Testimony of

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An Overview of the Fiscal Year 2017 Budget for the National Institute of Standards and Technology

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Chairwoman Comstock, Ranking Member Lipinski, and other members of the Subcommittee, thank you for the opportunity to appear before you today to present the President's Fiscal Year (FY) 2017 budget request for the Department of Commerce's National Institute of Standards and Technology (NIST). This budget request reflects the important role that NIST plays in American innovation, productivity, trade, and public safety.

The President, in his FY 2017 budget message, observed that "*by accelerating the pace of American innovation, we can create jobs and build the economy of the future…*" The measurement science and technology foundation that NIST provides is essential to accelerating American innovation toward breakthroughs in areas such as next-generation computing to strengthen the digital economy, and more efficient wireless technology to overcome the "spectrum crunch." Additionally, research supported by this budget will help embed NIST industrial sensor technologies on the factory floor, thereby extending NIST's success with the electronics industry to applications such as laser welding and bioengineering. In support of the Administration's emphasis on serving industry through outreach services, this budget pushes NIST to further embrace its role as "Industry's National Lab" by keeping its facilities open to industry partners and extending the National Network for Manufacturing Innovation to tackle the manufacturing challenges that *industry* identifies as most in need of co-investment to nurture innovation and accelerate commercialization.

To achieve these goals, the President has proposed a budget for NIST of $1.0 billion. This is $50.5 million above the FY 2016 enacted level. These funds will support NIST's work to foster the innovation that creates jobs and strengthens the U.S. economy.

In addition to the discretionary request, the President has proposed an additional $2.0 billion in NIST mandatory funds to fully fund a network of 45 institutes in the National Network for Manufacturing Innovation ($1.9 billion) and to renovate and modernize NIST facilities ($100 million). The latter is needed to complete the major renovation of the Radiation Physics Building - over a half-century old - that was begun in FY 2016 and that will create state-of-the-art laboratories for research in health, manufacturing, safety, and security. Mandatory funding is presented in the FY 2017 President's Budget throughout the Federal R&D enterprise to support research across a range of topics from health to clean energy technologies, reflecting the high priority of R&D in a time of limited discretionary funding.

Scientific and Technical Research and Services (STRS) Account ($730.5M, +$40.5M)

The NIST laboratory programs work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on sound scientific and technical principles. Today, the NIST laboratories address increasingly complex measurement challenges, ranging from the very small (nanoscale devices) to the very large (vehicles and buildings), and from the physical (renewable energy sources) to the virtual (cybersecurity and cloud computing). As new technologies are developed and evolve, NIST's measurement research and services remain central to innovation, productivity, trade, and public safety.

The President's budget continues to recognize this important role of NIST laboratory programs by requesting $730.5 million for Scientific and Technical Research and Services, which is a $40.5 million increase above FY 2016 and includes inflationary adjustments. This increase will allow NIST to lay the foundation for the next computing and wireless revolutions, transfer its money-saving technology to the factory floor, and bring its precision engineering prowess to bear on emerging markets.

The FY 2017 request also continues to fund critical NIST work in the areas of cybersecurity and forensic science at FY 2016 levels. In the area of cybersecurity NIST is investing a total of $74.2 million with $38.7 million supporting cyber R&D efforts at NIST, $31.5 million supporting the National Cybersecurity Center of Excellence including work on Identity Management, and $4M to support the National Initiative on Cybersecurity Education. In the area of forensic science NIST will continue to invest $9.8 million to address forensic measurement and standards needs.

Information about each of the new FY17 initiative requests follows:

Measurement Science for Future Computing Technologies and Applications (+$13.6M)

NIST has supported the U.S. semiconductor industry from its inception, providing measurement tools and scientific insights that have helped to drive a steady increase in computing power. As we reach the limits of today's semiconductor technology, this budget increase of $13.6 million would position the U.S. to unlock the potential of future computing technologies to revolutionize and transform U.S. economic competitiveness.

Within that amount, $8.8 million will support the development of measurement science, standards, tools, and technologies to advance new computing paradigms. NIST will develop, test, prototype, and benchmark potential types of logic, memory, and storage device concepts with the potential to become integral to a future "exascale" machine, some 30 times more powerful than today's most powerful computer.

The balance of the increase - $4.8 million - will be used to develop and deploy measurement science for next-generation computing applications. NIST will develop frameworks for uncertainty quantification in scientific computing and for calibration of modeling and simulation. These will help increase the capacity and capability of an enduring national high-performance computing ecosystem.

This initiative recognizes NIST as an essential part of the National Strategic Computing Initiative because of its continued success in pushing measurement science forward to advance computing technologies. In a recent report[1] submitted to the Department of Commerce, the Council on Competitiveness made the following observation about the potential benefit from modeling, simulation and analysis, and high performance computing:

[1] Modeling, Simulation and Analysis, and High Performance Computing: Force Multiplier for American Innovation, Final Report to the US Department of Commerce Economic Development Administration, Council on Competitiveness, 2015.

"Widespread deployment across the U.S. industrial landscape would dramatically enhance the U.S. ability to innovate, accelerate the development and commercialization of new products, and improve manufacturing productivity, driving U.S. economic growth and global market competitiveness."

Advanced Sensing for Manufacturing (+$2.0M)

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 that require new concepts, architectures, materials, and manufacturing methods.

The budget requests an increase of $2.0 million to accelerate research efforts targeting the development of advanced sensors needed to support the manufacture of advanced electronics and nanoengineered devices. With this increase, NIST will develop in-process imaging and analysis to enable improved process performance, quality control, and optimization.

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 its expertise in nanomanufacturing, digital design, chip-scale measurement technologies, robotics, additive manufacturing, and cyber-physical systems.

Biomanufacturing/Engineered Biology: Developing Engineering Principles for Efficient Biomanufacturing (+$2.0M)

Biomanufacturing has the potential to usher in the next Industrial Revolution to 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.

When techniques to provide accurate, quantitative measurements in biomanufacturing are not available, an inefficient trial-and-error approach is often employed. The biomanufacturing and engineering biology research communities have therefore requested NIST's help in providing confidence in these measurements and to establish robustness and harmonization of results.

The requested budget increase of $2.0 million will ensure quality and predictability in the design of synthetic biological systems for efficient production of fuels, chemicals, pharmaceuticals, and medical therapies.

This funding increase will support development of a suite of quantitative methods for accurate measurement of biological systems and create the necessary tools to methodically design and test engineered organisms, and engage relevant stakeholders to develop and evaluate predictive models. While data generation is important, assessing the data quality is equally critical; therefore, NIST will develop methods for data validation, including relevant reference data and standards.

Advanced communications: Addressing the Spectrum Crunch (+$2.0M)

The availability of secure, reliable, high-speed wireless communications is essential for the Nation's future economic health and security. Consumers and industry are becoming increasingly reliant on wireless devices to conduct their daily business and for the development of new technologies in areas as diverse as public safety communications, electrical power grid management, medical devices communications, and advanced manufacturing. While demand for wireless continues to grow, the available spectrum itself is a limited resource.

The proposed budget requests an increase of $2.0 million to develop the measurement science and tools necessary to quantify spectrum sharing and measure the spectrum efficiency of commercial wireless radio-frequency communication systems. This investment will accelerate the deployment of future wireless communications systems.

A portion of the increase will be used to enable more efficient sharing of the currently allocated spectrum by extending NIST's antenna measurement capability to include leading-edge adaptive antenna systems, and to provide a facility where industry can test these systems prior to their deployment.

The remaining new funds will be used to analyze the effectiveness of spectrum sharing, as one means to overcome spectrum scarcity. The requested funds will bolster the development of performance metrics, measurement methods, and tools, and will allow their implementation in a test and evaluation environment. The dissemination of simulation models and software building blocks of key spectrum-sharing functions will facilitate research and development of innovative spectrum-sharing technologies and expedite product development.

Ensuring a World Class Neutron Facility (+$4.8M)

Neutron scattering has been enormously successful as a unique probe of the structure and dynamics of materials for researchers from many different disciplines. One of NIST's top priorities this year is ensuring the continued operation and availability to industry and academic users of one of the world's foremost neutron research facilities - the NIST Center for Neutron Research (NCNR).

The NCNR is the sole facility of its kind in the United States with a focus on enhancing American industrial competitiveness. It is therefore essential to U.S. industry, and to our Nation's long-term economic growth, 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.

The budget proposes an increase of $4.8 million to ensure that NIST continues to provide access to the sophisticated measurement tools available through the NCNR. NIST is requesting these

funds to account for continued price increases for fuel manufacturing and shipping, and is investing in a lifetime extension of the neutron source facility to maintain availability.

Lab-to-Market/Technology Transfer: Expand Technology Transfer Activities to Leverage Existing Authorities to Promote Data Sharing Efforts (+$2.0M)

A wide range of life-changing commercial technologies has been nurtured by federally funded research and development (R&D), from the Internet, to the global positioning system (GPS), to life-saving vaccines. The federal R&D enterprise continues to support fundamental research and to expand the frontiers of human knowledge. One of the ways in which federal laboratories diffuse this knowledge is to make data and publications more easily accessible.

Federally funded R&D has historically led to dramatic economic growth, and there is significant potential to increase the public's return on this investment in terms of innovation, job creation, societal impact, competitiveness, and economic prosperity.

The proposed budget requests an increase of $2.0 million to expand lab-to-market and technology transfer activities through the development and deployment of data-sharing and collaborative tools and services.

With this funding, NIST will lead the development of infrastructures for information sharing, data dissemination, and increased collaboration to address national priorities and enhance business competitiveness. NIST will work with the Federal Laboratory Consortium (FLC) and offices within the Executive Office of the President (EOP) in the development of digital platforms to enhance cross-agency collaborations on technology transfer and development.

These platforms will expand to enable data-sharing and synchronization across government, non-profit, and for-profit platforms. NIST will coordinate its efforts across all departments and agencies that fund research and development (both intramural and extramural), consistent with each agency's mission.

Industrial Technology Services (ITS) ($189M, +$34.0M)

More than ever before, national priorities require the united efforts of diverse participants. NIST’s convening power and technical independence can help bring those participants together to meet those needs. 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 2017 request of $189.0 million, an increase of $34 million above FY 2016, for the ITS appropriation is directed to two programs: the Hollings Manufacturing Extension Partnership (MEP); and the National Network for Manufacturing Innovation (NNMI).

Hollings Manufacturing Extension Partnership (MEP) (+$12.0M)

The MEP program provides awards to a network of Manufacturing Extension Partnership Centers in every state and in Puerto Rico. These Centers work directly with local manufacturing companies to strengthen the competitiveness of our Nation's domestic manufacturing base, with particular focus on small and medium-size enterprises.

The requested $12.0 million increase will be used in FY 2017 to complete the final round of the multi-year competition of the MEP Centers, maintain the funding of states previously competed, and provide funding for additional performance-based awards to high-performing Centers.

The increased funding will allow the program to allocate funds across the network to reduce the variation in funding across the system, and to target additional resources for key performance objectives including improved data collection and dissemination. The increase in funding for MEP Centers will allow them to work with more very small, rural, and start-up firms, and will significantly improve market penetration with manufacturers having 1 to 19 employees.

The expected economic impacts that will be generated as a result of this increased investment are highly leveraged, and include an additional $800.0 million in new and retained sales, $352.0 million in new investment, $120.0 million in cost savings, and nearly seven thousand new and retained jobs.

National Network for Manufacturing Innovation (NNMI) (+$22.0M)

The budget provides increased funds for federal investment in the National Network for Manufacturing Innovation program, which serves to create an effective manufacturing research infrastructure for U.S. industry and academia to solve industry-relevant problems. The NNMI consists of linked Institutes for Manufacturing Innovation with common goals, but unique concentrations. Within an Institute, industry, academia, and government partner to leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization.

Each Institute in the NNMI has a unique technology focus with the objective of creating self-sustaining regional manufacturing hubs that have national impact. The institutes help support an ecosystem of manufacturing activity in regions of the U.S. The manufacturing innovation institutes support manufacturing technology commercialization by helping to bridge the gap from the laboratory to the market and address core challenges in scaling manufacturing process technologies.

The FY 2017 President's Budget request includes a $22.0 million increase for the program, for a total of $47.0 million, to fund an additional Institute. Funds are also provided within the totals for NIST to coordinate network activities of all institutes in the NNMI. This additional funding will keep NIST on a path to build out the network, together with our federal agency partners.

The FY 2017 President's budget request also proposes a mandatory appropriations account beginning in FY 2018. The mandatory request includes an additional $1.890 billion in one-time

mandatory appropriations in FY 2017 for this program, to be executed from FY 2018 to FY 2025, to complete the network of 45 institutes envisioned by the President.

Construction of Research Facilities (CRF) ($95M, -$24.0M)

Before I address the budget request for Construction of Research Facilities (CRF), I would like to take this opportunity to thank the Subcommittee for its strong support of critical renovations of aging and deteriorating infrastructure that would otherwise threaten NIST's ability to meet its mission. In particular, the FY 2016 appropriation has allowed NIST to begin work on our Radiation Physics Building, Building 245. The work conducted by NIST in Building 245, now over a half-century old, is essential to U.S. health and safety.

For example, some 39 million mammograms in this country every year are performed on machines, the reliability of which is traceable to calibrations performed in Building 245. Other examples of technologies relying on traceability carried out in this facility include: external radiation beam therapies (cancer treatment); internal radiation therapies; metabolic studies; nuclear imaging; portal monitoring; solar satellites; nuclear power safety; radiological emergency response; personnel monitoring; and medical device sterilization.

The FY 2017 CRF appropriation request of $95 million supports both new construction and renovation efforts for NIST's physical plant and infrastructure. While the CRF number is a decrease from the FY16 enacted level, that reflects the significant initial investment in FY16 to begin the renovation of Building 245. Forty million dollars in this request will fund the second phase of the multiyear renovations of Building 245; specifically, excavation and waterproofing of existing subterranean laboratory spaces that, today, routinely flood, and construction of an addition to house modern environmental control systems, thereby eliminating ongoing delays in calibrations and research. The remaining $55 million of the appropriation will be used to fund maintenance, repair, improvements, and major renovation of facilities occupied or used by NIST in Maryland, Colorado, and Hawaii, to protect the critical facility and infrastructure needs of the Institute.

In addition to the discretionary funding request for CRF, authorizing legislation will be proposed that would provide $100.0 million in mandatory funds to renovate and modernize NIST facilities in order to maintain and enhance current research and development capabilities. NIST will use the funding to accelerate ongoing construction projects at our Gaithersburg and Boulder sites.

Summary

In conclusion, the FY 2017 NIST budget request reflects the Administration's recognition of the important role that NIST plays in innovation, as well as the impact of NIST research and services in laying, and building, the foundation for our Nation's long-term job creation and prosperity.

NIST will continue its work with the private sector to ensure U.S. manufacturers have the research support they need. Through its laboratory programs, outreach efforts, and standards

development work, NIST is 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 continuing to work with you, Madame Chairwoman and members of the Subcommittee, and would be happy to answer any questions.

Dr. Willie E. May

On May 4, 2015, Congress confirmed **Dr. Willie E. May** as the 15th Director of the National Institute of Standards and Technology (NIST). He also serves as Under Secretary of Commerce for Standards and Technology, a position created in the America COMPETES Reauthorization Act of 2010. Dr. May had served as Acting NIST Director and Acting Under Secretary of Commerce for Standards and Technology since June 2014. Prior to that assignment, he was 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 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 2016 Appropriation is $964M. In addition, NIST receives an estimated $50 million in service fees and approximately $120 million for services rendered to other federal and state agencies on a cost reimbursable basis. NIST employs about 3,400 federal scientists, engineers, technicians, support staff, and administrative personnel at two main locations in Gaithersburg, MD, and Boulder, CO. NIST also hosts approximately 3,500 Associates from academia, U.S. industry, and other government agencies, who collaborate with NIST staff and access user facilities. NIST also partners with more than 1,300 manufacturing specialists and staff at more than 400 Manufacturing Extension Partnership locations around the country.
Dr. May led NIST's research and measurement service programs in chemistry-related areas for more than 20 years. Prior to that, his personal research activities were focused in the areas of trace organic analytical chemistry and physico-chemical properties of organic compounds, where his work was described in more than 85 archival publications.

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; and an Executive Board Member for the Joint Committee on Traceability in Laboratory Medicine (JCTLM). He also serves on the External Advisory Boards for the UK's National Physical Laboratory (NPL) and Japan's National Institute of Advanced Industrial Science and Technology (NAIST).

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-Winter Commencement Ceremonies, University of Maryland, College of Life Sciences, 2002; Council for Chemical Research Diversity Award; NOBCChE Henry Hill Award for exemplary work and leadership in the field of chemistry; Science Spectrum Magazine Emerald Award, 2005; Alumnus of the Year Award from the College of Chemical and Life Sciences at the University of Maryland, 2007; Member of the first class of inductees into the Knoxville College Alumni Hall of Fame, 2010; Fellow of the American Chemical Society, 2011; Honorary Doctor of Science and Speaker at Graduate School of Arts and Sciences Commencement Exercises, Wake Forest University, 2012; Keynote Speaker-Winter Commencement Ceremonies, University of Maryland, College of Computer, Mathematical and Natural Sciences, 2015.

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.