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Cyber-Physical Systems: NIST Role and Current Programs

*Workshop on Developing Dependable
and Secure Automotive Cyber-Physical
Systems from Components*

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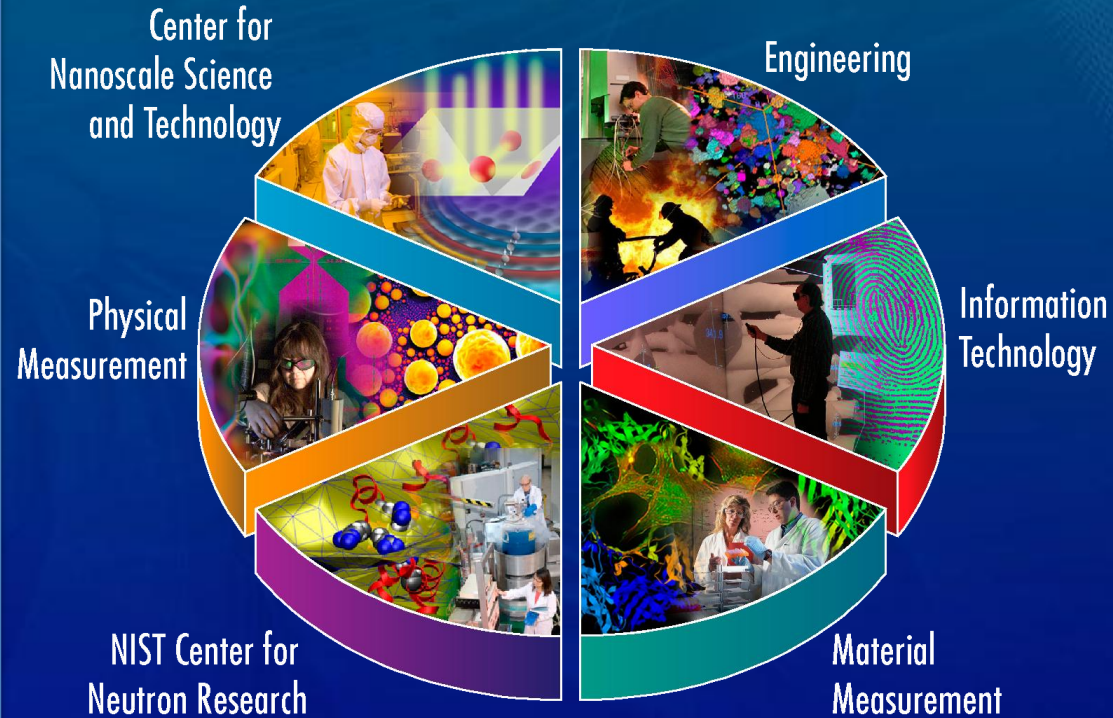
The NIST Laboratories

NIST's work enables

- Advancing manufacturing and services
- Helping ensure fair trade
- Improving public safety and security
- Improving quality of life

NIST works with

- Industry
- Academia
- Other agencies
- Government agencies
- Measurement laboratories
- Standards organizations



Providing measurement solutions for industry and the Nation



Engineering Laboratory Mission

To promote U.S. *innovation* and *industrial competitiveness* in areas of critical national priority **by anticipating and meeting the:**

- **measurement science and**
- **standards**

needs for technology-intensive manufacturing, construction, and cyber-physical systems in ways that enhance *economic prosperity* and improve the *quality of life*.



Scope of Measurement Science

Measurement science research and services include:

- development of performance metrics, measurement and testing methods, predictive modeling and simulation tools, knowledge modeling, protocols, technical data, and reference materials and artifacts
- conduct of inter-comparison studies and calibrations
- evaluation of technologies, systems, and practices, including uncertainty analysis
- development of the technical basis for standards, codes, and practices—in many instances via testbeds, consortia, standards and codes development organizations, and/or other partnerships with industry and academia



Why NIST Interest in CPS?

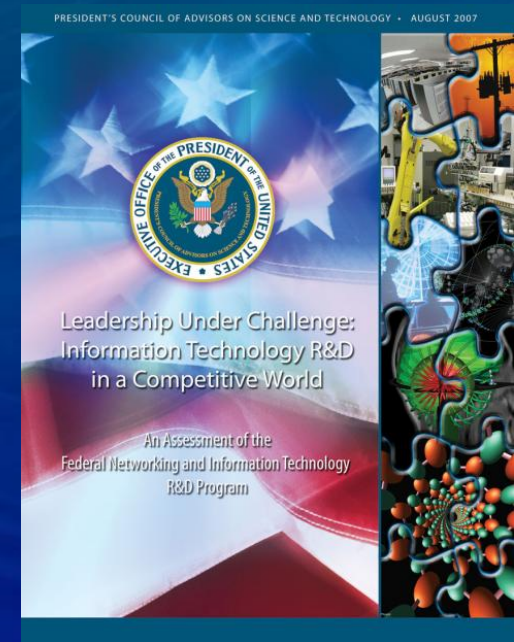
- Cyber core and connectivity of products, processes, and systems has become key driver of performance and customer value, life-cycle costs, and R&D investment and innovation
- Framework of principles, methods, tools, evaluation techniques, and standards for predictable, cost-effective engineering of cyber-physical systems is lacking—*creating technical barriers to innovation, competitiveness, and the mission effectiveness of government agencies*
- Increasing number of NIST activities involve CPS in some way



Unique NIST Mission Focus: Measurements and Standards

Increasing role in CPS

- Develop, document, and disseminate research-based standards for engineering CPS to function dependably in their environment, with necessary assurances of reliability, safety, security, and usability
- Establish a scientific basis, codified knowledge base, and shared principles for designing, building, certifying, and operating CPS



EL Strategic Goals

Measurement Science and Standards for:

- Smart Manufacturing, Construction, and Cyber-Physical Systems
- Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure
- Disaster-Resilient Buildings, Infrastructure, and Communities



NIST Activities That Involve CPS

Performance metrics, test/measurement methods, standards, and tools for:

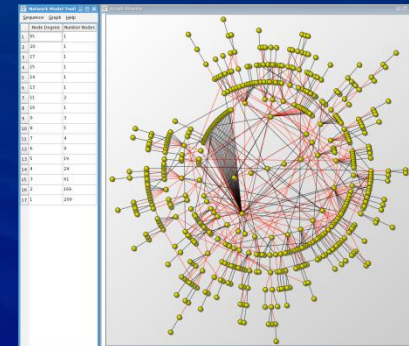
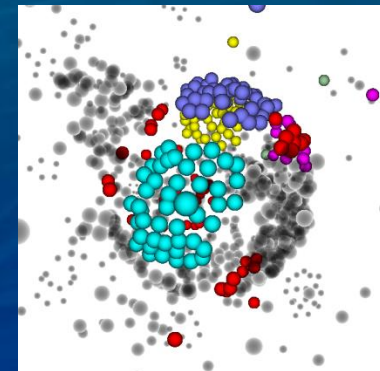
- Smart Grid Interoperability
 - NIST Framework and Roadmap for Smart Grid Interoperability Standards
 - Smart Grid Interoperability Panel
 - Smart Grid Cyber Security Strategy
- Smart Manufacturing, Construction, and Cyber-Physical Systems
 - Next-Generation Manufacturing Robotics
 - Industrial Control System Security and Network Standards
 - Performance Metrics and Standards for US&R and Bomb Disposal Robots
- Zero Net Energy, High Performance Buildings
 - Embedded Intelligence in Buildings; Virtual Cybernetic Testbed
- Pervasive Information Technologies
 - Semantic Interoperability of Medical Devices
 - Implant Communications in Body Area Networks
 - Smart Autonomous Sensors and Environments



NIST Activities That Impact CPS

Performance metrics,
test/measurement methods,
standards, and tools for:

- Complex Systems
- Cyber and Network Security
- Identity Management Systems
- Trustworthy Information Systems
- Information Discovery, Use and Sharing



NIST ITL Complex
Systems Program Images
www.nist.gov/itl/cxs



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EL Programs Aligned with EL Strategic Goals

- **Smart Manufacturing, Construction, and Cyber-Physical Systems**
 - Smart Manufacturing Processes and Equipment
 - Next-Generation Robotics and Automation
 - Smart Manufacturing and Construction Systems
 - Systems Integration for Manufacturing and Construction Applications
- **Sustainable and Energy-Efficient Manufacturing, Materials, and Infrastructure**
 - Sustainable Manufacturing
 - Sustainable, High-Performance Infrastructure Materials
 - Net-Zero Energy, High-Performance Buildings
 - Embedded Intelligence in Buildings
- **Disaster-Resilient Buildings, Infrastructure, and Communities**
 - Fire Risk Reduction in Communities
 - Fire Risk Reduction in Buildings
 - Earthquake Risk Reduction in Buildings and Infrastructure
 - Structural Performance Under Multi-Hazards

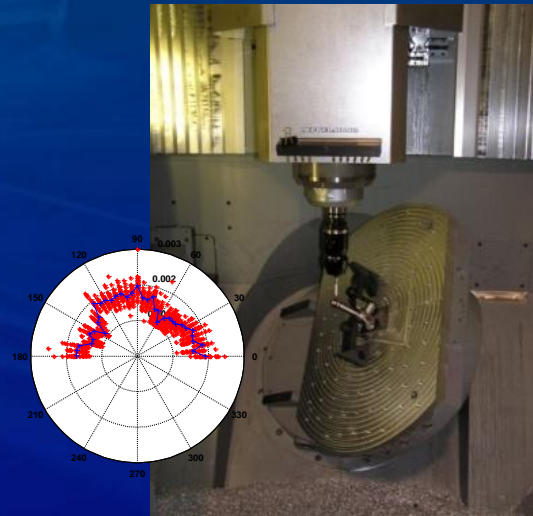
Our programs are identified, developed, carried out, the results implemented, and consequences measured in partnership with key customer organizations.



Smart Manufacturing Processes and Equipment Program

Objective: To develop and deploy advances in measurement science that will enable rapid and cost-effective production of innovative, complex products through advanced manufacturing processes and equipment

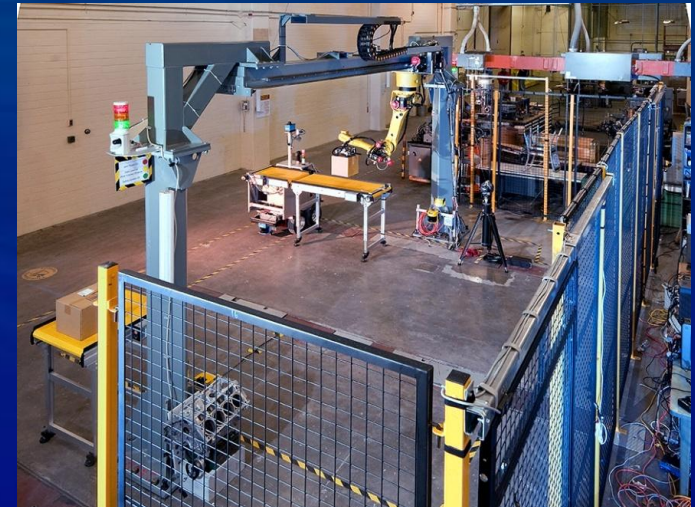
- **Additive Manufacturing Measurement Science** – helping users best apply metal-based additive manufacturing systems for agile manufacture of innovative complex, custom products, through ASTM F42 standards
- **Machine Tool Performance Standards** – reducing risks for purchasers of high-tech machine tools needed to produce high value-added products, through development of ISO 230 and ISO 10791 standards for machine tool performance
- **Machining Process Models** – enabling enhanced machining productivity and longer tooling life through new machining process and material measurement methods that improve models and simulations used to design and optimize manufacturing processes



Next Generation Robotics and Automation Program

Objective: To develop and deploy advances in measurement science to safely increase the versatility, autonomy, and rapid re-tasking of intelligent robots and automation technologies for smart manufacturing, construction, and cyber-physical systems applications

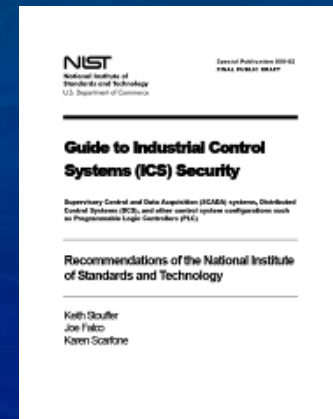
- **Next Generation Robot Safety:** enabling intelligent manufacturing equipment that is agile, responsive, robust, and able to work safely in collaboration with humans
- **Industrial Vehicle Safety** – enabling improved safety and manufacturing efficiencies through safety standards and test methods that allow non-contact obstacle sensors to be used on industrial vehicles such as automated guided vehicles and forklifts



Smart Manufacturing and Construction Systems Program

Objective: To develop and deploy advances in measurement science to enable real-time monitoring, control, and performance optimization of smart manufacturing and construction systems at the factory or site

- **Manufacturing Equipment Communications** – enabling efficiencies and cost savings through validation and pilot implementations that accelerate deployment of the MTConnect standard for communicating real-time factory floor information
- **Dimensional Measuring Equipment Standards** – enabling seamless product quality measurements and manufacturing cost and time savings, through test methods that certify conformance to the Dimensional Measuring Interface Standard (DMIS)



Systems Integration for Manufacturing and Construction Applications Program

Objective: To develop and deploy advances in measurement science for integration of engineering information systems used in complex manufacturing and construction networks to improve product and process performance

- **Manufacturing Information Models and Information Exchange Standards**
 - Validating critical standards to make sure they will work
 - Measuring the quality of information and data models
 - Translating data between disparate systems
 - Ensuring long-term access to data

