

Testimony of

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An Overview of the Fiscal Year 2016 Budget
for the
National Institute of Standards and Technology

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Chairwoman Comstock, Ranking Member Lipinski, and members of the Subcommittee, thank you for the opportunity to appear before you today to present the President's Fiscal Year (FY) 2016 budget request for the Department of Commerce's National Institute of Standards and Technology (NIST). This budget reflects the important role that NIST plays in addressing our Nation's top scientific and technical challenges. In releasing the budget, the President said he wanted to ensure that we *"invest in America's future and commit to an economy that rewards hard work, generates rising incomes, and allows everyone to share in the prosperity of a growing America."* The FY2016 request for NIST will contribute to a more competitive and prosperous America through investments that help secure cyberspace, revolutionize communications, strengthen U.S. manufacturing, and make our communities smarter and more resilient.

The President has proposed a fiscal year budget for NIST of \$1.1 billion. This is \$255.8 million above the FY 2015 enacted level

This budget request will support U.S. manufacturers both large and small, aid our communities in recovering from disasters, and improve the ways we connect to the world around us—from online banking transactions to using technology to efficiently manage the smart grid and health care systems. These funds will support NIST's work to foster innovation that creates jobs and strengthens the U.S. economy.

The largest portion of the requested increase, \$194 million, focuses on U.S. based manufacturing, including support for the National Network for Manufacturing Innovation (NNMI). The NNMI is envisioned to be a geographically diverse set of regional research hubs coordinated by NIST to accelerate development and adoption of cutting edge manufacturing technologies. The request seeks \$150 million to allow NIST to establish two new openly competed institutes that address manufacturing needs identified by industry. The funds requested for NIST are part of a larger \$350 million request across multiple agencies that will bring the total number of manufacturing institutes to sixteen.

Scientific and Technical Research Account Initiatives (+\$79.2M)

The NIST Laboratories are at the core of our mission. Our researchers conduct world-class research, often in close collaboration with industry that advances the nation's technology infrastructure and helps U.S. companies continually improve products and services. The FY 16 budget request of \$754.7 million, which is a \$79.2 million increase above FY 2015, makes the investments begun in FY 2008 to grow NIST's scientific capacity supporting manufacturing, advancing cybersecurity of critical infrastructure and the digital economy, and helping us to remain at the forefront of measurement science and technology research and development.

Ensuring a World Class Neutron Facility (+11.0M)

One of NIST's top priorities this year is ensuring the continued operation and availability to users in industry and academia of one of the world's foremost neutron research facilities.

The budget proposes an increase of \$11.0 million to ensure that NIST continues to provide a world-class neutron research facility and provide access to sophisticated measurement tools that can be used by industry. NIST is requesting funds for reactor facility enhancements in three areas in order to maintain the high availability and reliability of the source for the NIST Center for Neutron Research (NCNR) users: fuel manufacturing and shipping, primary cooling system upgrades, and heavy water replacement.

Neutrons have been enormously successful as a unique probe of the structure and dynamics of materials for researchers from many different backgrounds, including academia and industry. NCNR will maintain and grow its high quality facility to address the neutron supply-demand mismatch by investing in a lifetime extension of the source facility to maintain reliable operations and high availability to the end users.

NCNR is the only U.S. facility with a focus on enhancing industrial competitiveness. It is therefore essential to U.S. industry, and the long-term economic growth of the U.S., that the NCNR is optimally equipped to provide state-of-the-art measurement tools to the U.S. scientific and engineering community. The NCNR operates 24 hours a day, seven days a week for approximately 250 days of the year to support experiments by over 2,000 research participants annually. It is critical that the research reactor operates safely and reliably in order to support the NCNR mission to develop and provide advanced neutron measurement techniques and instrumentation for research.

Enhancing Cryptographic Capabilities and Privacy Technologies (+7M)

Cybersecurity remains one of the most pressing challenges facing our nation today, and the FY2016 request will continue to strengthen NIST's capabilities in this important area. Specifically, NIST requests an increase of \$7.0 million to strengthen the Nation's cybersecurity posture by providing strong cryptographic solutions and the development of privacy enhancing solutions and tools.

\$5.0 million of the \$7.0 million increase is aimed at ensuring the continued delivery of robust and independent cryptography capabilities. NIST must increase both its cadre of Federal cryptographers and its access to top academic talent and begin to build the quantum resistant public-key architectures and systems, which will take more than 15 years to fully develop and deploy.

The remaining \$2.0 million would fund development of privacy-enhancing technologies and architectures based on commercially available products that provide privacy protecting capabilities that are easy to use, design, and deploy by system users and developers.

In addition to the obvious financial ramifications with nearly \$262 billion of e-commerce transactions in the U.S. alone for 2013¹, interconnected networks of computers have become essential for critical functions that affect every aspect of our lives including air traffic control, factory operation, and electrical power distribution.

The annual cost to the global economy from cybercrime is estimated at more than \$445 billion², including both the gains to criminals and the costs to companies for recovery and defense. Investments in cybersecurity and the development of privacy tools are critical to prevent further expansion in the gap between attackers' capabilities and defenders' ability to prevent attacks from succeeding and limit the impact of those attacks that do succeed.

Quantum-Based Sensors and Measurements (+\$5M)

NIST requests an increase of \$5 million to develop and deploy cutting edge quantum-based measurement capabilities and quantum standards necessary to maintain U.S. leadership in quantum information science. NIST research will be targeted to engineer quantum systems for improved sensing and better and/or cheaper quantum standards.

The program will create, develop, and characterize robust and efficient hybrid quantum systems that enable efficient transformation of quantum information from one modality to another; develop tools for understanding, manipulating, controlling and measuring complex quantum systems; and to develop and explore quantum materials for future advanced quantum devices.

Quantum information science is an emerging research field that will revolutionize everything from computation and communications, to the development of precision measurement technologies. This field seeks to harness the fundamental laws of physics to dramatically improve information acquisition, transmission, and processing. Improvements in both basic and applied quantum information science have far-reaching industrial applications, national security implications, and economic benefits.

Measurement Science for Advanced Manufacturing Initiatives (+\$24M)

Strengthening measurement science R&D across the NIST labs that directly impacts manufacturing continues to be a top priority for NIST. As noted by the President's Council of Advisors on Science and Technology, "the United States' (U.S.) leadership in manufacturing comes from its leadership in advanced technologies and the innovation that fuels their discovery and adoption. Sustaining U.S. competitiveness in manufacturing is thus, ultimately, an exercise in staying at the forefront of new technologies and continually breaking boundaries in both what and how it can be manufactured." NIST has partnered with the U.S. manufacturing sector for more than a century, providing the measurement tools and other essential technical assistance that existing manufacturers and aspiring start-ups need. NIST continues to help manufacturers invent, innovate, and produce new products and services more rapidly and more efficiently than their competitors around the world.

¹ Forrester Research, Inc.'s February 4, "Market Overview: eCommerce Fraud Management Solutions, 2014.

² <http://www.mcafee.com/us/resources/reports/rp-economic-impact-cybercrime2.pdf>

NIST is requesting increases in the following areas:

» **ADVANCED SENSING FOR MANUFACTURING (+\$5M)**

NIST requests an increase of \$5 million to support sensing and measurement gaps in the areas of advanced sensors used for process control in manufacturing.

A highly integrated effort across NIST laboratories in measurement science and standards will accelerate the design, development, and manufacturability of advanced electronic and photonic devices -those that require new concepts, architectures, materials, and manufacturing methods.

The NIST laboratories have a long tradition of developing and delivering measurement science tools that support advanced manufacturing technologies. NIST will leverage its existing capabilities in materials modeling and simulation, in support of the Administration's Materials Genome Initiative, as well as expertise in nanomanufacturing, digital design, chip-scale measurement technologies, robotics, additive manufacturing, and cyber physical systems.

» **MATERIALS GENOME INITIATIVE (MGI) (+\$10M)**

The proposed \$10 million increase for the Materials Genome Initiative (MGI) provides the resources to accelerate NIST's progress in its key role in the MGI, an interagency effort to dramatically influence the pace for bringing new materials to market. NIST is already working to develop an advanced materials innovation infrastructure, including data assessment and validation, data standards, and modeling and simulation tools. This increase is necessary to enable NIST to meet the ambitious timelines demanded by industry and other stakeholders to provide this interoperability and accessibility of materials information. By leveraging resources and partnerships, NIST will assist U.S. manufacturers in achieving materials-by-design for high-tech products in a range of industrial sectors.

The proposed increase in funding will enable NIST to accelerate the development of a materials data infrastructure. New measurement science and standards developed based on the availability of this infrastructure will enable industrial researchers to effectively discover the data and models they need, assess the quality of these data and models, and use these data and models to maximum effect.

» **ENGINEERING PRINCIPLES FOR EFFICIENT BIOMANUFACTURING (+\$4.0M)**

NIST requests an increase of \$4.0 million to ensure quality and predictability in the design of synthetic biological systems for efficient production of fuels, chemicals, pharmaceuticals, and medical therapies. Maintaining a strong investment in forward-looking basic research is a critical component to maintaining the technical infrastructure required in innovation-intensive economies. Biomanufacturing has the potential to usher in the next Industrial Revolution into many U.S. manufacturing sectors. However, for biomanufacturing to reach a sustainable maturity in all sectors, there are three main hurdles that need to be overcome: reducing the risk of contamination; maintaining high productivity and efficiency, and;

reducing product variability among different manufacturing runs. Creating a more reliable, even predictable biomanufacturing process would address all the technological hurdles and help to reduce the uncertainty that currently hampers the regulatory process, most immediately for biologics.

This initiative addresses the technical challenges faced by the biomanufacturing industry by developing a suite of quantitative methods for accurate measurement of biological systems, creating the necessary tools to methodically design and test engineered organisms, and, by engaging relevant stakeholders, develop and evaluate predictive models.

» **MANUFACTURING ENTREPRENEURSHIP (+\$5M)**

To support innovation in the marketplace NIST has developed the NIST Manufacturing Entrepreneurship initiative, which will strengthen the U.S. manufacturing sector by reducing barriers that prevent new entrepreneurs from entering the manufacturing marketplace. NIST has the potential to foster and expand upon the early growth in manufacturing entrepreneurship by providing infrastructure needed to promote knowledge transfer among the “maker” community, and facilitate new models of collaboration between entrepreneurs, commercial manufacturers, and government agencies.

This initiative will provide access to manufacturing knowledge that increases the value and variety of what manufacturing entrepreneurs can design and manufacture and will provide a robust manufacturing eco-system that provides full support for new manufacturing entrepreneurs.

Advanced Communications (+\$9M)

The availability of secure, reliable, high-speed wireless communications is essential for the United States' future economic health and security. Businesses and consumers are becoming increasingly dependent on wireless devices that require reliable, fast and secure access to broadband data as well as voice and video services. The proliferation of wireless connections, numbered at 7 billion in 2013, is estimated to grow to over 10 billion by 2018³ placing a strain on the already congested frequency spectrum that is allocated to mobile wireless networks.

With the requested \$9 million, NIST will focus its efforts on research that supports industry to develop and deploy advanced communication technologies for both the existing and future frequency spectrum bands allocated for wireless communication systems. In addition, this initiative would focus on improving spectrum efficiency and spectrum sharing by developing performance metrics, measurement methods and tools and their successful implementation in a test and evaluation environment, as well as facilitating R&D of innovative spectrum sharing technologies and expedite product development.

³ 2013 Cisco VNI Mobile Forecast.

Finally, the initiative would fund the development of communications systems that operate at the recently-released millimeter-wave portions of the frequency spectrum that are well above the current cell-phone bands.

Disaster Resilience (+10M)

Preventing hazard events from becoming debilitating disasters requires resilient buildings and infrastructure. The development of improved building codes will first require a robust capability to predict the effects of hazards on the performance of complex structural systems, including: data to characterize the hazard, validated physics-based models to predict performance, metrics for measuring performance, acceptance criteria for differing levels of performance objectives, and mitigation strategies based on performance evaluation.

NIST requests \$10 million to develop the scientific basis to enable technology innovations, improve prediction capabilities, and improve codes and standards for cost-effectively reducing loss of life and property damage due to natural and man-made hazards.

Smart Cities and Cyber-Physical Systems (+\$5.0M)

NIST requests an increase of \$5 million to develop and accelerate the adoption and use of measurement science foundations that enhance innovation in smart city technologies and increase the market size for and accessibility to markets for U.S. industry. Facing rapid population growth, inefficient and aging infrastructures, and the needs of an increasingly digital society, communities across the Nation and around the world look to harness the power of emerging cyber physical systems and technologies to improve livability, workability, resilience, and sustainability by addressing their core challenges, including traffic congestion, public safety, and inadequate infrastructure.

The requested funds will fund development of the measurement science foundations for cities and commercial technology innovators to design and develop interoperable platforms that reliably and demonstrably leverage sensor-driven data for improved results; enable solutions that meet today's needs while evolving to accommodate new technologies and expanded requirements in the future. Further, it would fund development of standards and guidelines for interoperability, Smart City test beds for science-based design, and the development of IT building blocks for Smart City solutions to enable Smart City systems that can be protected against cyber threats; protect the privacy of residents while ensuring they can benefit from Smart City services and resources; and provide for reliable systems that function under stress or crisis situations.

Lab-to-Market/Technology Transfer (+\$4M)

Improving technology transfer from Federal R&D continues to be a top priority for the Administration. NIST requests an increase of \$4 million to expand lab-to-market and technology transfer activities through the development and deployment of data sharing and collaboration tools and services. The U.S. invests more than \$135 billion annually in research and development and a wide range of life-changing commercial technologies such as the Internet, to the Global Positioning System (GPS) to leading edge vaccines were nurtured by such

federally funded R&D in the past. Now we need to accelerate the transfer of federally funded R&D to U.S. businesses.

Industrial Technology Services (ITS) (+\$168M)

NIST's Industrial Technology Services (ITS) appropriation supports its external partnership programs that are designed to enhance American innovation and global competitiveness through partnerships with State and local organizations. The FY 16 request of \$306 million, an increase of \$168 million above the FY15 enacted, for the ITS appropriation consists of three programs: the National Network for Manufacturing Innovation (NNMI), the Hollings Manufacturing Extension Partnership (MEP), and the Advanced Manufacturing Technology Consortia program (AMTech).

National Network for Manufacturing Innovation (NNMI) (+150M)

The top priority for the Department and Administration in the FY 2016 request is the \$150 million to establish two new manufacturing institutes and conduct coordination activities related to the NNMI.

This initiative is part of a multi-agency effort to bring the National Network for Manufacturing Innovation (NNMI) to a total of 45 institutes, with discretionary funds requested in FY16 to launch or continue support a total of 16 institutes across the Departments of Energy, Defense, Agriculture, and Commerce. The \$150M requested for NIST is critical as it will support the creation of 2 openly competed institutes that specifically address advanced manufacturing needs generated by industry that fit outside the missions of our Federal partners. Ensuring that the U.S. has the technical infrastructure to support and attract a robust and vibrant domestic civilian focused manufacturing base, in addition to a strong defense manufacturing base, is a primary goal of the NNMI program. NNMI institutes will facilitate the adoption of new manufacturing technologies, tools, and methodologies that will make U.S. manufacturers more competitive.

Hollings Manufacturing Extension Partnership (MEP) (+\$11M)

The requested increase will focus on a recompetition of Centers in the MEP system. Through this process, MEP will take into account variations in the number of small and medium manufacturing firms in a region to ensure that Centers are adequately equipped and funded to address the needs of their manufacturing communities. In addition, MEP will disseminate the results and lessons learned from its pilot programs to build on efforts supporting industry collaboration through Business-2-Business networks; continue to support its partnership with the Department of Energy (DOE) and the Environmental Protection Agency (EPA) to focus on implementing sustainable manufacturing business practices; work with manufacturing firms to innovate and increase business opportunities to address new markets and to expand into overseas markets and identify manufacturers with current or future capabilities to address the procurement opportunities of the Federal government and original equipment manufacturers.

Advanced Manufacturing Technology Consortia (AMTech) (+\$6.9M)

For FY 2016, NIST requests an increase of \$6.9 million for the Advanced Manufacturing Technology Consortia. AMTech establishes industry-led consortia, which will identify and prioritize research projects supporting long-term industrial research needs. AMTech creates the incentive for multiple industry stakeholders to share financial and scientific resources, together with state and local government interests, as well as technical innovators at universities and government laboratories.

This year NIST will make planning awards to existing or established consortia for consortium enhancement and technology roadmap development. NIST will support and continually monitor newly established research consortia to track outputs and progress.

Construction of Research Facilities (CRF) (+8.7M)

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet its mission. State-of-the-art facilities are essential to supporting the world-class research conducted at NIST. The Construction of Research Facilities (CRF) appropriation supports both new construction and renovation efforts of NIST's physical plant and infrastructure at its two research campuses. The request for CRF of \$59 million would enable NIST to fund the next phase of planned multiyear critical renovations in our laboratories in Boulder, Colorado. The major construction projects funded through this request are:

- \$3 million for the renovation of Boulder Campus Building 3 to support existing and expanding Boulder research functions; and
- \$12 million for concept development, design documentation and initial relocation efforts associated with the renovation of Wing 5 of Boulder Building 1, an Eisenhower Administration-era building that is woefully out of date for the type and level of research conducted in Boulder.

Summary

In conclusion, the FY 2016 NIST budget request reflects the Administration's recognition of the important role that NIST plays in innovation, as well as the impact that the research and services NIST provides can have on laying the foundation for long-term job creation and prosperity.

NIST will continue its mission to work with the private sector to ensure U.S. manufacturers have the research support they need. The NIST laboratory programs, along with its outreach efforts and standards development work, are dedicated to providing U.S. industry with the tools needed to innovate, compete and flourish in today's fierce global economy.

I look forward to working with you, Madam Chairwoman and members of the Subcommittee, and would be happy to answer any questions.

Dr. Willie E. May



Dr. Willie E. May is currently serving as the Acting Director of the National Institute of Standards and Technology (NIST). He also serves as Acting Under Secretary of Commerce for Standards and Technology, a new position created in the America COMPETES Reauthorization Act of 2010. Prior to this assignment, Dr. May served as Associate Director for Laboratory Programs, where he was responsible for oversight and direction of NIST's seven laboratory programs and served as the principal deputy to the NIST Director.

As Acting NIST Director, Dr. May provides high-level oversight and direction for NIST. The agency promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology. NIST's FY 2014 resources total \$850.0 million indirect appropriations, an estimated \$47.3 million in

service fees, and \$107.0 million from other agencies. The agency employs about 3,000 scientists, engineers, technicians, support staff, and administrative personnel at two main locations in Gaithersburg, Md., and Boulder, Colo. NIST also hosts about 2,700 associates from academia, industry, and other government agencies, who collaborate with NIST staff and access user facilities. In addition, NIST partners with more than 1,300 manufacturing specialists and staff at more than 400 MEP service locations around the country.

Other National and International Responsibilities: Dr. May has several leadership responsibilities in addition to those at NIST. He is Vice President of the 18-person International Committee on Weights and Measures (CIPM), President of the CIPM's Consultative Committee on Metrology in Chemistry and Biology; Executive Board Member for the Joint Committee on Traceability in Laboratory Medicine; Board of Visitors for the University of Maryland College Park's College of Computer, Mathematical, and Natural Sciences.

Honors and Awards: Department of Commerce Bronze Medal Award, 1981; National Bureau of Standards (NBS) Equal Employment Opportunity (EEO) Award, 1982; Department of Commerce Silver Medal Award, 1985; Arthur Flemming Award for Outstanding Federal Service, 1986; NOBCChE Percy Julian Award for Outstanding Research in Organic Analytical Chemistry and Presidential Rank Award of Meritorious Federal Executive, 1992; Department of Commerce Gold Medal, 1992; American Chemical Society Distinguished Service in the Advancement of Analytical Chemistry Award, 2001; Keynote Speaker for the 2002 Winter Commencement Ceremonies, University of Maryland, College of Life Sciences; Council for Chemical Research Diversity Award, the NOBCChE Henry Hill Award for exemplary work and leadership in the field of chemistry, Science Spectrum Magazine Emerald Award in 2005, the 2007 Alumnus of the Year Award from the College of Chemical and Life Sciences at the University of Maryland, member of first class of inductees into the Knoxville College Alumni Hall of Fame in 2010 and Fellow of the American Chemical Society in 2011; Honorary Doctor of Science and Speaker at Graduate School of Arts and Sciences Commencement Exercises, Wake Forest University in 2012.

Employment History:

Worked as a senior analyst at the Oak Ridge Gaseous Diffusion Plant for three years prior to coming to the National Bureau of Standards in 1971. Led research activities in analytical chemistry for more than 20 years with his personal research being focused in the area of trace organic analytical chemistry, with special emphasis on retention mechanisms in liquid chromatography, the development of liquid chromatographic methods for the determination of individual organic species in complex mixtures (i.e., extracts of environmental, food, and clinical samples) and the determination of physico-chemical properties such as aqueous solubilities, octanol/water partition coefficients, and vapor pressures of organic compounds. This work is described in more than 100 peer-reviewed publications. More than 250 invited lectures have been presented at U.S. industrial sites, Colleges/Universities and Technical Meetings throughout the world.

Education:

1968	Knoxville College	B.S.
1977	University of Maryland	Ph.D.