSECURITY CENTER OF EXCELLENCE

MITRE

Summary: NIST Programs and Services

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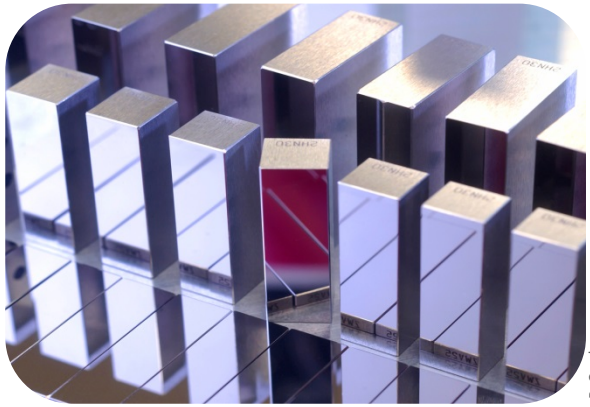
Facilitate trade and fair commerce

D. Stork/shutterstock.com

Improve public safety and security

06photo

Advance manufacturing and services



B. Gardner

Improve quality, ensures uniformity