NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

NATIONAL TECHNICAL INFORMATION SERVICE

FISCAL YEAR 2015 BUDGET SUBMISSION TO CONGRESS

Department of Commerce
National Institute of Standards and Technology
BUDGET ESTIMATES, FISCAL YEAR 2015
CONGRESSIONAL SUBMISSION

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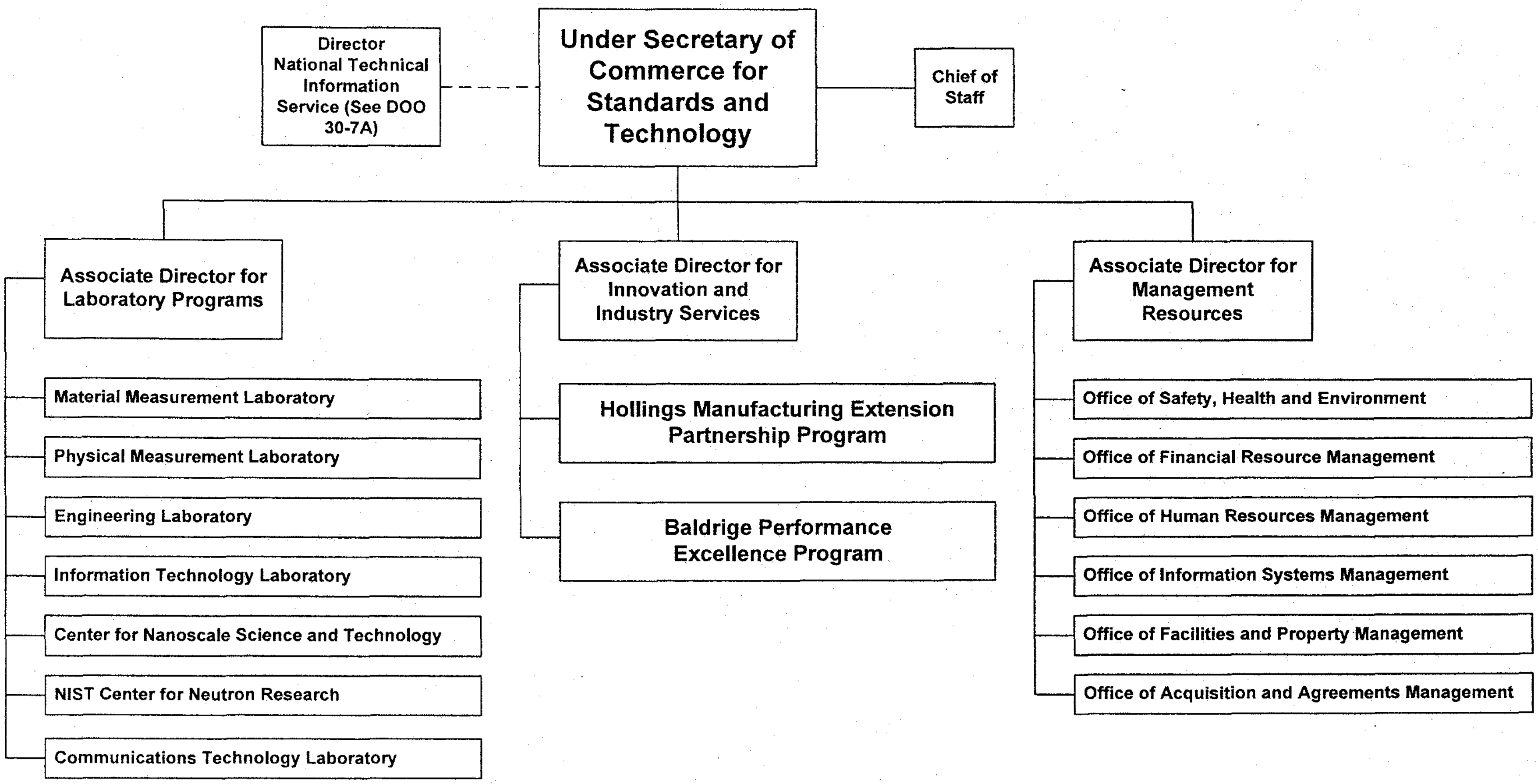
National Institute of Standards
and Technology

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology



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EXECUTIVE SUMMARY

The mission of the National Institute of Standards and Technology (NIST) is 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. For more than 110 years, NIST has maintained the national standards of measurement, a role that the U.S. Constitution assigns to the Federal Government to ensure fairness in the marketplace. Today, the NIST Laboratories, funded by the Scientific and Technical Research and Services (STRS) and Construction of Research Facilities (CRF) appropriations, address increasingly complex measurement challenges. For example, NIST develops measurements focusing on the very small (e.g., nanotechnology devices) and the very large (e.g., skyscrapers), the physical (e.g., methods for characterizing strands of DNA for forensic testing) and the virtual (e.g., methodologies and best practices for securing cyberspace). As new technologies develop and evolve, NIST's measurement research and services remain central to innovation, productivity, trade, and public safety. NIST promotes the use of measurements based on the international system of units (SI). The measurement science research at NIST is useful to all science and engineering disciplines.

NIST's portfolio also includes the Hollings Manufacturing Extension Partnership (MEP), funded by the Industrial Technology Services (ITS) appropriation. MEP is a Federal-state-industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The MEP program consists of Manufacturing Extension Partnership Centers located across the country that work directly with their local manufacturing communities to strengthen the competitiveness of our Nation's domestic manufacturing base. Funding for the MEP Centers is a cost-sharing arrangement consisting of support from the Federal government, state and local government/entities, and fees charged to the manufacturing clients for services provided by the MEP Centers. The ITS appropriation also includes the Advanced Manufacturing Technology Consortia (AMTech) to enable industry-led consortia to identify and prioritize directed basic research projects supporting long-term industrial research needs, and a newly proposed Manufacturing Innovation Institute Coordination program for the coordination of the new manufacturing innovation institutes.

For FY 2015, NIST is submitting a total discretionary request level of $900.0 million, $50.0 million above FY 2014 enacted levels. Within this total discretionary request level, NIST's Scientific and Technical Research and Services (STRS) appropriation includes a requested increase of $29.0 million above FY 2014 enacted levels, NIST's ITS appropriation includes a requested increase of $18.0 million above FY 2014 enacted levels, and NIST's Construction of Research Facilities (CRF) appropriation includes a requested increase of $3.0 million above FY 2014 enacted levels.

The increased resources requested would enable NIST to continue to expand and strengthen programs to more effectively address a number of scientific and technological issues of high-priority to the U.S., and that are critical for U.S. economic competitiveness and innovative capacity.

Additional information on the budget request, by appropriation, is subsequently provided.

DISCRETIONARY APPROPRIATIONS

Scientific and Technical Research and Service (STRS) Appropriation

The objectives of the STRS programs are to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change. NIST resources are devoted to meeting today's economic and societal challenges and to laying the foundation for future success. NIST activities help address a broad range of critical science and innovation challenges for the Nation. NIST's Laboratories funded by STRS play a unique role in the Nation's scientific, industrial, and business communities. NIST anchors the national measurement and standards system that is the language of research and commerce. NIST's presence and leadership in the Nation's measurement and standards system enables companies, researchers, government agencies, and universities to work with each other more easily, improving the Nation's economic security and quality of life. NIST also supports enacted legislation such as the America COMPETES Act, which outlines major roles for NIST in promoting national competitiveness and innovation, and the National Technology Transfer Advancement Act (NTTAA), which designates NIST as the coordinator for all Federal agencies using documentary standards.

The NIST laboratory programs funded by STRS appropriations provide industry, academia, and other Federal agencies with:

• Scientific underpinnings for basic and derived measurement units, international standards, measurement and calibration services, and certified reference materials;

• Impartial expertise and leadership in basic and applied research to enable development of test methods and verified data to support the efficient commercialization and exchange of goods and services in industry and commerce;

• Expertise and support for the development of consensus-based standards and specifications that define technical and performance requirements for goods and services, with associated measurements and test methods for conformity; and

• Unique, cutting-edge user facilities that support innovation in materials science, nanotechnology discovery and fabrication, and other emerging technology areas through the NIST Center for Neutron Research, which provides world-class neutron measurement capabilities to the U.S. research community, and the NIST Center for Nanoscale Science and Technology, which supports the U.S. nanotechnology enterprise from discovery to production by providing access to world-class nanoscale measurement and fabrication methods and technology.

The 2015 President's Budget continues to recognize the important role of NIST laboratory programs in advancing U.S. innovation by requesting $680.0 million for the Scientific and Technical Research and Services (STRS) appropriation, an increase of $29.0 million over the [FY 2014] enacted level. Within the request, current Administration priority areas targeted for budget increases include R&D investments in Forensic Science, Cyber Physical Systems, Advanced Materials, Synthetic Biology, and a Lab-to-Market initiative.

Brief summaries of NIST's FY 2015 STRS initiatives and other program changes are provided below.

1. +$3.5 million for Measurement Science and Standards for Forensic Science Infrastructure.

The request would enable the development of a scientific underpinning for forensics in the U.S. The current scientific measurement basis and the state of standardization of forensic science are widely acknowledged as needing to be strengthened. The goals of this initiative are to develop science based standards, measurement methods, tests and validation studies that will underpin reliable, accurate, interoperable and validated forensic analysis. Forensic disciplines to be addressed include: human identification (DNA, fingerprints, palm prints, face and voice recognition, scars-marks-tattoos, bite marks), controlled substances, trace evidence (microbial identification, fiber, coatings, soil, glass, gunshot residue), toxicology, impression evidence (tire marks, shoe prints, firearms, etc.), digital forensics, multimedia forensics (video, audio, images) and fire/arson investigation. Prioritization of NIST efforts in forensic science would be supported by the Scientific Area Groups made up of practitioners, academics, and other experts in the field of forensic science that were established under the Department of Justice-NIST Memorandum of understanding on Forensic Science.

2. +$7.5 million for Cyber-Physical Systems.

Today, whether it is on the manufacturing floor, in hospitals, the power grid, or on our highways and railways, machines and systems are being linked together through the internet to improve their efficiency, reliability, and usability. These networks of machines and devices are known as Cyber Physical Systems (CPS) designed to create adaptive and predictive systems that respond in real time to enhance performance. Examples of CPS include intelligent medical devices and personal health care technologies, smart grid and sustainable energy infrastructures, 21st century defense capabilities, secure and resilient smart-city infrastructures, and autonomous vehicles. Realizing the full potential of CPS requires better design and measurement tools. This initiative will provide: 1) scalable design strategies based on new standards for integrating architectural layers in hyper-complex CPSs and for connecting multiple CPSs from the component level (in composite medical systems, for example) to the continental scale (a Smart Grid goal); and, 2) a new focus on robust, science-based metrics and agile research and testing platforms for integrated CPS performance measurement and management. In addition, this initiative will create a new forum to help break down existing stovepipes between communities in order to promote cooperation and coordination amongst CPS designers and users across sectors for better connecting industry's needs to research capabilities, and allowing researchers to tackle cross-domain CPS challenges.

3. +$5.0 million for Advanced Materials.

This NIST requested increase would enable the creation of advanced materials discovery tools and data for industry. The proposed increase provides the resources to accelerate NIST's progress in its key role in the Materials Genome Initiative, an interagency effort to dramatically influence the pace for bringing new materials to market. NIST is underway in developing 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 greater 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.

4. +$7.0 million for Synthetic Biology.

The request would support efforts to ensure quality and predictability in the design of synthetic biological systems for efficient production of fuels, chemical feedstocks, pharmaceuticals, and medical therapies. Rapid advances in the ability to modify biological organisms at the genetic level have created a new engineering discipline, commonly referred to as synthetic biology. Relying on the ability to synthesize and assemble biological machinery, synthetic biology bypasses the less predictable and lengthy process of evolution to streamline the creation of organisms capable of performing a specific function. For example, synthetic biology can be used to create engineered bacterial and mammalian cell lines to produce fuels, chemical feedstocks, and drugs. Although synthetic biology is still in its infancy, the collective vision for the field is ambitious; improved tissue engineering, creating bio-computer interfaces, and implementing large-scale biofuel production are just some of the areas where synthetic biology could be exploited. A series of international symposia focused on synthetic biology identified several major technical challenges that needed to be overcome for synthetic biology to realize its full potential, including: lack of standardized biological parts, measurements, and databases; no broad understanding of the underlying scientific foundations for biological systems; no existing tools to test and control the interactions of synthesized biological materials, and; no existing interface for worldwide collaboration. This initiative addresses all these technical challenges 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 where engineered biological systems first be examined *in silico*. Ultimately, a data/analysis system consisting of a community-fed pipeline of highly qualified data and data-driven approaches will be created, thereby enabling a platform for world-wide collaboration. This pipeline will result in rapid examination of experimental parameter space with large, highly qualified datasets to produce experimentally testable predictive theories that constitute the fundamental principles controlling biological organisms. This approach has the potential to revolutionize not only biology and synthetic biology, but all aspects of biomedical science and medicine.

5. +$6.0 million Lab-to-Market.

A wide range of life-changing commercial technologies were nurtured by federally funded research and development (R&D), from the Internet, to the global positioning system (GPS), to leading-edge vaccines. The Federal R&D enterprise must continue to support fundamental research that is motivated primarily by our interest in expanding the frontiers of human knowledge, and diffusing this knowledge through open data and publications. At the same time, federally funded R&D has historically led to 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. NIST with its government wide-responsibilities for the analysis, planning, coordination, reporting, and general oversight of Federal technology transfer responsibilities is ideally positioned to support an Administration-wide effort in this area. This initiative will strengthen NIST and Federal Technology Transfer activities through (1) developing human capital, (2) empowering effective collaborations, (3) opening access to tangible and intangible assets, and (4) evaluating impact.

Construction and Research Facilities (CRF) Appropriation

This appropriation supports the construction of new facilities and the renovation and maintenance of NIST's current buildings and laboratories to comply with scientific and engineering requirements and to keep pace with Federal, State, and local health and safety regulations. The Construction of Research Facilities (CRF) request totals $59.0 million, an increase of $3.0 million over the FY 2014 enacted level.

1. -$11.8 million for Building 1 Renovation Decrease.

NIST requests a decrease in the amount of $11.8 million to reflect the completion of the Building 1 renovations accomplished with funding received in FY 2014. The FY 2014 appropriation funded $7.9 million to complete the renovations in Wings 3 and 6 and the balance of the funding, $3.9 million, will be used to construct swing space for the programs located in Wing 4.

2. +$11.1 million for Building 1 Renovation Increase.

NIST requests an increase to continue with the long-term plan to renovate the multi-wing Building 1 of the NIST Boulder, Colorado laboratories, which houses the majority of NIST Boulder research and measurement facilities. The FY 2015 requested increase of $11.1 million will fund the first construction phase of the interior and exterior renovation of Building 1, Wing 4. The remaining wing renovations will be completed with future funding requests.

3. +$3.7 million for Radiation Physics Building 245 Modernization.

NIST requests an increase of $3.7 million to begin efforts to improve the condition of the Gaithersburg Radiation Physics Building 245. The project is necessary to ensure that NIST's radiation physics measurements and research is not compromised due to the condition of the facility or the inadequate or inappropriate space in which the research is conducted. The FY 2015 funding provides for the initiation of planning, programming, acquisition and concept development, of the preferred option as identified and approved during the Department's Scalable Acquisition Project Management Framework Project Definition Phase.

Industrial Technology Services (ITS) Appropriation

NIST requests $161.0 million for the ITS appropriation, which consists of three extramural programs, the Hollings Manufacturing Extension Partnership (MEP), the Advanced Manufacturing Technology Consortia program (AMTech), and a newly proposed Manufacturing Innovation Institutes Coordination program. The request is an increase of $18.0 million above the FY 2014 enacted level.

Hollings Manufacturing Extension Partnership (MEP).

The request includes $141.0 million for MEP, a $13.0 million increase over the FY 2014 enacted level. MEP is a Federal-State-industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The program consists of 60 MEP Centers that work directly with their local manufacturing communities to strengthen the competitiveness of our Nation's domestic manufacturing base. MEP supports the mission of NIST and the Department of Commerce to promote U.S. innovation and competitiveness and enable economic growth for American industries, workers, and consumers. Across the country, MEP Centers serve as trusted advisors to their manufacturing clients. MEP helps companies navigate economic and business challenges, and provides an innovation framework to enable them to capitalize on opportunities and develop pathways leading to profitable growth. Services provided by MEP are grounded in technology-related activities, sustainability, efficiencies through continuous improvement, and the integration of supply chains.

+$13.0 million for MEP.

In FY 2015, MEP will continue to support the nationwide system of MEP Centers and build on the knowledge and technical services provided by the only Federal program uniquely designed to directly support the needs of U.S. manufacturers. The increased funding requested will continue mission appropriate MEP efforts to support national priorities such as the deployment of tools developed in FY 2014 by the Manufacturing Technology Acceleration Centers (M-TAC) pilot programs that strengthen the MEP system's ability to help manufacturers to enhance domestic supply chain competitiveness through direct consulting by teams of experts in specific technology areas and for workforce development activities. With additional Federal resources, the MEP network could broaden its reach and increase the effectiveness of our MEP centers, creating stronger companies and more middle-class jobs. As national investments are being made in advanced manufacturing and technology transfer, an optimally funded network of MEP centers will ensure that these initiatives reach the manufacturing community and that businesses are connected with new technologies and market opportunities, also using innovative tools such as business-to-business (B2B) connectivity.

Manufacturing Innovation Institutes Coordination.

The President's Budget request is $5.0 million in a new activity for coordination of manufacturing innovation institutes.

+$5.0 million for Manufacturing Innovation Institutes Coordination.

The President's Budget request is $5 million in a new activity for coordination of manufacturing innovation institutes. The funds would coordinate the four institutes already launched and the five institutes that the Administration has committed to funding, led by the Department of Energy, Department of Defense, and Department of Agriculture. The efforts support the National Network for Manufacturing Innovation (NNMI) with up to 45 manufacturing innovation institutes across the Nation. *The purpose of the institutes is to create a place, or "industrial commons" led by U.S. industry to close the gap between early-stage research and development and the deployment of technology innovations by U.S. manufacturers.* With these resources NIST will provide coordination among the evolving network of institutes, enabling sharing of best practices, reduction of the development of redundant start-up operations, and strengthening cross-institute collaborations.

Advanced Manufacturing Technology Consortia (AMTech).

The budget requests $15.0 million for AMTech, the same as the FY 2014 appropriation. Industry consortia are known to be extremely effective in identifying technology needs and roadblocks, yet often need a catalyst to enable consortium formation. The AMTech grants program enables industry-led consortia to identify and prioritize directed late basic to early applied 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. The program provides funding to industry-led consortia for the development of detailed roadmaps of long-term research challenges. Further, the program aims to seed industry-led consortia establishment by awarding project grants to support the research needed to help them achieve future desired technology developments. The AMTech program supports the Administration's priorities to invest in advanced manufacturing to foster innovation, create high-quality jobs, and enhance global competitiveness. By supporting consortia, the AMTech program will address multiple components of the innovation cycle, from discovery and pre-competitive technology development to accelerate the pace of innovation through various industry sectors. In FY 2015 AMTech will provide new grants to develop and support existing or new industry-led consortia on high-impact advanced manufacturing topics. Funding will include additional planning grants for consortia formation and development, and technology roadmapping that identify the long-term research needs, critical gaps and optimal approaches of industry. In addition, funding of existing consortia will take the form of merit-based grants to implement and enable the early stage, industry-led, long-term research identified by AMTech planning grant award teams.

Working Capital Fund

The Working Capital Fund finances research and technical services performed for other Government agencies and the public. These activities are funded through advances and reimbursements. The Fund also finances the acquisition of equipment, standard reference materials, and storeroom inventories until issued or sold.

Resources

The following is a comparison of NIST's FY 2015 request level with the FY 2014 Enacted level.

(Dollar amounts in millions)						
Appropriation	FY 2014 Enacted		FY 2015 Request		Change from FY 2014 Enacted	
	FTE	Amount	FTE	Amount	FTE	Amount
Scientific and Technical Research and Services	2,331	651	2,411	680	80	29
Industrial Technology Services	87	143	90	161	3	18
Construction of Research Facilities	76	56	76	59	0	3
Working Capital Fund	700	0	700	0	0	0
TOTAL DISCRETIONARY	**3,194**	**850**	**3,277**	**900**	**83**	**50**
TOTAL RESOURCES	**3,194**	**850**	**3,277**	**900**	**83**	**50**

NIST FY 2015 Investments in the Administration's Opportunity, Growth, and Security Initiative

In its FY 2015 budget, NIST has investments in the Administration's Opportunity, Growth, and Security Initiative. This initiative recognizes that, through the Bipartisan Budget Act of 2013 (BBA), Congress came together on a bipartisan basis and took an important first step toward replacing the damaging cuts caused by sequestration with longer-term reforms. While the President's Budget adheres to the BBA's discretionary funding levels for 2015, these levels are not sufficient to support the research and development necessary for innovative technology development, commercialization, and manufacture that will drive the growth our economy needs. For that reason, the Budget also includes $56 billion Opportunity, Growth, and Security Initiative that will help spur economic progress, promote opportunity, and strengthen national security. Moreover, the Opportunity, Growth, and Security Initiative is fully paid for with a balanced package of spending cuts and tax loophole closers, showing that additional pro-growth investments are easily affordable without increasing the deficit if Congress will enact common-sense spending and tax reforms.

For NIST, the Opportunity, Growth, and Security Initiative would provide $115 million that would help strengthen NIST's ability to support industry and government efforts to address today's biggest challenges in advanced manufacturing, cybersecurity, advanced communications, and forensic science. Specifically, it funds:

- Fully funding the requested FY 2014 initiatives in advanced manufacturing, cybersecurity, forensic science, and disaster resilience;
- Accelerated renovation of scientific facilities at the Boulder, Colorado laboratories;
- Expanded research and testing capabilities in advanced communications, including spectrum sharing and next-generation communication technologies;
- Enhanced research programs in quantum science;
- Robust and independent cryptography capabilities supporting NIST's cybersecurity programs;
- A data science and information program that can support the development of standards and validation tools for accessing processing, distilling, storing, and protecting data; and
- Strengthened forensics science research and collaborative efforts with stakeholders.

NIST will use $2.4 billion to revitalize U.S. manufacturing, the through the establishment of a National Network for Manufacturing Innovation (NNMI), which will consist of a network of institutes where researchers, companies, and entrepreneurs can come together to develop new manufacturing technologies with broad applications. This investment fulfills the President's call for a network of 45 institutes around the country (36 more institutes in addition to FY 2014 and FY 2015 base). Each institute will have a unique technology focus. These institutes will help support ecosystems of manufacturing activity in local areas. The Manufacturing Innovation Institutes will support manufacturing technology commercialization by allowing new manufacturing processes and technologies to progress more smoothly from basic research to implementation in manufacturing, in addition to providing a much-needed environment and support for work-force development in advanced manufacturing.

The NNMI Federal investment is designed to catalyze industry and non-federal co-investment in advanced manufacturing. Each institute is expected to have a plan to become self-sustaining and fully independent of NNMI Federal funds five to seven years after launch.

Reimbursable Program

NIST's reimbursable services consist of technical work performed for other Federal agencies, state and local governments, and the private sector. These services include calibrations and special tests, advisory services, and the sale of Standard Reference Materials. The unique measurements and standards expertise developed with appropriated funding gives NIST the capability to perform these services on a reimbursable basis. NIST accepts other agency work based on an established set of criteria which include: the need for traceability of measurements to national standards; the need for work that cannot or will not be addressed by the private sector; work supported by legislation that authorizes or mandates certain services; work that would result in an unavoidable conflict of interest if carried out by the private sector or regulatory agencies; and requests by the private sector for NIST action or services. NIST's reimbursable program is estimated to be $154.3 million in FY 2014 and $142.4 million in FY 2015.

Exhibit 3A

FY 2013 Annual Performance Report / FY 2015 Annual Performance Plan

National Institute of Standards and Technology (NIST)

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Part 1 Summary Information

Section 1 Overview

- *Mission Statement*

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.

- *Description*

Since 1901, NIST (known as the National Bureau of Standards until 1988) has developed and maintained key standards for the Nation, a role that the U.S. Constitution assigns to the Federal government, and has been supplying the measurements and tools to help U.S. industry compete. As a non-regulatory agency in the U.S. Department of Commerce (DOC), an experienced partner of industry, and the Federal research agency specifically focused on promoting U.S. economic competitiveness, NIST is well-positioned to accelerate and promote innovation and advanced technologies through its laboratory programs and its Innovation and Industry Services Programs.

NIST employs about 3,000 scientists, engineers, technicians, and support and administrative personnel and carries out its technical work at its two main research campuses in Gaithersburg, Md., and in Boulder, Colo. At these campuses, NIST also hosts about 2,700 associates and facility users from academia, industry, and other government agencies who collaborate with NIST staff. NIST also participates in seven external institutes in basic physics, quantum physics, biology/biotechnology, biomedical measurement science, advanced materials, cybersecurity, and marine science, located in Boulder, Colo., College Park, Md., Palo Alto, Calif., Chicago, Ill, Rockville, Md., and Charleston, S.C., respectively. In addition, NIST partners with nearly 1,300 manufacturing specialists and staff at about 400 Hollings Manufacturing Extension Partnership (MEP) service locations around the country.

- *FY 2013 Accomplishments*

NIST's David J. Wineland Wins 2012 Nobel Prize in Physics

David Wineland, a physicist at NIST Boulder, shared the 2012 Nobel Prize in Physics "for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems." This was NIST's fourth Nobel prize in physics over a period of 15 years. Wineland is internationally recognized for his research on trapped ions (electrically charged atoms). He conducted landmark experiments on laser cooling, which involves using lasers to cool ions to near absolute zero—leading to the

development of laser-cooled atomic clocks, advances in experimental quantum computing, and ultraprecise next-generation atomic clocks.
(http://www.nist.gov/public_affairs/releases/wineland-nobel-release.cfm)

NIST Releases Preliminary Cybersecurity Framework to Protect Critical Infrastructure

In February 2013, President Obama issued Executive Order 13636, "Improving Critical Infrastructure Cybersecurity," which directed NIST to work with stakeholders to develop a voluntary framework for reducing cyber risks, recognizing that U.S. national and economic security depends on the reliable functioning of critical infrastructure. Through a request for information and a series of workshops held throughout FY 2013, NIST engaged with more than 3,000 individuals and organizations on standards, best practices and guidelines that can provide businesses, their suppliers, their customers and government agencies with a shared set of expected protections for critical information and IT infrastructure. NIST released its Preliminary Cybersecurity Framework in October 2013 to help critical infrastructure owners and operators reduce cybersecurity risks in industries such as power generation, transportation and telecommunications. NIST plans to release the official framework in February 2014. (http://www.nist.gov/itl/cybersecurity-102213.cfm)

NIST Awarded $7.4 million in Grants for Additive Manufacturing Research

NIST awarded two grants totaling $7.4 million to fund research projects aimed at improving measurement and standards for the rapidly developing field of additive manufacturing. Benefits of additive manufacturing include producing goods quickly and on-demand, with greater customization and complexity and less material waste. NIST awarded $5 million to the National Additive Manufacturing Innovation Institute (NAMII) in Youngstown, Ohio, which is operated by the National Center for Defense Manufacturing and Machining, for a three-phase collaborative research effort involving 27 companies, universities and national laboratories. Northern Illinois University in DeKalb, Ill., received $2.4 million to develop tools for process control and qualifying parts made with layer-by-layer additive-manufacturing processes. (http://www.nist.gov/director/3dgrant.cfm)

Industry Partners Join National Cybersecurity Center of Excellence

The National Cybersecurity Center of Excellence (NCCoE), a public-private partnership hosted by NIST, is working with industry on projects designed to increase protections for private-sector intellectual property and data from cyber threats. The center established formal partnerships with a number of major companies, which have pledged to contribute resources and expertise to the center. Other organizations are participating in the center's projects to find real-world solutions to cybersecurity challenges in the healthcare and energy sectors. For example, in September 2013, the NCCoE proposed a new "building block" that will help organizations inventory and assess the state of installed software across their IT systems, contributing to enhanced security. NIST also announced its intentions to establish a Federally Funded Research and Development Center to support the NCCoE. (http://www.nist.gov/itl/csd/nccoe-041513.cfm and http://www.nist.gov/itl/nccoe-launches-new-building-block.cfm)

Two Ways to Make Pure Carbon Nanotubes for Commercial Use

NIST materials researchers are at the forefront of efforts to resolve important issues in the commercial use of carbon nanotubes. Carbon nanotubes can have extremely valuable properties that would make possible novel materials or microelectronic devices, but because there are myriad possible configurations of nanotubes, an important commercial issue is how to produce pure quantities of the desired configuration. NIST addressed these challenges in two separate projects. Working with colleagues from the University of Southern California, they developed a technique for growing virtually pure samples of single-wall carbon nanotubes with identical structures, a process they liken to "cloning" the nanotubes. NIST researchers also adapted an old biochemistry trick once used to purify protein samples to divide mixed solutions of carbon nanotubes. The technique could be a fast, easy and cheap way to produce high-purity samples of carbon nanotubes for use in nanoscale electronics and many other applications.
(http://www.nist.gov/public_affairs/tech-beat/tb20121114.cfm#nanotubes)
(http://www.nist.gov/public_affairs/tech-beat/tb20130430.cfm#nanotubes)

NIST Chip Measurement Advance Earns 'Oscar of Innovation'

A fundamental advance in measurement capabilities that could save semiconductor manufacturers billions of dollars annually has earned a 2013 R&D 100 Award for its NIST inventors. The new method integrates statistical techniques and measurements made with two or more instruments to rigorously determine the sizes of nanoscale transistor features on semiconductor chips. The up to three-fold improvement in measurement accuracy achievable with the measurement innovation could save manufacturers as much as $7 for each chip they produce. (http://www.nist.gov/pml/div683/rd100-071213.cfm)

NIST and the U.S. Forest Service Propose System to Help Communities Resist Wildfires

Researchers from NIST and the U.S. Forest Service created the proposed Wildland Urban Interface (WIU) Hazard Scale, the first-ever rating system that allows communities to assess their risk from wildfires—on a building-by-building basis—and then ties that assessment to improved building codes and practices that could help reduce the threat. The problem of WUI fires, particularly in the western and southern regions of the United States, has been growing more prevalent as housing developments push into wilderness areas.
(http://www.nist.gov/el/fire_research/wildland-fire-hazard-scale-120512.cfm)

New NIST Measurement Tool Is On Target for the Fast-Growing MEMS Industry

As markets for miniature, hybrid machines known as Micro-Electro-Mechanical Systems (MEMS) grow and diversify. NIST has introduced a long-awaited measurement tool that will help device designers, manufacturers, and customers to see eye to eye on eight-dimensional and material property measurements that are key to device performance. Two NIST-developed test chips are quality assurance tools that enable accurate, reliable comparisons of measurements on MEMS devices made with different equipment and by different labs or companies. These capabilities will make it easier to characterize and troubleshoot processes, calibrate instruments and communicate among partners. (http://www.nist.gov/pml/div683/mems_043013.cfm)

'Standard Quantum Limit' Smashed, Could Mean Better Fiber-Optic Communications

Scientists at NIST and the University of Maryland's Joint Quantum Institute have potentially found a way to overcome a longstanding barrier to producing cleaner signals for fiber optic communications. The findings, which demonstrate for the first time an error rate far below the "standard quantum limit," could increase the efficiency of fiber-optic systems by reducing both the power needed to send a signal and the number of errors the receiver makes. Fiber optic system designers have struggled for decades to get past this limit, which is the best performance an ideal conventional receiver could ever attain. The research team found a way to get far past this limit using off-the-shelf technology to construct a receiver in an innovative way. The effort could lead to more efficient technologies that harness quantum effects, as well as improved data encryption systems. (http://www.nist.gov/pml/div684/limit-010813.cfm)

NIST Biometric Special Publication Provides Two New Ways to Identify Government Workers

NIST issued a new publication that broadens agency security options for Personal Identity Verification (PIV) cards—government-issued smart card used by federal employees and contractors to access government facilities and computer networks. *Biometric Data Specifications for Personal Identity Verification (Special Publication 800-76-2)* adds iris images as biometric identifiers and on-card fingerprint comparison as options for the cards. NIST researchers determined that an iris image compressed to 3 kilobytes provides enough detail to accurately recognize an individual's iris. The specifications also describe how to pace one or two compact fingerprint templates and a recognition algorithm on the card. Collaboration with industry and the standards community led to the ISO/IEC 19794-6 iris standard published in late 2011 that ensures that iris data is interoperable, that is, it can be exchanged easily between cameras and readers from different makers and across the world. (http://www.nist.gov/public_affairs/tech-beat/tb20130723.cfm#iris)

Manufacturing Extension Partnership (MEP) Awards Three Center Agreements and Initiates New Projects

The Hollings MEP creates about $2.5 billion in new sales annually, serving tens of thousands of small and mid-sized manufacturers. In FY 2013, the program awarded new cooperative agreements for centers in Arizona, Maryland, and Rhode Island and announced it would provide funding to award a new cooperative agreement in Nebraska and provide support for an effort to understand the technical needs of small and mid-sized manufacturers in Alaska, a project that could lead to a new MEP center in the state. MEP also announced it would fund up to two pilot projects for Manufacturing Technology Acceleration Centers (M-TACs) that would help manufacturers adopt and/or adapt advanced technologies into their manufacturing processes and products. In addition, MEP partnered with the Department of Labor's Employment and Training Administration, and the Delta

Regional Authority to support the development and implementation of a regional economic development strategy accelerating job creation by encouraging re-shoring by U.S. firms, fostering Foreign Direct Investment, encouraging U.S. companies to keep or expand their businesses in the U.S., and training local workers. MEP programs helped companies such as Milwaukee-based Prolitec, a 50-employee manufacturer, which participated in Wisconsin MEP's ExporTech program and saw its export sales quadruple in two years. MEP is also a co-producer of Manufacturing Day held annually to highlight the importance of manufacturing to the nation's economy and draw attention to the many rewarding high-skill jobs in manufacturing. More than 830 open houses, job fairs, and manufacturing plant tours were held in 48 states and Puerto Rico. (http://www.nist.gov/mep/)

Microscopy Technique Could Help Computer Industry Develop 3-D Components

A technique developed several years ago at NIST for improving optical microscopes now has been applied to monitoring the next generation of computer chip circuit components, potentially providing the semiconductor industry with a crucial tool for improving chips for the next decade or more. The technique, called Through-Focus Scanning Optical Microscopy (TSOM), has now been shown able to detect tiny differences in the three-dimensional shapes of new circuit components, which until very recently have been essentially two-dimensional objects. TSOM is sensitive to features that are as small as 10 nanometers across, perhaps smaller—addressing some important industry measurement challenges for the near future and helping maintain the viability of optical microscopy in electronics manufacturing. (http://www.nist.gov/public_affairs/tech-beat/tb20130625.cfm#tsom)

Section 2 Corresponding DoC Strategic Themes, Goals, and Objectives

Goal	Objective Number	Objective Name	Leader
Innovation	2.1	Grow a more productive, agile, and high-value manufacturing sector through partnerships and collaborations that accelerate technology development and commercialization.	Willie May, Associate Director for Innovation & Industry Services, NIST
Innovation	2.2	Increase the capacity of U.S. regional economies to accelerate the production of value-added goods and services by providing services to and investments in businesses and communities.	Willie May, Associate Director for Innovation & Industry Services, NIST
Innovation	2.3	Strengthen the Nation's digital economy by championing policies that will maximize the potential of the Internet, expanding broadband capacity, and enhancing cybersecurity to provide a robust environment for innovation.	Larry Strickling, Assistant Secretary for Communications and Information, National Telecommunications and Information Administration (NTIA)
Innovation	2.4	Accelerate the development of industry-led skills strategies that result in a productive workforce for employers and high-quality jobs for workers.	Matt Erskine, Deputy Assistant Secretary, Economic Development Administration (EDA)
Innovation	2.5	Accelerate growth of innovation-intensive economic sectors by building public and private capacity to invent, improve, and commercialize new products and services.	Willie May, Associate Director for Laboratory Programs, NIST
Environment	3.1	Advance the understanding and prediction of changes in the environment through world class science and observations.	Kathy Sullivan, Acting Under Secretary of Commerce for Oceans and Atmosphere and Acting National Oceanic and Atmospheric Administration (NOAA) Administrator

Environment	3.3	Strengthen the resiliency of communities and regions by delivering targeted services to build capacity.	Kathy Sullivan, Acting Under Secretary of Commerce for Oceans and Atmosphere and Acting NOAA Administrator `
Environment	3.5	Enable U.S. businesses to adapt and prosper by developing environmental and climate-informed solutions.	Willie May, Associate Director for Laboratory Programs, NIST
Data	4.1	Transform the Department's data capacity to enhance the value, accessibility and usability of Commerce data for government, business and the public.	Mark Doms, Under Secretary for Economic Affairs, Economics & Statistical Administration (ESA)

Objective 2.1: Grow a more productive, agile, and high-value manufacturing sector through partnerships and collaborations that accelerate technology development and commercialization.

The U.S. manufacturing sector continues to be a mainstay of U.S. economic productivity, generating $1.9 trillion in gross domestic product (GDP) in 2012 (11.9 percent of total U.S. GDP). Moreover, manufacturing has a larger multiplier effect than any other major economic activity—$1 spent in manufacturing generates $1.35 in additional economic activity. Despite the U.S. manufacturing sector's apparent productivity, missed opportunities exist where the full economic and commercial value from investments in research are not realized.

The United States excels at basic science and invention. But, the commercial and economic rewards that emerge from these accomplishments are realized after discovery—especially at the points of manufacturing scale-up and commercialization. This is particularly true for complex, cost-efficient, high-value-added products whose commercialization requires development and mastery of equally complex manufacturing processes.

As overall U.S. R&D efforts have begun to lag that of other nations, the composition of industrial R&D has shifted toward short-term research. These trends leave industry's long-term needs unmet and ultimately undermine the nation's competitiveness. The Department is ideally positioned to address these challenges through its unique convening power. It will bring together public-private partnerships that can produce cutting edge research. These partnerships with businesses will accelerate technology development and commercialization, and strengthen the nation's position in the global competition for new products, new markets, and new jobs. In addition, NIST is the only research laboratory in the U.S. government specifically focused on enhancing industrial competitiveness, including a robust research portfolio concentrated on the technical challenges particularly associated with advanced manufacturing.

Strategies:

Establish the National Network for Manufacturing Innovation (NNMI). There is a gap in the U.S. innovation infrastructure that hinders the transition of new manufacturing processes and technologies from the lab bench to the manufacturing floor. The NNMI, a proposed national network of up to 45 institutes, will bring together companies, universities and community colleges, and government to develop world-leading technologies and capabilities that U.S.-based manufacturers can apply in production. As self-sustaining hubs, these institutes will create, showcase, and deploy new capabilities, new products, and new processes that can impact commercial production. They will build workforce skills at all levels and enhance manufacturing capabilities in companies large and small.

Support industry consortia to identify and address shared technical challenges. A common vision of long-term technology challenges can spur innovation across an industry. NIST's Advanced Manufacturing Technology (AMTech) program will provide grants to industry-led consortia to identify and prioritize research projects critical to long-term industrial advances. These technology roadmaps and related outputs will help guide applied research to meet industry's needs, some of which AMTech will support through university and government laboratory research funding.

Collaborate with industry on measurement science and standards to solve technical challenges. Rejuvenating U.S. manufacturing will require the development of measurements that support new, advanced manufacturing techniques. NIST will enhance partnerships with the U.S. manufacturing sector to develop and disseminate test methods, measurement tools and know-how, and scientific data that are embedded in the processes, products, and services of nearly every U.S. manufacturing industry.

Progress to Date:

As part of the AMTech program, NIST has launched a competition to award 8-16 grants to support new or existing industry-driven consortia to develop research plans that address high-priority challenges impeding the growth of advanced manufacturing in the United States.

Working with the Department of Defense (DOD) and the Department of Energy (DOE), the NIST-hosted Advanced Manufacturing National Program Office (AMNPO) is working to establish six new Institutes for Manufacturing Innovation. As part of these efforts, NIST has provided $19.5M to support research efforts at the various institutes. In addition, AMNPO has been working to establish a framework for managing the evolving network of institutes (best practices for intellectual property agreements, training programs, etc.) as well as working with staff on the Hill to draft legislation to authorize the NNMI program. A bipartisan bill that would authorize the NNMI program was recently introduced in the House.

Plans and Evaluations:

The NIST Visiting Committee on Advanced Technology (VCAT) assessed NIST's portfolio of manufacturing programs. Their recommendations are included in the *2012 Annual Report* at: http://www.nist.gov/director/vcat/. Manufacturing remained a focus of VCAT in 2013.

In addition, the VCAT's *2011 Annual Report* strongly endorsed the AMTech program as a model public-private partnership program for supporting technological innovation and facilitating its deployment to support advanced manufacturing. The VCAT's full set of specific recommendations on this topic is available at: http://www.nist.gov/director/vcat/upload/VCAT-Mfg-Summary-Recommendations.pdf .

The AMTech program was singled out in the President's Council of Advisors on Science and Technology (PCAST) "Report to the President on Ensuring American Leadership in Advanced Manufacturing" (June 2011) as a public-private partnership model that is needed to catalyze American excellence in advanced manufacturing. This report is available at: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-advanced-manufacturing-june2011.pdf .

The National Research Council (NRC) reviewed the NIST Center for Neutron Research (NCNR) in 2013, including the NCNR's efforts to enhance partnerships with industry. The NRC's report is available at: http://www.nist.gov/director/nrc/upload/ncnr-final-report-2013.pdf .

Objective 2.2: Increase the capacity of U.S. regional economies to accelerate the production of value-added goods and services by providing services to and investments in businesses and communities.

American communities must position themselves to compete in the new economy. However, communities with significant economic challenges may not have the knowledge or network needed to leverage their assets and identify opportunities. To understand the needs of producers and attract and expand investment they need partners and expert guidance. The Department assists with strategic place-based investments that help create a productive industrial ecosystem. This support includes resources for infrastructure, planning, and technical assistance to strengthen the capacity for innovation in manufacturing. Technical assistance funding focuses on enhancing industry-required skills and identifying international supplier opportunities for small businesses.

The Department is dedicated to helping regional economies thrive and provides grants to state and local governments and non-profits in communities and regions suffering from economic distress. Technical and business assistance is also provided to smaller manufacturers through partnerships between federal and state governments and non-profit organizations. Some grants and services are specifically targeted to increasing the competitiveness of minority businesses.

Strategies:

Support small and mid-sized manufacturing by restoring robust supply chains. Small and mid-sized manufacturers are central to regional economic growth and innovation, but they can face unique challenges in deploying advanced manufacturing technologies. Through its national network of 60 centers, the NIST Hollings Manufacturing Extension Partnership (MEP) will expand its efforts to strengthen the competitive position of small and mid-sized manufacturers through new efforts within the MEP network, including the establishment of Manufacturing Technology Acceleration Centers (M-TACs) and supplier scouting.

Progress to Date:

MEP has launched a Request for Information (RFI) to gather input on the M-TACs, and is planning to establish five pilot M-TACs with existing resources. The MEP program continues to provide valuable services to America's small and medium manufacturers. For every one dollar of federal investment, the MEP generates nearly $19 in new sales growth and $21 in new client investment. This translates into $2.2 billion in new sales annually. For every $1,978 of federal investment, MEP creates or retains one manufacturing job.

Plans and Evaluations:

The National Academy of Sciences (NAS) issued a report in September of 2013 on its review of "21st Century Manufacturing: The Role of the Manufacturing Extension Partnership of the National Institute of Standards." The objectives of this evaluation which began in FY 2011 are to generate a better understanding of the operation, achievements, and challenges of the MEP program and provide recommendations to improve program operations and impact.

Objective 2.3: Strengthen the Nation's digital economy by championing policies that will maximize the potential of the Internet, expanding broadband capacity, and enhancing cybersecurity.

The digital economy is the great engine of innovation and economic growth of the 21st century, and the Department is its principal defender and champion in the federal government. The Internet engine that powers this vast marketplace of electronic goods and services was developed within the federal government. But it has flourished in the private sector—where it should remain.

This extraordinary platform for innovation, growth, and social progress faces urgent policy questions that demand a thoughtful government response. How can personal information and intellectual property be protected online? How can the Nation's critical digital infrastructure be defended from cyber-attacks? How can high-speed and affordable Internet access for all

Americans be ensured? And, how can these goals be achieved while preserving, here and around the world, the fundamentally open nature of the Internet, free from unnecessary regulation?

NIST has essential responsibility and a central role in answering these questions. It oversees the development of voluntary industry cybersecurity and other online safety standards. And it has a growing role in advanced communications, with the establishment of the Communications Technology Laboratory, which will form part of the joint Center for Advanced Communications (CAC) with the National Telecommunications and Information Administration (NTIA).

Strategies:

Foster advanced communications technologies. Spectrum sharing and other innovations in advanced communications will drive economic growth and development. The Department will leverage the key research and engineering expertise and capabilities of NIST and NTIA by establishing the CAC. This unique national asset will provide both research and testing capabilities. NIST and NTIA will partner with industry, academia, and government agencies to foster the invention, development, and deployment of future advanced communications technologies.

Create a standards framework to reduce cyber risks to critical infrastructure. The national and economic security of the United States depends on the reliability of critical infrastructure, including the electric grid, financial sector, and communications system. Taking full advantage of existing cross-sector security standards and guidelines, NIST is leading the development of a Cybersecurity Framework that will help critical infrastructure owners and operators to identify, assess, and manage cyber risk. NIST will support future private sector implementation of this framework.

Progress to Date:

The new center will implement a key provision of a memorandum President Obama issued on June 14, 2013, on "Expanding America's Leadership in Wireless Innovation" (http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio). In support of the new CAC, NIST has established a new Communications Technology Laboratory at the Boulder campus. NIST has procured an initial set of advanced instrumentation necessary to develop required new metrology capability at NIST to support the CAC. As part of the initial efforts of the CAC, NIST and NTIA have established a partnership with DOD and other Federal agencies to ensure that the government has timely access to spectrum testing capabilities in order to help facilitate the development of new spectrum sharing technologies and to streamline their deployment.

Cybersecurity Framework -- Under Executive Order 13636, *Improving Critical Infrastructure Cybersecurity,* NIST was charged with the responsibility to develop a voluntary framework – based on existing standards, guidelines, and practices – for reducing cyber risks to critical infrastructure. The Framework seeks to promote the wide adoption of practices to increase cybersecurity across all sectors and industry types. It seeks to provide owners and operators a flexible, repeatable and cost effective risk-based approach to implementing security practices while allowing organizations to express requirements to multiple authorities and regulators. The first version of the framework was released on February 12, 2014 (http://www.nist.gov/cyberframework/upload/cybersecurity-framework-021214.pdf). The framework is not a static document and will continue to evolve over time. Updates on framework progress can be found at: http://www.nist.gov/itl/cyberframework.cfm .

Plans and Evaluations:

With the publication of the framework, NIST brings its technical expertise in the development and use of cybersecurity guidance to promote voluntary adoption of the framework. The Cybersecurity Framework identifies areas for improvement that should be addressed through future collaboration with particular sectors and standards-developing organizations. Areas for improvement include authentication; automated indicator sharing; conformity assessment; cybersecurity workforce; data analytics; international aspects, impacts, and alignment; privacy standards; and supply chains risk management. NIST will be developing a roadmap to address these areas. NIST will also be working towards development of a governance plan for the Cybersecurity Framework with a goal to establish a voluntary critical infrastructure provider group that will steward the development and refinement of future versions of the framework.

Objective 2.4: Accelerate the development of industry-led skills strategies that result in a productive workforce for employers and high-quality jobs for workers.

A skilled and adaptable workforce is critical to U.S. global competitiveness and sustainable economic growth. An employer-aligned, (i.e., demand-driven) comprehensive approach to skills development is essential to helping businesses across all sectors better access skilled workers to grow, innovate, and be more productive. A skills strategy focused on industry-driven solutions helps address the difficulties many industries, particularly manufacturing, have in filling jobs requiring specific technical skills—even with many Americans still looking for work. NIST is an honest broker for business and possesses the convening power, regional economic development expertise, and supply-chain-need analytical capability to highlight and address the workforce demands of growing industries.

Strategies:

Implement industry-driven initiatives that provide U.S. workers with in-demand skills. Many unemployed or underemployed workers lack the skills that businesses need to fill the millions of open jobs across the Nation. NIST will capitalize on its relationships with businesses and state and local governments to champion and support employer-aligned skills programs. Through MEP's national system of centers, NIST will support and promote programs that identify the future hiring needs of small manufacturers and expose young people to STEM (science, technology, engineering, mathematics) fields.

Progress to Date:

NIST MEP, in collaboration with MEP centers, is currently in the process of developing a talent management system - Strategic Management Acquisition and Retention of Talent (SMARTalent). SMARTalent is intended to help manufacturers operationalize their workforce development strategies. As manufacturers focus on workforce planning and investment, this resource, in combination with the expertise of the local MEP center, can help most effectively operationalize investments with the objective to enable manufacturers to eliminate task redundancies and streamlines processes.

MEP also supports industry efforts to respond to a long-standing issue for recruiting new talent for small manufacturers – public image of manufacturing. To help re-brand manufacturing and inform education providers and the general public about advanced manufacturing, MEP is reaching out through social media, publications, conferences, presentations, partnerships and direct Center involvement to change the image of manufacturing. All workforce initiatives and/or activities are relayed throughout the MEP network for utilization. MFG Day (http://www.mfgday.com/), co-produced by Hollings MEP, Fabricators and Manufacturers Association, National Association of Manufacturers, The Manufacturing Institute, along with the Science Channel and Shell Oil, showcases a nation-wide number of activities, open houses and events to interest the public in advanced manufacturing.

Plans and Evaluations:

The need for a tool such as SMARTalent is described in a 2012 report "Taking Measure of Talent" from the *Harvard Business Review.* The report stated that companies implementing talent management programs that automate tasks and gather data on workforce actions were gaining an edge over their competitors. SMARTalent will provide business-focused data for decision-making in individual small firms, but will also provide information to academia about new manufacturing skills, and allow benchmarking and workforce support for manufacturers regionally and nationally.

NIST MEP uses a broad array of research and reports to shape its program direction. For report highlights related to skills and workforce for small and medium sized manufacturers, see the MEP website at: http://www.nist.gov/mep/state-of-mfg/education_workforce.cfm .

Objective 2.5: Accelerate growth of innovation-intensive economic sectors by building public and private capacity to invent, improve, and commercialize new products and services.

In order for innovative products to enter and compete in the marketplace successfully, a robust scientific and technological infrastructure is required. Fundamental research at the forefront of science provides the seeds for the development of new products and services. Policies that accelerate the rate of transfer of technologies from lab to market bolster the return on government investment in R&D. Agreed upon ways to measure the performance and quality of new products against more established technologies provide the foundations of product interoperability and allows them to compete in the international marketplace. By investing in knowledge transfer mechanisms that are critical to growing new companies and facilitating innovation, the Department promotes regional and community capacity to generate and take advantage of new ideas about products and processes.

NIST plays a central role in providing the foundation critical to the growth of high-value, innovative economic sectors. Its measurement science expertise creates the infrastructure necessary to measure the performance and quality of products and services. NIST programs enable innovators to accelerate the movement of new products and technologies to the marketplace.

Strategies:

Develop and provide next-generation measurement tools and standards. Precise measurements and robust standards are critical for an innovative high-technology economy and provide the foundations for interoperability between products and systems, enabling global trade. In close cooperation with industry, academia, and other federal agencies, NIST will advance measurement science, develop standard protocols and test methods, and evaluate and generate data supporting innovative areas of the economy. NIST's connections with private sector standards developing organizations will help ensure that new and updated standards have strong technical underpinning.

Build research capacity in emerging areas of research to meet tomorrow's challenges. Technological innovation is accelerating at a pace unprecedented in human history, and the continued competitiveness of U.S. industries will require breakthroughs in measurement science in all disciplines. Through the Centers of Excellence Program, NIST will partner with leaders in academia and industry to augment internal research programs and develop access to leading talent, ensuring that the Agency can meet future measurement science needs.

Accelerate rate of lab-to-market commercialization. A wide range of life-changing commercial technologies were nurtured by federally funded R&D, from the Internet, to the global positioning system (GPS), to leading-edge vaccines. The federal R&D enterprise must continue to support fundamental research and diffuse this knowledge through open data and publications. Through streamlined processes and increased engagement with entrepreneurs, DOC will facilitate industry access to federal laboratories and federally funded research.

Progress to Date:

Investments to grow and strengthen the NIST Laboratory Programs have been the top priority of the agency for the past several years and as a result funding for the NIST Laboratory Programs has increased by 12.4% from FY 2010 through FY 2013. These increased resources have enabled NIST to launch a number of key programs to further accelerate innovation in a number of critical priority areas. Highlights include:

- NIST on a Chip -- NIST is developing a next-generation plan for advancing measurement services, called NIST on a Chip. NIST on a Chip is an integrated program to develop and deploy NIST-traceable measurements and physical standards that are deployed in the customer's lab, factory floor, device, or system; are easily used and integrated; are rugged, yet small in size and weight; and have low power consumption. As the reference standard is integrated into the device or process, many of the difficulties of the traditional measurement service model can be overcome, including minimal down time and recalibration, as well as improved flexibility for innovation. Measurement technologies include force, fluid flow, pressure, length, voltage, current, magnetic field, time and frequency, optical power, displacement, and electric field. Examples of work in this area can be found at: http://www.nist.gov/pml/newsletter/ .
- Centers of Excellence -- In FY 2013, NIST launched the NIST Centers of Excellence Program. The NIST Centers of Excellence will provide an interdisciplinary environment where researchers from NIST, academia, and industry will collaborate on emerging areas of basic and applied research and innovations in measurement science. These centers are meant to:
  - Foster expanded development of expertise in measurement science and its role in innovation through the education and training of scientists and engineers;
  - Provide greater opportunities for NIST to engage with industry and entrepreneurs; and
  - Enhance technical innovation through earlier alignment of measurement science with emerging and innovative fields of research.

  The first center competed in FY 2013 will be in the area of Advanced Materials. Full details can be found at: http://www.nist.gov/coe/advmat/index.cfm .

Plans and Evaluations:

During FY 2012, NRC convened a panel of experts to perform an assessment of the manufacturing-related programs at NIST. The assessment considered manufacturing research at NIST broadly with emphasis on three specific advanced manufacturing areas: nanomanufacturing; smart manufacturing; and next generation materials measurements, modeling, and simulation. The NRC Assessment Report is available at: http://www.nist.gov/director/nrc/upload/final-manufacturing-report2012.pdf .

The NRC will be conducting technical assessments of the scientific impact of selected NIST laboratories on a yearly basis. For FY 2014, the NRC will conduct technical assessments of the scientific impact of the Engineering Laboratory and the Material Measurement Laboratory on the following criteria: the technical quality and merit of the laboratory programs relative to the state-of-the-art worldwide, the effectiveness with which the laboratory programs are carried out and the results disseminated to customers, the relevance of the laboratory programs to the current and future needs of stakeholders, and the adequacy of the facilities and laboratory equipment to perform the program functions.

In early FY 2014, the VCAT focused on cybersecurity and advanced manufacturing to help shape and define the NIST role in each of these national priority areas. The Committee will be developing specific recommendations to position NIST to best respond to each of these areas. These recommendations will be provided in the VCAT's 2013 Annual Report. The current report can be found at: http://www.nist.gov/director/vcat/ .

Objective 3.1: Advance the understanding and prediction of changes in the environment through world class science and observations.

To meet the needs of communities and businesses in a changing environment, comprehensive and integrated observations and an improved understanding of the Earth system are needed. To make this improved understanding useful to society, it must be employed in models and applications that are used in planning and decision making.

NIST supports the research, development, and observations required for state-of-the-art models and applications critical to national well-being. Also, NIST is working to develop reliable, internationally-accepted measurement standards and methodologies that are the basis for future-generation measurement and monitoring capabilities. NIST will continue to work closely with its scientific partners to advance R&D to support the lives and livelihoods of the Nation's citizens.

Strategies:

Improve the understanding of greenhouse gas processes. As the effects of increased greenhouse gas become more apparent, there is a growing need for a better understanding of the processes that cause the increase. The National Oceanic and Atmospheric Administration (NOAA) and NIST will work cooperatively to link measurements and standards supporting the atmospheric and emissions monitoring communities. The efforts of both bureaus will advance measurement capabilities of the monitoring networks and improve measurements of greenhouse gas emissions on scales ranging from the global to metropolitan areas and cities.

Progress to Date:

NIST has funded cooperative agreements furthering research efforts to sustain and expand greenhouse gas (GHG) measurements test beds in the U.S. currently located in Indianapolis, Ind. and Los Angeles, Calif. The Indianapolis testbed, begun in 2011, is a greenhouse gas observing network within and around the city with 12 real-time observing locations on communications, 6 of which are capable of collecting samples for later analysis, as well as other instrumentation. The research testbed in Los Angeles was started in 2012 and is ramping up an operation network of up to 15 observing stations in and around the South Coast Air Basin with unique challenges in population density and geographic topography.

Plans and Evaluations:

NIST Greenhouse Gas and Climate Science Measurements Program will develop advanced measurement tools and standards to improve the accuracy and capability for remote observations of greenhouse gas, both satellite and surface-based with an emphasis on cities and metropolitan areas. The program will independently verify greenhouse gas emissions inventories, and extend measurement science to better understand and describe the Earth's climate. The program will also enable international measurement standards and protocol developments that ensure accuracy, confidence, and reliability of local and global assessments of GHG emissions.

Objective 3.3: Strengthen the resiliency of communities and regions by delivering targeted services to build capacity.

Many U.S. communities face significant environmental changes, natural disasters, or economic disruptions. They need plans to reduce the effects, adapt to future changes, and support long-term recovery efforts. A key component of these plans should be actionable information to aid in managing risk and in developing and evaluating options to adapt to and mitigate future environmental and economic change. NIST will strengthen community-based resilience efforts. It will promote preparedness, protect critical public resources, support science and research germane to preparedness and resilience, and ensure that federal operations continue to serve citizens in a changing climate. The means to these ends will be building on a strong scientific foundation and decades of engagement with interagency, academic, and private sector partners.

Strategies:

Lead the development of a Disaster Resilience Framework. To protect critical infrastructure and public resources, NIST will lead the development of a Disaster Resilience Framework for building and infrastructure resilience. The framework will apply to many types of hazards (e.g., tornadoes in the Midwest and earthquakes on the West Coast). A Disaster Resilience Standards Panel convened by NIST will further refine the framework and identify model resilience guidelines to put the framework into action. This national effort will require significant engagement with stakeholders and federal agencies, including NOAA, the Department of Homeland Security (DHS), the Federal Emergency Management Agency, the U.S.

Geological Survey (USGS), the Department of Transportation (DOT), the Department of Housing and Urban Development, and the National Science Foundation (NSF). The kick off meeting to develop the framework is scheduled for April 7, 2014.

Progress to Date:

NIST completed a 2-year technical investigation into the impacts of the May 22, 2011, tornado that struck Joplin, Mo. The key conclusion from the report is that nationally accepted standards for building design and construction, public shelters and emergency communications can significantly reduce deaths and the steep economic costs of property damage caused by tornadoes. Recommendations for achieving these standards are featured in a draft report issued on November 21, 2013, and are strongly supported by a second NIST report released December 3, 2013, that documents impacts observed following the May 20, 2013, tornado in the Newcastle-Moore area of Oklahoma. The NIST Joplin study was the first to perform a scientific assessment of the impact of a tornado in four major categories: tornado characteristics, building performance, human behavior, and emergency communication—and the impact of each on life-safety, and the ability to protect people from injury or death. It also is the first to recommend that standards and model codes be developed and adopted for designing buildings to resist tornadoes.

Plans and Evaluations:

The President's Climate Action Plan (issued in June 2013) directs NIST to convene a panel on disaster-resilience standards to develop a comprehensive, community-based resilience framework and provide guidelines for consistently safe buildings and infrastructure—products that can inform the development of private-sector standards and codes. To accomplish this, NIST will convene a series of regional workshops engaging the broad network of stakeholders on the role that buildings and infrastructure lifelines play in ensuring community resilience. Based on workshop results, NIST will develop a Disaster Resilience Framework to establish the overall performance goals; assess existing standards, codes, and practices; and identify gaps that must be addressed in order to bolster community resilience. NIST plans to release the Disaster Resilience Framework for public comment in April 2015. This document will be the starting point to establish a Disaster Resilience Standards Panel (DRSP). The DRSP will be a self-governing body, supported by NIST, that will meet regularly to put the framework into action.

The NRC conducts technical assessments of the scientific impact of selected NIST laboratories on a yearly basis. For FY 2014, the NRC will conduct a technical assessment of the scientific impact of the Engineering Laboratory programs including the Resilience program.

In early FY 2014, the NIST VCAT was briefed on the NIST Resilience Initiative program to help shape and define the NIST role in this national priority area. The Committee will be developing specific recommendations to position NIST to best respond to different priority areas. These recommendations will be provided in the VCAT's Annual Report. The current report can be found at: http://www.nist.gov/director/vcat/ .

The National Construction Safety Team (NCST) Advisory Committee advises NIST on carrying out investigations of building failures conducted under the authorities of the NCST Act. Members are selected based on their technical expertise and experience, established records of distinguished professional service, and their knowledge of issues affecting NIST studies. The NCST Advisory Committee submits a report to Congress annually.

The National Academies has an on-going program on disaster resilience that has produced two reports, "Disaster Resilience: A National Imperative" (2012) and "Launching a National Conversation on Disaster Resilience in America: Workshop Summary" (2013). These reports are used to inform the NIST Resilience Program.

Objective 3.5: Enable U.S. businesses to adapt and prosper by developing environmental and climate informed solutions.

To survive and flourish, businesses must be able to adapt to the changing environment by balancing environmental, social, and economic concerns. When businesses adopt processes and solutions that recognize the importance of the environment and climate, the results can include cost savings and new commercial products and services that improve profitability and competitiveness. At the same time, the positive power and reach of business and markets will further our shared environmental, social, and economic goals for the health of the Nation.

The Department is uniquely equipped to develop and provide new environmental and climate informed services that help businesses enhance their value. NIST's programs in this area can be leveraged to empower U.S. companies and foster environmental and climate business solutions that benefit the Nation.

Strategies:

Develop standards and tools to assess green building technologies. NIST will develop measurement science that enables architects and developers to design buildings that produce as much energy as they consume and to use more durable materials. NIST will leverage its expertise in the areas of energy, service life prediction, life-cycle assessment, and indoor air quality to deliver test methods/performance metrics that assist the marketplace in capturing the value of green building technologies. This work requires partnerships with DOE, industry, and standards development organizations.

Progress to Date:

NIST completed construction of the Net-Zero Energy Residential Test Facility and has initiated a series of controlled experiments. The Net Zero facility is a unique laboratory at NIST in Gaithersburg, Md. This facility, operated by the Energy and Environment Division in NIST's Engineering Laboratory, will allow researchers to test various high-efficiency and alternative energy systems, materials, and designs. During the first year of operation, NIST researchers will simulate a family of four living in an energy efficient home and monitor how the house performs. The goal is to demonstrate that a net-zero energy house—one that produces as much energy as it consumes over the course of a year—can fit into any neighborhood. Following the year-long experiment, the facility will be used to test existing and new energy efficient technologies and develop methods of test that better reflect how those technologies will perform in a real home, rather than a laboratory.

Plans and Evaluations:

NIST will complete and publish a new software tool called BIRDS (for Building Industry Reporting and Design for Sustainability). The tool will be a free, web-based application to further research, design, and planning efforts focused on building energy use and technologies to improve energy efficiency. BIRDS complements NIST's Building for Environmental and Economic Sustainability tool which is widely used in industry and government. BIRDS will help users put an environmental score on a proposed building design and to assess the life cycle costs associated with that building. The BIRDS database will include different types of buildings constructed to a variety of building energy code levels. It will help developers assess life cycle cost trade-offs over different investment time horizons for buildings with different environmental performance.

The NRC will be conducting technical assessments of the scientific impact of selected NIST laboratories on a yearly basis. For FY 2014, the NRC will conduct technical assessments of the scientific impact of the Engineering Laboratory and Materials Measurement Laboratory programs including sustainability programs. The NRC report will be completed in December of 2014.

Objective 4.1: Transform the Department's data capacity to enhance the value, accessibility and usability of Commerce data for government, business and the public.

The Department of Commerce produces and uses large and growing amounts of data, including data on the economy, our population, and our environment. This data is fundamental to our mission and is used for the protection of life and property and to enhance economic growth. To meet these needs, Commerce data must be accessible, useable, reliable, and comprehensive.

Simply continuing to produce quality data is not enough. In order to realize the potential value of the data Commerce produces, barriers to accessing and using the data must be minimized. Barriers that reduce the data's value include an absence of common formats and standards, capacity constraints limiting the amount of data that can be released, suboptimal organization across various websites making finding the data difficult, and a lack of customer awareness about what Commerce provides.

By making relatively modest investments and reaching out to a wide array of data users, each of these barriers can be reduced. Commerce can lead actions that are needed to make sure government data gets used to make our businesses more competitive, our governments smarter, and our citizens more informed.

Strategies:

Expand data interoperability across Commerce, and expand open data access and dissemination. The Department will use a standards approach to develop an interoperable Commerce Data Infrastructure. Adherence to a set of common standards and architecture would result in a powerful data platform that provides universal access to data in usable form. Improving discovery and analysis by enhancing access will make data produced by Commerce more effective. Usable open data will promote economic growth and energize a data-as-a-service marketplace for entrepreneurs, new businesses, and the public. This infrastructure and its enabling standards will be developed in a close collaboration between the public and private sectors.

Progress to Date:

In response to the Office of Management and Budget (OMB) Memorandum M-13-13 "*Open Data Policy- Managing Information as an Asset*" and Office of Science and Technology Policy (OSTP) Memo Feb. 2013 "*Increasing Access to the Results of Federally-Funded Scientific Research,* NIST has established a Scientific Data Committee[1] (SDC) to serve as a resource to NIST laboratories and the NIST Director's office on data preservation and access standards, technologies, metadata issues, and implementation priorities, processes, performance measures, and strategies for the preservation of and access to digital scientific data at NIST. As of October 1, 2014, NIST will create data management plans for scientific data generated at NIST. Additionally, an Interagency Technical Advisory Group (iTAG) with members from NIST, the Census Bureau, DOE, the Department of Treasury, the National Archives and Records Administration, and the Smithsonian has been established to provide a forum for Federal agency and entity coordination on operational requirements and insights on how to maximize access to scientific and technical data.

Plans and Evaluations:

The NIST/SDC Open Data Plan has three elements. The first element is to develop and pilot an extensible data registry that describes data sets using common metadata and uses persistent identifiers to provide access to those NIST digital objects regardless of their physical location; the second element is to develop and pilot a tool to help NIST-funded researchers to plan for data management at the beginning of each project; and the third is to conduct training and outreach to make data

[1] http://inet.nist.gov/pao/upload/NIST-Scientific-Data-Committee-Charter.pdf

providers aware of their responsibilities and data consumers aware of available data assets. NIST has established a Data Coordinator and a Data policy group to oversee these efforts.

Objective 4.3: Foster the private sector's development of new data-based businesses, products and services.

Strategies:

Drive the development of Big Data standards and measurement science. The availability of vast data resources carries the potential to answer questions previously out of reach. There is also broad agreement that Big Data will overwhelm traditional approaches. The rate at which data volumes, speeds, and complexity are growing is outpacing scientific and technological advances in data analytics, management, transport, and more. A lack of consensus on some important, fundamental questions will confuse potential users and hold back progress. What are the attributes and characteristics that define Big Data environments? What are the central scientific, technological, and standardization challenges that need to be addressed to accelerate the deployment of robust Big Data solutions? NIST will drive advancements in Big Data standards by forming communities of interest from industry, academia, government, and other standards bodies, with the goal of developing consensus definitions, taxonomies, secure reference architectures, and a technology roadmap.

Progress to Date:

On June 19, 2013, the NIST Big Data Public Working Group (NBD-PWG) was launched with participation from industry, academia, and government across the nation. The NBD-PWG will form a community of interest from all sectors including industry, academia, and government, with the goal of developing a consensus in definitions, taxonomies, secure reference architectures, and a technology roadmap. The NBD-PWG has created five subgroups: Definitions and Taxonomies, Use Case and Requirements, Security and Privacy, Reference Architecture, and Technology Roadmap. These subgroups have developed a set of consensus working drafts.

Plans and Evaluations:

NIST will lead the NBD-PWG to create a vendor-neutral, technology and infrastructure agnostic framework which would enable Big Data stakeholders to pick-and-choose best analytics tools for their processing and visualization requirements on the most suitable computing platform and cluster while allowing value-added from Big Data service providers.

Part 2 Performance Results and Plans

Section 1: FY 2013 Summary Description of Performance by Objective

FY 14-18 Strategic Goal: Foster a more innovative U.S. economy—one that is better at inventing, improving, and commercializing products and technologies that lead to higher productivity and competitiveness

FY 14-18: Strategic Objective: Accelerate growth of innovation-intensive economic sectors by building public and private capacity to invent, improve, and commercialize new products and services

Benefits:

NIST's mission to promote innovation and industry competitiveness is best served by supporting activities throughout the research and development pipeline, from the most basic science to the deployment of advanced technologies. NIST programs are designed to span this pipeline, supporting advanced manufacturing by facilitating pre-competitive and applied research as well as technology deployment, and performing world-class metrology and technology research and services.

Recurring Indicators

Indicator	Target	Actual	Status	Trend
Citation impact of NIST-authored publications	1.1	1.93*	Exceeded	Positive
*Actual for this indicator will lag at least 9 months. The number shown here is based on FY 2012 data.				

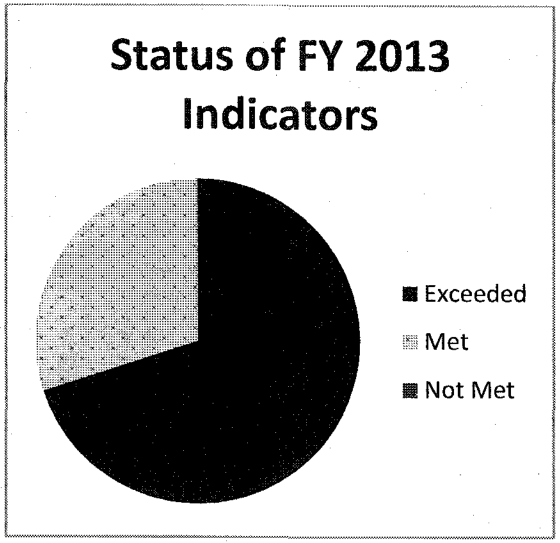
Non-recurring Indicators (these indicators appear only in FY 2013 and are not tied to the new goals and objectives)

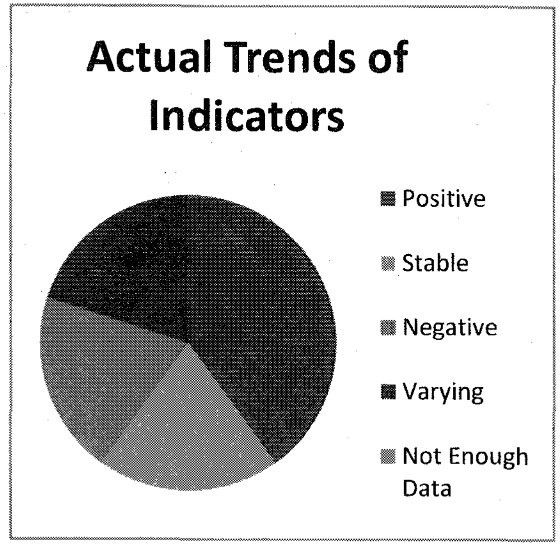
Indicator	Target	Actual	Status	Trend
Qualitative assessment and review of technical quality and merit using peer review	Complete annual peer review	Completed	Met	Stable
Peer-reviewed technical publications	1,210	1,393	Exceeded	Positive
Standard Reference Materials sold	31,000	32,267	Exceeded	Positive

NIST-maintained datasets downloaded	18M	18.6M	Exceeded	Varying
Number of calibration tests performed	13,000	14,974	Exceeded	Negative
Number of clients served by MEP Centers receiving Federal funding	32,500	30,131	Met	Varying
Increased sales attributed to MEP Centers receiving Federal funding ($ in Billions)	$2.2M from FY 2012 funding	$2.2M from FY 2012 funding**	Met	Negative
Capital investment attributed to MEP Centers receiving Federal funding ($ in Billions)	$1.3M from FY 2012 funding	$2.6M from FY 2012 funding**	Exceeded	Positive
Cost savings attributed to MEP Centers receiving Federal funding ($ in Billions)	$1.1 from FY 2012 funding	$1.2M from FY 2012 funding**	Exceeded	Stable

**The FY 2013 actuals will be available in January 2015 due to the lag time associated with collecting and analyzing the Hollings MEP client survey data six months after the services are delivered. This data lag, coupled with the time line for producing the FY 2013 Annual Performance Report, precludes the reporting of actual FY 2013 data for this indicator.

All FY 2013 Indicators:





Section 2: Detailed Description of Past and Future Performance by Objective

New or Recurring Indicators

Objective 2.1: Grow a more productive, agile, and high-value manufacturing sector through partnerships and collaborations that accelerate technology development and commercialization.

Indicator	**Level of co-investment by non-federal sources** in NNMI **institutes**							
Description	This indicator reflects how well the focus area of the National Network for Manufacturing Innovation (NNMI) Institutes matches a real national need and is intended to measure the extent to which the industrial partners perceive that they are receiving value from the existence of the Institute. Non-federal partners dedicate resources when they believe that there will be economic benefit. Non-federal sources include industry partners of all sizes, state and local governments, economic development entities, institutions of higher education, private organizations and individuals. Investment includes cash and in-kind resources provided.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	$0	$6 million
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	None.							

Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Proposal letters of commitment and project reporting	Annual	Electronic and paper at NIST Advanced Manufacturing Program Office	Data reflects direct and verifiable counts. Internal controls include verification and review by NIST Advanced Manufacturing	Data will likely not reflect all non-federal contributions to the institute.	None

			Program Office and Grants Management Division personnel.		

Indicator	**Industry use of NIST research facilities**							
Description	This indicator reflects the value, relevance, and usefulness of NIST research facilities to industry users. NIST research facilities are unique capabilities that can be leveraged through partnerships with businesses, especially manufacturers, to accelerate discovery and commercialization of innovative products. This indicator counts the number of Cooperative Research and Development Agreements between industry and NIST laboratories, as well as the number of industrial institutions that use the NIST user facilities (NIST Center for Neutron Research and the Center for Nanoscale Science and Technology).							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	215	225
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	Data may not include all instances of industry use of NIST research facilities indirectly through support of academic research.							

Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Technology Partnerships Office, NIST Center for Neutron	Ongoing	NIST Technology Partnerships Office, NIST Center for Neutron	Data represents direct and verifiable counts. Internal controls include verification and review by NIST Technology Partnerships Office, NIST Center for	Data does not reflect scope of partnership (i.e., whether one experiment or an ongoing, multifaceted investigation).	None

Research, Center for Nanoscale Science and Technology		Research, Center for Nanoscale Science and Technology	Neutron Research, Center for Nanoscale Science and Technology, and the NIST Program Coordination Office		

Objective 2.2: Increase the capacity of U.S. regional economies to accelerate the production of value-added goods and services by providing services to and investments in businesses and communities.

Indicator	**Number of firms receiving in-depth technical assistance from MEP centers**							
Description	Number of client firms receiving services from MEP centers where those services were substantial and essential and therefore could reasonably be assumed to have directly or entirely led to the impacts reported through the MEP client survey.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	8340	8750
Actual	N/A	N/A	N/A	N/A	7614	7943*		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	*The FY 2013 data covers the first three quarters of the fiscal year. The actual will be provided once the fourth quarter data becomes available upon completion and confirmation of the survey at the end of March 2014.							
Validation and Verification *(same as shown on the table below for the other MEP indicator)*								

Indicator	**Percentage of MEP clients receiving in-depth technical assistance that increase their competitiveness**
Description	Percentage of MEP clients receiving in-depth technical assistance that reported increasing sales, reducing costs, or making new investments as a result of the services received.

	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	60%	62%
Actual	N/A	N/A	N/A	N/A	61%	57%*		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data.							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	*The FY 2013 data covers the first three quarters of the fiscal year. The actual will be provided once the fourth quarter data becomes available upon completion and confirmation of the survey at the end of March 2014.							

Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
The client impact survey is administered by a private firm, Fors Marsh Group, located in Arlington, Va.	The survey is conducted four times per year, and clients are selected based on when they completed the first project with a MEP Center in the previous year.	Survey data is sent directly to MEP for analysis. MEP reviews and stores survey data received from Fors Marsh Group.	Internal controls include verification and significant review of the client responses by MEP staff. Criteria are in place for identifying outliers in the data. Centers verify the outlier and if necessary, the data are revised based on the Center review.	As with similar survey instruments, sources of uncertainty include variation in interpretation of specific questions; in the estimation techniques used in response to specific questions; in the quality of industry data; missing values; and other common survey problems.	None

Objective 2.3: Strengthen the Nation's digital economy by championing policies that will maximize the potential of the Internet, expanding broadband capacity, and enhancing cybersecurity.

Indicator	**Number of products integrating the Cybersecurity Framework**							
Description	This indicator demonstrates that NIST consistently produces useful and relevant cybersecurity publications and reference materials that technology vendors can integrate into product and service offerings. Critical infrastructure owners and operators use these products and services to improve their management of cybersecurity risk. This indicator also demonstrates transfer of technology from government to industry to support market needs and facilitate innovation.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	10	15
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	None.							
Validation and Verification *(same as shown on the table below for the other cybersecurity indicator)*								

Indicator	**Number of citations of the Cybersecurity Framework**							
Description	This indicator demonstrates that NIST-produced Cybersecurity Framework and associated reference materials are being cited in relevant standards, guidelines, and practices by critical infrastructure sectors, sector-specific agencies, and others. The Cybersecurity Framework may be cited in professional journals; international/national/industry standards, guidelines, and practices; sector-specific federal agency guidance to industry; cybersecurity media reports; and other resources.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	10	15
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		

Trend	Not Enough Data				
Explanation (if not met in FY 2013)	N/A				
Actions to be taken / Future Plans	N/A				
Adjustments to targets	N/A				
Information Gaps	None.				
Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Information Technology Laboratory research and stakeholder outreach	Ongoing	Information Technology Laboratory	Review and verification by Information Technology Laboratory personnel	None	None

Objective2.4: Accelerate the development of industry-led skills strategies that result in a productive workforce for employers and high-quality jobs for workers.

Indicator	**Number of MEP centers partnering with skills training providers (e.g., community colleges) to link manufacturing firms with skills training resources.**							
Description	This indicator reflects the number of MEP centers involved in activities supporting the development of a workforce with industry-aligned skills. MEP is working with partners throughout the national network of centers to provide the tools, services, and connections necessary to develop a workforce with industry-aligned skills.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	50	55
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data.							
Explanation (if not met in FY 2013)	N/A							
Actions to be	N/A							

taken / Future Plans					
Adjustments to targets	N/A				
Information Gaps	None.				
Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
MEP center project reporting	Annual	Manufacturing Extension Partnership office	Review and verification by Manufacturing Extension Partnership office personnel.	Output measure only.	None.

Objective 2.5: Accelerate growth of innovation-intensive economic sectors by building public and private capacity to invent, improve, and commercialize new products and services.

Indicator	**Citation impact of NIST-authored publications**							
Description	This indicator demonstrates that NIST consistently produces useful and relevant scientific and technical publications and is outcome-oriented. The "relative citation impact" indicator is the ratio of the average number of citations per publication (citation rate) for all NIST publications in a year to the average citation rate for a large group of peer institutions in the world. Publications typically lag by a minimum of two years due to the time needed for research, writing, journal peer review, and publication processes.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	1.1	1.1	1.1	1.1	1.1	1.1	1.5	1.5
Actual	1.76	1.76	1.77	2.1	1.93	1.93*		
Status	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded		
Trend	Positive.							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							

Adjustments to targets	Due to consistent outperforming of the previous target, NIST increased the FY 2014 target from 1.1 to 1.5. This brings NIST's target in line with the performance of peer institutions in the U.S. (the average relative citation impact of U.S. institutions is about 1.5). The FY 2011 and FY 2012 levels are anomalous in the history of NIST, and NIST did not meet the 1.5 target as recently as 2007.				
Information Gaps	*The FY 2013 actual for this indicator will lag at least nine months. The number shown here is based on FY 2012 data.				
Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
Thomson Reuters InCites™	Annual	NIST	Internal controls include verification and review by NIST Information Services Office and the NIST Program Coordination Office.	Factors such as self-citations, citation circles, and multiple authorship may affect the reliability of any data of this nature.	None

Objective 4.1: Transform the Department's data capacity to enhance the value, accessibility, and usability of Commerce data for government, business, and the public.

Indicator	**Milestones completed for Commerce interoperability framework**							
Description	NIST will, in collaboration with other agencies, develop an interagency reference architecture and Commerce Interoperability Framework (CIF) or Common Access Platform (CAP).							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	N/A	Complete CIF/CAP and prototype and pilot at NIST.	Expand CIF/CAP pilot to include additional bureaus/ agencies
Actual	N/A	N/A	N/A	N/A	N/A	N/A		
Status	N/A	N/A	N/A	N/A	N/A	N/A		
Trend	Not Enough Data.							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							

Adjustments to targets	N/A				
Information Gaps	None.				
Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Information Technology Laboratory	Ongoing	NIST Information Technology Laboratory	Internal controls include review by Information Technology Laboratory personnel.	Data provides information on output levels only.	None

Indicator	**Milestones for Big Data standards**							
Description	This indicator, measured in number of consensus-based standards on Big Data, reflects the success of NIST in accelerating consensus on important, fundamental questions about Big Data that accelerate progress. NIST will collaborate with industry, other government agencies and academia to develop consensus-based Big Data standards.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	N/A	N/A	N/A	N/A	N/A	7	7	7
Actual	N/A	N/A	N/A	N/A	N/A	7		
Status	N/A	N/A	N/A	N/A	N/A			
Trend	Not Enough Data.							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	None.							

Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NIST Information Technology Laboratory	Ongoing	NIST Information Technology Laboratory	Direct and verifiable counts. Internal controls include review by Information Technology Laboratory personnel.	Data provides information on output levels only.	None

Non-Recurring Indicators:

Indicator	**Qualitative assessment and review of technical quality and merit using peer review**					
Description	From FY 2007-FY 2011, the National Research Council (NRC) assessed half of the NIST Laboratories each year. The assessment process focused on the quality, relevance, and technical merit of the NIST Laboratories Programs. Overall, these assessments attest to NIST's high quality programs, relevance of work to the measurement and standards needs, and impressive technical merit. In FY 2012, the NRC assessments were restructured and focused on the crosscutting area of NIST laboratory efforts supporting advanced manufacturing. For FY 2013 and beyond, the NRC returned to conducting annual technical assessments of selected NIST laboratories for their scientific impact, beginning with the NIST Center for Neutron Research. The NRC Assessment Reports are available at: http://www.nist.gov/director/nrc/.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	Complete annual peer review	Complete annual peer review	Complete annual peer review	Complete annual peer review	Complete annual peer review	Complete annual peer review
Actual	Completed	Completed	Completed	Completed	Completed	Completed
Status	Met	Met	Met	Met	Met	Met
Trend	Stable.					
Explanation (if not met in FY 2013)	N/A					

Indicator	**Peer-reviewed technical publications**					
Description	This indicator reflects the quality and demand for NIST publications used to transfer its research results to support the Nation's infrastructure and to provide measurements and standards to those in industry, academia, and government agencies. This indicator is a direct count of NIST technical manuscripts that have been published in an elite body of influential scientific peer-reviewed journals as compiled in the Web of Science® bibliographic database maintained by Thomson Reuters. While publications are a good indicator of scientific productivity, their number does not readily correlate to increases in funding or other influences that may be expected to drive up other metrics. NIST number of publications is well within acceptable rates for an institution of its size. Publications typically lag by a minimum of two years due to the time needed for research, writing, journal peer review, and publication processes.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	1,100	1,275	1,300	1,350	1,210	1,210
Actual	1,271	1,463	1,243	1,210	1,335	1,393
Status	Exceeded	Exceeded	Met	Met	Exceeded	Exceeded

Trend	Positive.
Explanation (if not met in FY 2013)	N/A

Indicator	**Standard Reference Materials sold**					
Description	Standard Reference Materials (SRM) is the definitive artifact-based source of measurement traceability in the United States. SRMs are certified in the NIST Laboratories for their specific chemical and material properties. Customers use SRMs to achieve measurement quality and conformance to process requirements that address both national and international needs for commerce and trade and public safety and health. This indicator represents a direct count of the number of SRM units sold to customers in industry, academia, and other government agencies. The conversion of research results into robust, deliverable measurement services typically takes at least three additional years. SRMs are one of the measurement service outputs possible, and as new, more relevant SRM types are produced, older less relevant SRMs are discontinued. Production capacity at current staffing levels has stabilized at about 1,300 different SRMs available.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	31,000	31,000	31,000	31,000	31,000	31,000
Actual	33,373	29,769	31,667	32,864	33,441	32,267
Status	Exceeded	Met	Exceeded	Exceeded	Exceeded	Exceeded
Trend	Positive.					
Explanation (if not met in FY 2013)	N/A .					

Indicator	**NIST-maintained datasets downloaded**					
Description	NIST's online data systems cover a broad range of substances and properties from many different scientific disciplines and are heavily used by industry, academia, other government agencies, and the general public for technical problem-solving, research, and development. This indicator is a direct count of the number of downloads of NIST-maintained data excluding web-based time related services.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	130M	200 M	24.5M*	24.5M**	18M	18M
Actual	195.5 M	226M	25.0M*	19.1M	22.6M	18.6M
Status	Exceeded	Exceeded	Exceeded	Not Met	Exceeded	Exceeded

Trend	Varying.
Explanation (if not met in FY 2013)	N/A

Indicator	**Number of calibration tests performed**					
Description	NIST calibrations are the definitive service-based source of measurement traceability in the United States. Customers use calibrations to achieve measurement quality and traceability to address both national and international needs for commerce and trade and public safety and health. This measure represents a direct count of the number of units calibrated by NIST for customers in industry, academia, and other government agencies. Several factors are contributing to a continuing decline in the number of calibration tests performed annually by NIST, although the rate of decline is difficult to predict. Where possible and appropriate, NIST is transferring calibration capabilities to the private sector and to other agencies so that traceability is obtainable from other sources thereby improving the accessibility of industry to precision measurements. Secondly, NIST has experienced a reduction in calibrations work performed for the Defense Primary Standards Labs. Lastly, increasing international application of the Mutual Recognition Arrangement has resulted in the acceptance and use of calibrations from other national measurement institutes, thereby reducing the dependency upon traceablity to NIST.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	12,000	15,000	15,000	9,700	14,000	13,000
Actual	25,944	18,609	17,697	18,195	17,206	14,974
Status	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded
Trend	Negative					
Explanation (if not met in FY 2013)	N/A					

Indicator	**Number of clients served by MEP Centers receiving Federal funding**
Description	This indicator represents the annual number of new and repeat clients served by MEP Centers who received training, technical, and business assistance ranging from informational seminars and training classes to in-depth technical assistance. The targets for FY 2012 and beyond reflect MEP's transition to a service mix with more emphasis on innovation and growth. These services, while more closely aligned to the program mission to improve client competitiveness, are also more resource intensive than the more traditional services targeted at cost reduction and quality improvement. In addition, the ongoing need for the system to develop increased capabilities

	and capacity to deliver these services will constrain the resources available to engage new clients and will likely flatten the performance trend for this indicator. The FY 2012 actual in the FY 2012 PAR was an estimate. The amount has since been updated.					
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	14,500	25,500	29,000	30,000	32,500	32,500
Actual	31,961	32,926	34,299	33,838	31,373	30,131
Status	Exceeded	Exceeded	Exceeded	Exceeded	Met	Met
Trend	Varying.					
Explanation (if not met in FY 2013)	N/A					
Indicator	**Increased sales attributed to MEP Centers receiving Federal funding ($ in Billions)**					
Indicator	**Capital investment attributed to MEP Centers receiving Federal funding ($ in Billions)**					
Indicator	**Cost savings attributed to MEP Centers receiving Federal funding ($ in Billions)**					
Description	These indicators are positively associated with productivity growth and competitiveness, which are crucial for American manufacturers to succeed in the rapidly changing manufacturing environment. Data is collected through an annual survey of clients receiving services from MEP Centers. The targets for FY 2012 and beyond reflect MEP's transition to a service mix with greater emphasis on innovation and growth. These services have been shown to have a longer cycle time from delivery to realized impacts. In addition, the ongoing process of developing capabilities and capacity in the system to deliver these services will further constrain the resources available to generate these impacts. The combination of these factors is likely to flatten the rate of performance improvement for these indicators. The actual data reported from FY 2011 funding in the FY 2012 PAR was an estimate based on three-quarters of actual and one-quarter of estimated client impacts. The amounts have since been updated. The FY 2013 actuals will be available in January 2015 due to the lag time associated with collecting and analyzing the Hollings MEP client survey data six months after the services are delivered.					
Increased sales attributed to MEP Centers receiving Federal funding ($ in Billions)						
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	$.6	$2.0	$2.5	$2.0	$2.2	$2.5
Actual	$3.6	$3.5	$3.6	$2.5	$2.2	Available in January 2015
Status	Exceeded	Exceeded	Exceeded	Exceeded	Met	N/A
Trend	Negative					

Capital investment attributed to MEP Centers receiving Federal funding ($ in Billions)						
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	$.5	$1.0	$1.0	$1.1	$1.3	$1.4
Actual	$1.7	$1.9	$1.9	$2.5	$2.6	Available in January 2015
Status	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded	N/A
Trend	Positive					

Cost savings attributed to MEP Centers receiving Federal funding ($ in Billions)						
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013
Target	$.3	$1.0	$1.2	$1.1	$1.1	$1.1
Actual	$1.4	$1.3	$1.3	$0.9	$1.2	Available in January 2015
Status	Exceeded	Exceeded	Exceeded	Not Met	Exceeded	N/A
Trend	Stable					
Explanation (if not met in FY 2013)	N/A					

Part 3 - Resource Requirements Table

NIST Resource Requirements (obligations in $M)

	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Actual	FY 2012 Actual	FY 2013 Actual	FY 2014 Estimate	FY 2015 Base	Increase / Decrease	FY 2015 Request
STRS	$450.0	$536.5	$709.3	$509.7	$575.1	$582.6	$684.1	$660.6	$24.1	$684.7
ITS	144.9	161.2	202.1	211.3	135.5	122.3	166.0	143.7	17.3	161.0
CRF	138.3	231.7	459.9	91.0	35.6	75.0	74.9	56.7	2.3	59.0
WCF	172.0	170.8	158.6	167.6	170.8	172.3	164.7	142.4	1.3	143.6
Total Funding	905.2	1,100.2	1,529.9	979.6	917.0	952.2	1,089.7	1,003.4	45.0	1,048.3
Direct	733.1	803.4	894.8	806.7	738.3	777.3	923.6	861.0	43.7	904.7
Reimbursable	172.1	171.7	159.5	168.5	171.7	173.5	166.1	142.4	1.3	143.6
Recovery Act Funds	-	125.1	475.6	4.4	7.0	1.4	-	-	-	-
Total	905.2	1,100.2	1,529.9	979.6	917.0	952.2	1,089.7	1,003.4	45.0	1,048.3
Total FTE	2,812	2,881	2,999	3,021	2,973	2,942	3,194	3,219	58	3,277

Part 4 Agency Priority Goals

NIST does not have any Agency Priority Goals for FY 2013.

Part 5 Other Information

Section 1 Major Management Priorities and Challenges

DOC Management Challenge #1: Stimulate Economic Growth in Key Industries, Increase Exports, and Enhance Stewardship of Marine Fisheries.

Responsible Bureau Official: Under Secretary of Commerce for Standards and Technology and NIST Director

In the area of Advanced Manufacturing, NIST is playing a leading role. Manufacturing is at the heart of what NIST does and NIST has identified strengthening U.S. advanced manufacturing capabilities as a strategic priority. Through FY 2012 and FY 2013, NIST has improved its support for advanced manufacturing through a portfolio of programs that spans the spectrum from cutting edge research to services provided directly to manufacturers.

- Research at **the NIST laboratories** develops and delivers measurement science tools that support advanced manufacturing technologies, including materials modeling and simulation, nanomanufacturing, biomanufacturing, smart manufacturing, robotics, and other enabling technologies. Measurement science and standards services developed at NIST provide the basic and applied research underpinnings to support advances in manufacturing. NIST provides the enabling interoperability standards and tools to allow manufacturers and researchers to lower costs and accelerate innovation. Unique, cutting edge user facilities support innovation in materials development and deployment, nanotechnology discovery and fabrication, and other emerging technology areas.
- The **Hollings Manufacturing Extension Partnership** is supporting technologies and practices that increase the competitiveness and resilience of our nation's small and medium manufacturing base. A federal-state-local partnership, MEP is enabling future growth with a long-term focus on encouraging cultures of continuous improvement, accelerating the adoption of new technology to build business growth, responding to evolving supply chains, implementing environmentally sustainable processes, and supporting a strong workforce.
- The **Baldrige Performance Excellence Program** promotes excellence in organizational performance; recognizes the quality achievements of U.S. manufacturers, small businesses, and other types of organizations; and publicizes successful performance management strategies.
- The **Advanced Manufacturing National Program Office** serves as the central point of contact for Federal activities and will strengthen strategic coordination among Federal agencies including NIST, NASA, DOD, NSF, and DOE.

Proposed and newly enacted programs specifically focused on supporting advanced manufacturing fill much needed gaps in the U.S. research infrastructure.

- The proposed **National Network of Manufacturing Innovation** is envisioned as a nationwide network of up to 15 Institutes for Manufacturing Innovation to provide the R&D infrastructure needed to support a robust advanced manufacturing sector by filling a critical gap in the U.S. innovation pipeline.
- The **Advanced Manufacturing Technology Consortia program** established in FY 2013 will provide funding to establish industry-led consortia to create technology roadmaps to identify and tackle long-term R&D challenges shared by industry.

DOC Management Challenge #4: Implement Framework for Acquisition Project Management and Improve Contracts Oversight

Responsible Bureau Official: Senior Bureau Procurement Official / Chief, Acquisition Management Division

<u>Implement the Planned Framework for Acquisition Project Management</u>

NIST has two projects which fall within the requirements of the Acquisition Project Management Framework/Guidebook: 1) General Purpose Lab Renovations and 2) Building 245. Both are facility type acquisitions. In addition, NIST has implemented the Contract Review Board (CRB), an internal review board for requirement actions exceeding $350,000. Specifically, the CRB reviews solicitations to ensure compliance with the regulations. The CRB is comprised of representatives from the requesting office, an Acquisition Management Division (AMD) Policy and Compliance representative, a DOC Contract Law Division representative, and the Contracting Officer/Specialist.

<u>Oversee High-risk Contracts</u>

NIST monitors the trends pertaining to high-risk contracts on a monthly and quarterly basis. Training provided to NIST AMD staff as well as to NIST personnel involved in the acquisition process has included information pertaining to the risks associated with high-risk contracts and the additional administration required for high-risk contracts. NIST has not and does not plan to award cost-plus award-fee and cost-plus-award-term contracts.

<u>Maintain an Acquisition Workforce that Holds Bureau Officials Accountable</u>

NIST has taken strides to standardize acquisition processes across NIST, for both the acquisition staff and the program officials. Several Standard Operating Procedures (SOP's) will be issued and will be effective October 1, 2013. The SOP's will significantly improve the submission of requirements packages to the NIST acquisition office and contract administration.

Implement an Effective Suspension and Debarment Program

As necessary, NIST will coordinate with Office of General Counsel, Contract Law Division to address possible suspension or debarment actions.

NIST Internal Management Challenge: Achieve Operational Efficiency and Economy – NIST is working to enhance operational efficiency and economy to support a world-class research program.

Responsible Bureau Official: Under Secretary for Commerce for Standards and Technology and NIST Director

Key management challenges for NIST include:

- **Safety management** -- NIST is continuing a long process of improving safety management practices and developing a robust safety culture at the laboratories. This effort has made significant progress, but still requires management focus and priority.
- **Integrating program and support functions** -- NIST is undertaking a significant effort to improve how we procure goods and services. This effort will improve NIST scientific staff's ability to do their mission-critical work by focusing on timeliness, value, effort, and responsiveness. As a part of this effort, NIST managers and staff are defining processes and methodologies that will refine and streamline acquisitions.
- **Budget constraints and travel ceilings** --The current budget-constrained environment poses significant risks to NIST's ability to maintain programs that improve U.S. competitiveness, particularly when other countries are increasing investments in measurements, standards, and technology development. Similarly, travel caps are reducing NIST scientists' participation in technical meetings, standards development activities, etc. Participation in these activities supports technology transfer from NIST laboratories and provides NIST staff critical insights about external competition and the science and technology landscape.
- **Access to a world class workforce** -- NIST's ability to perform best-in-the-world research is dependent on our ability to attract and work with world-class researchers. Foreign researchers working with NIST staff at NIST facilities are an integral part of this dynamic. Collaboration with these experts enables NIST researchers to better understand and stay on the cutting-edge of scientific developments around the world. Also, sustained pay freezes and the generally negative impressions about Federal employees continue to be a challenge in recruiting the best and brightest scientific minds in the U.S. to work at NIST and contribute to our important mission.

Section 2 Cross-Agency Priority Goals / Collaborations

Cross-Agency Priority Goals

NIST is a participant in the Cybersecurity Cross-Agency Priority Goal (CAP) to achieve 95 percent use of the Administration's priority cybersecurity capabilities on Federal executive branch information systems by the end of FY 2014. NIST's responsibilities under this CAP include the following:

- Update and maintain technical standards to facilitate use, expand the industry and build in flexibility, security and interoperability, and support increased adoption of administration cybersecurity priorities by Federal Departments and Agencies. This will enhance organizational maturity, technology use, and visibility through Open Standards.
- Support strong authentication for information systems through U.S. Government smartcard technical standards, reference materials, tools, tests, and validations.
- Develop and deploy U.S. Government Guidelines, testing capabilities, and tools supporting automated security assessments, risk mitigation processes, and automated data feeds with standardized machine readable formats.

Cross-Agency Collaborations

NIST has a key coordination role in working with other agencies to help achieve its objective aimed at strengthening U.S. advanced manufacturing through partnerships and collaborations that accelerate technology development and commercialization.

- **Advanced Manufacturing** --The Nation's long-term competitiveness relies heavily on global leadership in advanced manufacturing capabilities. In support of this effort, NIST maintains key relationships with OSTP, the National Economic Council, NSF, NASA, DOE, and DOD. NIST hosts the Advanced Manufacturing National Program Office (AMNPO) which is working closely with NSF, DOD, DOE, NASA, and other agencies to coordinate federal advanced manufacturing programs and create the necessary foundation for the proposed National Network for Manufacturing Innovation (NNMI).

NIST is working closely with a number of other agencies to develop and provide measurement tools and standards to promote industrial competitiveness, enable innovation, and increase efficiency. Key examples include:

- **National Nanotechnology Initiative** -- NIST actively participates in and leads many activities within the National Nanotechnology Initiative (NNI). For example, NIST and OSTP co-chair the Nanoscale Science, Engineering, and Technology Subcommittee which is the interagency convening group of the NNI. The NNI consists of the individual and cooperative nanotechnology-related activities of 27 Federal agencies with a range of research and regulatory roles and responsibilities.

- **Materials Genome Initiative** -- NIST is a lead agency in the Administration's effort to build a materials innovation infrastructure in the U.S. This interagency activity is leveraging expertise at NIST, DOE, DOD, NSF, and other agencies to develop computational approaches that will dramatically reduce the development time of new materials for more effective and cheaper products.
- **Cybersecurity** -- NIST is playing a critical role in implementing a framework for reducing cyber risks to critical infrastructure, per the Presidential Executive Order "Improving Critical Infrastructure Cybersecurity" issued in February 2013. OMB, DHS, and the National Security Agency are key government stakeholders in this effort and are working with NIST to create a public-private partnership to develop a standards-based framework to identify and mitigate cybersecurity risks to the nation's critical infrastructure.
- **Advanced Communications** -- NIST and NTIA recently signed a Memorandum of Understanding to establish a national Center for Advanced Communications at the DOC Boulder facilities. The Center will leverage the unique NIST and NTIA technical expertise in communication technologies and will work closely with the private sector and other federal agencies, including DOD and the Federal Communications Commission. The Center will address measurement and standards challenges in the rapidly evolving communication technologies.
- **Measurement Science and Standards in Forensic Science** -- NIST works with the Department of Justice (DOJ) and forensic science practitioners to establish practices that will enable greater transparency and rigor in the use of forensic evidence within the criminal justice system. For example, NIST and DOJ recently signed a Memorandum of Understanding to create a National Commission on Forensic Science to help address important issues identified in a National Academies' report that studied the nation's forensic science approach.
- **Standards and Trade Policy** -- NIST partners with the Office of the U.S. Trade Representative on significant issues relating to trade policy and standards-related issues that impact trade policy.
- **Interoperability of Electronic Health Records (EHR)** -- NIST is working in close collaboration with the Department of Health and Human Services Office of the National Coordinator for Health IT to promote interoperability of electronic health records.
- **Biosciences** -- Ongoing collaborations between NIST and the Food and Drug Administration range from the reliability of active implanted medical devices, to biological drugs and stem cell-based therapies, to certified reference materials for dietary supplements.

Through the MEP, NIST collaborates with a number of other agencies in support of its objective to improve the competitiveness of small and medium-sized businesses. Most recently, MEP has collaborated actively with multiple other agencies (including the Economic Development Administration, the Department of Labor (DOL), the Small Business Administration (SBA), the U.S. Department of Agriculture, DoE, and the Delta Regional Authority) on priority Administration initiatives to grow the economy and create jobs. In some cases, such as with the Advanced Manufacturing Jobs and Innovation Accelerator Challenge and the Make it in America competition, MEP has been a full partner, providing funding and leadership to help shape and implement the initiatives for maximum impact. In others, MEP has been a supportive non-funding partner, bringing our expertise and insights regarding US manufacturing to the initiatives. These recent activities are in addition to the long-standing relationships NIST MEP has had with a number of agencies and programs, including:

- **E3: Economy, Energy, and Environment** -- MEP is collaborating with DOE, the Environmental Protection Agency, DOL, SBA, and USGS on E3, a coordinated federal and local technical assistance initiative that is helping manufacturers across the nation adapt and thrive in a new business era focused on sustainability.
- **ExporTech** -- Deployed nationally as a collaboration between MEP, U.S. Export Assistance Centers, and other partners including District Export Councils, State Trade Offices, Ex-Im Bank and SBA, ExporTech helps companies enter or expand in global markets.
- **Supplier Scouting** -- In partnership with (DOT), DOE, DOD, and other NIST programs, MEP has been using its extensive network of manufacturers and suppliers to help American companies meet the requirements of the Buy America and Buy American standards.

Section 3 Program Evaluations

The NRC provides expert assessments of the NIST Laboratory programs. The NRC assessments assure decision-makers within the Federal government that NIST maintains the highest standards of effort, performance, and relevance. The assessments also help NIST respond to recommendations and advice as provided to NIST by its advisory body, the Visiting Committee on Advanced Technology. In addition, the process of bringing expert NRC panelists to the NIST campus creates an opportunity for NIST scientists to obtain direct feedback and to foster professional relationships with experts in their field. For FY 2014, the NRC will conduct technical assessments of the scientific impact of the Engineering Laboratory and the Material Measurement Laboratory on the following criteria: the technical quality and merit of the laboratory programs relative to the state-of-the-art worldwide, the effectiveness with which the laboratory programs are carried out and the results disseminated to customers, the relevance of the laboratory programs to the current and future needs of stakeholders, and the adequacy of the facilities and laboratory equipment to perform the program functions.

Section 4 Hyperlinks to Any Other More Detailed Plans or Evaluations

The NRC Assessment Reports for NIST are available at: http://www.nist.gov/director/nrc/index.cfm .

Section 5 Data Validation and Verification

The FY 2013 Summary of Performance includes the Secretary's Statement, an assessment of the reliability and completeness of the Department's performance data.

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Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2014 Enacted	2,366	2,331	$657,400	$684,108	$651,000
less: Unobligated balance from prior year	0	0	0	(29,408)	0
plus: Unobligated balance from prior year transferred to WCF	0	0	0	3,700	0
less: Transfers from DoJ	0	0	(4,500)	(4,500)	0
less: Transfer from EAC	0	0	(1,900)	(1,900)	0
2015 Adjustments to base:					
Annualization of positions financed in FY 2014	0	26			
plus: Restoration of 2014 deobligation offset	0	0	1,000	0	1,000
plus: Uncontrollable cost changes	0	0	8,557	8,557	8,557
less: Estimated recoveries, 2015	0	0	(1,000)	0	(1,000)
2015 Base Request	2,366	2,357	659,557	660,557	659,557
plus: 2015 Program changes	72	54	27,750	27,750	29,000
less: Inflationary adjustment			(8,557)	(8,557)	(8,557)
plus: Transfer from DoJ			3,000	3,000	0
plus: Transfer from EAC			1,900	1,900	0
2015 Estimate	2,438	2,411	683,650	684,650	680,000

Comparison by program/sub-program:		2013 Actual Per-sonnel	2013 Actual Amount	2014 Enacted Per-sonnel	2014 Enacted Amount	2015 Base Per-sonnel	2015 Base Amount	2015 Estimate Per-sonnel	2015 Estimate Amount	Increase/ (Decrease) Over 2015 Base Per-sonnel	Increase/ (Decrease) Over 2015 Base Amount
Measurement science, services, and programs											
Laboratory programs	Pos./Approp	2,068	$517,116	2,164	$578,012	2,164	$585,600	2,213	$597,512	49	$11,912
	FTE/Obl.	1,984	520,914	2,134	593,675	2,154	586,460	2,191	599,022	37	12,562
Corporate services	Pos./Approp	44	17,312	44	17,312	44	17,652	44	17,312	0	(340)
	FTE/Obl.	42	17,617	43	17,550	43	17,755	43	17,415	0	(340)
Standards coordination and special programs	Pos./Approp	137	45,343	158	55,676	158	56,305	181	65,176	23	8,871
	FTE/Obl.	132	44,071	154	72,883	160	56,342	177	68,213	17	11,871
TOTALS	Pos./Approp	2,249	579,771	2,366	651,000	2,366	659,557	2,438	680,000	72	20,443
	FTE/Obl.	2,158	582,602	2,331	684,108	2,357	660,557	2,411	684,650	54	24,093

Comparison by program/sub-program:	2013 Actual Personnel	2013 Actual Amount	2014 Enacted Personnel	2014 Enacted Amount	2015 Base Personnel	2015 Base Amount	2015 Estimate Personnel	2015 Estimate Amount	Increase/ (Decrease) Over 2015 Base Personnel	Increase/ (Decrease) Over 2015 Base Amount
Adjustments for:										
Recoveries		(4,688)		(1,000)		(1,000)		(1,000)		0
Refunds		(500)		0		0		0		0
Unobligated balance, start of year		(18,439)		(29,408)		0		0		0
Unobligated balance, end of year		29,408		0		0		0		0
Unobligated balance, expired account		35		0		0		0		0
Unobligated balance transfer to other accounts				3,700						
Budget Authority		588,418		657,400		659,557		683,650		24,093
Financing from transfers:										
Transfers to other accounts		0		0		0		1,250		1,250
Transfers from DoJ for forensic sciences and OLES		(6,040)		(4,500)		0		(3,000)		(3,000)
Transfer from Election Assistance Commission		(2,607)		(1,900)		0		(1,900)		(1,900)
Appropriation		579,771		651,000		659,557		680,000		20,443

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: REIMBURSABLE OBLIGATIONS
(Dollar amounts in thousands)

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Comparison by program/sub-program:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Measurement science, services, and programs											
Laboratory programs	Pos./BA	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	0	0	0	0	0	0	0	0	0

Exhibit 7

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Total Obligations	$582,602 [1/]	$684,108	$660,557	$684,650	$24,093
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	0	0	0	0	0
Total offsetting collections	0	0	0	0	0
Adjustments for:					
Recoveries and refunds	(5,188)	(1,000)	(1,000)	(1,000)	0
Unobligated balance, start of year	(18,439) [1/]	(29,408)	0	0	0
Unobligated balance, end of year	29,408	0	0	0	0
Unobligated balance, expired	35	0	0	0	0
Unobligated balance transfer to WCF	0	3,700	0	0	0
Budget Authority	588,418	657,400	659,557	683,650	24,093
Financing:					
Transfer to other accounts	0	0	0	1,250	1,250
Transfers from other accounts	(8,647) [2/]	(6,400) [2/]	0	(4,900)	(4,900)
Appropriation	579,771	651,000	659,557	680,000	20,443

[1/] FY 2013 including ARRA HHS transfer carryover, which is no year.

[2/] $2,607K from EAC and $6,040K from DoJ in FY 2013; planned $1,900K from EAC and $4,500K from DoJ in FY 2014; and planned $1,900K from EAC and $3,000K from DoJ in FY 2015.

Adjustments
to Base

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	FTE	Amount
Adjustments:		
Restoration of FY 2014 deobligation offset	0	1,000

In FY 2014, NIST's STRS budget authority was reduced by $1,000,000 based on an estimated level of prior year deobligations. This adjustment would restore the reduction in FY 2015.

	FTE	Amount
Financing:		
Recoveries of prior year deobligations	0	(1,000)

NIST's FY 2015 STRS budget authority is reduced by the estimated level of prior year deobligations in FY 2015.

Other Changes:

Annualization of 2014 pay raise	0	711

A pay raise of 1 percent is assumed to be effective January 1, 2014.

Total cost in FY 2015 of 2014 pay raise	$2,844,000
Less amount requested in FY 2014	(2,133,000)
Less amount absorbed in FY 2014	0
Amount requested in 2015 to provide full-year cost of 2014 pay raise	711,000

2015 Pay increase and related costs	0	2,450

A general pay raise of 1.049 percent is assumed to be effective January 1, 2015.

Total cost in FY 2015 of pay increase	$2,394,000
Less amount absorbed in FY 2015	0
Amount requested for FY 2015 pay increase	2,394,000
Payment to Departmental Management Working Capital Fund	56,000
Total adjustment for FY 2015 pay increase	2,450,000

Annualization of positions financed in FY 2014	26	0

NIST requires an additional 26 FTE to staff FY 2014 requested increases at their full operating level in FY 2015.

New positions in 2014	117
Less 5 percent lapse	(6)
Full-Year FTE	111
Less FTE Funded in 2014	(85)
Annualization of Positions/FTE in 2015	26

Personnel benefits		$4,655
Civil Service Retirement System (CSRS)	($342)	
Federal Employees' Retirement System (FERS)	3,676	
Thrift Savings Plan (TSP)	316	
Federal Insurance Contribution Act (FICA) - OASDI	295	
Health Insurance	618	
Employees' Compensation Fund	92	

Civil Service Retirement System (-$342,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees' Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 7 percent in FY 2014 to 5.0 percent in FY 2015. The contribution rate will remain at 7.0 percent in FY 2015.

Payroll subject to retirement systems ($244,407,206)	
Cost of CSRS contributions in FY 2015 ($244,407,206 x .050 x .07)	$855,425
Cost of CSRS contributions in FY 2014 ($244,407,206 x .070 x .07)	1,197,595
Total adjustment to base	(342,170)

Federal Employees' Retirement System ($3,676,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 93.0 percent in FY 2014 to 95.0 percent in FY 2015. P.L. 112-240 enacted in January 2013 modified the federal retirement annuity establishing a Revised Annuity Employee (RAE) reducing the amount of government FERS contribution percentage from 11.9 percent to 9.6 percent for those employees hired after January 1, 2013 with less than five years of creditable service. On October 1, 2013, the Board of Actuaries of the FERS retirement system recommended changes to long term economic and demographic assumptions. As transmitted to agencies by OMB, plans are increased by 1.3 percentage points from 11.9 percent of pay to 13.2 percent.

Payroll subject to retirement systems ($240,841,548) (non-RAE employees)	
Basic benefit cost in FY 2015 ($240,841,548 x .950 x .132)	$30,201,530
Basic benefit cost in FY 2014 ($240,841,548 x .930 x .119)	26,653,934
Increase (FY 2014-FY 2015)	3,547,596

Payroll subject to retirement systems ($3,565,658) (RAE employees)	
Basic benefit cost in FY 2015 ($3,565,658 x .950 x .132)	$447,133
Basic benefit cost in FY 2014 ($3,565,658 x .930 x .096)	318,342
Increase (FY 2014-FY 2015)	128,791
Total adjustment to base	3,676,387

Thrift Savings Plan ($316,000) – The cost of agency contributions to the TSP will also rise as FERS participation increases. The contribution rate will increase from 4.57 percent to 4.61 percent in FY 2015.

Thrift plan cost in FY 2015 ($244,407,206 x .950 x .0461)	$10,703,814
Thrift plan cost in FY 2014 ($244,407,206 x .930 x .0457)	10,387,551
Total adjustment to base	316,263

Federal Insurance Contributions Act (FICA) - OASDI ($295,000) – As the percentage of payroll covered by FERS rises, the cost of OASDI contributions will increase. In FY 2015, the maximum salary subject to OASDI tax will remain at $119,100 in FY 2015. The OASDI tax rate for employers also remains at 6.2 percent in FY 2015.

FERS payroll subject to FICA tax in 2015 ($244,407,206 x .950 x .904 x .062)	$13,013,608
FERS payroll subject to FICA tax in 2014 ($244,407,206 x .930 x .903 x .062)	12,725,545
Increase (FY 2014-FY 2015)	288,063
OTP payroll subject to FICA tax in FY 2015 ($5,735,794 x .950 x .904 x .062)	305,406
OTP payroll subject to FICA tax in FY 2014 ($5,735,794 x .930 x .903 x .062)	298,645
Increase (FY 2014-FY 2015)	6,761
Total adjustment to base	294,824

Health insurance ($618,000) – Effective January 2013, NIST's contribution to Federal employees' health insurance premiums increased by 3.6 percent. Applied against the FY 2014 estimate of $17,169,000 the additional amount required is $618,084.

Employees' Compensation Fund ($92,000) – The Employees' Compensation Fund bill for the year ending June 30, 2012 is $92,151 higher than for the year ending June 30, 2012.

Rental Payments to GSA	0	1

GSA rates are projected to increase 1.6 percent in FY 2015. This percentage was applied to the FY 2014 estimate of $82,000 to arrive at an increase of $1,312.

Communications, utilities, and miscellaneous charges	0	(4,353)

Postage	1
HCHB Water/Sewer increase	1
Electricity rate decrease	(1,501)
Natural Gas rate decrease	(2,854)

Effective January 22, 2012, the Governors of the Postal Service implemented a rate increase for shipping services. The overall price change is 4.6 percent. When applied to the FY 2014 postage estimate of $24,000, this results in an increase of $1,104.

The average increase for HCHB Water/Sewer is projected to be 44 percent. This percentage was applied to the 2014 DCWASA estimate of $2,000 for a increase of $880.

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended February 2013 and 2012, the per kilowatt hour rate decreased 7.4 percent (from .103 to .095) for Gaithersburg, Maryland; increased .1.9 percent (from .426 to .434) for Kauai, Hawaii; decreased 5 percent (from .071 to .067) for Boulder, Colorado; and increased .8 percent (from .090 to .091) for Ft. Collins, Colorado for a net decrease of $1,501,000.

The natural gas ATB amount was derived using a year to year comparison of the average cost per therm. In analyzing the 12 months ended February 2013 and 2012, the per therm rate decreased 37.4 percent (from .772 to .483) and decreased 60.5 percent (from 1.526 to .603) for Gaithersburg and Boulder respectively resulting in a net decrease of $2,854,000.

Other Services		0	2,489
Working Capital Fund (Departmental Management)	2,463		
Personal Identity Verification (PIV)	(170)		
Commerce Business Systems (CBS)	183		
National Archives and Records Administration (NARA) storage costs	13		

Working Capital Fund (Departmental Management) ($2,463,000) – An additional $2,463,000 is required to fund cost increases in the Departmental Working Capital Fund (includes $2,220,000 for Business Application Solutions).

Personal Identity Verification (PIV) (-$170,000) – A decrease of $170,000 reflects a one-time investment in 2014 for Personal Identity Verification (PIV). This non-recurring cost is removed in FY 2015.

Commerce Business Systems (CBS) ($183,000) – An increase of $183,000 is required in FY 2015 consistent with the CBS Capital Asset Plan.

National Archives and Records Administration (NARA) storage costs ($13,000) - NARA estimates reflect an increase of $13,000 in FY 2015 for records storage and maintenance costs.

Supplies and Materials		0	158
Scientific journal subscriptions	$158		

Scientific journal subscriptions ($158,000) - This adjustment to base addresses the FY 2012 to FY 2013 inflationary increase in costs for NIST's subscriptions journals which exceed the inflationary increases provided through the regular general pricing level deflator. The application of the 6.2 percent deflator results in an increase of $158,472 when applied to the FY 2014 estimate of $2,556,000.

General pricing level adjustment	0	2,446

This request applies the OMB economic assumption of 1.4 percent for FY 2015 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: transportation of things $14,574; rental payments to others $24,780; communications, utilities, and miscellaneous charges $53,970; printing and reproduction $6,090; other services $1,356,166; supplies and materials $425,712; and equipment $563,542.

Subtotal, Other changes	26	8,557
Total, Adjustments to base	26	8,557

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APPROPRIATION ACCOUNT: Scientific and Technical Research and Services (STRS)

The STRS account contains the Measurement Science, Services, and Programs, which contains three budget sub-programs: Laboratory Programs, Corporate Services, and Standards Coordination and Special Programs. These three sub-programs, as well as initiatives proposed within each sub-program, are described in further detail in this section of the budget.

The 2015 President's Budget recognizes the important role of NIST programs to advancing innovation by requesting $680.0 million for the STRS appropriation. Within the request, current Administration priority areas targeted for budget increases include Research and Development (R & D) investments in Forensic Science, Cyber Physical Systems, Advanced Materials, Synthetic Biology, and a Lab-to-Market initiative.

SIGNIFICANT ADJUSTMENTS-TO-BASE (ATBs):

NIST will fund inflationary costs to current programs from administrative efficiencies. These costs include a 2015 Federal Pay Raise and inflationary increases for non-labor activities. STRS ATBs in FY 2015 total $8.557 million.

BUDGET PROGRAM: Measurement Science, Services, and Programs

Measurement Science, Services, and Programs Overview

The NIST Measurement Science, Services, and Programs work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on a sound scientific and technical foundation. NIST promotes the use of measurements based on the international system of units (SI). The measurement science research at NIST is useful to all science and engineering disciplines. The NIST Laboratories directly support U.S. innovation and industrial competitiveness by developing new measurement instruments and facilities to address critical barriers to innovation; disseminating validated measurement methods and protocols; providing reference data, reference materials, and calibration services to ensure that industry-performed measurements are traceable to NIST standards; and developing testing protocols and supporting laboratory accreditation programs. NIST works actively with other metrology institutes from around the world to ensure that the global marketplace is supported with sound measurements and standards.

The NIST Laboratories also support the development of written standards and specifications that define technical and performance requirements for goods and services. These standards, also known as documentary standards, are often developed collaboratively with the private sector through an open, consensus-based process. NIST scientists and engineers lend their expertise to these efforts in order to promote standards that are based on sound science and to ensure that the standards are supported by effective measurements and testing for conformity to the standards.

Primary areas being researched with the program's base resources include the following:

- maintaining and disseminating national measurement standards;
- developing new measurement technologies and ways to tie needed measurements to fundamental national standards;

- developing, maintaining, and improving existing measurement science, services, references, and standards; and
- pursuing basic and applied research in measurement areas within NIST's mission.

The work performed by the NIST Laboratories affects many aspects of daily life in the U.S. Examples include:

- **Manufacturing** – NIST programs in Advanced Manufacturing are developing the tools to enable new more competitive ways to manufacture current generation products and that support the manufacture of new products that are emerging from advanced technologies.
- **Cybersecurity** – NIST programs focused on information technology and cybersecurity, and enabling the adoption of a robust and secure cyber infrastructure that will increase productivity and foster continued innovation.
- **Interoperability** – Critical emerging technologies such as the Smart Grid and national healthcare information systems have the potential to transform our society and revitalize the U.S. economy. NIST programs are helping to accelerate the development of standards needed to ensure that the many interconnected components in these systems can fully function and exchange information seamlessly across systems.

Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Measurement science, services, and programs
Sub-program: Laboratory programs

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) over 2015 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Strategic and emerging research initiative fund	Pos./Approp	34	$12,553	34	$12,553	34	$12,833	34	$12,553	0	($280)
	FTE/Obl.	32	11,863	33	13,410	33	12,833	33	12,553	0	(280)
National measurement and standards laboratories	Pos./Approp	1,687	422,329	1,771	476,225	1,771	482,779	1,820	495,725	49	12,946
	FTE/Obl.	1,619	424,187	1,746	489,785	1,763	483,427	1,800	497,023	37	13,596
User facilities	Pos./Approp	244	71,206	256	78,206	256	78,582	256	78,206	0	(376)
	FTE/Obl.	234	73,731	254	78,954	257	78,780	257	78,404	0	(376)
Postdoctoral research associateship program	Pos./Approp	103	11,028	103	11,028	103	11,406	103	11,028	0	(378)
	FTE/Obl.	99	11,133	101	11,526	101	11,420	101	11,042	0	(378)
Total	Pos./Approp	2,068	517,116	2,164	578,012	2,164	585,600	2,213	597,512	49	11,912
	FTE/Obl.	1,984	520,914	2,134	593,675	2,154	586,460	2,191	599,022	37	12,562

BUDGET SUB-PROGRAM: Laboratory Programs

BASE JUSTIFICATION:

Laboratory Programs Overview

The objectives of the Laboratory Programs are to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology which drive technological change. NIST's Laboratories play a unique role in the Nation's scientific, industrial, and business communities. NIST anchors the national measurement and standards system that is the language of research and commerce. Maintaining the national standards of measurement is a role that the U.S. Constitution assigns to the Federal government to ensure fairness in the marketplace. NIST's presence and leadership in the Nation's measurement and standards system enables companies, researchers, government agencies, and universities to work with each other more easily, improving the Nation's economic security and quality of life.

NIST resources are devoted to meeting today's economic and societal challenges and to laying the foundation for future success. NIST activities help address a broad range of critical challenges for the Nation. Current Administration priority areas targeted for budget increases include Forensic Science, Cyber Physical Systems, Advanced Materials, Synthetic Biology, and a Lab-to-Market initiative. NIST also supports enacted legislation such as the America COMPETES Act which outlines major roles for NIST in promoting national competitiveness and innovation, and the National Technology Transfer Advancement Act (NTTAA), which designates NIST as the coordinator for all Federal agencies using documentary standards.

The individual descriptions of the activities under NIST's Laboratory Programs are described below.

1. NIST Center for Neutron Research (NCNR)

Program Description:

The NCNR safely and reliably operates a national-user facility providing neutron-based measurement capabilities to U.S. researchers from industry, academia, other NIST laboratories, and other government agencies in support of materials research, neutron imaging, chemical analysis, neutron standards, dosimetry, and radiation metrology. Neutrons, uncharged particles from the nucleus of atoms, have unique properties that make them ideal probes of the structure and motion of materials at the scale of atoms and molecules in a material. The NCNR provides an intense source of neutron beams that are used to probe the molecular and atomic structures and dynamics of a wide range of materials. The facility also boasts a unique, large-volume, liquid hydrogen cold source, that produces the largest number of “cold” (or low-energy) neutron beams in the country. Cold neutrons are used to probe the underlying structures and slow dynamics in advanced materials such as plastics, magnetic films, chemical catalysts, biological materials, and composites. With such state-of-the-art measurement capabilities, the NCNR plays an essential role in broad sectors of nano-science and technology. In a wide range of applications, neutron beam measurement techniques are on a par with x-rays or microscopes in their ability to probe materials that are the focus of today’s most important research areas, including materials, biotechnology, and nanotechnology. The NCNR operates as a national-user facility that provides merit-based access to all qualified researchers. The NCNR also supports critical NIST research in materials research, chemistry, physics, nanoscale science, and other related fields. Use of the NCNR facilities for proprietary research is possible on a full-cost recovery basis. As a result, researchers from industry, academia, and other Federal agencies depend on NCNR’s unique research capabilities to work on cutting edge science. The capabilities of the NCNR are further leveraged through a variety of cost-sharing partnerships with other agencies, industries, and universities to expand specific measurement capabilities and to broaden the access to unique neutron instrumentation. The NCNR is significantly expanding its collaboration with the Nation's industrial and academic researchers with new instrumentation and analysis methods for macromolecular structure and dynamics, elemental trace analysis, determination of magnetic nano-structures, neutron imaging, and neutron spectroscopy.

Examples of Accomplishments:

Research and Facility Performance:

- National Research Facility/Neutrons: The NCNR has operated with high availability for decades and provides, on average, 250 days of reactor operation annually to support scientific research. During FY 2013, over 2,100 researchers directly benefited from access to NCNR capabilities which accounted for over one-half of all neutron research done in the United States. These researchers also represent 148 U.S. universities, 39 corporations, and 36 U.S. government organizations and laboratories.

- High-Impact Research: Research performed at the NCNR resulted in 264 publications in FY 2013. With a significant fraction of these papers published in prominent journals, the NCNR ranks as one of the highest impact neutron facilities in the world.

Priority Objectives for FY 2015:

The recent cold neutron expansion project concluded in 2012 resulting in five new measurement capabilities. This expansion also resulted in additional capacity for new, advanced neutron measurement capabilities, the design and development of which are now underway. By 2015 the NCNR will have made significant progress in the design and development of two world-class cold neutron instruments that will be made available to the U.S. scientific community upon completion. The recently expanded facility has allowed NIST to provide new neutron-measurement capabilities to the U.S. research community. Examples of research the expanded NCNR will support include:

- Energy Efficiency and Alternative Energy: Studying nanomaterials for the structure and behavior of new materials at the nano-scale, making it possible to improve process technologies and develop new materials applications in areas ranging from lighter weight advanced materials for the auto industry to new nanocomposites for polymer-based solar cells to new materials and approaches for the efficient storage of energy.

- Fuel Cell and Battery Design: Imaging the interior of complex devices and materials non-destructively to "see" how they function under various operating conditions. NCNR neutron imaging has made it possible to look through the steel casings of operating fuel cells and watch the flow and movement of water molecules as the cell functions, leading to better designs and performance.

- Drug and Vaccine Development: Improving the study of the structure and motions of very large biological molecules such as proteins. Neutrons can see detailed protein structure such as bending or folding which helps identify the protein's function. The insights gained could lead to the development of new drug therapies, new anti-toxins, and improved vaccines.

- Environment: Studying chemical interactions with porous or other complex structured materials. The unparalleled penetration and imaging power of neutrons is being used to develop new, more efficient industrial catalysts and better ways to remove toxins from the environment, as well as to achieve a better understanding of complex biological systems at the cellular level.

- Advanced Computer Technology: Studying advanced new materials that can be used to advance computer technology beyond the integrated circuit. As the size of transistors reaches fundamental limits, further advances in the computation power of computer chips will require new materials that can exploit other electronic properties, such as electronic spin, to carry information in the device.

- Materials Performance: Probing the internal stresses in materials such as pipelines, turbine blades, railroad rails, and shock absorbers, which are essential to understanding and improving the performance of products used in industry, transportation, and national defense.

- Data Storage: Increasing the density of stored information. The advance of information technology requires a concomitant increase in the density of stored information. This required the development of new nanostructured-magnetic materials. Neutrons allow researchers to develop a detailed understanding of the magnetism to develop these new data-storage systems.

2. Center for Nanoscale Science and Technology (CNST)

Program Description:

In the few years since its inception, the CNST has become a major national resource for nanoscale science and the development of nanotechnology, and the only national nanocenter with a focus on commerce. Unique in its mission to provide the measurement infrastructure that underlies all progress in this critically important 21st century technology, the CNST serves the U.S. industrial and scientific research communities by providing a venue for highly-collaborative, multidisciplinary research and direct access to state-of-the-art nanoscale measurement and fabrication tools. The continued development of nanotechnology is key to firmly establishing U.S. leadership in such diverse fields as manufacturing, healthcare, electronics, information technology, biotechnology, and energy. For example, for the case of energy, nanoscale phenomena lie at the heart of a great many energy production, storage, and transmission processes. Research in CNST's NanoLab aimed at providing measurement solutions that enable the optimization of the nanostructure of photovoltaic devices can therefore have a profound impact by enhancing the conversion of the sun's energy to electricity. Such research demands a multidisciplinary approach and the development and ready availability of advanced tools, which manipulate and measure the properties of structures - where size can be counted in atoms. The CNST was purposely built to satisfy these demands and offer many unique measurement capabilities in an open, collaborative, multi-disciplinary research environment. This is where innovative research takes place that advances state-of-the-art of measurement and fabrication ("fab"). A critical component of the CNST, the NanoFab, is available through a simple, merit-based application process. Users can economically access expensive state-of-the-commercial-art fabrication and measurement tools, and processes. Proprietary research can be performed on a full-cost recovery basis. Having now completed its initial ramp up in staff, equipment, facilities, and processes, the CNST continues to expand its strategic relationships and collaborations with industrial and academic partners. In an effort to keep up with increasing demand, the CNST is engaged in a new program to recapitalize and update its equipment and instrumentation and thereby meet the needs of its stakeholders. In

FY 2013, the NanoFab updated key elements of its nanofabrication capability in thin film deposition, nanoscale-lithography, and metrology, including capabilities for x-ray diffraction and ellipsometry. The effort continues in FY 2014 with significant added capacity in electron-beam lithography technology, wet-chemical processing tools, and advanced metrology tools capable of keeping pace with the ever-increasing requirements for improved accuracy and resolution. Starting in FY 2014 the emphasis will be on ensuring compatibility with industrial process by scaling tool capabilities to accommodate 200 mm substrates.

Examples of Accomplishments:

CNST research focuses on industry and government priorities, as demonstrated by these recent examples:

- National User Facility: In the few years since its inception, both the capabilities and the associated impact of the CNST have grown rapidly. In fiscal year 2012 alone, over 1,650 researchers representing over 360 institutions from 40 states and the District of Columbia participated in projects at the CNST. CNST projects resulted in 160 publications and patents in FY 2012, and helped more than 130 companies meet their measurement and fabrication needs.

- Nanomanufacturing: In support of nanomanufacturing efforts in industry and academia, the CNST has developed transmission electron microscope imaging and tomography techniques that provide quantitative information on the dispersion of nanoscale carbon reinforcements in nanocomposites. This information permits the development of structure-property relationships that enable, precise, high-throughput measurements for quality control.

- Nanomanufacturing: The CNST, in collaboration with academia, has developed a high-throughput, non-contact optical measurement method to enable defect detection in roll-to-roll nanoimprint fabrication processes. This will permit in-line process control in a manufacturing environment.

- Nanomanufacturing: The CNST is leading a cross-NIST program, in collaboration with industry, to develop experimentally and theoretically validated, high-throughput, non-contact, microwave measurements for quality- and process-control measurements to enable the manufacture of carbon-based nanocomposites. These metrology tools will help accelerate the deployment of these advanced materials in the aerospace and other industries.

- Nanoscale Fabrication: In order help enable innovation, the CNST is accelerating the prototyping process. To enable users to rapidly make reproducible, high-quality nanostructures for diverse applications, the CNST, in conjunction with a major instrument vendor, has developed an automated, metrology-driven software tool-set that permits even novice users to perform sophisticated focused ion-beam nanofabrication processes.

- Nanomanufacturing: With an eye toward enabling the development of more efficient catalysts for the synthesis of nanomaterials such as carbon nanotubes, the CNST has developed a unique environmental transmission electron microscope system, incorporating *in situ* Raman spectroscopy. This enables both atomic-scale resolution of active catalysis processes and precise local temperature and chemistry measurements that permit accurate kinetic studies. The information obtained will enable rational catalyst design.

- Energy Conversion, Storage, and Transport: In collaboration with several U.S. companies and national labs, the CNST developed a suite of methods for functional and structural characterization of thin-film photovoltaic materials that can be applied to optimize existing and emerging photovoltaic technologies and devices. The new methods are based on excitation by electron and/or light beams and current collection by nano-probes and contacts combined with advanced modeling methods to yield unique quantitative, nanoscale mapping of photovoltaic properties.

- Future Electronics: The CNST advanced the development of two new approaches to providing a new platform for two-dimensional, non-volatile, low-power electronics, which is being hotly pursued by the electronics industry as a replacement for silicon in its pursuit of faster, smaller, and more energy-efficient electronic devices. Using instrumentation unique to the CNST, researchers from several institutions collaborated on world-class measurements of the electronic properties of graphene and topological insulators, and imaged the nanoscale magnetic structure of multiferroic materials.

- Nanomanufacturing and Characterization: In support of such key industrial nanomanufacturing applications as integrated circuit editing and failure analysis, CNST researchers demonstrated a new ion beam source that provides unique performance in brightness, species selection, and energy spread, enabling new imaging modalities and better nanomachining capabilities. The CNST-developed technology was successfully transferred to a high tech start-up, creating new job opportunities in an area where the U.S. can lead.

Priority Objectives for FY 2015:

- Nanofabrication: Enable U.S. industry to develop myriad novel nanostructures for use in diagnostic and distributed sensing in applications, ranging from targeted drug delivery to enhancing oil recovery, by providing new self-assembly methods and associated metrology techniques that will accelerate research on new multifunctional nanoparticles.

- Nanomanufacturing: Support the rapid development of scalable nanomaterial production processes with applications in the high-performance materials, healthcare, and energy sectors. Advance the development of high-throughput metrology techniques to enable rapid, precise, and accurate measurements of nanoparticle size and shape in manufacturing, using integrated opto-nanofluidic devices to enable process control of engineered nanomaterials.

- Future Electronics: Help magnetic storage and information processing component manufacturers exploit new spintronic effects in their development of new, high density, low power memory and processing devices by developing new all-optical ferromagnetic spectroscopy measurement capabilities providing unprecedented measurements of high-anisotropy materials and ultra-thin magnetic films in the terahertz regime.

- Nanoscale Characterization and Manufacturing: Develop innovative nanoscale focused ion beam applications, working with industrial partners to fully integrate CNST-developed technology with state-of-the-art ion beam systems. Explore new imaging modalities and nanomachining opportunities that promise technological solutions to key nanomanufacturing needs in integrated circuit editing, failure analysis, nanoscale sample analysis, and the development of new nanomaterials for the electronics and energy sectors.

- Solar Energy/Photovoltaics: In collaboration with the National Renewable Energy Laboratory, develop methods for nanoscale characterization of surfaces and interfaces that limit the performance of current and emerging, high-efficiency silicon-based photovoltaic devices. Using this metrology and the well-controlled processes offered in the CNST NanoFab, assist in the development of low-cost nanomanufacturing processes transferable to manufacturing facilities.

- Solar Energy/Solar Fuels: Correlate the activity of nanocatalysts with their structure, composition, and morphology to accelerate the development of photoelectrochemical materials with improved performance. The CNST will develop methods for measuring the activity of photoelectrochemical catalysts designed for water oxidation with nanoscale spatial resolution, based on electron microscopy in environmental cells and superresolution optical microscopy.

- New Generation of Nanotechnologists: Help educate a new generation of nanotechnologists by providing hundreds of young scientists and engineers with the ability to use some of the world's most advanced instrumentation to address the challenge of measuring the subtle phenomena of nature that occur only on the nanometer scale. Through two-year-long postdoctoral appointments and visiting fellowships available to scientists from academia, industry, and government laboratories, CNST will provide in depth, post-graduate training in nanotechnology for more than 50 researchers. In cooperation with the National Science Foundation, the CNST will provide internship opportunities for community college students preparing for careers in nanotechnology, who will gain hands-on experience with state-of-the-art nanofabrication tools.

3. Physical Measurement Laboratory (PML)

Program Description:

The PML develops and disseminates the national standards of length, mass, force and shock, acceleration, time and frequency, electricity, temperature, humidity, pressure and vacuum, liquid and gas flow, and electromagnetic, optical, microwave, acoustic, ultrasonic, and ionizing radiation. Its activities range from fundamental measurement research to the provision of measurement services, standards, and data.

PML applies its measurement capabilities to problems of national significance through collaborations with industry, universities, professional and standards setting organizations, and other government agencies. It supports the research community in such areas as communication, defense, electronics, energy, environment, health, lighting, manufacturing, microelectronics, radiation, remote sensing, space, and transportation. PML establishes spectroscopic methods and standards for infrared, visible, ultraviolet, x-ray, and gamma-ray radiation; investigates the structure and dynamics of atoms, molecules, and biomolecules; develops the electrical, thermal, dimensional, mechanical, and physical metrology for measuring the properties of precision-measurement devices and exploratory semiconductor, quantum electronic, nanoelectronic, bioelectronic, biooptical, optoelectronic, and quantum-information devices and systems; and examines the thermophysical and interfacial properties of streams of flowing fluids, fluid mixtures, and solids. It develops and disseminates national standards by means of calibrations, measurement quality assurance, standard reference materials, technology transfer, education/training, and a comprehensive weights and measurement program to promote uniformity and accuracy at the international, Federal, state, and local levels. It generates, evaluates, and compiles atomic, molecular, optical, ionizing radiation, electronic, and electromagnetic data in response to national needs; measures and improves accuracy of the fundamental physical constants; and develops and operates major radiation sources for measurement science and metrology.

NIST's base activities within PML support a broad range of scientific, technological, commercial, and consumer needs.

- Time and Frequency: NIST maintains the Nation's standards for time and frequency measurement, an increasingly important field that supports advanced communications, electronic systems, power grids, and high-speed commerce. NIST focuses on developing the highest accuracy standards and methods of disseminating time and frequency, through the Internet, radio broadcasts, and satellites. The Internet service alone provides official time to the public several billion times each day.

- Medical Radiation and Imaging Technology: NIST calibrations underlie the safety and efficacy of diagnostic procedures (such as mammography) and therapeutic procedures (such as for cancer treatment). Well in excess of 22 million therapeutic radiation procedures[1] and nearly 40 million x-ray mammograms[2] annually are traced to NIST standards. NIST researchers have a robust program in a broad range of medical imaging technologies.

- Electrical and Electronics Metrology: Electronics are highly dependent on measurements enabled by NIST programs. NIST supports the electronics industry in many ways in its drive to develop ever smaller and more functional semiconductor products. The accuracy of every electricity revenue meter in the U.S. relies on standards provided by NIST. NIST is currently developing new techniques to support increasing complex, smaller, and more integrated devices, where feature sizes continue to be reduced and the role of defects and imperfections become increasingly important. In addition, NIST is developing techniques for to support state variables other than charge for future electronic logic.

- Optoelectronics and Optical Technology: According to a report by the National Research Council, "public companies active in optics and photonics generated an estimated 10 percent of all public-company revenues within the U.S. in 2010. These 282 unique public companies account for \$3 trillion in revenues and 7.4 million high-value U.S. jobs."[3] These companies require accurate and trusted standards in areas such as lighting, communications, photography, color and appearance, spectroscopy, and imaging. Work at NIST is important for environmental monitoring instruments used to measure temperature, atmospheric composition, and other aspects important in large-scale climate studies.

- Mechanical and Dimensional Metrology: NIST leads the development of new measurement standards to support U.S. manufacturing and harmonize the U.S. with international standards, removing impediments to U.S. competitiveness. NIST activities in this area promote lower costs for U.S. manufacturers, assure quality and interchangeability of parts, and achieve acoustical standards for the safety of workers in noisy environments.

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[1] *All therapeutic radiation procedures performed in the United States must be traceable to NIST standards. According to the American Cancer Society (http://www.cancer.org), there will be over 1.6 million newly diagnosed cancers in the United States in 2013. Approximately 60 percent of cancer patients are treated with radiation therapy during the course of the disease. An estimate of the number of cancer patients treated annually using radiation therapy is, therefore, about 900,000. Each patient will have a total of between 25 and 30 fractionated dose procedures (between 22 million and 27 million individual procedures performed annually). Therapeutic radiation procedures are also used for diseases other than cancers. However, statistics on these are not available.*

[2] *All mammograms performed in the United States must be traceable to NIST standards. As of June 1, 2013, almost 40 million mammograms were being performed annually. See* http://www.fda.gov/Radiation-EmittingProducts/MammographyQualityStandardsActandProgram/FacilityScorecard/ucm113858.htm.

[3] *See* http://www.nap.edu/catalog.php?record_id=13491. *See also* http://spie.org/Documents/AboutSPIE/PDF/HLII-OpticsandPhotonics.pdf.

- Fluid Dynamics: NIST maintains, improves, and disseminates the national measurement standards for gas flow, liquid flow, air speed, pressure, temperature, and humidity. Such measurements underlie process chemistry and manufacturing, equitable commerce in natural gas and liquid fuels, wind turbine performance, aircraft altimeter accuracy, and atmospheric monitoring.

- Public Health and Safety: NIST expertise in radiation detection and measurement supports critical needs of first responders, homeland security surveillance, medical sterility, and nuclear energy. Optical measurement systems support needs in highway and aviation safety, missile defense, and medical diagnosis. NIST aids the law-enforcement community with performance standards for bullet forensics.

- Weights and Measures: NIST promotes uniformity in U.S. weights and measures laws, regulations, and standards to achieve equity between buyers and sellers in the marketplace nationwide and internationally. This enhances consumer confidence, enables U.S. businesses to compete fairly at home and abroad, and strengthens the U.S. economy. NIST works with state and local officials and business, industry, and consumer groups, to achieve these goals.

- Advanced Training and Technology Transfer: Through NIST's joint institutes with the University of Colorado (JILA) and the University of Maryland (Joint Quantum Institute), NIST helps train graduate students and postdoctoral fellows in advanced science and technology, who support research and innovation in industry, academia, and government laboratories. Many NIST-supported trainees have gone on to establish high-technology companies; and create new jobs and products for the U.S. economy.

Examples of Accomplishments:

- Public Safety: NIST devised and refined a set of testing procedures for the 2,000 x-ray scanners used at 450 major U.S. airports. Passengers check more than 30 million pieces of luggage each month. Since 2004, Federal legislation has required all checked bags be scanned for explosives and other threats. NIST led the development of the American National Standard for Evaluating Image Quality of X-ray Computed Tomography (CT) Security-Screening Systems (IEEE ANSI N42.45), and developed and fabricated dozens of suitcase-sized test articles containing test objects to support implementation of the standard.[4]

- Remote Sensing: NIST has developed a laser-based technique to rapidly scan the air over large areas for low concentrations of chemicals. The high-speed technique uses electro-optics rather than mechanical tuning to detect the spectra—molecular fingerprints—of trace gases mixed in the air. The technique is broadly applicable, both for security applications (such as detecting explosives and toxins) and environmental analysis (such as measuring the concentrations of greenhouse gases).[5]

- Communications: NIST reported on its study of impairments to emergency radio communications. Radio communications can be unreliable in underground tunnels and large, complicated structures, posing a safety hazard for emergency responders. New tests of wireless emergency safety equipment have defined the challenges more precisely and suggest how emergency communications might be improved.[6]

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[4] *See* http://www.nist.gov/pml/div682/grp02/ct-standards-save-time-and-money.cfm
[5] *See* http://www.nist.gov/mml/csd/atmosphere-051413.cfm
[6] *See* http://www.nist.gov/pml/electromagnetics/subway-041713.cfm

- Chip-Scale Atomic Clocks: NIST scientists have devised atomic clocks small enough to be manufactured in microelectronic chips. These low-power devices make highly-accurate timekeeping portable and are useful, for example, in improving the resilience of Global Positioning System (GPS) receivers. A spin-off technology, the chip-scale atomic magnetometer, is being investigated for possible use in medical applications, such as measuring human brain activity. NIST's early experimental chip-scale atomic clock recently went on display in the Smithsonian Air and Space Museum,[7] and the scientists behind the work recently won the Rank Prizes in optoelectronics.[8]

Priority Objectives for FY 2015:

- Advanced Communications: Develop calibrated signal sources for high-speed modulated signals that will help enable deployment of advanced communication systems that use higher frequency spectrum than that generally commercialized today. Opening up this frontier of spectrum will enable expanded use of broadband (high-data rate) devices and applications. Measurement methods to be developed by NIST will enable the engineering of advanced devices and the implementation of spectrum management policy. NIST will develop free field test systems to verify the performance of wireless systems and spectrum-sharing technologies.

- Advanced Communications: Develop technology and metrology for long-path free-space optical communications using frequency combs. This will help enable deployment of free-space optical communications as a secure, broadband, ground- or satellite-based communication technology that is not constrained by availability of radio spectrum.

- Large-Scale Dimensional Metrology: Further develop a new multilateration technique using laser trackers to provide world-class measurement accuracy on large, complex three-dimensional (3-D) structures, such as airplanes. Applications include construction and advanced manufacturing.

- Better Microscopy for Nanomanufacturing: Further develop innovative approaches to solving vibration and drift problems in production line, scanned particle beam microscopy by utilizing super-fast image capture and a NIST-developed alignment program to improve image sharpness.

- Medical Imaging Technology: Design and calibrate "phantoms" to better calibrate PET-CT scanners, and use them to monitor scanner performance during clinical trials. Calibrated phantom standards will assist in evaluating the instrumental effects on clinical data. Additionally, continue development and validation of a phantom to calibrate magnetic resonance imaging (MRI) scanners. Together, these will improve the accuracy of medical diagnostic imaging, lead to more effective treatments, and speed the discovery and validation of new drugs and therapies.

- Energy and the Environment: Develop neutron-imaging methods to quantify shale structure and the efficiency of fossil fuel extraction processes from shale deposits. We will quantify the efficiency of supercritical CO_2 extraction methods. This approach to oil recovery allows for CO_2 sequestration and greater utilization of natural resources.

- Environmental Protection: Demonstrate a new capability based on a horizontal smokestack simulator to determine the accuracy of sensors measuring the mass flow of gas from power plants

[7] *See* http://timeandnavigation.si.edu/multimedia-asset/experimental-chip-size-atomic-clock
[8] *See* http://www.nist.gov/pml/div688/rank-052813.cfm

and other sources of greenhouse gas emissions. The simulator will allow an improved quantification of the complex flow patterns observed in industrial smokestacks.

- Electronics and Information Technology: Research low-power consumption technologies for data processing and data storage, including the use of spintronics. This will potentially reduce the rapidly growing energy demand of devices and systems from hand held to large server centers.

- Photonics: Perform research and development for new, ultraprecise laser technologies that will eventually outperform current best lasers by a factor of 100 or more in precision, with impacts on better atomic clocks, improved communications, new forms of quantum computing and quantum communications, and improvements to a wide range of precision measurements. These advances leverage NIST's pioneering of new types of laser technologies, including "super-radiant lasing," new ultrastable laser cavity systems, and continuing advances in laser frequency combs.

- Measurement Science: Continue to develop new "NIST on a chip" technologies, to provide a broad range of NIST-traceable embedded standards for use almost anywhere e.g., on the factory floor to support advanced manufacturing, in operating aircraft and vehicles to improve efficiency and safety, in the home to support improved, cost-effective health care. This research will build on NIST's pioneering research on chip-scale atomic clocks, magnetometers, and related devices to support a wide range of measurements. This program will broadly disperse NIST traceable precision measurements, and will build new means of technology transfer from NIST to industry partners.

- Measurement Science: Demonstrate an integrated chip-scale, photonic device for the accurate measurement of temperature, based on the temperature-dependent optical properties of micro-ring resonators. Such devices will allow manufacturers to fully integrate temperature measurement into manufacturing processes and instrument systems to improve quality and performance.

- Measurement Science: Develop a fully automated intrinsic Air Conditioning (AC) voltage standard source, based on quantized pulses from superconducting circuit arrays for frequencies up to 2 Mega Hertz (MHz). This will enable higher precision and accuracy of AC voltage measurements in electrical and electronics products across a wide range of industries.

- Measurement Services: Strengthen the Nation's precision timing and synchronization infrastructure through a new official U.S. standard for time, based on the second-generation laser-cooled atomic fountain clock. Timing and synchronization are a critical part of our modern technology, supporting such applications as GPS, communications, and electric power distribution.

- Measurement Services: Strengthen NIST's programs in the delivery of calibration services by furthering the development of the miseenpratique for the electronic kilogram. This will allow an international redefinition of the kilogram, to be based on fundament constants of nature, and improve the method of delivering services. Develop new, dynamic measurement techniques in both force and length metrology to support real-time measurements for advanced manufacturing.

4. Material Measurement Laboratory (MML)

Program Description:

The MML serves as the national reference laboratory for measurements in the material, biological, and chemical sciences through activities ranging from fundamental and applied research on the composition, structure, and properties of industrial, biological, and environmental materials and processes, to the development and dissemination of certified reference materials, critically evaluated data, and other programs to enable measurement quality.

MML serves a very broad range of industry sectors ranging from transportation to biotechnology by conducting research, and providing its output in the form of measurement services and measurement quality assurance tools to address problems of national importance, such as greenhouse gas emissions measurements; renewable energy; the Nation's aging infrastructure; environmental quality; food safety and nutrition; forensics and homeland security; healthcare measurements; and manufacturing ranging from advanced materials to photovoltaics to biologic drugs.

Specifically, MML conducts research in:

- Materials Science and Engineering to provide the measurement science, standards, technology, and data required to support the Nation's need to design, develop, manufacture, and use materials. In partnership with U.S. industry, other government agencies and other scientific institutions, we develop and disseminate measurement methods, theories, models, tools, critical data, reference materials, reference data, standards, and science underpinning the Nation's materials science and engineering enterprise. These activities foster innovation and confidence in measurements needed to advance technology and facilitate manufacturing in industrial sectors, such as energy, electronics, transportation and the environment.

- Materials Measurement Science to provide the measurement science, measurement standards, and measurement technology required to enable world-leading characterization of materials in support of the Nation's needs for the determination of the composition, structure, and properties of materials. In partnership with U.S. industry, government agencies and other stakeholders, we develop state-of-the-art instrumentation, methods, models and software to accurately and precisely measure materials over a range of length and time scales. We provide benchmarking and validation of emerging materials analysis methods, and disseminate reference materials, standards and scientific data to foster innovation and advance a wide range of technologies, such as those for public safety, forensics, homeland security and nanomanufacturing.

- Biosystems and Biomaterials to address the Nation's needs for measurement science, standards, data, methods and technology in the quantification of complex biological systems, materials and processes, from the nano- to the macro-scale. In partnership with U.S. industry, other government agencies and other scientific institutions, we develop and disseminate infrastructure supporting quantitative biology and biomaterial measurements with the intent of fostering innovation and confidence for stakeholders in biomedicine and healthcare, manufacturing, food safety, environmental health, and national security. We enable the U.S. to maximize the return on our national investment in the bioscience enterprise through interdisciplinary research drawing from expertise in the physical, information, and biological sciences.

- Biomolecular Measurement to provide the measurement science, standards, technology, and data required to support the Nation's needs in determining the composition, structure, quantity, and function of biomolecules. In partnership with U.S. industry, government agencies, and scientific institutions, we perform fundamental and applied research on the measurement of macromolecules such as proteins and nucleic acids, as well as peptides, glycans, metabolites, lipids, and natural products. We provide measurement science, reference materials, reference data, and technologies to foster innovation and confidence in measurements needed to advance biotechnology, deoxyribonucleic acid (DNA) forensics, biomedical and bioscience research, and health care.

- Chemical Sciences to provide the measurement science, standards, technology, data and chemical informatics required to support the Nation's needs in the determination of chemical composition and chemical structure of gases, organic, and inorganic species and in the measurement of a wide variety of chemical properties and processes, including chemical reactivity and mechanisms, and thermochemical properties. In partnership with U.S. industry, government agencies, and academic scientific institutions, we perform fundamental and applied research to advance and create state-of-the-art chemical measurement capabilities, theoretical and computational methods for quantitative measurements, and sensing of solids, liquids, gases, plasmas, transient species, and multicomponent matrices. We also formulate and disseminate reference materials and measurement standards, and critically evaluate reference data. These activities support the chemical science, technology, and engineering enterprise with the intent of fostering innovation and confidence in measurements and technologies used in a wide range of applications, including chemical analysis, environmental and climate assessment, clinical health assessment, food and nutritional assessment, sensing, manufacturing, and energy transformation.

- Applied Chemicals and Materials to provide the measurement science, standards, technology, instrumentation, models and data required to support the Nation's needs for design, production, and assessment of chemical and material products. In partnership with U.S. industry, other government agencies and other scientific institutions, we provide thermophysical and mechanical properties; analysis of reliability and performance of materials and structures; and information systems for chemical and materials engineering, with the intent of fostering innovation and confidence in the Nation's physical and energy infrastructures, enabling advances in chemical manufacturing and in electronics, and promoting sustainability.

MML is also responsible for coordinating the NIST-wide Standard Reference Materials (SRM) and Standard Reference Data (SRD) programs. NIST SRMs and SRD are key technology transfer mechanisms that enable U.S. industry to achieve traceability of their measurements to NIST's fundamental standards and best-in-the-world measurements, and to the SI. This traceability enables industry to more easily address international comparability and compliance, which is necessary for the U.S. to export its products worldwide.

In order to address the growing challenges of data and informatics in the chemical, biological and materials sciences, and to meet objectives of recent Administrative directives related to public data availability, MML has established an Office of Data and Informatics (ODI). The ODI is charged with coordinating and building capabilities within MML to better analyze, condition, and properly store the large data sets inherent to contemporary chemical, biological and materials experimentation and simulation and modeling. In addition, the ODI will build capabilities and best practices in data validation and provenance, as well as interchange standards needed to serve large datasets to the public, and to make them available for complex scientific endeavors. As such, it will serve national initiatives related to Big Data, as well as the Materials Genome Initiative (MGI). In addition, the ODI shapes the next generation of innovative SRDs produced by MML.

Examples of Accomplishments:

Accomplishments (and continuing activities) include research and measurement service delivery focus on industry and government priorities, as described below:

- Advanced Materials: Provided the underpinning measurement science, standards and leading-edge measurement tools needed to establish quantitative processing-structure-property relationships of advanced materials, in ways that enable U.S. industry and other government agencies to discover, develop and optimize advanced materials and to harness their properties for technology innovations. Advanced materials include ceramics, metals, polymers, semiconductors, composites, fluids, and some biomaterials, in bulk, particulate, and multilayer forms, that have new or improved properties. MML provides the tools and standards for accurate measurements of material composition, structure, and properties for sustainable and safe manufacture, use and recycling of products that contain advanced materials.

- Bioscience and Healthcare: Increased the accuracy, comparability, and efficacy of measurements used in medical diagnostics and advanced therapeutics in ways that enabled reduced U.S. healthcare costs and improve quality of life through more informed medical decision-making. For more than 25 years, NIST has maintained standards for electrolytes, organic biomarkers (such as cholesterol, creatinine and glucose), drugs of abuse and toxic metals. NIST provides needed measurements and standards to support the measurement of health status markers in serum, urine, and tissue; the development of innovative biologic medicines such as protein therapeutics, cell-based regenerative products, and vaccines; the development of advanced dental materials, tissue engineering scaffolds, nanoparticle-based therapies for cancer; and safe and reliable implanted medical devices.

- Electronics: Quantified the composition, structure, properties and dimensions of current and emerging electronic materials and devices, and assessed electronics fabrication routes in ways that enabled development and manufacture of advanced electronics by U.S. industry. This work enables industrial development and commercialization of next-generation semiconductor devices, magnetic materials for low-noise sensors and next generation computer logic, and flexible organic electronic devices; as well as tests and standards to ensure the safe and reliable long-term use of these products.

- Energy: Supported the development, production and reliability of materials and devices related to advanced energy sources, renewable energy, energy storage and energy-harvesting, as well as the safe and effective use of petroleum, in ways that enabled the Nation to adopt new energy technologies and to ensure energy security. MML measurement methods, reference materials and data are essential for a cleaner fossil fuel economy, and support the development, manufacture and quality control of biofuels, next generation photovoltaics, advanced batteries and heat-harvesting thermoelectric devices.

- Environment and Climate: Verified assessments of soil, air, and water, as well as environmental threats, and supported environmental remediation strategies, in ways that enabled our Nation to protect its environmental resources and develop science-based environmental policy. MML measurement methods, certified reference materials, reference data, and measurement quality assurance programs are central to environmental contaminant measurement and monitoring programs, provide needed improvements to the reliability and comparability of measurements and assessments of environmental quality and climate. In addition, MML has developed an advanced specimen banking program that enables retrospective analyses and determination of trends of contaminants in the environment and animals.

- Food Safety and Nutrition: Underpinned measurements of the composition of food and water in ways that enabled the Nation to prevent contaminated food and water from entering supply streams, ensured the reliability of nutrition information on product labels, and enabled consumers to make well-informed dietary choices. MML reference materials enable food manufacturers and distributors to accurately assess the nutritional content of their products. MML also has expertise in chemical analysis supports new methods to detect contamination.

- Manufacturing: Supported the industrial production of finished goods from raw chemicals, raw materials and biological sources, and facilitated the design of materials for manufactured products in ways that promote innovation, U.S. industrial competitiveness, and job creation. MML research and standards products provide essential support to a large number of U.S. manufacturing sectors, including automotive, electronics, materials and chemicals production, and biopharmaceuticals.

- Physical Infrastructure: Provided measurement science and test methods, including non-destructive evaluation techniques, needed to assess the health of aging physical infrastructure components and materials, to predict their lifetime and failure, and to gauge their performance under extreme environmental conditions in ways that enabled the Nation to prioritize infrastructure remediation, and to manufacture more resilient infrastructure components. These include reference materials and standards for assessing material strength and hardness, standards for fuel pipeline safety, methods to assess the performance of plastic pipes for water and gas, and methods to test and predict the heath of critical connections and join-ends in bridges and buildings.

- Safety, Security, and Forensics: Advanced threat detection, improve the accuracy of forensics measurements and helped ensure the reliability of protective technologies and materials, in ways that foster homeland security, the safety of public servants, and effective law enforcement. These include advanced instrumentation and reference materials that enable the accurate and reliable detection of chemical, biological, radiological, nuclear and explosive threats; standards and reference materials that support DNA-based human identity testing for forensics and biometrics; and measurement methods that ensure the reliability of soft body armor.

Priority Objectives for FY 2015:

Advanced Materials: To enable innovation, manufacture, use and recycling of high priority advanced materials in a range of industry sectors, MML will develop and deploy:

- instruments, measurement methods, and standards to determine the composition and structure of advanced materials with the unprecedented resolution and accuracy needed by industry to advance the development of products that contain such materials; for example, semiconductors, engineered nanomaterials, and catalysts. These measurement tools include microscopy and spectroscopic methods to image materials at the atomic and molecular scales, and a suite of NIST-developed synchrotron spectroscopy instrumentation to be installed at the world's premiere synchrotron user facility, NSLS-II (Brookhaven National Laboratory).

- a new industry consortium, nSoft, established in 2013, will help a wide range of industry partners (currently leading U.S. chemical, materials and pharmaceutical firms) leverage advanced neutron-based measurement methods housed at NIST needed to accelerate the development and commercialization of new "soft materials", including polymers, colloidal materials, complex fluid formulations, petroleum based products, consumer products, and pharmaceuticals.

- instruments, measurement methods, standards and validated data to determine the properties of advanced materials for myriad industries. For example, reference materials to calibrate instruments for nanoscale measurements, including reference flexural cantilever arrays for force measurements in scanning probe microscopes, which are ubiquitous in industrial laboratories.

- cutting edge and scalable methods to separate Carbon Nanotubes (CNT) by length, chirality and electronic structure needed to measure their intrinsic added-value in CNT-enabled products, and to produce nanotube reference materials needed to assess potential environmental, health, and safety (EHS) risks of CNTs.

- databases of critically evaluated crystal structure, diffusion rates, interatomic potentials, and phase equilibrium diagrams needed by industry to design, develop, and process advanced materials without expensive brute-force empiricism.

- transferable instruments, validated protocols and assays, standards, and validated data to determine the physico-chemical and toxicological properties of engineered nanomaterials and nanotechnology-enabled products, essential to assess and manage EHS risks, with a focus on industry-relevant advanced materials such as carbon-based nanomaterials and nanoparticles of titanium dioxide, silver, and silicon dioxide. A specific thrust area is the detection, quantification, and characterization of the release of silver nanoparticles from treated textiles and CNTs from polymer-based nano-composites.

Bioscience and Healthcare: MML will develop and disseminate reference methods, SRMs, measurement quality assurance programs, and new instrumentation, needed to increase the accuracy and comparability of healthcare assessments and to advance biomedical technologies. Research activities will include:

- programs aimed at advancing engineering biology and addressing the grand challenge of understanding the underlying principles that direct biological systems response. This includes the production of sufficient highly-qualified data to permit hypothesis-independent selection of mathematical models that describe the biological response. NIST will provide the mechanism for community engagement, bringing together academics, industry and other agencies, and the fundamentals of measurement assurance, to create a data/analysis pipeline that will enable discovery of biological principles.

- protocols and reference materials for blood protein health status marker detection (such as those used for detection of heart attack, kidney function, and prostate cancer).

- DNA and Ribonucleic acid (RNA) measurement methods and standards that support whole genome sequencing, early detection and diagnosis of disease such as cancer, and genetics-based diagnostics for detection of chromosomal disorders such as Huntington's Disease and Fragile X Syndrome.

- measurement protocols, reference data, and reference materials to support the development, manufacturing and regulatory approval of innovative biopharmaceuticals such as protein therapeutics.

- advanced bioimaging techniques that will enable label-free, information rich, 3D imaging of cells and tissues needed to improve early detection of disease (such as cancer) and significantly advance understanding of the structure and function of complex biosystems.

- documentary standards and best-practice protocols for measuring key attributes of stem cells linked to their safety and efficacy as requested by the cell therapy industry and the Federal Drug Administration (FDA).

- measurements and data needed to ensure the reliability of implanted medical devices non-destructive in-line means to detect faulty capacitors and leads in active medical devices like pacemakers.

- measurement protocols and reference materials for improving the design and reliability of new dental materials, such as mercury-free polymer composite filling materials.

Electronics: In support of the U.S. semi-conductor and electronics industry and the users of advanced electronic materials in a number of industries, MML will develop and disseminate:

- measurement methods and instrumentation needed to accelerate the commercialization of devices based on emerging electronic technologies, including organic flexible electronics, enabling industry to determine the source of materials performance variations that hinder reliable manufacture of innovative products such as flexible displays.

- measurement methods, instruments and reference materials needed by the U.S. semiconductor industry to produce the nanoscale structures, and to employ the novel materials, inherent to the manufacture of next-generation microelectronic devices. These include dimensional metrologies to ensure the quality of manufactured structures and films, and 3D chemical imaging and depth profiling techniques to gauge the reliability of emerging materials deposition and doping routes for manufacturing multi-layered devices and interconnects.

Energy: To keep abreast of current measurement needs of U.S. industry as they design, manufacture, and deploy renewable energy resources, MML will develop and disseminate:

- measurement methods and reference materials to accelerate the commercialization of solar devices made from thin-film semiconductors, and organic photovoltaics. These include measurement tools requested by the budding U.S. solar industry to benchmark material performance, optimize processing and design, monitor manufacturing processes, and determine failure mechanisms that shorten lifetime.

- measurement methods, data, and reference materials that enable our Nation to develop and use alternative and renewable fuels. These include needed fundamental physical property data and the production of data and reference materials needed for the reliable manufacturing and quality control of biofuels such as ethanol and biodiesel, alternative aviation and motor fuels, and pinene and terpene based fuels. In addition, a new program will assess corrosion and other failure mechanisms specific to alternative fuels that can threaten the Nation's ability to use its existing petroleum pipeline infrastructure to transport these newer energy sources.

- measurement methods and reference materials to accelerate the industrial development of energy harvesting and energy storage devices. These include instrumentation and reference materials needed by the U.S. automotive industry to test the performance of thermoelectric devices that recover waste-heat, and measurements that will help industry to commercialize better batteries and fuel cells.

Environment and Climate:

MML will develop and disseminate:

- measurement methods, data, chemical informatics tools, and reference materials to allow precise measurements of key greenhouse gases, including carbon dioxide, methane, and reactive species. This will include two reference materials for calibrating atmospheric levels of Chlorofluorocarbons (CFCs) as well as very accurate measurements of optical properties of methane.

- measurement methods and data necessary to design and evaluate candidate sorbent materials for industrial scale carbon capture and sequestration systems. This includes a new facility, built by leveraging ARPA-E funds, which will establish best practices for measuring sorbent performance and act as a central point for performing comparable tests of new sorbent materials produced by academia, government and academia.

- reference materials, data and a comprehensive marine specimen repository, needed to ground assessments of environmental events, such as the Deep Water Horizon Oil spill, as well as related and remediation efforts, including means to better monitor oil and other residues in marine sediments and animal tissues. In 2015, the marine specimen repository will have expanded to include specimens from Pacific waters.

- reference materials, data, and measurement methods to enable sound scientific assessment of the state of aquatic and soil environments when impacted by contaminants attributed to chemical releases from industrial activities, including hydrocarbons in marine environments, and heavy metals, such as hexavalent chromium, in soil.

- measurement methods, data, and reference materials to allow precise measurements of the optical properties of environmental aerosols, such as so-called black and brown carbon species that will enable substantially better models for predicting atmospheric warming phenomenon.

- reference data and thermophysical property values to needed to predict candidate compounds that can be used as more environmentally benign refrigeration fluids with lower green-house warming potential and ozone depletion potential.

Food Safety and Nutrition: In this area, reference measurement methods and reference materials or data will be developed and disseminated for underpinning measurements made for determining:

- folate species, vitamin B12, vitamin B6, and vitamin D metabolites to support human nutrition assessment studies being conducted by the Centers for Disease Control (CDC) and National Institutes of Health (NIH).

- accurate levels of iodine and other key nutrients in baby foods, breakfast cereals and table salt, in partnership with the NIH Office of Dietary Supplements.

- identity and properties of bacterial foodborne pathogens by coupling emerging genomic methods with mass spectrometry techniques.

Manufacturing: Enabled by new funding provided in FY 2012 and FY 2013 appropriations and the reprioritizing of current resources, MML will grow priority measurement science and standards programs that will enhance the competitiveness of U.S. manufacturers. Priority program development will include:

- Additive Manufacturing (AM): In concert with the NIST-wide program in additive manufacturing, MML will develop state-of-the-art measurement, characterization, and modeling methods for understanding how processing variables determine the resistance of AM processed materials to mechanical failure. This program will examine methods for measuring and characterizing the chemistry and microstructure of the bonding interface of both polymeric and metallic materials and the quantification of the influence of precursor materials and processing variables on the integrity of the bonds between the voxels of material and the resistance of AM processed materials to fracture.

- Automotive Light-Weighting: In partnership with the Nation's leading automotive manufacturers, The NIST Center for Automotive Light-Weighting will deploy data, measurement protocols and models that enable the automotive industry to rapidly design and produce vehicle components from advanced light-weight alloys, which promise to radically improve fuel efficiency. Starting in 2014, a new NIST-led industry consortium will be formed to leverage a suite of ARRA-funded instrumentation built at NIST that will be used to radically reduce the time and cost needed to introduce lightweight aluminum, high-strength steel and magnesium alloys into vehicle parts, and to ensure the crashworthiness of these parts. In 2015, this partnership will include mechanical and lifetime assessments of lightweight composites proposed for use in vehicles.

- Biomanufacturing and Synthetic Biology: The MML program in biomanufacturing will develop measurement methods, protocols, and standards for improved measurement of biologic products. Biotechnology drugs, currently dominated by protein therapeutics, are the fastest-growing class of pharmaceuticals and one of the fastest growing categories of health care spending. MML will work closely with industry, the FDA, and other standards organizations with the goal of developing new measurement science and tools for improved physical/chemical characterization of biologic products. Improved measurement infrastructure will enable greater manufacturing flexibility, the development of biosimilars and new innovative products, and ultimately, safer, more effective biologic medicines. With increased funds in FY 2014, MML will establish a new mass spectrometer facility to accelerate development of a monoclonal antibody SRM. This SRM will be used to assess the ability of industry laboratories nationwide to reliably determine the structure and function of a model biologic drug. In addition, MML will establish a mammalian cell culture facility at the Institute for Bioscience and Biotechnology Research, a collaborative NIST-University of Maryland Institute, to support host cell proteomic and metabolomics studies. In addition, NIST has established a new partnership with Stanford University and a collection of regional industry start-ups which is aimed at providing the metrology needed to underpin the emerging and highly promising area of Synthetic Biology. This Advanced Biological Measurement Science partnership will advance U.S. industry's ability to synthesize new pharmaceuticals, specialty chemicals and novel materials using cell-based "factories" designed for these specific purposes.

- Materials Genome Initiative (MGI): MML expertise in materials measurements and modeling is an essential component to this interagency effort aimed at accelerating industrial innovation by significantly reducing the time from discovery to commercialization for new materials. The MGI will integrate modeling and simulation tools with experimental tools and digital data/informatics in ways that enable rapid prediction and optimization of materials properties. To support this revolutionary approach, MML, in collaboration with NIST's Information Technology Laboratory, will continue to develop the key infrastructure to enable data and models to be exchanged between researchers and integrated in real time, and provide the critical quality metrics (validation, verification, sensitivity, and uncertainty quantification) for these data and models to allow realization of advanced, new materials. To achieve these ends, NIST will continue to assess and implement the best technical modalities for materials data exchange, develop digital repositories of materials data and models, and work with its stakeholders to establish additional repositories, using shared, consensus-based, materials metadata standards. In response to FY 2012-2013 assessments (drawn from two interagency/industry workshops), MML will execute a two-year plan to invest FY 2013 budget increases towards determination of best practices for exchange of materials information for a number of targeted materials applications, including thermodynamic, diffusive and mechanical properties. These new efforts will enable for true "integration" of computation and experiment to realize new metrologies and "big data" driven materials research. To support and centralize MGI and other "big data" enterprises in the materials sciences, MML will establish an Office of Data and Informatics which will provide expertise, coordination and infrastructure needed for data driven research enterprises in the Laboratory.

- Nanomanufacturing: In collaboration with the NIST CNST, MML will contribute to a nanoparticle manufacturing metrology program to include efforts in separation, synthesis, integration, performance and baseline measurement validation. MML scientists will contribute to the development of tools and methodologies to characterize engineered nanoparticle concentration, size and size distribution, shape and shape distribution, surface functionalization, electronic/optical properties, behavior in complex fluid environments, scalable synthesis processes and the underlying theory.

- Process Measurements for Manufacturing with Advanced Materials: In partnership with industry, MML will develop measurement tools capable of monitoring advanced high-volume manufacturing processes used to produce technologies, such as flexible electronics, organic photovoltaics and carbon-nanotube based composites. The work will focus on techniques for monitoring processes, such as interface formation, film formation, nanotube growth, deposition distribution and structure formation at the speeds needed for high-volume manufacturing, and often with nanometer-level resolution.

Physical Infrastructure: MML will focus its measurement science base in areas critical to maintenance and assessment of our Nation's physical infrastructure. MML will develop, validate, and disseminate:

- measurement techniques that will establish the safety of gusset plate connections in fracture-critical bridges, and that support the establishment of standards for non-destructive bridge condition assessments, in collaboration with the FHWA Turner-Fairbank Research Center.

- measurements and SRMs needed to improve our Nation's ability to detect hidden flaws due to corrosion and fatigue.

- test methods and standards to qualify steels used in fuel pipelines, and measurements that foster the repurposing of pipelines for alternative fuels like hydrogen, ethanol and biofuels, that are needed by the DOT and DOE to determine the safety rating of these materials for alternative fuels, and are needed to assess biodegradation mechanisms that can degrade pipelines in the presence of new fuels.

- measurements to foster robust U.S. water infrastructure, including means to evaluate next generation plastic water pipelines used in nuclear plant cooling, test the mechanical integrity and fouling resistance of water filtration membranes, and to detect emerging contaminants including nanomaterials and drug metabolites.

Safety, Security, and Forensics:

In this area, MML will develop and deploy:

- measurement methods, reference materials, and data to ensure that the Nation has reliable and effective detection capabilities for Chemical, Biological, Explosive, and Nuclear threat materials, including new test protocols for the efficient sampling of contraband residues requested by the Transportation Security Administration, and control and calibration systems for assessing the performance of biothreat assays.

- new methods for collecting and analyzing contraband residues from fingerprints, credit cards, and clothing using advanced chemical imaging and aerodynamic techniques.

- reference materials and methods of DNA profiling for consistent genetic typing within the forensics and biometrics communities, including new tests to evaluate prototype rapid DNA typing equipment.

- new imaging and mechanical testing protocols for evaluating the performance of soft body armor materials at high strain rates.

5. Engineering Laboratory (EL)

Program Description:

The EL provides the measurement science and standards needed for the technology-intensive manufacturing, construction, and cyber-physical infrastructure communities. EL carries out mission functions in fire prevention and control; national earthquake hazards reduction; national windstorm impact reduction; national construction safety teams; building materials and structures; engineering and manufacturing materials, products, processes, equipment, technical data, and standards; green manufacturing and construction; manufacturing enterprise integration; and smart grid devices and systems. EL also carries out other engineering research and services to support mission functions as may be necessary, including systems integration and engineering; intelligent systems and control; robotics and automation; cyber-physical systems; sustainability and energy efficiency; economic analysis and life cycle assessment; productivity measurement; and safety, resilience, and environmental performance.

The EL's measurement science research and services include the development of performance metrics, measurement and testing methods, predictive modeling and simulation tools, knowledge modeling, protocols, technical data, and reference materials and artifacts; the conduct of inter-comparison studies and calibrations; the evaluation of technologies, systems, and practices, including uncertainty analysis; and the 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.

The impacts of EL's mission programs are focused on three strategic goals in areas of critical national priority: Disaster-Resilient Buildings, Infrastructure, and Communities; Sustainable and Energy-Efficient Materials and Buildings; and Smart Manufacturing and Cyber-Physical Systems. EL achieves these end-use impacts by serving as an authoritative source of (1) critical solution-enabling measurement science and (2) critical technical contributions underpinning emerging standards, codes, and regulations that are used by the U.S. manufacturing, construction, and infrastructure industries to strengthen leadership in domestic and international markets. The programs described below support EL's strategic goals; they all develop and deploy advances in measurement science with the specific objectives listed.

Smart Manufacturing and Cyber-Physical Systems

- Performance of Smart Manufacturing Systems: To enable composable, integrated systems architectures, real-time predictive models and data analytics, and system assurance tools for assembly-centric smart manufacturing systems.

- Standards for Smart Manufacturing Systems: To enable performance, quality, interoperability, and cybersecurity standards for real-time monitoring, control, and optimization of assembly-centric smart manufacturing systems.

- Robot Systems for Smart Manufacturing: To safely increase the versatility, autonomy, and agile re-tasking of collaborative robot systems with humans-in-the-loop for next-generation smart manufacturing systems.

- Measurement Science for Additive Manufacturing: To enable rapid design-to-product transformation through characterization, sensing, control, and assurance of materials, processes, and parts using additive manufacturing systems.

- Smart Grid: To enable integration of interoperable and secure real-time sensing, control, communications, information and power technologies to increase the efficiency, reliability, resiliency, and sustainability of the Nation's electric grid.

Sustainable and Energy-Efficient Materials and Buildings

- Sustainable Engineered Materials: To enable sustainable use of engineered materials in manufacturing and construction, including cementitious, polymeric, and composite materials.

- Net-Zero Energy, High-Performance Buildings: To move the Nation toward net-zero energy, high-performance buildings while maintaining a healthy indoor environment.

- Embedded Intelligence in Buildings: To improve building operations to achieve energy efficiency, occupant comfort, and safety through the use of intelligent building systems.

Disaster-Resilient Buildings, Infrastructure, and Communities

- Disaster Resilient Systems: To enhance the community-centric resilience of buildings and infrastructure to natural and manmade hazards.

- Fire Risk Reduction in Communities: To improve the resilience of communities and structures to unwanted fires through innovative fire protection and response technologies and tactics.

- Fire Risk Reduction in Buildings: To increase the safety of building occupants and the performance of structures and their contents by enabling innovative, cost-effective fire protection technologies.

- Earthquake Risk Reduction in Buildings and Infrastructure: To resist earthquake effects, improve safety, and enhance resilience of buildings, infrastructure, and communities.

Examples of Accomplishments:

Smart Manufacturing and Cyber-Physical Systems

- Performance of Smart Manufacturing Systems: Developed new Product Manufacturing Information (PMI) validation and conformance test methodologies, tests, and supporting tools and released them to industry users. The suite of new testing methods and tools allows manufacturers to ensure that computer-aided design (CAD) and manufacturing (CAM) software applications are making correct use of PMI standards.

- Standards for Smart Manufacturing Systems: Established a factory equipment network testbed to measure the effectiveness of standards for collecting and distributing real-time production information from factory floor equipment. The testbed improves standards that enable automated real-time collection and distribution of production information to increase the responsiveness and performance of manufacturing operations.

- Robot Systems for Smart Manufacturing: Developed a "ground truth" system for assessing the performance of sensors that identify and locate objects. This measurement system will provide the technical foundation for American Society for Testing and Materials (ASTM) E57.02 standards for measuring—and spurring improvement of—the performance of perception systems that reduce the setup and fixturing needed for robots to perform new tasks.

- Measurement Science for Additive Manufacturing: Completed design of a new test artifact for metal-based additive manufacturing, and proposed the artifact for standardization by ASTM F42 committee. The standard test artifact will provide a critical common point of reference for defining, evaluating, and improving the performance of additive manufacturing equipment.

- Smart Grid: Completed/coordinated development of key new smart grid information exchange standards supporting consumer-to-grid interactions, including those for demand response, load and generation predictions, and energy usage and pricing information. First adopter electric utility implementations based on NIST technical guidance and software tools have enabled 19 million U.S. customers to receive access to their energy usage information in a standardized format through the Green Button Initiative.

Sustainable and Energy-Efficient Materials and Buildings

- Sustainable Engineered Materials: Completed two test methods for characterizing the rheology of cement paste that were adopted in ASTM standards (ASTM C1738-11a and C1749-12) and issued two new SRMs for cement paste and mortar rheology. The standards and SRMs will enable improved consistency and repeatability in determining the properties of cement and concrete through the widespread use of science-based rheometers instead of existing empirical tests.

- Net-Zero Energy, High-Performance Buildings: Completed Building Industry Reporting and Design for Sustainability (BIRDS) software to measure the sustainability performance of new commercial buildings using energy efficiency technologies, including energy usage, carbon footprint, and cost-effectiveness of new buildings built to different energy efficiency targets in existing and emerging building energy codes. The software tool allows: (1) designers and standards developers to analyze the business case for building to different/higher energy efficiency targets, and (2) policy makers and building officials to assess the benefits and costs of adopting newer and more stringent versions of building energy codes in their jurisdictions.

- Embedded Intelligence in Buildings: Developed fault detection and diagnostic components for the California Energy Commission's Universal Translator tool. This free tool works in conjunction with commercial building automation and control systems to assist commercial building owners in detecting and diagnosing equipment faults and control errors in heating ventilating and air-condition systems that reduce energy efficiency and occupant comfort.

Disaster-Resilient Buildings, Infrastructure, and Communities

- Disaster Resilient Systems: Completed development of methodology and guidance for assessing the robustness of building structures. The guidance provides practicing engineers with a unique new capability to design and optimize system level safety performance and reserve capacity for building structures.

- Fire Risk Reduction in Buildings: Developed guidelines for evaluating the smoldering performance of cover fabrics used in residential upholstered furniture. Use of the guidelines will reduce the fire hazard posed by residential furniture and significantly improve life safety.

- Fire Risk Reduction in Communities: Developed standard test methods for evaluating the thermal performance of self-contained breathing apparatus (SCBA) used by fire fighters. Performance-based testing of critical personal protective equipment such as SCBA will ensure that fire fighters can depend on critical equipment to work under actual firefighting conditions, leading to improved safety for fire fighters and building occupants.

- Earthquake Risk Reduction in Buildings and Infrastructure: Completed a comprehensive study comparing performance-based standards for design of new—and retrofit of existing—steel frame buildings to resist earthquakes. The results of the study, which showed that existing seismic retrofit standards for this important class of buildings are over conservative, will spur the development of more cost-effective seismic retrofit standards methods that will improve the safety of the existing building stock through broader adoption and use in practice.

Priority Objectives for FY 2015:

- Performance of Smart Manufacturing Systems: Develop a service-oriented reference architecture for smart manufacturing systems to enable the computation, measurement, and exchange of key performance metrics to support data analytics, predictive models, and performance assurance at the factory and supply network levels. The reference architecture will enable improved production efficiency and quality for smart manufacturing systems.

- Standards for Smart Manufacturing Systems: Complete a major update of the *Guide to Industrial Control System (ICS) Security* (Special Publication 800-82 (Revision2)) encompassing ICS risk management, recommended practices and architectures, security capabilities and technologies, and security control baselines tailored to risk levels. The guidance will enable improved ICS security in manufacturing and critical infrastructure industries, while addressing the demanding performance, reliability, and safety requirements of these systems.

- Robot Systems for Smart Manufacturing: Develop metrics, a measurement system, and measurement procedures to quantify and evaluate the performance of people detection sensors that provide workspace situational awareness for manufacturing robotics. These performance metrics and measurement tools will enable accelerated development and deployment of safe human-robot interactions in manufacturing applications and environments. Design and develop a testbed that instantiates the calibration and related challenges for robot sensors, grippers, and arms in small and medium-sized enterprise (SME) workcells. This testbed will provide an environment in which to develop and validate models and tools for calibration of the robot systems.

- Measurement Science for Additive Manufacturing: Develop new measurement methods, and complete a draft ASTM F42 standard, for characterizing the plastic yield, fracture, and fatigue performance of parts made from advanced metal alloy powders using additive manufacturing processes. Standardized methods for measuring the mechanical properties of parts made by additive manufacturing will reduce risks and accelerate adoption of metal additive technologies, enabling rapid design-to-product transformation.

- Smart Grid: Implement a smart grid test bed to provide a unique technical capability for measuring, evaluating, and demonstrating the performance of interconnected and interacting advanced smart grid devices, subsystems, and systems. This test bed platform will accelerate the development of smart grid interoperability standards, advances in smart grid technology, and technical specifications and methods to enable distributed, scalable, and extensible testing and validation of smart grid systems.

- Net-Zero Energy, High-Performance Buildings: Complete the collection of high-fidelity datasets on the performance of photovoltaic systems installed on the NIST campus over a one-year period, and compare the experimental results with predictions from computer simulations. These data will be used to improve computer models used by developers and designers of photovoltaic systems to determine the best configurations that maximize output and return on investment.

- Embedded Intelligence in Buildings: Develop software tools and a rating methodology for evaluating the performance of commercial fault detection and diagnostic (FDD) products designed to ensure that air conditioners and heat pumps perform as designed throughout their lifetime. A reliable way to measure the performance of FDD tools is a critical step in achieving market acceptance of this new technology that will impact the energy efficiency of millions of air conditioners and heat pumps used in homes and small businesses.

- Sustainable Engineered Materials: Develop experimental protocols and complete accelerated environmental exposures for novel nano-engineered fiber-reinforced polymer composites. These protocols and experiments will provide (1) the first controlled Ultraviolet (UV) environmental stressor exposure and UV degradation data for this emerging class of engineering materials, and (2) critical insight on the service life of these materials, enabling widespread their use by industry.

- Disaster Resilient Systems: Complete first version of a community-centric Disaster Resilience Framework for critical buildings and infrastructure lifelines based on a cross-sector, all hazards approach, considering the technical interdependence of a community's physical and human assets, operations, and policies/regulations. The framework will inform the development of private sector standards and codes to achieve resilience of the built environment, where resilience performance is the ability to withstand, respond to, and recover quickly from a disruptive hazard event. Develop and document user requirements, data elements, and analytical/simulation methods for systems-based modeling environment.

- Fire Risk Reduction in Buildings: Develop nano-engineered fire retardant coatings and characterize their performance in reducing the fire hazard of polyurethane foam, a key component in the fire hazard of typical residential furniture. Reduction of the fire hazard of residential furniture will lead to significantly improved life safety.

- Fire Risk Reduction in Communities: Develop standard test methods to characterize the fire resistance performance of building elements and mulch to resist ignition when exposed to firebrands. Performance based testing of ignition resistant landscaping and building products will reduce fire losses of buildings exposed to wildland-urban interface fires.

- Earthquake Risk Reduction for Buildings and Infrastructure: Complete laboratory testing and analysis of reinforced concrete wall models to address wall slenderness and ground motion induced uplift phenomena first seen in 2010 Maule, Chile, earthquake and issue recommendations for improved modeling methods and model building code provisions. Adoption and use of updated model building codes will improve the safety of buildings with slender reinforced concrete wall elements in major earthquakes.

6. Information Technology Laboratory (ITL)

Program Description:

The ITL enables the future of the Nation's measurement and standards infrastructure for information technology by accelerating the development and deployment of information and communication systems that are interoperable, secure, reliable, and usable; advancing measurement science through innovations in mathematics, statistics, and computer science; and conducting research to develop the measurements and standards infrastructure for emerging information technologies and applications. We accomplish these goals through collaborative partnerships with our customers and stakeholders in industry, government, academia, and consortia. Based on input from these customers and stakeholders, we have focused our research and development agenda on these broad program areas.

- Advanced Communications: National initiatives such as Health IT, telemedicine, Smart Grid, environmental monitoring, and mobile and cloud computing depend on robust, scalable, and advanced networking technologies with new trustworthy ways of dynamically provisioning resources. Current wired and wireless network infrastructures already show strain when meeting the rapidly escalating requirements for capacity and capabilities to connect clouds and ascertain that services deployed are always available. In addition, the growing scale and complexity of distributed information systems built upon these infrastructures increases the risk and implications of systemic failure. ITL's Advanced Communications initiative focuses on three areas: (1) design and analysis of "clean slate" approaches for network architecture and protocol design that are not constrained by today's Internet technology and subscribe to the cloud vision; (2) development of a measurement science for robust distributed system design; and (3) design and analysis of spectrum efficient communication technologies.

- Advanced Materials: As part of the multi-agency Materials Genome Initiative (MGI), ITL is working with the MML to develop the measurement science, tools and standards necessary to enable greatly improved efficiency in the Nation's development and manufacture of new products and services based on innovative materials. In particular, ITL will extend its expertise in the development and use of materials modeling and simulation for manufacturing, and collaborate in the creation of a national measurement and standards infrastructure that will substantially lower the cost of both design and manufacturing for industries seeking to realize the benefits of computer-based materials discovery and optimization.

- Cloud Computing: Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. NIST's role in cloud computing is to promote the effective and secure use of the technology by providing technical guidance and promoting standards that enable cloud users to benefit from increased efficiency for cost savings and enhanced capabilities for applications such as Big Data and mobile computing.

- Complex Information Systems: Complex Systems are composed of large numbers of interrelated, interacting entities which taken together, exhibit a macroscopic behavior which is not predictable by examination of the individual entities. The Complex Information Systems Program seeks to understand the fundamental science of these systems and develop rigorous descriptions (analytic, statistical, or semantic) that could enable characterization, prediction and control of their behavior. Initially focused on the Internet, Grid Computing, and Cloud Computing, this Program's outputs may also have impact in other areas, such as biotechnology, nanotechnology, semiconductors, and complex engineering.

- Cyber Physical Systems (CPSs): CPSs are hybrid networked cyber and engineered physical elements co-designed to create adaptive and predictive systems for enhanced performance. The convergence of networking and information technology with manufactured products, complex engineered systems, and associated services are enabling a new generation of "smart" or cyber-physical systems (CPS). These CPS are critical components and key value added features of items that people use every day - from transportation and telecommunication systems to networked buildings and medical devices. As CPSs have grown exponentially in complexity, dramatic improvements in the systems engineering, integration and testing are needed. This initiative will enable NIST to develop foundational elements of Cyber Physical Systems including a reference architecture. NIST will develop core cybersecurity infrastructure for CPS and enable networking and interoperability of distributed CPS.

- Cybersecurity Automation: NIST develops the underlying essential standards to enable automating cybersecurity vulnerability discovery, configuration management, and security metrics. These standards allow for the design of machine readable cybersecurity policies that can be automatically disseminated, enforced, audited and remediated by commercial tools in near real time as well as tool based, standardized cybersecurity vulnerability management at enterprise scale. The program is focused on extending the standards to areas of cybersecurity where automation is needed to identify threats and accelerate vulnerability remediation. The program provides a standardized base for commercial tools and organizations to fully implement a threat-vulnerability-asset based cybersecurity continuous monitoring program.

- Cybersecurity Research and Development: This Administration has declared the cyber infrastructure a strategic asset, and the President has established a set of high-priority recommendations in the Cyberspace Policy Review and the Executive Order on Improving Critical Infrastructure Cybersecurity. NIST has a leading role in the Department of Commerce program of cybersecurity and privacy initiatives that support realizing the potential for e-commerce to foster innovation, bolster U.S. industrial competitiveness, and enhance our economic prosperity and security. NIST will continue and expand existing efforts to improve the cybersecurity assurance posture of current and future information technologies and improving the trustworthiness of IT components such as claimed identities, data, hardware, software for networks and devices, mobile device security, and information analytics. NIST will apply its security research and standards expertise and proven ability for industry collaboration to enable organizations to improve the efficiency and effectiveness of their cybersecurity practices and work towards the Administration's mandate to significantly improve the security and interoperability of our Nation's cyberspace infrastructure.

- Cybersecurity Standards: NIST's role in the standardization of cybersecurity technologies is exercised by the deep technical expertise held by NIST personnel. NIST cybersecurity experts engage with a variety of national and international standards bodies including the American Standards Committee (ASC) X9 (financial industry standards), the International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC), the Institute of Electrical and Electronics Engineers (IEEE), the Internet Engineering Task Force (IETF), and the Trusted Computing Group (TCG). By way of example, NIST's participation in these organizations has assisted in the development of fundamental Internet standards such as IPv6 and Domain Name System Security (DNSSEC) in the IETF. In ISO, NIST contributed to the issuance of ISO/IEC 19790, Security Requirements for Cryptographic Modules, and ISO/IEC 24759, Test Requirements for Cryptographic Modules. These efforts have led to consistent testing of cryptographic modules across the global community, enhancing the security and reliability of encryption tools and techniques. Assignment of full time personnel to standards bodies would help accelerate the standardization and adoption other U.S. information and critical infrastructure technology.

- Health Information Technology: NIST's laboratories are contributing to the healthcare industry by providing its standards, measurement science and testing expertise. NIST collaborates with the Health and Human Services (HHS) Office of the National Coordinator, major standards development organizations, professional societies and the public sector in fostering interoperable, secure, reliable, and usable standards-based solutions for the exchange of health information. ITL focuses on ensuring key health information standards are complete and testable and, providing the necessary conformance tests, interoperability tools and techniques where appropriate. These activities, when integrated into standards, software and certification processes, will raise the quality of the clinical outcomes, lower cost of Health IT implementation, enable greater patient safety, and foster adoption of Health IT.

- Identity Management Systems: Identity management systems are responsible for the creation, use, and termination of electronic identities that are routinely used to access logical and physical resources, and have become a ubiquitous part of our national infrastructure. In this area, NIST is pursuing the development of common models and metrics for identity management, critical standards, and interoperability of electronic identities. These efforts will improve the quality, usability, and consistency of identity management systems while protecting privacy.

- National Cybersecurity Center of Excellence (NCCoE): The U.S. Department of Commerce, through NIST, has established a public-private partnership to operate the NCCoE. By working collaboratively with the Information Technology industry, the NCCoE tackles some of industry's most significant cybersecurity challenges by reducing barriers to adoption of more secure technologies. The NCCoE and its technology partners demonstrate example solutions that are standards-based, practical, open and usable.

- National Initiative for Cybersecurity Education (NICE): The goal of the NICE is to establish an operational, sustainable and continually improving cybersecurity education program for the Nation to use sound cybersecurity practices that will enhance the Nation's security. NICE is a national campaign designed to improve the cybersecurity behavior, skills, and knowledge of every segment of the population, enabling a safer cyberspace. The NICE initiative, involving more than 20 Federal departments and agencies, ensures coordination, cooperation, focus, public engagement, technology transfer and sustainability for cybersecurity education and training. NICE is comprised of four components: National Cybersecurity Awareness, led by the Department of Homeland Security (DHS); Formal Cybersecurity Education, led by the Department of Education and the National Science Foundation; Cybersecurity Workforce Structure led by the Department of Homeland Security and supported by the Office of Personnel Management; and Cybersecurity Workforce Training and Professional Development, led by the Department of Defense, and DHS.

- National Strategy for Trusted Identities in Cyberspace (NSTIC): The National Strategy for Trusted Identities in Cyberspace is an initiative established in direct response to the recommendations of the White House Cyberspace Policy Review, which called for an effort to raise the level of trust associated with the identities of individuals, organizations, services, and devices involved in online transactions. The crux of these activities has taken place in the privately-led Identity Ecosystem Steering Group (IDESG), established in 2012 with support from the NSTIC National Program Office (NPO) at NIST to develop a framework of standards, policies and accreditation processes necessary to implement NSTIC and develop, in collaboration with stakeholders, a standards roadmap for credential issuers, relying parties and service providers. The NPO works closely with the Executive Office of the President, the Federal CIO Council, the Cybersecurity Interagency Policy Committee, and other identified governing bodies to obtain appropriate guidance, expertise, and issue resolution. NIST has a leading role in the Department of Commerce's cybersecurity and privacy initiatives, which contribute to the potential for ecommerce to foster innovation, bolster U.S. industrial competitiveness, and enhance our economic prosperity and security.

- Next Generation Internet Technologies: Today's Internet provides critical infrastructure to almost every aspect of our society, yet many of the Internet's core protocols and services are vulnerable to attack and misconfiguration and are reaching critical scaling limits due to the growth of the Internet. The Internet Infrastructure Protection program focuses on evolving the current Internet's core protocols for naming, addressing and routing to be more robust and secure and to support continued viability of the current Internet architecture.

- Quantum Information: Quantum science and engineering has the potential to revolutionize 21st century technology in much the same way that lasers, electronics, and computing did in the 20th century. As part of the larger NIST Quantum Information Program, ITL aims to understand the potential for quantum-based technology to transform computing and communications, and to develop the measurement and standards infrastructure necessary to exploit this potential. The principal goals are:

    - to understand the potential opportunities and risks for quantum information to revolutionize information science;
    - to develop theory, methods, architectures and algorithms to enable engineering and testing of quantum computing components and systems; and

- to demonstrate and test communication components, systems and protocols for the quantum era.

- Smart Grid: By linking information technologies with the electric power grid, the Smart Grid promises many benefits, including increased energy efficiency, reduced carbon emissions, and improved power reliability. As outlined in the Energy Independence and Security Act of 2007 (Public Law 110-140), NIST has been given "primary responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of Smart Grid devices and systems." NIST works nationally and internationally with industry, other government agencies, academia, and other stakeholders on cybersecurity, and communication requirements, performance metrics, measurement methods, and standards. ITL leads NIST Smart Grid activity in cybersecurity and the use of wireless and power line communication infrastructures. ITL provides smart grid users and stakeholders with guidance and tools to help them make informed decisions about smart grid information infrastructures.

- Smart Manufacturing: ITL efforts will focus in the following areas that are required for robust smart manufacturing: 1) Data integration, where information obtained from the manufacturing floor through sensors is aggregated into different levels of abstraction with appropriately evaluated ontologies (terminologies, relationships between these terms) and functional and behavioral taxonomies; 2) Manufacturing intelligence, which involves using state-of-the-art software techniques, including artificial intelligence tools, for formulating decisions and executing actions at the shop floor, factory, enterprise, and networks of suppliers, utilizing information and knowledge models developed through data integration techniques; 3) Software modeling, verification, and assurance, which will ensure that the software (which generally forms a large part of current manufactured systems) developed for the smart cyber-physical infrastructure is reliable, verifiable, accurate, and properly assured; and 4) Cybersecurity, where data/information needs to be transmitted (from various sensors and other devices) in a trusted and secure manner, within and across networks.

- Virtual Measurement Systems (VMS): The Virtual Measurement Systems Program focuses on a metrology infrastructure for scientific computation. Scientific computing is used throughout NIST to assist in the achievement of the institutional mission to provide world class measurement capabilities to U. S. industry. In addition, scientific computing is increasingly used to inform policy and decision-making at all levels of industry and government. A metrology infrastructure is essential to stabilize the use of scientific computing in both capacities. Elements of this infrastructure being developed under the VMS Program include: analysis and dissemination of numerical benchmark problems, uncertainty characterization and propagation, and traceability for computational models. Success in these program goals will result in predictive computing with quantified reliability. In turn, this will provide a solid foundation for the use of scientific computing as a measurement and decision-making tool.

- Voting Systems Standards and Research: The 2002 Help America Vote Act gave NIST a key role in helping to realize nationwide improvements in voting systems for domestic and overseas voters. To assist the Election Assistance Commission (EAC) with the development of voluntary voting system guidelines, HAVA established the Technical Guidelines Development Committee (TGDC) and directed NIST to chair the TGDC and provide necessary technical support and research to support the development of voting system standards. NIST has focused its research in areas that were developed in consultation with the EAC, the TGDC, the Federal Voting Assistance Program (FVAP), election officials, manufacturers, test labs, academics, and other partners and stakeholders to include:

- o security of computers, computer networks, and computer data storage used in voting systems;
- o methods to detect and prevent fraud;
- o protection of voter privacy; and
- o assessment of the role of human factors in the design and application of voting systems, including assistive technologies for individuals with disabilities (including blindness) and varying levels of literacy.

- Wireless Interoperability: The Wireless Interoperability program focuses on measurement science, in the form of methods, metrics and models, for wireless interoperability and innovation. Today, a growing range of wireless technologies serve to connect billions of people and devices around the world. These devices and technologies are being used in ever more complex settings at higher demand levels and for innovative applications that stretch their original design. Innovation in usability, interoperability, scalability and the efficient use of finite temporal, spectral, and spatial resources is needed to meet the challenges posed by this rapid growth. This program provides the effective metrics and measurement tools required to enable innovation in a multi-vendor, multi-technology environment and ensure reliability and resilience in mission-critical applications such as public safety and smart grid communications. The assessment capabilities developed by this program will be used to identify performance gaps and foster the development of new protocols and technologies that improve the scalability, reliability and interoperability of next generation wireless systems.

Examples of Accomplishments:

- Advanced Communications: NIST established an initial reconfigurable test-bed for software defined networking (SDN) experimentation. SDN is a radically new paradigm for the design, implementation and deployment of network control protocols for routers and switches. The NIST SDN test-bed will enable NIST to test and evaluate emerging SDN technologies in terms of their security, scalability and robustness. In addition, NIST developed two design-time methods to identify potential failure scenarios in distributed information systems. NIST applied those methods to identify vulnerabilities in infrastructure-as-a-service clouds. NIST shared these design-time methods at various academic and industry conferences, and among government programs, including the Mission-oriented Resilient Cloud program of the Defense Research Projects Agency and with the Defense Information Systems Agency.

- Advanced Materials: Massively parallel graphics processing unit (GPU) computer systems have emerged offering ultra-high performance. A single GPU can match the computation power of a mid-range CPU cluster, but at much lower cost and power consumption. Use of such systems could not only enable higher fidelity materials simulations, but bring practical materials modeling within reach for many more industrial firms. However, solution methods that take advantage of the unique features of such systems remain challenging to realize. We have completed an analysis of methods for the solution of the Landau-Lifschitz-Gilbert equation, which models the magnetic properties of materials at the micro- and nano-scale, on GPU systems. Speed-ups of up to 100-fold were demonstrated, verifying the great potential of this approach.

- Cloud Computing: NIST released for public comments Special Publication 500-299 "NIST Cloud Computing Security Reference Architecture." This document provides the first example of a comprehensive logical framework for analyzing the complex distribution of security controls in all of the fundamental cloud platforms, from software-as-a-service to infrastructure-as-a-service models. The document provides a step-by-step implementation example to illustrate how the framework is applied in decision-making, evaluation, and acquisition processes and also includes tools to facilitate implementation of the framework. NIST brought the Cloud Computing and Big Data communities together at a forum with over 600 participants from academia, industry, and government to set out first steps in realizing the potential for progress at the intersection of these exciting technologies. As a result of this forum, NIST launched the Big Data Public Working Group with commercial, academic, and government stakeholders working together to establish shared goals and identify opportunities for cooperation and coordination. In October, 2013, NIST is bringing together the Cloud and Mobile Computing communities in a new forum to explore the potential for synergy between these two technologies to drive innovation and economic growth. NIST continues to make progress in addressing the high priority interoperability, security, and portability requirements defined in the roadmap. The roadmap priorities are those which must be met for U.S. government agencies to accelerate deployment of Cloud Computing. Key accomplishments include: work with the private sector to leverage the NIST Cloud Computing Reference Architecture to develop international standards through International Organization for Standardization/ International Electrotechnical Commission (ISO/IEC) and other entities, and categorize commercial cloud services to make it easier for cloud consumers to compare product offerings. This work was completed through the NIST hosted public working groups and collaboration web site, in partnership with academia, industry, standards organizations, government, and the international community.

- Complex Information Systems: Characterizing the structure of large networks is an important problem in the study of complex systems. One important means of understanding a network is to visualize it. While it is straightforward to visualize small networks of hundreds or a few thousands of nodes and edges using conventional visualization packages, rendering large networks is nearly impossible. In such cases the rendered image is nearly a solid blot of color in which is difficult to extract any meaningful information. An alternate approach is to visualize important network properties, rather than the actual network itself. Such network portraits allow an analyst to quickly ascertain key properties of a network under study. NIST has developed a new formalism, the Q-matrix, a connected component size distribution matrix for a percolation process on the network. The Q-matrix admits a unique fixed-size visualization from which common network metrics are evident. Among the interesting characteristics of the Q-matrix is that network graphs from similar application areas (e.g., social networks, email networks, web graphs, peer-to-peer networks, road networks, citation graphs) share similar visual characteristics. This makes such a framework useful for network identification and classification.

- Cyber Physical Systems: To enable effective use of encryption in large-scale complex CPS NIST engaged with the cryptographic community to define requirements and considerations for a key management infrastructure for large scale industrial CPS. NIST also engaged with the cybersecurity community to define requirements and considerations for a Risk Management Framework for CPS – based on NIST SP 800-39. NIST co-sponsored a CPS Cybersecurity workshop at the NIST Gaithersburg campus. NIST's co-sponsor was the Computer Security Research Alliance – industry consortia. Over 100 people attended the sessions which focused on issues such as supply chain security, securing legacy systems, and building secure CPS systems from the start. The workshop identified unique cybersecurity requirements for cyber physical systems that will inform the CPS cybersecurity research agenda. NIST also developed a prototype system to help reduce false alarms due to medical device interactions, and improve medical equipment maintenance and diagnostic efficiency by implementing a comprehensive system event and data logger for medical CPS (Integrated Clinical Environment ICE) for end-to-end system performance measurement, characterization, analysis, and fault-diagnosis (for ASTM F 2761 standards). NIST helped to ensure synchronization of device clocks and time stamps – which is critical for situational awareness of CPS - by developing a framework for testing that will allow distributed multivariate control systems to identify and resolve timing related challenges for complex heterogeneous CPS.

- Cybersecurity Automation: To facilitate the adoption of cybersecurity automation technologies, NIST conducted a variety of outreach activities. NIST organized and ran the annual Security Automation Conference, an annual event that showcases security automation technologies and provides a forum for security automation researchers. NIST worked with international standards organizations. For example, NIST served in the Internet Engineering Task Force's (IETF) Managed Incident Lightweight Exchange (MILE) working group, and supported the formation of the IETF Security Automation and Continuous Monitoring (SACM) working group. In support of these outreach activities, NIST developed an initial prototype for analyzing continuous monitoring architectural concepts as currently documented in NIST IRs. To ensure that government efforts to foster and adopt cybersecurity automation techniques are coordinated and cost effective, NIST liaised with the National Security Agency, Department of Defense and Department of Homeland Security to coordinate a government strategy around industry engagement, standards activities in international bodies, and ongoing development of specifications and guidance around the use of security automation specifications with existing secure transport protocols.

- Cybersecurity Research and Development: With the continued proliferation of information, and the explosion of devices connecting to the expanding communication infrastructure and the evolving threat environment, the need for research to support the development of cybersecurity standards and best practices continues. To address these challenges, NIST devised new security and privacy testing methodologies for smart phone software application functionality. Our research in hardware-enabled security continued with the development of guidelines on mechanisms that measure and report the integrity of mobile device hardware. In addition, NIST research continued to expand into the cybersecurity aspects of cyber-physical and embedded systems, and the mechanisms for enabling and protecting public safety communications. To facilitate the use of strong cryptography, NIST completed its five year competition for a new cryptographic hash algorithm. The winning algorithm, Keccak (pronounced "catch-ack"), was created by Guido Bertoni, Joan Daemen and Gilles Van Assche of STMicroelectronics and Michaël Peeters of NXP Semiconductors. The team's entry beat out 63 other submissions that NIST received after its open call for candidate algorithms in 2007, when it was thought that SHA-2, the standard secure hash algorithm, might be threatened. Keccak will now become NIST's SHA-3 hash algorithm.

- Cybersecurity Standards: NIST has finalized its first set of guidelines for managing security and privacy issues in cloud computing. *Guidelines on Security and Privacy in Public Cloud Computing* (NIST Special Publication 800-144) provides an overview of the security and privacy challenges facing public cloud computing and presents recommendations that organizations should consider when outsourcing data, applications and infrastructure to a public cloud environment. The document provides insights on threats, technology risks and safeguards related to public cloud environments to help organizations make informed decisions about this use of this technology.

- Health Information Technology: NIST developed and made publically available the final test procedures and associated conformance tools for the 2014 Edition Electronic Health Record (EHR) certification criteria. The Office of the National Coordinator for Health Information Technology (ONC) approved and posted the final test procedures and applicable test data and tool files for the 2014 Edition EHR certification criteria. The procedures are being used for testing and certifying

EHR technology under the ONC Health Information Technology Certification Program. Testing laboratories and certification bodies will use the test procedures to evaluate conformance and functionality of complete EHRs or EHR Modules against the standards, implementation specifications, and certification criteria adopted by the Health and Human Services Secretary for 2014 certification. In addition, NIST designed and built an innovative test-bed to study and evaluate wireless connectivity of wearable and implantable medical devices.

- Identity Management Systems: As part of its programs to develop standards and guidelines for government-wide secure, reliable credentials to support strong authentication, NIST completed draft Special Publication 800-157 on derived Personal Identity Verification (PIV) credentials for mobile environments. The use of derived credentials leverages current identity proofing, vetting and electronic credentials of PIV and allows a flexible approach to authentication that accommodate innovation in mobile devices.

- National Cybersecurity Center of Excellence (NCCoE): NIST executed a Joint Project Agreement with the State of Maryland and Montgomery County, Maryland to establish the NCCoE, based at a facility shared by NIST and the State of Maryland, to engage the commercial, academic, and Federal, state, and local government sectors to: foster transfer and broad adoption of cybersecurity capabilities and practices from the laboratory to practical, affordable, and useful business use cases and applications across the full range of commercial and government sectors; research and develop new principles and mechanisms underlying security standards, metrics, and technologies; promote the emergence of a private sector-led ecosystem for trusted identities in cyberspace; establish a comprehensive library of practical and effective standards, guidelines, metrics, and best practices for secure and privacy preserving information technologies; develop and test methods for composing, discovering, monitoring, and measuring the mechanisms, configurations, and practices that affect the security posture of systems and enterprises; and communicate cybersecurity principles and technologies to cyber systems developers, providers, and user. NIST established long-term partnership agreements with industry and established two use cases in security: health information technology and protection of intellectual property in the manufacturing environment. NIST examined options for cybersecurity research and engineering development processes in support of the NCCoE.

- National Initiative for Cybersecurity Education (NICE): In FY 2013, the National Cybersecurity Workforce Framework version 1.0 was finalized after NIST submitted it to the Office of Management and Budget (OMB) for Federal government-wide review. The Office of Personnel Management (OPM) added a Cybersecurity Data Element in the OPM 2012 Guide to Data Standards with cybersecurity function codes to allow Federal civilian workforce to identify Federal positions for which the primary function is cybersecurity; enable OPM and Federal agencies to identify the cybersecurity workforce, determine baseline capabilities, examine hiring trends, identify skill gaps, and more effectively recruit, hire, train, develop and retain an effective cybersecurity workforce; allow Federal HR Professionals to better understand the workforce and what issues need to be addressed; and provide a platform for organizations outside of the Federal government to similarly organize their cybersecurity professionals. In FY 2013, NIST has taken on the co-chair role in the OPM led Cross-Agency Priority Goal: Closing Skills Gaps in the Federal cybersecurity workforce to improve mission performance. As part of its outreach role, members of the NIST NICE Leadership Team continue to attend events, symposia, forums, competitions, educational outreach meetings, and workshops across the country highlighting the strategic goals of NICE and describing activities supporting those goals.

- National Strategy for Trusted Identities in Cyberspace (NSTIC): The Identity Ecosystem Steering Group (IDESG) work has been augmented and accelerated by a number of pilots that the NSTIC

National Program Office has awarded through the NSTIC Grant Program to advance the NSTIC vision, objectives and guiding principles, demonstrate innovative frameworks that can provide a foundation for the Identity Ecosystem, and tackle barriers that have to date, impeded the Identity Ecosystem from being fully realized. Pilots collaborate with the IDESG, sharing lessons learned, and contributing to the development of an Identity Ecosystem Framework.

- Next Generation Internet Architectures: NIST staff, working in collaboration with the Internet Engineering Task Force (IETF), contributed modeling and analysis results and design guidance to the development of a new Border Gateway Protocol Security (BGPSEC) specification. NIST specifications and testing infrastructure assisted Federal agencies in the wide scale operational deployment of Internet Protocol version 6 (IPv6). NIST guidance and test tools facilitated the continued roll out of Domain Name System Security (DNSSEC) technologies across the .gov domain.

- Quantum Information: Experimental efforts to demonstrate quantum devices suitable for quantum computations are rapidly growing and showing increasing success on multiple platforms. While the ion-trap platform is still leading the field, superconducting qubits are rapidly approaching parity, and solid-state qubits are showing increasing promise. One of NIST's goals is to establish easily applied benchmarking protocols that can quantify the performance of these devices in a platform-independent way in order to enable the fair comparison of alternate technologies as well as to track community progress in the quest for developing practical quantum computers. Presently, our main benchmarking strategy involves the implementation of randomized quantum operation sequences and comparing the output to that expected for an ideal computation. This yields an "error per gate" that can be reported as a device quality measure. Our latest implementation of such a benchmark involved random two-qubit circuits and established an error per so-called Clifford operation as well as an error per phase-gate, one of the standard elementary two-qubit gates. This work has established a method for benchmarking that can readily be scaled to more qubits. The NIST benchmarking protocols have already been adopted by several experimental groups.

- Smart Grid: NIST published "Guidelines for Assessing Wireless Standards for Smart Grid Applications," NISTIR 7761V2. Completed the development of a new wireless authentication protocol based on designing new hashing schemes to overcome weaknesses in current standards. Coordinated and collaborated with industry groups, Smart Grid Interoperability Panel (SGIP) Priority Action Plans, other Federal Agencies, and international stakeholders in efforts to accelerate harmonization of the Smart Grid security architecture with the SGIP Smart Grid Architecture Committee's conceptual architecture and European Union's conceptual architecture. Researched and documented potential privacy issues in the smart grid, including Plug-in Electric Vehicles (PEVs), usage of Customer Energy Usage Data (CEUD) in new settings, and new privacy enhancing tools and methods. Published a Smart Grid Cloud Cybersecurity White Paper. Conducted cybersecurity related tests in relation to the Institute of Electrical and Electronics Engineer (IEEE) 1588 standard on time synchronization.

- Smart Manufacturing: NIST developed guidance that provides a set of standardized cybersecurity controls to protect smart manufacturing systems; updated the National Vulnerability Database to reflect the needs of smart manufacturing; developed a framework for integrating data at several levels of abstraction; developed use cases for determining the metrics and measures needed to evaluate smart manufacturing systems; created algorithms combining mathematical, statistical, and computational techniques that signal incipient changes in large-scale networked smart manufacturing systems; Identified and characterized software assurance tools for cyber physical manufacturing systems (CPMS); and studied the software assurance needs of small to medium enterprises (SMEs).

- Virtual Measurement Systems: NIST has set new accuracy records for computations of non-relativistic ground state energies of few electron atomic systems. Fundamental understanding of atomic systems is necessary for a wide variety of applications including material design, drug discovery, and providing a test bed for quantum theory. Despite their small size, atomic systems present enormous challenges for scientists hoping to compute their properties from first principles. As understood since the dawn of the quantum mechanical era in the 1930's, non-relativistic atomic systems are governed by the Schrodinger equation. These difficulties have resulted that much of our computational infrastructure is predicated on simplifying approximations. At NIST we have taken a different approach. For several years we have invested in developing the foundational analytical and numerical machinery to solve the few-electron Schrodinger system with no approximations. This investment has resulted in several extreme-accuracy firsts in the world of computational atomic. In FY 2013, NIST researchers computed the ground-state energy of the 4-electron Beryllium atom to nine digits of accuracy using 70,000 unknowns to represent the solution. By extending these results they were able to perform the most accurate computations of the isoelectronic series through most of the periodic table up to and including Thorium. The 4-electron case is particularly exciting as, due to the NIST formalism, a theorem exists showing that, in principle, the higher electron systems will present no new analytical difficulties. These results are being prepared for publication.

- Voting Systems Standards and Research: NIST continued to develop key research findings related to both Help America Vote Act (HAVA) and the Uniformed and Overseas Citizens Absentee Voting Act (UOCAVA). This research includes: Information systems security for UOCAVA-supporting systems; assessment of risk of current UOCAVA (mail) voting systems, and accessibility and usability for voting systems. NIST developed a risk assessment methodology for current UOCAVA (mail) voting systems; chaired the IEEE Working Group on Common Data Formats and led the development of two additional IEEE standards for electronic exchange of voting system data: Election Night Reporting and Event Logging; developed initial methods to enable automated analysis of voting system software; and developed common test methods for usability and accessibility, and source code testing across Voting System Test Laboratories. To facilitate broad development and adoption of voluntary voting system guidelines, NIST organized and ran the Future of Voting Systems Symposium, which provided a forum for discussion of current and future standards development and certification strategies.

- Wireless Interoperability: NIST developed an effective approach to modeling the public safety broadband network at multiple scales and obtained initial results on the network coverage and capacity of a nationwide public safety network spanning the entire United States. The performance trends and trade-offs highlighted by this work provided the technical underpinnings for the "Middle Class Tax Relief and Job Creation Act of 2012," (Public Law 112–96) that allocates 20 Mega Hertz (MHz) of spectrum in the D-Block (700 MHz) to public safety communications. NIST refined the modeling approach for the Nationwide Public Safety Broadband Network (NPSBN) and investigated several key factors impacting the network performance. The results shared with the First Responder Network Authority (FirstNet) are being used to set the performance requirements of the NPSBN. NIST established a programmable wireless test bed to design and evaluate algorithms and technologies for the dynamic allocation of spectrum. NIST established a Smart Grid networking test bed to evaluate security and interference issues with applicable wireless technologies.

Priority Objectives for FY 2015:

- Advanced Communications: Develop advanced test and measurement techniques to characterize and improve promising "clean slate" designs for fundamentally new architectures and protocols for core Internet services, including: new routing and addressing paradigms, information centric networking architectures and software defined networks. NIST's initial focus will address characterizing the robustness and security properties of emerging Software-Defined Networking (SDN) technologies. NIST will develop techniques to predict catastrophic run-time events in distributed systems. The resulting measurement science will provide a rigorous foundation for industrial methods to signal the onset of catastrophic events on the basis of measurable precursor behaviors. If successful, the reliability of modern distributed information systems will increase, and failure-related costs will diminish. NIST will also investigate ways to develop a measurement-based network knowledge plane with broad applicability to management, diagnosis, and security.

- Advanced Materials: Working closely with the Materials Measurement Laboratory to achieve the goals of the inter-agency Materials Genome Initiative, ITL will develop techniques and tools for the quality assessment of computational tools and materials data, as well as the development of standards, protocols and related tools for the seamless interchange of data among computational platforms.

- Cloud Computing: Continue work on the high priority interoperability, security and portability requirements identified in the "USG Cloud Computing Technology Roadmap" to accelerate USG adoption of cloud computing. Priority objectives are as follows: (1) Develop metrics that facilitate performance assessment and enable adopters to develop effective service level agreements, (2) develop decision-making frameworks for agency leaders responsible for adopting cloud computing and map the decision elements directly to measurable components of service level agreements, (3) mature the draft security reference architecture for cloud computing through community input and map its security capabilities to the established set of NIST security controls, (4) provide leadership in international standards efforts to promote interoperability and ensure U.S. providers can be competitive in a global a cloud services marketplace, and (5) promote community-based efforts to explore the synergy that lies at the intersection of cloud computing and applications including Big Data and mobile computing.

- Complex Information Systems: Continue to develop metrics that enable the characterization of key structural and dynamical properties of abstract networks and their relation to the reliability and security of information systems. Computational modeling, simulation, and validation strategies for efficient estimation will also be developed and applied to the assessment of critical infrastructure such as the Internet, cloud computing, and the power grid.

- Cyber Physical Systems (CPS): Continue to accelerate improvements to CPS cybersecurity through the development of a Risk Management Framework (RMF) for CPS – based on NIST SP 800-39, "Managing Information Security Risk: Organization, Mission, and Information System View" and an associated impementation guide to assist small and large stakeholders in implementing the RMF. NIST will continue to collaborate with the cryptographic community to develop a framework for key management of large scale industrial CPS. NIST will help reduce false alarms due to medical device interactions, and improve medical equipment maintenance and diagnostic efficiency by demonstrating a comprehensive system event logger and analysis for a complex distributed networked CPS with distributed controls to measure, characterize, analyze, and conduct advanced diagnostics for ASTM International F 2761 standards. NIST will help to resolve timing related challenges for complex heterogeneous CPS by testing distributed multivariate control systems.

- Cybersecurity Automation: Develop prototypes and conduct experiments to perform security measurement and management in a variety of contexts (cloud infrastructure, operating system, smartphone, etc.). These activities will demonstrate a resilient monitoring and management framework and show how the architectural principles employed could be scaled to the size and diversity of future U.S. infrastructure needs. Primary objectives are as follows: (1) define key elements and a measurement and management architecture and work with industry and government to develop consensus on the architectural approach and to solicit feedback, (2) research the operational constraints of the approach by constructing prototypes and performing experiments while updating key elements and the architecture as needed, (3) standardize key findings by working with Standards Development Organizations, author and update NIST publications as needed to incorporate new findings, and (4) publish user guidance for implementing measurement and management solutions using best practices.

- Cybersecurity Research and Development: Continue to extend its research agenda for high-quality, cost effective security and privacy mechanisms to foster improved cybersecurity. To address challenges in privacy, NIST will continue to build its privacy research program to study privacy technologies that can support privacy principles identified in cybersecurity and identity management programs. NIST will continue to develop measurement capabilities to support the full secure software and hardware lifecycle for information technology and cyber physical systems. Through industry and academic partnerships, programs, NIST will lead and participate in programs to examine the diverse cybersecurity aspects of a broad set of areas, including supply chain risk management; security analytics; cryptography; cloud, mobile, hardware-enabled security; and cyber-physical and embedded systems.

- Cybersecurity Standards: Continue to provide its expertise to engage with a variety of national and international standards bodies including the American Standards Committee (ASC) X9 (financial industry standards), the International Organization for Standardization (ISO), the Institute of Electrical and Electronics Engineers (IEEE), the Internet Engineering Task Force (IETF), and the Trusted Computing Group (TCG). For example, NIST will continue to contribute its expertise in development of a set of secure software development and engineering specifications based on international standards. NIST will also continue to provide contributions for international standards efforts in support of device configuration and management protocols and data formats.

- Health Information Technology: Promote interoperability and adoption of Health IT by applying NIST expertise in standards development, harmonization, and testing; security; usability; and certification processes. This will enable broader applications of electronic health records and health IT through telehealth and mobile devices; in other venues including the home and alternative places of care (e.g., nursing homes); and, by incorporating emerging technologies such as clinical decision support, interoperability of next-generation medical devices and medical environments, and wireless medical wearable Commercial adoption of emerging technologies, along with their integration into care facility infrastructure through telehealth will extend the reach of healthcare to environments outside hospitals and clinics; leading to higher quality of care and at the same time lowering cost.

- Identity Management Systems: Continue the development of common models and metrics for identity management, critical standards, and interoperability of electronic identities to improve the quality, usability, and consistency of identity management systems while protecting privacy. The focus of the effort will incorporate remote authentication services for individuals and devices to cloud-based services through a wide set of platforms including mobile devices.

- National Cybersecurity Center of Excellence (NCCoE): NIST established 13 long term partnership agreements with some of the largest global IT companies and has established three sector specific communities of interest (Healthcare, Energy, and Financial Services) that are providing the NCCoE with information for cybersecurity use cases. The NCCoE has over twenty IT companies signed up to participate in the first healthcare use case.

- National Initiative for Cybersecurity Education (NICE): Continue to provide collaboration and coordination for the NICE component areas. The NIST NICE Leadership Team (NNLT) will facilitate bi-weekly coordination meetings for component leads, host an annual public/private sector NICE workshop, and maintain the NICE website to disseminate cybersecurity education/workforce information. The NNLT will also continue to participate in public-private partnership events, symposia, forums, competitions, educational outreach meetings, and workshops to promote cybersecurity education, and support initiatives promoting greater national awareness and a stronger cybersecurity workforce.

- National Strategy for Trusted Identities in Cyberspace (NSTIC): The NSTIC National Program Office will continue to work with the Identity Ecosystem Steering Group (IDESG) to improve the Identity Ecosystem Framework, as well as award additional pilots to advance implementation of the NSTIC.

- Next Generation Internet Technologies: Develop test and measurement techniques and test bed environments to foster the wide scale adoption of trustworthy email technologies based upon Domain Name System Security (DNSSEC) technologies. NIST will work with industry and other agencies to demonstrate and develop wide scale deployment guidance for emerging DNS-based anti-phishing technologies.

- Quantum Information: Continue to develop accurate and efficient methods for quantum state tomography, that is, the assessment of the quality of quantum states generated in the laboratory. Current methods, which suffer from intensive resource requirements and statistical bias, must be significantly improved to enable the scaling of quantum information processing to practical levels. In addition, NIST will continue to assess algorithms that may provide the basis for future public key cryptography systems that are resistant to attack by adversaries with quantum resources.

- Smart Grid: Continue to develop and disseminate methods and guidelines for assessing the suitability of network communication technologies and architectures and their use for Smart Grid applications. This will be accomplished by enhancing and using advanced system-level performance metrics and simulation models to accurately characterize the interactions between the power systems and the underlying communications infrastructures, identifying gaps in the communication systems and facilitating the development of standard technologies for filling them. NIST will perform research to identify the most common platforms used in the Smart Grid in order to further extend the security content automation protocol (SCAP) which can help decrease the cost of cybersecurity implementation in the smart grid. Additionally, NIST will explore the application of resource constrained cryptography for processing platforms that are applicable for the Smart Grid. NIST will also study potential privacy issues in the smart grid, including Plug-in Electric Vehicles, usage of Customer Energy Usage Data (CEUD) in new settings, and new privacy enhancing tools and methods.

- Smart Manufacturing: In collaboration with industry, other agencies and academia, NIST will actively advance standards development activities related to smart manufacturing cybersecurity; develop protocols for information security across the smart manufacturing enterprise and develop guidance to decrease costs of cybersecurity for manufacturing through the use of cybersecurity automation protocols; develop methods for integrating and validating information exchange between various heterogeneous systems; develop a framework for measuring the performance of intelligent manufacturing systems; and develop test methods for evaluating various algorithms developed for characterizing and detecting failures in large-scale networks.

- Virtual Measurement Systems: Research and develop metrology constructs – standard reference computations, uncertainty quantification, and traceability – for scientific computation and computer-assisted measurement technologies. Applications will include quantitative simulation and validation of medical imaging technologies such as magnetic resonance imaging (MRI) and computational simulation of materials processes. A new application area is image manipulation and enhancement in forensic analysis of latent fingerprint images. Results in this application area will contribute to a systematic and scientific basis for fingerprint image enhancement, as well as serve as a test case for the development of comparable analyses for other image-based methods in forensic sciences. Overall, the results from this program will contribute to the goal of predictive computing with quantified reliability.

- Voting Systems Standards and Research: Continue to accelerate the development and adoption of advanced voting technologies through research and development of standards and test methods in security, reliability, usability, accessibility, and privacy of voting systems. Research on software assurance and testing will be aimed at ensuring the correctness, security, and integrity of voting systems. We will continue to work with IEEE on a suite of standards aimed at achieving interoperability of voting system components with a particular focus on ballot definition, auditing, and geo-political districting. Emerging technologies, such as the internet voting and hand-held equipment, including phones and tablets will be explored as elements of a low-cost, secure, and accessible voting system. We will conduct research on methods for achieving auditability of voting systems, without the use of paper, which can support both security and accessibility requirements so that high-level, technology-independent requirements can be developed. This will result in more trustworthy voting systems for Federal, state, and local elections in the U.S.

- Wireless Interoperability: Develop measurement science tools to expedite the development and deployment of new communication protocols in support of scalable, reliable, secure, interoperable wireless communications. In addition, NIST will develop a modeling framework consisting of performance metrics and measurement methods necessary to enable the development and evaluation of efficient and dynamic spectrum management techniques and the use of frequency bands that are not used today. Contribute NIST public safety measurement and modeling results to Third Generation Partnership Project (3GPP), Technical Specification "Group Communication System Enablers for Long-Term Evolution (LTE)."

7. Strategic and Emerging Research Initiative (SERI)

Program Description:

The SERI program provides the NIST Director with the programmatic flexibility to seed the development of new competencies that enable NIST to contribute to the solution of future national needs and goals by investing in high-risk, high-payoff innovative research. SERI supports the

Department of Commerce and NIST's mission of promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology that drive technological change.

The primary activities being conducted with the program's base resources are the development of new competencies necessary to develop and maintain knowledge related to measurement techniques that solve problems in areas of national need that NIST has identified. The SERI program gives NIST the flexibility to quickly develop capabilities to solve new measurement problems for emerging national needs. Examples of past national need areas that had related measurement and standards competencies addressed through SERI include Smart Grid, physical infrastructure, advanced manufacturing, and reduction of greenhouse gas (GHG) emissions. SERI allows NIST to develop these measurement and standards competencies more quickly, which enables emerging problems to be addressed much more efficiently and effectively, leading to even greater economic benefits.

Current Objectives and Examples of Accomplishments:

Forensics Metrology

SERI funding is being utilized to increase NIST competence in a range of forensic science specialties. Public trust in the justice system relies on the validity and certainty of evidence presented to the courts. Increasingly that evidence is gathered and analyzed with innovative forensic technologies and any time a new technology is developed, accurate measurements, standards, and uncertainty estimates are needed to ensure that the technology works as intended. In 2009 a committee of the National Research Council (NRC) made a number of important recommendations for strengthening the public's trust in forensic science findings, included was strong support for improved measurement and validation methodologies, development of additional forensic standards, and dissemination of best practices to strengthen the precision and reliability of forensic science analyses. Despite its long experience in the field, the bulk of NIST's efforts have been on narrowly targeted projects funded by other agencies, from fingerprint technologies to DNA testing to computer forensics. With SERI funding, NIST strategically selected five specific areas in which to develop new competencies:

- Rapid High Sensitivity DNA Extraction Using Direct Rapid Analysis Generating Extracted Nucleotides (DRAGEN)
- Nuclear Forensic Reference Materials (RM) for Attribution of Urban Nuclear Terrorism
- Establish a "National Ballistics Evidence Search Engine (NBESE) based on 3D topography measurements on correlation cells
- Metrics for Manipulation and Enhancement of Forensic Images
- Production of Seized Drug Analysis Standards through Inkjet Printing Technology

Redefinition of the Kilogram (kg)

SERI funding is being utilized by NIST to support the international efforts to prepare for a future redefinition of the unit of mass - the kg - the last remaining International System of Units (SI) basic unit defined by an artifact. NIST initiated two efforts to redefine the kilogram with an invariant of nature, the Watt-Balance Project and the Avogadro Project. The Watt-Balance Project measures the force required to balance a one kg mass artifact against the pull of earth's gravity by monitoring the voltage and current (hence the name "watt") involved in doing so. The Avogadro Project involves the determination of Planck's constant, requiring "counting" the number of atoms (via unit cell volume of a crystal) in each of two highly pure one kg single-crystal enriched silicon spheres about

94 millimeters (mm) in diameter to define their molar mass. The result provides a determination of the Avogadro constant, which in turn can be used to obtain Planck's constant using the well-known values of other constants. Specifically, SERI funding has accomplished the following:

- Setup of the multicollector inductively coupled plasma mass spectrometer (MC-ICPMS) for the Avogadro Project
- Performing repeated molar mass measurements using optimized design to evaluate reproducibility and ensure it meets the goal of the project
- Recalibrated components of the previous watt balance to enable the redefinition
- Initiated the development of a new, robust watt balance capable of routine mass dissemination after the redefinition

National Strategy for Trusted Identities in Cyberspace (NSTIC)

SERI funding was utilized in FY 2011 to initiate the NIST effort in support of NSTIC, which President Obama signed in April 2011. This strategy charts a course for the public and private sectors to collaborate to raise the level of trust associated with identities of individuals, organizations, networks, services, and devices in online transactions. The vision is a future in which "Individuals and organizations utilize secure, efficient, easy-to-use, and interoperable identity solutions to access online services in a manner that promotes confidence, privacy, choice, and innovation." SERI funding enabled the initiation of the NIST effort and building of a platform to maximize initiative funding received for FY 2012. Specifically, SERI funding accomplished the following:

- Laid the groundwork for the NSTIC National Program Office that will lead the implementation of NSTIC and coordinate activities with the private sector stakeholders;
- Worked with industry, academia, advocates, non-profits and governments to develop a comprehensive view of the problem space and inform the NSTIC vision, objectives, and guiding principles; and
- Issued grants to advance the NSTIC vision, objectives, and guiding principles. In FY 2012, NIST awarded more than $9.0 million for pilot projects to five U.S. organizations. In January 2013, NIST released the Federal Funding Opportunity (FFO) for the second round of pilots.

Climate Research/GHG Monitoring

SERI funding was utilized to develop competence across NIST in development and validation of novel methodologies and procedures for remote monitoring and measurement of greenhouse gas emissions. This competence forms the basis of a recently-funded effort in which NIST will:

- provide the measurement science basis for accurate and comparable quantitative measurements of GHG emissions; and
- ensure measurement capabilities for accurate and reliable assessment of current GHG baselines, verification of GHG emissions, and quantification of GHG sinks that absorb GHGs through quantitative measurements; and
- enable development of international measurement standards to ensure the accuracy of global assessments of GHG emissions.

Biomanufacturing

SERI funding was utilized to jump start NIST's ability to address inefficiencies and stimulate innovation in healthcare by addressing challenges associated with the development and manufacture of biologic drugs. NIST used SERI funding to develop competence in the measurement needs and techniques in biomanufacturing and to procure instruments used to characterize proteins/biologic drugs. NIST will use these competencies and accomplish the NIST role in the development of a suite of fundamental measurement science, reference standards and reference data to enable more accurate and confident characterization of key attributes of protein drugs that are directly linked to their safety and efficacy. Specifically, these competencies form the basis of a recently-funded effort in which NIST will focus on three measurement challenge areas related to 1) the characterization of protein therapeutics and their manufacture; 2) protein stability: protein structure; and 3) protein cell variability. These tools will facilitate the development of the Biomanufacturing industry and offer the possibility of lower cost biosimilars, thereby allowing U.S. citizens affordable access to these innovative and life-saving biopharmaceutical medicines.

8. Innovations in Measurement Science (IMS)

Program Description:

IMS Program provides funds to explore high-risk, leading-edge research concepts that anticipate future measurement and standards needs of industry and science. These funds are a principal mechanism for initiating the new programs and research directions necessary for NIST to keep pace with and respond quickly to the increasingly complex nature, and the shorter time frame, of technology development.

Since its inception in 1979, the IMS Program has: 1) funded over 100 research projects that have evolved into core activities within the NIST Laboratories, 2) formed the cutting edge of NIST's research programs, and 3) attracted some of the Nation's top scientific talent to NIST. Four NIST Nobel Prize winners in Physics (Dr. William Phillips, 1997; Dr. Eric Cornell, 2001; Dr. Jan Hall, 2005; and Dr. David Wineland, 2012) each conducted projects that were funded by the IMS Program. Other program achievements include the development of a cold-neutron small-angle scattering facility, a bold concept that ultimately led to the NIST Center for Neutron Research (NCNR), now a premier research program that attracts almost 2,300 affiliated researchers annually from industry, government, and academia.

One current research effort funded through the IMS program is addressing fundamental problems with the essential links between electrical and mechanical units from the International System of Units (SI). The calculable capacitor, a device that realizes the capacitance unit (farad) from the meter, was originally created 40 years ago after many years of research and has been used ever since. With the availability of new technologies, such as modern lasers and digital electronics, it is now possible to build the next generation of calculable capacitors with improved reliability, accessibility, and accuracy. In this project, NIST will use femtosecond laser frequency comb technology to create a new calculable capacitor that would, for the first time, realize an SI electrical unit based directly on an atomic clock. NIST's goal is for its new calculable capacitor to have measurement uncertainties roughly a factor of two lower than those of other calculable capacitors currently being developed around the world.

9. Postdoctoral Research Associateship Program

Program Description:

NIST supports a nationally competitive Postdoctoral Research Associateship Program which is administered in cooperation with the National Research Council (NRC). The NIST NRC postdoctoral program recruits outstanding research scientists and engineers to work on NIST research projects, strengthens communications with university research, and provides a valuable mechanism for the transfer of research results from NIST to the scientific and engineering communities.

The NIST NRC postdoctoral program is an important part of NIST's efforts to support industry through advancing measurement, standards, and technology, and represents a highly cost-effective means of technology transfer to and from NIST of the latest measurement sciences and technologies. Incoming associates bring the most recent advances in university research to NIST, while actively contributing to NIST projects. The program increases technology transfer from NIST to industry, academia, and other government agencies, contributing to the employment pool of highly-qualified scientists and engineers for these sectors. NIST's mission to support U.S. industry with measurements, standards and technology depends on a constant infusion of new ideas and expertise to address the rapidly advancing needs of a technology-driven economy. Skilled and motivated people are the most effective source of technology and knowledge transfer. The highly competitive NIST NRC postdoctoral program ensures a continuing infusion of postdoctoral associates who bring to NIST the benefits of the latest academic research.

Examples of Accomplishments:

NIST NRC postdoctoral associates carry out state-of-the-art research which supports industry through advancing measurements, standards, and technology throughout the core programs of NIST. Each of the projects advances measurement and standards research areas in some way, but a few examples of areas of research by recent postdoctoral associates include such projects as:

- Development of measurement techniques for characterizing the interaction of carbon nanomaterials and living systems;

- Development of ways to control single-atom imaging and manipulation to use for quantum simulation, quantum information and quantum metrology;

- Design of a prototype optical nanocalorimeter to perform thermal measurements on nanoparticles and thin films. Prototype system to measure specific heat capacity, heat of fusion and mass changes for deposited aluminum samples;

- Development of methods for the modeling of nucleic acids using scattering and nuclear magnetic resonance (NMR) restraints;

- Developed uniform nanoscale structure devices to provide surface sensitivity for biosensors, to be used to fabricate devices with high performance and low-cost without the requirement for high resolution lithography;

- Development of a method to fabricate nanofiber scaffolds with low fiber diameter variability contributing to investigations on stem cell differentiation for tissue engineering applications; and

- Use of neutron reflectometry to characterize the structural evolution of antibiofouling coatings in water.

Priority Objectives for FY 2015:

The priority objectives for FY 2015 for the NIST NRC postdoctoral program are to continue to recruit the best applicants for the program and to make best use of the available resources to bring on as many highly-qualified postdoctoral associates as possible. NIST scientists and engineers, acting as mentors/advisers for the program, are constantly refining and proposing new research areas in which to interest applicants. The program is a very flexible and responsive way to focus new NIST activities to address critical national priorities including those in energy, environment, information technology security, and physical infrastructure. NIST continues to improve the focus of the program to ensure a continuing infusion of motivated postdoctoral associates into the NIST measurement science laboratories, ensuring mutually-beneficial technology and knowledge transfer between NIST and the postdoctoral associates. Across all NIST laboratories, the program strongly supports the goals of the NIST Three Year Programmatic Plan. The postdoctoral program addresses NIST priorities to meet critical national needs, strengthening and focusing NIST's laboratories and research to ensure U.S. leadership in measurement science and standards in these areas.

10. Communications Technology Laboratory (CTL)

In FY 2014, through a reprogramming request to Congress, NIST established a new Organizational Unit (OU), CTL, under the Associate Director for Laboratory Programs. The CTL will be headquartered at the NIST facility in Boulder, Colorado and will be part of the joint NIST/NTIA Center for Advanced Communications (CAC), which will serve as a hub for collaboration with other government agencies, and industry.

Rapid advances in communications technology have fundamentally changed the way we as a Nation work and live. With these advances have come significant challenges that, if not addressed, will significantly impact our Nation's ability to reap the civilian and economic benefits of this technology while ensuring our national security needs are met. Examples of these challenges include:

- The exponential growth of wireless data usage – scarce spectrum must be more efficiently used to meet the demand;
- The evolution of broadband access in the home – this has moved from a luxury to a necessity with increasing needs for ever-higher bandwidth;
- The vulnerability of all Internet-capable devices to a variety of security threats; and
- The threat of natural disasters and terrorism on communications infrastructure.

Both NIST and NTIA possess world-class advanced communications capabilities in the areas of spectrum sharing, testing, standards coordination, public safety communications, electromagnetics and quantum electronics, among others. As stand-alone efforts, the work of the two agencies has effectively addressed the needs of sponsors and improved the overall understanding of communications technology in the marketplace. By finding synergies within the agencies' respective authorized areas of activity and taking advantage of and leveraging the critical mass of NIST and NTIA research and engineering capabilities concentrated in Boulder, Colorado through the formation of the CAC, the DOC will create a unique national asset that will provide the infrastructure necessary for effective engagement and collaboration with industry, academic and government partners necessary to effectively and efficiently address current and future advanced communications challenges

PROGRAM CHANGE(S):

1. Cyber Physical Systems: Advanced Cyber Physical Systems for National Priorities (Base funding: $4.2 million and 8 FTE; Program Change: +$7.5 million and +15 FTE)

NIST requests an increase of $7.5 million and 15 FTE for a total of $11.7 million to improve the design, performance, and integration of cyber physical systems that can reduce costs, increase efficiency and reliability, improve safety, and provide security when applied to national priorities for advanced manufacturing, health care, energy, defense, homeland security, and transportation.

Proposed Actions: Improve the design, performance, and integration of cyber physical systems for application to national priorities.

Cyber Physical Systems (CPSs) are the networked integration of cyber and engineered components, designed to create adaptive and predictive systems that respond in real time to enhance performance. These systems include advanced manufacturing environments and robotics, intelligent medical devices and personal health care technologies, smart grid and sustainable energy infrastructures, 21st century defense capabilities, secure and resilient smart-city infrastructures, autonomous vehicles, and many others. The President's Council of Advisors on Science and Technology (PCAST) has identified CPSs as "a national priority for Federal R&D." This high priority reflects the broad economic impact of CPS across nearly all sectors of our society, including manufacturing, transportation, energy, health care, defense, and homeland security and emergency response. Realizing the full economic benefits of next-generation cyber physical systems requires three changes to the Nation's current approach. First, conventional design approaches are inadequate for achieving the degree of integration of physical and virtual elements required to create next-generation cyber physical capabilities. This initiative shifts away from conventional approaches toward scalable design strategies based on new standards for integrating architectural layers in hyper-complex CPSs and for connecting multiple CPSs from the component level (in composite medical systems, for example) to the continental scale (a Smart Grid goal). Second, current means for performance prediction, measurement, and management do not scale to the level of complexity required for advanced CPSs. This initiative provides a new focus on robust, science-based metrics and agile research and testing platforms for integrated CPS performance measurement and management. Third, much current CPS work is done in isolation, focused on solutions limited to a single domain such as health care and with limited cooperation across the commercial, academic, and government sectors. This initiative bridges existing silos by creating a new forum for cooperation and coordination, connecting industry's needs to research capabilities, allowing researchers to tackle cross-domain CPS challenges and apply progress in one domain to others, and enabling entrepreneurs and industry leaders to apply those research results for real-world benefits. In summary, this initiative provides the measurement science foundations and the organizational structures to enable researchers, entrepreneurs, and U.S. businesses to pursue the full economic benefits of advanced cyber physical systems.

Action 1: Scalable CPS design at the intersection of physical and virtual worlds ($2.9 million)

The design and engineering of a cyber-physical system, from initial concept through successful operation, requires a new systems science and engineering approach[9]. This approach must simultaneously embrace all levels of the CPS architecture, from physical components and their associated sensors and actuators at the base layers, through middle-layer control systems and analytics, to the overall optimization and user functionality at higher layers.

[9] http://www.nist.gov/el/upload/12-Cyber-Physical-Systems020113_final.pdf

Principles for integrating these layers in a scalable design strategy include:

- integrating concepts from engineering, information technology, physics, and materials science;
- providing for interoperability, modularity, and composability;
- enabling designed-in resilience, safety, cyber- and physical-security, and privacy;
- interconnecting data and analytics across levels and between systems through networking; and
- supporting all phases of the design cycle from initial concept to manufacturing and deployment.

This action item comprises applying these principles across four areas to enable new, scalable CPS design approaches. The first area is the development of a common language and consensus definitions that enable shared progress across current, siloed CPS domains. These include a reference architecture, syntax, and ontologies that provide the basis for modeling, programming, control, and communications languages that span domains and disciplines. Second is the development of formal methods for models and simulations that are robust and realistic; based on sound principles from engineering, information technology, physics, and materials science; and useable across multiple domains and applications. Third – and complementing the formal methods effort – is the development of standards for interoperability and composability across architectural layers and between components and systems. Fourth is the development of an infrastructure comprising tools, platforms, test beds, and integrated design environments to enable the application of these formal methods and standards to the co-design of heterogeneous, interacting components. Test beds and research platforms developed under this initiative will be modular, reconfigurable, remotely accessible, and adaptable to multiple domains and applications. The test bed will comprise a set of modules corresponding to the elements of the NIST CPS Reference Architecture. These modules will include:

- Sensors and Actuators
- Control Systems
- Analytics and Data Services
- Modeling and Simulation
- Cybersecurity
- Networking and communications

This modular design enables rapid reconfiguration between experiments and agile application to multiple CPS domains ranging from advanced manufacturing to transportation and health care.

The expected benefits of work under this action item are as follows:

- New design approaches and tools will decrease time and reduce costs from design to market – including testing and certification – for new or redesigned cyber physical systems.

- Capabilities for adaptive and predictive control, including the integration of multi-physics models and models of diverse software components will expand the performance envelope of existing systems and enable innovation for completely new systems.

- Provisions for managing time and synchronization across applications, implementing real-time computing, and managing multiple concurrency models enable verifiably safe and reliable CPSs for time-critical and life-critical applications.

- Integration of communications, information services, and data analytics across wired and wireless networks at multiple scales and among interacting systems allow the application of big data approaches to meeting complex and demanding system requirements.

- Advanced design methods will allow the reliable and cost-effective use of advanced adaptive and responsive materials, facilitate the full exploitation of novel properties of new materials, and enable the application of advanced manufacturing methods to the production of complex CPS components and assemblies.

Action 2: Next-generation CPS performance prediction, measurement, and management ($3.2 million)

Action 2 focuses on the capabilities required for predicting, measuring, and managing the performance of the more capable and powerful cyber physical systems enabled by the new design approaches targeted under Action 1. In this context, CPS performance metrics include efficiency, sustainability, agility, reliability (including time critical performance), resilience, usability, safety, security, and privacy.

Work under this action item will be undertaken in four areas. The first area is the development of metrics for measuring and verifying operational performance for key attributes such as accuracy, safety, timing, reliability, predictability, and adherence to tolerances and limits. The second area focuses on security and privacy status during operations and includes security automation and quantitation suitable for CPS applications, high-confidence networks with assured quality of service, and means for real-time identity management and authorization. The third area is sustainability and energy management including advanced battery systems, ambient energy, low power environments, high efficiency operations, and environmentally friendly materials and life-cycle management. The final area is focused on managing performance in failure modes including model-based diagnostics and prognostics for fault and failure mode prediction, detection, and managing for resilience (including resilience against cascading failure).

Examples of benefits from this action item include the following:

- The ability to measure performance with defined uncertainty in complex or life safety-critical environments enables CPS operations that reduce accidents and save lives.

- Security automation provides the basis for composable security in complex applications, real-time awareness, and interoperable security solutions.

- Secure systems that preserve privacy engender the levels of trust and confidence needed for widespread adoption and for application in sensitive settings such as health care.

- Sustainable, energy-efficient systems enable extended autonomous operations while protecting the environment.

- Resilient systems that manage failures effectively prevent catastrophic incidents such as a cascading electric grid collapse.

Action 3: The Cyber Physical Systems Alliance – A cross-domain, multi-sector alliance for progress ($1.4 million)

The current structure of the CPS community has three limitations. First, much of the community's current work is domain-specific. This means that core challenges, such as approaches for integrating discrete and continuous models, may be tackled repeatedly in potentially redundant work producing isolated and conflicting solutions. Second, the academic and commercial CPS communities have limited means for ongoing interaction. As a result, academic researchers may have limited insights into the rapidly changing, real-world needs of industry. Commercial interests may not have access to existing research capabilities that need not be duplicated or disruptive new technologies that could affect their business model. Third, there is a lack of shared research environments facilitating access to common tools, test beds, and resources. This results in duplication of effort, redundant deployment of small-scale resources, and under-utilization of existing test beds.

NIST's mission to promote economic growth and competitiveness puts it in a unique position to address these limitations through the creation of a Cyber Physical Systems Alliance. The essential features of the Alliance are the following. First, it is a forum for interaction across the CPS community providing both virtual and in-person opportunities for interaction. On the virtual side, this includes social networking, crowd-sourcing, community-driven open source software development, and virtual meeting and public working group capabilities. In-person opportunities include a program of workshops, conferences, an entrepreneur/innovator exchange program, and training/education opportunities.

Second, the Alliance provides a shared platform for progress. This includes a robust cyber infrastructure providing shared tools and design environments, an integrated test bed portal, performance evaluation tools and platforms, an open source software registry, reference data repository, and cloud-based analytical capabilities.

Third, the Alliance can be a catalyst for research progress. This includes a robust process for achieving consensus around research priorities; mechanisms that rally the community around shared projects including challenge competitions, design-a-thons, data jams, and other innovative approaches; and a research fellows exchange program with NIST that promotes multi-disciplinary expertise.

Fourth, the Alliance is a driver for adoption and deployment. This includes a robust process for achieving consensus around industry needs (closely linked to the research priorities effort); an incubator program that spawns new products, services, and enterprises; and a clearinghouse for innovation concepts.

While initially launched with NIST funding, the Alliance is intended to evolve quickly into a community-based organization that is not solely dependent on continued NIST support, receiving its own funding through memberships, grants, contracts, or other means according to its business plan. This will be accomplished through a three-phase implementation plan beginning with initial NIST support under phase 1; then a ramp-down of NIST support as outside support increases in phase 2; and, finally, a transition to a sustainable state under a successful business model in phase 3.

Examples of benefits under this action item include the following:

- This action puts NIST in a leadership position and solidifies its partnership with the CPS community to promote advances that are adopted and deployed for economic growth.
- The Alliance enables the community to work together to achieve shared goals and enhance the impact on economic growth of research outcomes.

In addition to its general benefits to society, the Alliance provides a number of specific benefits to NIST. Importantly, the Alliance provides NIST with both a channel for uptake by industry of the outcomes of its work and a connection to basic research capabilities that complement its efforts. It provides a forum for aligning the goals and efforts of NIST with its counterparts from across the broader CPS community in industry and academia. The Alliance provides opportunities for NIST researchers to interact with and gain experience from active efforts being conducted in both academia and industry. The Alliance can provide a home for public working group activities and other community efforts in which NIST actively participates. It will also be a source of NIST fellows and student researchers.

Statement of Need and Economic Benefits

Today, everything from household objects - like a smart spoon that compensates for hand tremors, allowing Parkinson's patients to retain their independence and dignity - to extraterrestrial explorers - like the Mars rovers interacting with us from an average of 225 million kilometers away - are cyber physical systems that blend physical and virtual components. These systems range in size from a molecular medical robot[10] 2,000 times smaller than the thickness of a human hair to the Internet operating at global scale. Moreover, they are critical to the future of nearly every economic sector.

It has been estimated that the deployment of next-generation cyber physical systems across the transportation, energy, and health sectors alone has the potential to boost U.S. productivity growth by as much as 1.5 percent and increase per capita GDP by 25-40 percent by 2030[11]. The implementation of new cyber physical systems to achieve just a one percent improvement in efficiency can save over a 15 year period 30 billion dollars in aviation sector fuel costs, 66 billion dollars in power generation, 63 billion dollars in health care, and 27 billion dollars in freight rail costs.

It is estimated that future CPS technologies could eliminate 93 percent of the six million automotive crashes caused each year by human error and reduce by half the current 80 billion dollars per year cost of traffic congestion[12]. With a projected global population exceeding nine billion people by 2050, an uncertain climate future, and up to 50 percent food loss between production and consumption, the application of advanced CPS technologies to the entire food chain is critical to meet the needs of future generations.

To create the next generation of cyber physical systems and realize the benefits evident in the numbers above, a coordinated effort across all sectors is needed to overcome current limitations in CPS design capabilities and performance measurement and management approaches. Overcoming these limitations is the focus for this initiative. Further, the focus must be global and not just local since the sectors that will benefit from CPSs, such as transportation and manufacturing, involve global markets. American competitiveness in these markets will require standards and interfaces compatible around the world. This is an area in which the unique expertise of NIST is particularly important. Finally, because of the complexity of cyber physical systems and the nature of the challenges, a joint effort across academic, commercial, and government sectors is needed. Creating platforms and environments for working together across sectors is another goal of this initiative.

Base Resources Assessment

In the relevant areas of cyber physical systems, NIST invested a total of $4.2 million in base STRS funds and 8 FTEs in FY 2014.

NIST has expertise in a number of CPS domains including advanced manufacturing, smart grid, transportation, civil infrastructure, buildings and structures, defense, health technologies, emergency response, materials science, physical measurements, cybersecurity, and others. Through this initiative,

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[10] Douglas, S., Bachelet, I., and Church, G. Science (2012), Vol. 335 no. 6070 pp. 831-834
[11] http://www.ge.com/sites/default/files/Industrial_Internet.pdf
[12] http://www.nitrd.gov {need complete URL for NITRD CPS SSG White Paper}

this domain expertise can be translated into all-domain CPS progress by adapting measurement science solutions across domains and developing cross-domain and domain-independent solutions. NIST's activities cover the full research lifecycle, from fundamental research to disseminating the results of that research. This includes:

- developing and reviewing standards;
- providing technical guidelines on measurements and other processes for use by other agencies and organizations;
- developing tools, tests, and test beds for evaluating technologies, including the security of emerging information technologies;
- establishing validation tools, methods, and other resources that can be used to confirm the proper implementation of standards; and
- conducting outreach across sectors and domains to increase awareness of NIST activities and outputs.

Cybersecurity has been identified as one of the critical challenges to next-generation cyber physical systems, and this is an area of exceptional NIST expertise. NIST has a leading role in the Department of Commerce program of cybersecurity and privacy initiatives including the National Cybersecurity Center of Excellence (NCCOE). NIST's work in Federal information systems management security guidelines, information processing standards, and personal identity verification are used across the Federal government and by state, local, and private entities to meet their security needs.

Schedule and Milestones

Action 1: Scalable CPS design at the intersection of physical and virtual worlds

1.1 Common CPS language and definitions – Publish consensus reference architecture, ontologies and technology roadmap (FY 2015, revise FY 2018); Publish domain-specific and domain-independent modeling, control, and communications language guidelines (FY 2015-FY 2017).

1.2 Formal methods for models and simulations – Convene public working group and hold initial workshop (FY 2016); Publish draft guidelines (FY 2018); Publish formal methods guidelines (FY 2019).

1.3 Standards for interoperability and composability – Convene public working group and launch workshop series (FY 2016); Publish draft standards (FY 2017); Publish final standards (FY 2019); Publish guidelines for verification and validation (FY 2019).

1.4 Infrastructure tools and test beds – Complete test bed module 1 with associated tools and interfaces (FY 2016); Complete 3 additional test bed modules and tool sets (FY 2017-2019).

Action 2: Next-generation CPS performance prediction, measurement, and management

2.1 Metrics for operational performance – Publish draft guidelines for accuracy and reliability (FY 2017); safety and timing (FY 2018); measuring/modulating usability (FY 2018); and predictability and tolerance (FY 2019); Publish final guidelines one year after each draft release.

2.2 Security and privacy – Publish initial guidelines identifying principles for modeling security implications of physical interactions (FY 2016); hold a workshop on security automation needs for CPS (FY 2016); publish initial guidelines for identity management: modeling, assessing, and enforcing security and trustworthiness of system components (FY 2017); hold a follow-up workshop on security automation use cases for CPS (FY 2017); publish initial guidelines on security automation for CPS (FY 2018); and privacy (FY 2019).

2.3 Sustainability and energy management – Publish battery degradation model (FY 2016) and state-of-charge measurement (FY 2017); ambient energy and low power guidelines (FY 2018); materials and life-cycle management (FY 2019).

2.4 Fault and failure modes – Launch workshop series and convene public working group (FY 2016); Publish initial guidelines for managing for CPS resilience (FY 2017); model-based diagnostics and prognostics (FY 2018); soft failure/rapid recovery (FY 2019).

Action 3: The Cyber Physical Systems Alliance

3.1 Receive and review initial proposals, issue year one award (FY 2015).

3.2 Conduct annual review of progress under the forum, platform, research, adoption/deployment, and business model goals (FY 2016 – FY 2019).

3.3 Conduct comprehensive third year review for possible transition to phase 2 (FY 2017).

3.4 Receive and review phase two proposals, issue award as appropriate (FY 2019).

Deliverables

Action 1: Scalable CPS design

- Published consensus CPS reference architecture, taxonomy, and technology roadmap for use in research design, development, deployment and operations across industry and academia
- Workshop series outcomes reports and documented working group consensus reports for:
  - formal methods for models and simulations; and
  - standards for interoperability and composability
- Published guidelines for:
  - CPS modeling, control, and communications languages;
  - formal methods for modeling and simulation; and
  - interoperability and composability verification, validation, and certification
- Standards for CPS interoperability and composability adopted by national and international standards development organizations
- Distributed, modular CPS test bed and associated tools available for remote access and flexible use by researchers at NIST and across academia and industry

Action 2: CPS performance prediction, measurement, and management

- Workshop series outcomes reports and documented working group consensus reports for:
  - security automation needs for CPS;
  - security automation use cases; and
  - CPS fault and failure modes.
- Published guidelines for:
  - CPS accuracy and reliability;
  - predictability and fault tolerance;
  - safety and timing;
  - CPS security automation, identity management, high-confidence networks, privacy, and cryptography;

- ambient energy and low power environments, and materials and lifecycle management; and
- managing for resilience, model-based diagnostics and prognostics, failure and recovery.

- Published models and open source software tools available online for analyzing battery degradation and state-of-charge measurement in advanced battery systems

Action 3: The Cyber Physical Systems Alliance

- Open community forum for collaboration, coordination, and sharing in CPS research, development, deployment and operations across industrial, academic, and government sectors;
- One or more annual events to catalyze CPS research progress including challenge competitions, design-a-thons, data jams, and other community-based events;
- Open CPS cyber infrastructure providing shared tools and design environments, integrated test bed portal, performance evaluation tools and platforms, open source software registry, reference data repository, and cloud-based analytical capabilities;
- One or more public working groups and new incubator efforts each year; and
- Open, online clearinghouse for sharing of CPS innovation concepts.

Performance Goals and Measurement Data:

Actions 1 and 2: Scalable CPS design and CPS performance prediction, measurement, and management

Performance Goal: Publications	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	4	6	8	9	9
Without increase	2	4	4	4	4
Description:	Number of new NIST Special Publications, Internal Reports, scientific and technical journal articles, and conference articles and reports				

Performance Goal: Guidelines	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	4	5	6	8	8
Without increase	2	3	3	3	3
Description:	Number of new technical specifications and guidelines developed and published				

Performance Goal: Test beds & tools	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	1	1	3	5	6
Without increase	0	0	0	0	0
Description:	Test bed modules, software tools, and models/simulations				

Action 3: The Cyber Physical Systems Alliance

Performance Goal: Community-enabling resources & events	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	3	3	4	6	6
Without increase	0	0	0	0	0
Description:	Combination of community events, research challenges, tools and design environments, incubators and working groups, and clearinghouse events				

PROGRAM CHANGE PERSONNEL DETAIL

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Cyber Physical Systems

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Chief CPS advisor	Gaithersburg	ZP V	1	$124,996	$124,996
Computer scientist	Gaithersburg	ZP V	1	124,996	124,996
Mechanical engineer	Gaithersburg	ZP V	1	124,996	124,996
Electronic engineer	Gaithersburg	ZP V	1	124,996	124,996
Systems engineer	Gaithersburg	ZP V	1	124,996	124,996
IT specialist	Gaithersburg	ZP IV	1	106,263	106,263
Mechanical engineer	Gaithersburg	ZP IV	1	106,263	106,263
Physicall scientist	Gaithersburg	ZP IV	1	106,263	106,263
Mathematician	Gaithersburg	ZP IV	1	106,263	106,263
Computer scientist	Gaithersburg	ZP IV	1	106,263	106,263
Grant administrator	Gaithersburg	ZA IV	1	106,263	106,263
Stakeholder coordinator	Gaithersburg	ZA IV	1	106,263	106,263
Network specialist	Gaithersburg	ZP III	1	75,621	75,621
Electronics technician	Gaithersburg	ZT III	1	57,426	57,426
Administrative support	Gaithersburg	ZA III	1	75,621	75,621
Administrative office assistant	Gaithersburg	ZS III	1	38,363	38,363
IT specialist	Gaithersburg	ZP II	1	52,146	52,146
Control systems engineer	Gaithersburg	ZP II	1	52,146	52,146
Administrative/technical support	Gaithersburg	ZA III	2	52,146	104,293
Total			20		1,824,437
Less Lapse		25%	(5)		(456,109)
Total full-time permanent (FTE)			15		1,368,328
2015 Pay Adjustment (1%)					13,683
TOTAL					1,382,011

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	15
Other than full-time permanent	0
Total	15
Authorized Positions:	
Full-time permanent	20
Other than full-time permanent	0
Total	20

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Cyber Physical Systems

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$1,382	$215,687
11.3	Other than full-time permanent	0	16,334
11.5	Other personnel compensation	0	1,889
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	1,382	233,910
12	Civilian personnel benefits	430	69,185
13	Benefits for former personnel	0	52
21	Travel and transportation of persons	131	9,081
22	Transportation of things	51	1,056
23.1	Rental payments to GSA	0	69
23.2	Rental Payments to others	0	1,776
23.3	Communications, utilities and miscellaneous	818	27,468
24	Printing and reproduction	33	454
25.1	Advisory and assistance services	0	158
25.2	Other services	933	46,360
25.3	Purchases of goods & services from Gov't accounts	620	23,618
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	1,600	18,102
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	98	9,761
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	463	32,855
31	Equipment	541	37,675
32	Lands and structures	0	399
33	Investments and loans	0	0
41	Grants, subsidies and contributions	400	87,043
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	7,500	599,022

2. Advanced Materials: Accelerating advanced materials discovery and data tools for industry (Base Funding: $13.8 million and 21 FTE; Program Change: + $5.0 million and +10 FTE).

NIST requests an increase of $5.0 million and 10 FTE for a total of $18.8 million to enable the creation of advanced materials discovery tools and data for industry.

Proposed Actions:

The proposed increase provides the resources to accelerate NIST's progress in its key role in the Materials Genome Initiative, an interagency effort to dramatically influence the pace for bringing new materials to market. NIST is underway in developing 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 US manufacturers in achieving materials by design for high-tech products in a range of industrial sectors.

Action 1: Measurement science and data infrastructure for advanced materials ($2.0 million)

NIST will invest in key competence enhancement in integrated computational materials engineering with the proposed increase in funds. This expertise in computation will augment existing NIST competence in experimental materials science, enabling critical co-designed measurement science methods and infrastructure tools, such as standards. This increased technical capacity will enable NIST to pursue new programmatic thrusts using advanced computational and experimental techniques, to achieve Administration targets in materials design in important domains including big data for materials, functional electronic materials, and additive manufacturing.

Action 2: Sustain and enhance the NIST Materials Data Repository (MDR) to meet national needs ($1.0 million)

The proposed increase will enable NIST to build off of the pilot effort in standing up the MDR, initiated in FY 2014. NIST will reach out to key stakeholders in the government, private sector, and academia to share data in the MDR. These relationships will be essential to ensure that the MDR becomes a central resource for both depositing and accessing materials data. As part of this action, NIST will collaborate with other Federal agencies, non-profit organizations, and other stakeholders to host materials data from a variety of sources.

Action 3: Ensure integration with NIST Advanced Materials Center of Excellence, CHiMaD ($2.0 million)

NIST will put in place the critical resources to sustain and enhance its relationship with the Chicago-based Center for Hierarchical Materials Design (CHiMaD). Initiated in FY 2014, CHiMaD is a NIST-sponsored Center of Excellence funded in part by a $25.0 million award from NIST over five years. The CHiMaD consortium is led by Northwestern University and also includes the University of Chicago, the Northwestern-Argonne Institute of Science and Engineering (a partnership between Northwestern and the Department of Energy's Argonne National Laboratory) and the Computation Institute (a partnership between the University of Chicago and Argonne). The consortium also plans to work closely with QuesTek Innovations, a small business spin-off of Northwestern; ASM International, a well-known professional society of materials scientists; and Fayetteville State University. As a NIST Center of Excellence, CHiMaD is a new alliance between NIST and these organizations, which is intended to leverage and extend NIST's capability in the area of advanced materials design and data tools. Maximum success of this joint partnership with CHiMaD requires NIST investment in the laboratory research program. Beyond the initial external award to CHiMaD, as part of the NIST Center of Excellence Program, the resources requested here are essential to enable NIST to invest in staff and research programs that align and integrate with CHiMaD activities.

Statement of Need and Economic Benefits:

Today, the discovery and optimization of new materials for innovative products is a time-consuming and laborious process. Expensive trial-and-error-based experimentation results in highly inefficient exploration of the potential candidates for a desired new material system. This is in part because the materials design space is highly complex. For example, in metals, whether high strength steel for automobiles or lightweight aluminum for airplanes, a few percent change in composition or slight modification in manufacturing processes can make a such a large difference that performance metrics, such as strength, can vary by 50 percent or more. In another example, composite materials such as those used in advanced inks and new concrete formulations may include dozens of components, each of which can profoundly affect the material's properties. Identical arguments can be made for such diverse applications as solar cells, advanced batteries, catalytic materials, and next-generation electronics. The result is much lost opportunity for the discovery and optimization of new materials on which new higher performance products can be based.

However, a powerful new paradigm for materials discovery and optimization has begun to emerge: materials by design. The possibilities and opportunities were outlined in the 2008 National Research Council study *Integrated Computational Materials Engineering (ICME): A Transformative Discipline for Improved Competitiveness and National Security.*[13] This approach, championed by the Administration in the Materials Genome Initiative, stands in contrast to traditional trial-and-error-based approaches. Indeed, computational approaches based on physics-based material models, when integrated with carefully chosen experiments, can lead to hugely reduced development time, materials of higher performance, and far more effective and cheaper products. For example, GE has cut their jet engine alloy development cycle from fifteen years to nine years by using computational approaches and Procter and Gamble has saved about 17 years of design time in 2009 alone through their commitment to virtual computing in product design and development. A variety of other products, ranging from automobile engines to computer chips, are ripe to benefit from such modern methods of materials engineering -clearly a major enabler for the future of manufacturing and American industry.

The proposed increase in funding will enable NIST to accelerate their 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.

Base Resource Assessment:

NIST's investment in advanced materials design infrastructure for industry totaled $13.8M in FY 2014. The ongoing effort at NIST is a significant part of the multi-agency Materials Genome Initiative[14] (MGI), whose other major partners include the National Science Foundation and the Departments of Energy

[13] National Research Council. (2008). Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security. Washington, D.C.: The National Academies Press. (available online at http://www.nap.edu/catalog.php?record_id=12199).

[14] http://www.whitehouse.gov/sites/default/files/microsites/ostp/materials_genome_initiative-final.pdf

and Defense. The goal of the MGI is to significantly reduce the time and cost needed to discover, develop, manufacture, and deploy advanced materials. NIST has a leading role in the MGI, and currently serves as co-chair of the National Science and Technology Council's MGI Subcommittee under the Committee on Technology.

The generation and evaluation of physical reference data and the development of databases that can be widely used by industry is mandated by the NIST mission. NIST has expertise in data generation, collection, assessment, and dissemination, as well as model design and validation from atomic scale to the device scale. This expertise has provided a theoretical underpinning for NIST's efforts in measurement science and standards for advanced materials for some time. Specific linkages between modeling and simulation methods (e.g. those that focus at different length scales) must work in the intended manner in order to predict, assess, and validate material properties. NIST initiated in FY 2012 two use cases in structural metallic alloys and advanced composites to elucidate best practices, help identify and develop needed standards, focus integration efforts, and expose challenges that inhibit success.

In FY 2014, NIST embarked on a five-year collaboration with the Chicago-based Center for Hierarchical Materials Design (CHiMaD), a NIST Center of Excellence. CHiMaD is specifically focused on collaborating with NIST to help NIST achieve its goals within the MGI. The CHiMaD program is complementary to NIST's existing efforts and the requested increase in funds will enable NIST to maximize the impact and integration of this fledgling collaboration.

Besides the crucial collaboration with CHiMaD, other partners and stakeholders in this initiative include government agencies, namely DOE, DOD, and NSF, via the MGI Subcommittee of the NSTC. Also essential are the industry stakeholders that develop, model, and use advanced materials (e.g., including GE, Dow, DuPont, Procter & Gamble, Ford, and GM). NIST has relationships with the Materials Research Society, TMS, and ASM International, all professional societies that have initiated broad MGI related activities among their 60,000 members, and who provide a substantial resource for collaboration with universities and industry.

Schedule and Milestones:

Action 1: Integrated Computational Tools, Databases, and Experimental Techniques

- Build up NIST expertise in state-of-the art computational tools and experimental techniques (FY 2015 - FY 2019).
- Develop and publish new methods and data to accelerate materials by design in structural metallic alloys and advanced composites (FY 2015 - FY 2016).
- Develop new tools and techniques to accelerate materials by design in biomaterials and organic electronics (FY 2017 - FY 2019).

Action 2: Sustain and enhance the NIST Materials Data Repository (MDR) to meet national needs

- Transition MDR to an open model, with registered participants who are eligible based on NIST criteria, e.g., materials scientists, laboratory researchers, and product engineers working in materials development (FY 2015).

- Convene workshops and other meetings to engage with industry, government, non-profit organizations, and other stakeholders to continually ensure that the MDR meets community needs (FY 2015 - FY 2019).
- Develop partnerships to integrate and leverage MDR with other advanced materials databases (FY 2016 – FY 2019).

Action 3: Ensure integration with NIST Advanced Materials Center of Excellence, CHiMaD

- Expand NIST capabilities in areas in advanced materials computational and experimental tools that best complement CHiMaD research programs to ensure long-term knowledge gain at NIST (FY 2015 – FY 2018).
- Promote coordination between NIST and CHiMaD through site exchanges and joint research projects (FY 2015 – FY 2018).

Deliverables:

Action 1: Integrated Computational Tools, Databases, and Experimental Techniques

- Demonstration of dramatically reduced design times for new advanced materials using fully-integrated computational materials engineering in a set of use cases covering several types of materials. NIST-developed models, simulations, and experimental data will be integrated to enable a "materials by design" approach for new industry-relevant materials with desired properties.
- Creation and dissemination of modeling and simulation tools, experimental data sets and protocols, and data standards via peer-reviewed publications, qualified databases, and other appropriate sharing mechanisms.

Action 2: Sustain and enhance the NIST Materials Data Repository (MDR) to meet national needs

- NIST curated repository of materials data including modeling and simulation results, standard reference data, critically evaluated data sets and associated models for materials development use by industry, academia, and other stakeholders.
- Partnerships with private sector and government data repository providers that ensure the maximum utility of the NIST MDR and integration with other relevant materials data streams outside of NIST.
- Development of new analytical tools to optimize industry's use of MDR to accelerate the deployment of advanced materials in high-tech products and processes.

Action 3: Ensure integration with NIST Advanced Materials Center of Excellence, CHiMaD

- Complementary expertise at NIST and partner consortium CHiMaD to address critical materials challenges in both "hard" (inorganic) and "soft" (organic) advanced materials in fields as diverse as self-assembled biomaterials, smart materials for self-assembled circuit designs, organic photovoltaic materials, advanced ceramics and metal alloys.
- New relationships between NIST staff and technical experts at CHiMaD member organizations, including academic and industry connections, that strengthen and

broaden the dissemination of NIST measurement science and standards for advanced materials.

Performance Goals and Measurement Data:

Performance Goal: Cumulative number of integrated computation and experimental materials design demonstration projects	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	4	5	6	7	8
Without increase	2	3	3	4	4
Description: Perform "materials by design" demonstration projects that show the utility of integrated computational and experimental approaches to developing advanced materials, with a focus on materials relevant to major industry sectors such as electronics and aerospace.					

Performance Goal: Number of non-NIST participating organizations in the NIST Materials Data Repository	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Increase	12	24	48	80	100
Without Increase	8	10	12	14	16
Description: As NIST continues to develop the Materials Data Repository, success will be defined by the participation of many organizations (e.g., consortia, national laboratories, universities, companies, and other Federal agencies), as quantified in two primary modes: (1) active submission of data sets to MDR, or (2) access and use of MDR data sets for materials design by participating organizations.					

PROGRAM CHANGE PERSONNEL DETAIL

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Advanced Materials

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Physicist	Gaithersburg	ZP IV	1	$106,263	$106,263
Materials Scientist	Gaithersburg	ZP IV	2	106,263	212,526
Statistician	Gaithersburg	ZP IV	1	106,263	106,263
Data Scientist	Gaithersburg	ZP IV	1	106,263	106,263
Physicist	Gaithersburg	ZP III	1	75,621	75,621
Applied Mathamatician	Gaithersburg	ZP III	1	75,621	75,621
Materials Scientist	Gaithersburg	ZP III	2	75,621	151,241
Data Scientist	Gaithersburg	ZP III	1	75,621	75,621
Chemical Engineer	Gaithersburg	ZP III	2	75,621	151,241
Administrative/Technical Support	Gaithersburg	ZA II	1	52,146	52,146
Total			13		1,112,807
Less Lapse		25%	(3)		(278,202)
Total full-time permanent (FTE)			10		834,605
2015 Pay Adjustment (1%)					8,346
TOTAL					842,951

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	10
Other than full-time permanent	0
Total	10
Authorized Positions:	
Full-time permanent	13
Other than full-time permanent	0
Total	13

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Advanced Materials

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$843	$215,687
11.3	Other than full-time permanent	0	16,334
11.5	Other personnel compensation	0	1,889
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	843	233,910
12	Civilian personnel benefits	262	69,185
13	Benefits for former personnel	0	52
21	Travel and transportation of persons	41	9,081
22	Transportation of things	11	1,056
23.1	Rental payments to GSA	0	69
23.2	Rental Payments to others	0	1,776
23.3	Communications, utilities and miscellaneous charges	552	27,468
24	Printing and reproduction	22	454
25.1	Advisory and assistance services	0	158
25.2	Other services	806	46,360
25.3	Purchases of goods & services from Gov't accounts	394	23,618
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	500	18,102
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	84	9,761
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	557	32,855
31	Equipment	428	37,675
32	Lands and structures	0	399
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	87,043
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Direct Obligations	4,500	599,022
	NIST Transfer to Working Capital Fund	500	
	Total increase requested	5,000	

3. Synthetic Biology: Ensuring Quality and Predictability in Synthetic Biological Systems (Base Funding: $1.0 million and 3 FTE; Program Change: +$7.0 million +12 FTE.

NIST requests an increase of $7.0 million and 12 FTEs for a total of $8.0 million to ensure quality and predictability in the design of synthetic biological systems for efficient production of fuels, chemical feedstocks, pharmaceuticals, and medical therapies.

Proposed Actions: Ensuring quality and predictability in synthetic biological systems (+$7.0 million)

Rapid advances in the ability to modify biological organisms at the genetic level have created a new engineering discipline, commonly referred to as synthetic biology. Relying on the ability to synthesize and assemble biological machinery, synthetic biology bypasses the less predictable and lengthy process of evolution to streamline the creation of organisms capable of performing a specific function. For example, synthetic biology can be used to create engineered bacterial and mammalian cell lines to produce fuels, chemical feedstocks, and drugs. Although synthetic biology is still in its infancy, the collective vision for the field is ambitious; improved tissue engineering, creating bio-computer interfaces, and implementing large-scale biofuel production are just some of the areas where synthetic biology could be exploited. To date, synthetic biology research has largely been confined to efforts to identify and refine biological units that perform specific genetic or biochemical functions and to improve the DNA synthesis and construction method. Designing organisms for a specific function is typically done through trial-and-error, which is both costly and inefficient. A series of international symposia focused on synthetic biology identified several major technical challenges that needed to be overcome for synthetic biology to realize its full potential, including: lack of standardized biological parts, measurements, and databases; no broad understanding of the underlying scientific foundations for biological systems; no existing tools to test and control the interactions of synthesized biological materials, and; no existing interface for worldwide collaboration.[15] This initiative addresses all these technical challenges 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 where engineered biological systems first be examined *in silico*. Ultimately, a data/analysis system consisting of a community-fed pipeline of highly qualified data and data-driven approaches will be created, thereby enabling a platform for world-wide collaboration. This pipeline will result in rapid examination of experimental parameter space with large, highly qualified datasets to produce experimentally testable predictive theories that constitute the fundamental principles controlling biological organisms. This approach has the potential to revolutionize not only biology and synthetic biology, but all aspects of biomedical science and medicine.

Action 1: Coordinate, develop and assess measurement infrastructure for biological systems.

The trial-and-error approach, which is commonly employed in synthetic biology, is a typical yet ineffectual response when techniques to provide accurate, quantitative measurements are not available. Such measurements, however, are critical for understanding how biological systems are controlled on a genetic level. Unfortunately, these types of measurements are quite difficult. By their very nature, biological cells are inherently "noisy" and interact with the environment in unexpected ways. The synthetic biology and biomedical research communities have requested NIST's help in measurement and standards development in an effort to provide confidence in the measurements and

[15] Positioning Synthetic Biology to Meet the Challenges of the 21st Century: Summary Report of a Six Academies Symposium Series. The National Academies Press. 2013. Available from: http://www.nap.edu/download.php?record_id=13316

to establish robustness and harmonization of results. Consequently, NIST is needed to coordinate the strategic development and implementation of accurate and quantitative measurements of engineered biological systems. New, robust measurement technologies will be developed and benchmarking tools for existing techniques will be disseminated. While data generation is important, assessing the data quality is equally critical. Therefore, methods for data validation, including relevant reference data and standards, will be developed. It is envisioned that these efforts will help lead to the generation of sufficient highly qualified dataset, and NIST will assist these communities develop a suitable framework that can help them address their larger (and currently unforeseen) challenges. NIST will also develop a technical roadmap for NIST metrology as it relates to engineered and synthetic biology.

Action 2: Develop robust design and testing tools for biological systems.

The bedrock of synthetic biology is the ability to manipulate and modify a specific region of genetic material. Manipulation and modification relies on a detailed understanding what genetic material is present, in what configuration (what is being produced, commonly referred to as the gene or DNA sequence) and how actively that sequence is expressed (how much material is being produced). For example, two DNA sequences may produce different amounts of the same protein. While there are several well-established methods for DNA sequencing, methodologies to accurately quantify DNA expression are currently lacking. This may lead to less-than-optimal design of engineered organisms via the trial-and-error approach and loss of inter-operability among different laboratories. Based on established expertise in gene sequencing, NIST will develop and test standards for DNA modification and synthesis, including assessing the results of DNA modification on gene expression. Such rigorous genetic characterization accompanied by a quantitative functional activity descriptor will enable a better understanding of how biosynthetic pathways function. NIST will also provide high quality data on biological systems engineered with systematic genetic modifications, which can serve as gene expression references for the synthetic biological community to better standardize reporting and promote inter-operability. Further, NIST will focus on robust, high throughput methods for generating large volumes of validated data on gene expression for engineered biological systems. These large data volumes will be available to synthetic biology community for both input and export of genetic designs, which will further assure inter-operability of methods and comparability of results.

Action 3: Develop and deploy predictive models for biological systems.

Computational tools are just as important to the development of synthetic biology as validated lab-based measurement and testing protocols. Such tools allow the synthetic biology community to investigate any and all genetic combinations at computer terminals (*in silico*) rather than *in vitro* at the lab bench, thus saving both time and money. Through collaborations, NIST will develop and critically evaluate theoretical models that allow prediction of a desired biological response. These models will connect DNA sequences to dynamic behaviors, and will likely require collaboration from a number of different fields, including physics, mathematics, statistics, biology, and computer science. NIST will work with the community to collate and evaluate data and predictive models. NIST will also engage the community to develop a shared resource of data, theoretical models, and modular modeling component repository to allow critical assessment of model performance models. Early and wide-spread adoption of modeling codes, including units of measure and data validation protocols, will promote world-wide collaboration and standardization.

Statement of Need and Economic Benefits

The enormous potential of synthetic biology motivated six academies, including the United Kingdom's Royal Society and Royal Academy of Engineering, the United States' National Academy of Sciences and National Academy of Engineering, and the Chinese Academy of

Science and Chinese Academy of Engineering, to collectively organize a series of international symposia on the scientific, technical, and policy issues associated with synthetic biology. During the two-year period when the three symposia were taking place, the governments of the United Kingdom and China made investments in synthetic biology a priority (by comparison, the United States invests roughly $140.0 million annually in this area). The United Kingdom and China also advanced formal strategies and benchmarks for funding allocation purposes. Additionally, in Europe, the European Commission and the Organization for Economic Co-operation and Development (OECD) have taken an active interest in the field. During the course of the symposia series, representatives from China, the United Kingdom, the U.S., and the OECD discussed national plans, as well as planned and ongoing international collaborations, for stimulating progress in synthetic biology. The United States Congress has established a bipartisan caucus on synthetic biology, and the House of Representatives included provisions on synthetic biology in the recently passed Manufacturing Competitiveness Act.

The synthetic biology industry is expected to rise from $1.6 billion (2011) to $10.8 billion in 2016, with roughly $590.0 million invested from the U.S. and Europe between 2005 to 2010.[16,17] Even if synthetic biology never moves beyond providing commodity chemicals, it has the potential to provide tens of billions of dollars of products per year.[18] So far, success has been slow and costly because engineering biology is not yet systematic, and largely relies on exhaustive design-build-test cycles for every new application. Better measurements and a theoretical understanding of the control mechanisms of biological systems will make the engineering of biological systems for the production of desired functions more predictable.

Base Resource Assessment

NIST currently invests about $1 million specifically targeted at addressing the measurement challenges in the area of synthetic biology. These current efforts are largely centered in measurement assurance of DNA sequence. NIST has established close and fruitful connections with DARPA, NSF, and academic and industrial collaborators in this arena, and has been active in road-mapping efforts with the synthetic biology community. The proposed program would add capacity in systematic design and measurement of engineered biological response, which in turn would support theoretical work and development of predictive models.

Schedule and Milestones:

Action 1: Coordinate, develop and assess measurement infrastructure for biological systems.

- Develop advanced measurement methods based on NIST-invented technologies to measure small molecule products from engineered organisms. (FY 2015).

- Convene the synthetic biology community to determine requirements for standards and metrology (FY 2015 - FY 2019).

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16 UK Synthetic Biology Roadmap Coordination Group. A synthetic biology roadmap for the UK [Internet]. Technology Strategy Board (UK): 2012. 33 p. Requested by UK Department for Business Innovation and Skills. Available from: http://www.innovateuk.org/_assets/tsb_syntheticbiologyroadmap.pdf

17 Woodrow Wilson International Center for Scholars. Trends in synthetic biology research funding in the United States and Europe [Internet]. Washington (DC): Woodrow Wilson International Center for Scholars; 2010. 9 p. Available from: http://www.synbioproject.org/process/assets/files/6420/final_synbio_funding_web2.pdf

18 Potential Impacts on Synthetic Biology on Livelihoods and Biodiversity: Eight Case Studies on Commodity Replacement. A Submission to the Convention on Biological Diversity from ETC Group. 2013. Available from: https://www.cbd.int/doc/emerging-issues/emergingissues-2013-07-ETCGroup(1)-en.pdf.

- Develop measurement methods at NIST for evaluating sequence fidelity (FY 2015).
- Develop protocols, reference materials and benchmarking methods and materials for assuring high quality measurements of cell function and products (FY 2015 - FY 2019).

Action 2: Develop robust design and testing tools for biological systems.

- Increase NIST capacity for high content analysis of cell function and cellular products with state of the art equipment and newly recruited personnel (FY 2015 - FY 2016).
- Design, construct and deploy biological components that allow testing of desired response characteristics and response function in engineered cells (FY 2016 - FY 2019).

Action 3: Develop and deploy predictive models for biological systems.

- Develop and test new thermodynamic and statistical mechanical models of cell population responses. (FY 2015 – FY 2017).
- Work with and engage the community to contribute, along with NIST, data and models for engineered biological systems via an interactive Web presence. (FY 2015 – FY 2019).
- Model complex adaptive responses (emergence) across multiple scales of biological organization. (FY 2016 – FY 2018).
- Develop and test models to describe and predict the effects of organization and complexity on the function of single cells and cell communities. (FY 2018 – FY 2019).

Deliverables:

Action 1: Coordinate, develop and assess measurement infrastructure for biological systems.

- Coauthor publication on the use of gradient elution moving boundary electrophoresis (GEMBE) on detecting morphine produced by an engineered organism (FY 2015).
- Host a *Synthetic Biology Standards Consortium* with existing partners (BioBricks Foundation, DARPA Living Foundries, SynBERC) to guide, foster, and develop metrology products (FY 2016).
- Develop a technical roadmap for NIST metrology for engineered and synthetic biology for publication in the peer-reviewed literature (FY 2016).
- Conduct inter-laboratory study of synthesis fidelity (FY 2016).
- Hold workshop to engage regulatory agencies and stakeholders to identify standards needs for release of engineered organisms (FY 2017).
- Publish recommendations/guidance for gene synthesis quality (FY 2017).

- Disseminate relevant benchmarking tools for fluorescence microscopy and flow cytometry to the community (FY 2017).
- Provide reference data on characteristics and functional activity of selected engineered organisms (FY 2018 – FY 2019).

Action 2: Develop robust design and testing tools for biological systems.

- Perform collaborative research on systematic refactoring of gene clusters (FY 2015).
- Develop a robust engineering platform that allows assessment and control of directed evolutionary response in engineered biological systems. (FY 2015 – FY 2016).
- Demonstrate a reliable method for inserting large DNA constructs into engineered cells (FY 2016).
- Develop a platform compatible with microscopy for cell and gene manipulation (FY 2015 – FY 2016).
- Establish robust high throughput methods for generating large volumes of validated data on engineered systems (FY 2016 – FY 2019).

Action 3: Develop and deploy predictive models for biological systems.

- Organize a workshop on quantitative biology with academic and industrial participants (FY 2015).
- Provide a mathematical description of cell system performance with 1 and 2-dimensional landscapes (FY 2017).
- Develop a model to describe evolution of microbial systems and effect on production. (FY 2017 – FY 2019).
- Demonstrate the ability to predict the output of an engineered system according to the class of engineered components (FY 2019).
- Predict fundamental performance limits of natural and engineered biosystems for design and optimization (FY 2019).
- Establish an interactive Web presence that allows users to submit high quality data, and/or models, and to assemble a selection of resulting mathematical kernels to analyze their data or the data of others (FY 2016 – FY2019).
- Hold a Critical Assessment of Model Performance study to evaluate performance of models across stakeholders (FY 2019).

Performance Goals and Measurement Data:

Performance Goal: Develop measurement tools for biological systems	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Increase	6	9	12	15	15
Without Increase	3	3	3	3	3
Description: Number of NIST Special Publications, Internal Reports, Professional conference and journal articles, standard technical contributions annually related to synthetic biology metrology and measurement tools					

Performance Goal: Develop widely-adopted testing tools for biological systems	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Increase	4	18	24	50	70
Without Increase	2	2	6	12	15
Description: Number of peer-reviewed publications and professional conference proceedings that reference or use a NIST developed protocol and number of standard reference materials/data sold annually					

Performance Goal: Deploy predictive model for biological systems	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Increase	0	0	5	10	15
Without Increase	0	0	0	0	0
Description: Number of models, test and measurement tools released to public use annually.					

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Synthetic Biology

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Molecular Biologist	Gaithersburg	ZP IV	1	$106,263	$106,263
Biochemist	Gaithersburg	ZP IV	1	$106,263	$106,263
Biological Engineer	Gaithersburg	ZP IV	1	$106,263	$106,263
Computational Biologist	Gaithersburg	ZP IV	1	$106,263	$106,263
Biologist	Gaithersburg	ZP IV	1	$106,263	$106,263
Computer Scientist	Gaithersburg	ZP IV	1	$106,263	$106,263
Biological Engineer	Gaithersburg	ZP III	1	75,621	$75,621
Biochemist	Gaithersburg	ZP III	1	75,621	$75,621
Physical Chemist	Gaithersburg	ZP III	2	75,621	$151,242
Computational Biologist	Gaithersburg	ZP III	1	75,621	$75,621
Biomedical Engineer	Gaithersburg	ZA III	1	75,621	$75,621
Computer Scientist	Gaithersburg	ZA III	1	75,621	$75,621
Research Biologist	Gaithersburg	ZP III	2	75,621	$151,242
Administrative/technical support	Gaithersburg	ZA II	1	52,146	$52,146
Total			16		1,370,313
Less Lapse		25%	(4)		(342,578)
Total full-time permanent (FTE)			12		1,027,735
2015 Pay Adjustment (1%)					10,277
TOTAL					1,038,012

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	12
Other than full-time permanent	0
Total	12
Authorized Positions:	
Full-time permanent	16
Other than full-time permanent	0
Total	16

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Synthetic Biology

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$1,038	$215,687
11.3	Other than full-time permanent	0	16,334
11.5	Other personnel compensation	0	1,889
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	1,038	233,910
12	Civilian personnel benefits	323	69,185
13	Benefits for former personnel	0	52
21	Travel and transportation of persons	45	9,081
22	Transportation of things	11	1,056
23.1	Rental payments to GSA	0	69
23.2	Rental Payments to others	0	1,776
23.3	Communications, utilities and miscellaneous charges	759	27,468
24	Printing and reproduction	8	454
25.1	Advisory and assistance services	0	158
25.2	Other services	1,046	46,360
25.3	Purchases of goods & services from Gov't accounts	315	23,618
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	500	18,102
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	84	9,761
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	581	32,855
31	Equipment	40	37,675
32	Lands and structures	0	399
33	Investments and loans	0	0
41	Grants, subsidies and contributions	1,500	87,043
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	6,250	599,022
	Transfer to Working Capital Fund	750	
	Total increase requested	7,000	

4. STEM Education – Summer Institute for Middle School Science Teachers Program Change: $0.0 million 0 FTE.

In 2014, the President's Budget proposed a government-wide STEM reorganization to create a coherent framework for delivering STEM education to more students and more teachers more effectively while reducing fragmentation, and the Administration published a Five-Year Federal Strategic Plan on STEM Education to help align the reorganization with key goals and strategies. The areas of priority for this plan include: improving pre-kindergarten-through-grade-twelve (pre-K-12) instruction; increasing and sustaining youth and public engagement with STEM; enhancing undergraduate STEM education; creating a national strategy around graduate fellowships; and better serving groups historically underrepresented in STEM.

The 2015 Budget builds on these efforts by proposing a reorganization for STEM education. NIST's Summer Institute for Middle School Science Teachers program will be redirected to implement a Department of Education initiative to improve K-12 STEM instruction. NIST will internally re-allocate funding projected for Summer Institute for Middle School Teachers program to other program efficiencies.

Department of Commerce
National Institute of Standards and Technology
Laboratory Programs
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Department of Defense			
Air Force	$7,569	$8,499	$8,275
Army	1,559	1,321	1,270
Navy	866	683	650
Other, Department of Defense	11,606	14,920	13,018
Subtotal, Department of Defense	21,600	25,423	23,213
Department of Agriculture	206	100	100
Department of Commerce	13,780	14,570	14,570
Department of Energy	6,303	7,808	4,875
Dept. of Health & Human Services	3,788	5,787	2,911
Dept. of Homeland Security	16,175	18,875	17,434
Department of Justice	6,439	11,369	7,481
Department of Transportation	416	466	566
Department of Veterans Affairs	210	199	150
Environmental Protection Agency	74	50	50
General Services Administration	44	55	55
National Aeronautics & Space Admin.	2,508	3,432	3,225
National Science Foundation	2,761	2,844	2,840
Nuclear Regulatory Commission	2,211	1,875	1,875
Other	5,448	5,539	5,323
Subtotal, Other Agency	81,963	98,392	84,668
Calibrations & Testing	8,524	8,379	8,443
Technical & Advisory Services	20,976	20,723	20,647
Standard Reference Materials	16,309	14,087	14,139
Subtotal, Other Reimbursables	45,809	43,189	43,229
Total, Reimbursable Program	127,772	141,581	127,897
Equipment Transfers	0	3,700	1,250
Equipment Investments	26,661	21,447	15,450
IE Amortization	(11,550)	(14,537)	(15,450)
WCF Operating Adjustments	17,418	0	0
Total, WCF Investments	32,529	6,910	0
Total, Reimbursable Program and WCF Investments	160,301	152,191	129,147

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Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Measurement science, services, and programs
Sub-program: Corporate services

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) over 2015 Base	
Line Item		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Computer support	Pos./Approp	10	$7,582	10	$7,582	10	$7,617	10	$7,582	0	($35)
	FTE/Obl.	10	7,690	10	7,758	10	7,662	10	7,627	0	(35)
Business systems	Pos./Approp	34	9,730	34	9,730	34	10,035	34	9,730	0	(305)
	FTE/Obl.	32	9,927	33	9,792	33	10,093	33	9,788	0	(305)
Total	Pos./Approp	44	17,312	44	17,312	44	17,652	44	17,312	0	(340)
	FTE/Obl.	42	17,617	43	17,550	43	17,755	43	17,415	0	(340)

BUDGET PROGRAM: Corporate Services

PROGRAM JUSTIFICATION:

Corporate Services Overview

This program includes the NIST central IT support for NIST's technical programs which provides secure, centrally managed IT infrastructure resources supporting NIST's technical mission leading to improved measurement methods, standards advances, reference data, and research results benefiting numerous sectors of the U.S. economy. This program also provides the necessary resources to operate and maintain administrative and financial management systems at NIST that satisfy the requirements established by the Department of Commerce; Office of Management and Budget; Government Accountability Office; Department of Treasury; General Services Administration; and Congress.

1. Computer Support

The scope of this effort includes: securely deploying and managing computing, software, and networking resources as well as distributed, redundant storage for NIST data; and, management of the central computing facilities to meet Federal IT security requirements and the specialized requirements of the IT equipment located therein. These resources enable NIST laboratories and programs to perform mission-specific needs, disseminate NIST results to the public, and collaborate with NIST partners.

Examples of Accomplishments:

- Migrated email to a cloud Software as a Service provider, reducing costs and substantially expanding the collaboration capabilities available to NIST users.

- Established a mobile application development center of excellence and developed custom mobile applications for NIST users and the public.

Priority Objectives for FY 2015:

- Manage the IT infrastructure including computing systems, software, data storage, networking, and security capabilities to support all NIST programs including in new research buildings.

- Optimize the portfolio of computing platforms, data storage, backup storage, network interconnects, system security mechanisms including the mandated Enterprise Cybersecurity Monitoring and Operations (ECMO) infrastructure, and software components to meet the unique requirements of NIST users and programs.

- Migrate services to cloud providers in cases where it would provide optimal benefit to NIST.

2. Business Systems

The DoC and the Administration have undertaken major modernization initiatives of various business systems, functions, and processes. DoC envisions common, Department-wide, user-friendly, and flexible systems to support financial management, procurement management, travel management, grants management, property management, and other administrative functions. New business systems or upgrades to existing systems will be implemented over the next several years. Any new systems acquired will be integrated within the Department's Framework for business systems modernization. They will also interface with other internal and external administrative and management systems. NIST's business systems are an integral part of the vision for the administrative and financial management systems formulated by the DoC.

Example Accomplishments:

- Used incremental upgrades and performance tuning to keep the financial system and associated business systems at NIST operating smoothly.

- Implemented system modifications to ensure continued compliance with OMB and Treasury directives and mandates.

Priority Objectives for FY 2015:

- Implement, operate, and maintain administrative management systems that support the delivery of administrative services to NIST and its cross serviced customers.

- Operate and maintain CBS and the NIST CBS Portal that supports delivery of services to NIST and its cross-serviced customers.

- In conjunction with the Department and NIST's customers, plan for the successor to the Commerce Business System architecture.

Department of Commerce
National Institute of Standards and Technology
Corporate Services
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Department of Commerce	$2,568	$3,006	$3,006
General Services Administration	8	10	10
Subtotal, Other Agency	2,576	3,016	3,016
Equipment Investments	3,871	1,379	1,769
IE Amortization	(672)	(1,664)	(1,769)
Total, WCF Investments	3,199	(285)	0
Total, Reimbursable Program and WCF Investments	5,775	2,731	3,016

Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Measurement science, services, and programs
Sub-program: Standards coordination and special programs

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) over 2015 Base	
Line Item		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Standards coordination	Pos./Approp	137	$45,343	158	$55,676	158	$56,305	181	$65,176	23	$8,871
and special programs	FTE/Obl.	132	44,071	154	72,883	160	56,342	177	68,213	17	11,871
Total	Pos./Approp	137	45,343	158	55,676	158	56,305	181	65,176	23	8,871
	FTE/Obl.	132	44,071	154	72,883	160	56,342	177	68,213	17	11,871

BUDGET PROGRAM: Standards Coordination and Special Programs

PROGRAM JUSTIFICATION:

Standards Coordination and Special Programs Overview

Standards Coordination and Special Programs houses two cross NIST activities managed by the Associate Director for Laboratory Programs and Associate Director for Innovation and Industry Services that deal with coordinated high-profile R&D programs, documentary standards coordination and policy development. In addition, the NIST Centers of Excellence will be managed under this sub-program.

1. Office of Special Programs (OSP)

The OSP serves as the project and program management office for the Associate Director for Laboratory Programs, enhancing management oversight, planning, and resource coordination for high-profile programs that critically depend on the expertise and capabilities of two or more NIST laboratories.

The OSP currently consists of the following four programs:

- Forensic Sciences: In cooperation with the Department of Justice, the Department of Defense, the Department of Homeland Security and the National Science Foundation, develops performance standards, measurement tools, operating procedures and equipment guidelines that help criminal justice agencies make informed procurement, deployment, applications, operating, and training decisions. Provides unique expertise on performance standards for critical technologies in forensic science such as firearms and toolmark analysis, pattern and impression analysis including latent friction ridge analysis, footprint, tread and tire analysis, trace evidence including paint and coatings, fiber, hair, glass, metals and plastics analysis, geological evidence analysis, questioned document analysis, crime scene analysis, fire scene and fire debris analysis, explosives analysis, controlled substance and toxicology analysis, computer forensics, multi-media, digital and image analysis, voice spectral analysis, serology and DNA analysis, and medicolegal and death investigation. Works with law enforcement, universities, professional and scientific organizations, and other government agencies, to solve difficult technical forensic science standards challenges.

- Energy Research Program: As a new program in 2014, provides the measurement science and technical underpinnings for standards related to energy research that requires expertise and capabilities of more than one NIST organizational unit (OUs). Works closely with the Department of Energy and its laboratories to identify and prioritize the evolving metrology needs for which NIST research is required. Establishes the measurement service portfolios (reference materials, reference data, and calibrations) essential to DOE programs and the relevant stakeholder communities, when these cross the boundaries of individual OUs. Works primarily in the sector associated with renewable and sustainable energy, including the fields of transportation and fuels, energy efficiency, electric power generation, and energy storage.

- Greenhouse Gas Measurements and Climate Research Program: Provides the measurement science basis for accurate and comparable quantitative measurements of greenhouse gas emissions. Ensures measurement capabilities for accurate and reliable assessment of current greenhouse gas baselines, validation of greenhouse gas emission sources, and quantification of greenhouse gas sinks through improved quantitative measurements. Enables development of international measurement standards to ensure the accuracy of global assessments of greenhouse gas emissions.

- National Security Standards Program: Provides an intra and interagency coordinated approach to the development of technical standards and conformity assessment activities, related to national security, through federal, state, local, private sector, and international engagement. The focus is on measurement science and standards for Chemical/Biological/Radiological/Nuclear/Explosive (CBRNE) detection, personal protective equipment (PPE), and physical infrastructure resilience and security. Efforts in this program support the 2011 *National Strategy for CBRNE Standards* through improved interagency collaboration for standards development.

Examples of Accomplishments:

- Forensic Sciences: Designed a national framework for the development, approval and adoption of standards to support the Forensic Sciences in the U.S. This key standards infrastructure was designed to provide a national uniform organized framework to address technology and standards development needs for the highly diverse and fragmented universe of forensic science disciplines. Working with stakeholders from Federal, state and local government criminal justice and forensic science practitioners, academic researchers, measurement science and statistics subject matter experts, the organizational infrastructure was established to develop standards for the methods and protocols used in crime laboratories across the U.S., to ensure scientific rigor and to conduct research to validate new and existing methods, and develop standards for forensic science terminology, report wording and expert testimony.

- Forensic Sciences: Created a standard reference material that has globally standardized forensic firearms examinations and propelled the next generation of ballistic imaging software and instrumentation. The standard bullet was pivotal in the creation of algorithms for data collection and is the basis of uniform image capture for the National Integrated Ballistics Information Network, a national system utilized to associate firearms used in crimes to evidentiary fired bullets and casings.

- Greenhouse Gas Measurements and Climate Research Program: Completed the development of the spectral reference data for carbon dioxide at unprecedented levels of accuracy that directly support the observing instruments to be employed in NASA's Orbiting Carbon Observatory. Demonstrated a robust, low component cost, observing instrument technology prototype for carbon dioxide and methane intended for widespread use in surface-based observing networks.

- National Security Standards Program: Sponsored a National Academy of Science Workshop on "An All-Government Approach to Increase Resilience for International CBRNE Events" which brought together Federal and International response and military agencies to discuss consequence management and the U.S. government's role during international CBRNE disaster events (e.g., Fukushima)

- Office of Law Enforcement Standards: Leveraged the 700 MHz Public Safety Broadband Demonstration Network to conduct mission critical research, development, testing, and evaluation for public safety broadband communications features such as indoor/in-building coverage, extended cell coverage, and priority, quality of service, and pre-emption. Worked with the program's more than 70 Cooperative Research and Development Agreement (CRADA) partners to upgrade to network's $70+ million worth of equipment to the most advanced feature sets and standards releases. The 700 MHz Public Safety Broadband Demonstration Network continues to be one of the most vendor-diverse LTE networks in the world; test results are consumed by program sponsors such as the Department of Homeland Security's Office for Interoperability and Compatibility and the agency responsible for creating the nationwide public safety broadband network (NPSBN), FirstNet.

Priority Objectives for FY 2015:

- Forensic Sciences: Establish the administration of the Organization of Scientific Area Committees and be responsible for managing five Scientific Area Committees, a Forensic Science Standards Board, Quality Infrastructure Committee, Legal Resource Committee, Human Factors Committee and subcommittees to promulgate national standards, guidelines, and best practices throughout the forensic science community. In collaboration with the Department of Justice, prepare a report of the National Commission on Forensic Science and provide recommendations to the Attorney General.

- Greenhouse Gas Measurements and Climate Research Program: Implement a high-spatial-density regional monitoring network as a test bed for investigating the performance of dense observing networks having significantly improved spatial resolution for greenhouse gas source and sink identification and quantification at local and regional scales.

- National Security Standards Program: Coordinate efforts with the Department of Defense (DoD) Test and Evaluation Capabilities and Methodologies Integrated Process Team (TECMIPT). Coordinate standards development and knowledge sharing with the European Union's Joint Research Centre specific to national security. Establish a method for information/personnel sharing, for the support of national security standards development efforts, with the European Union Joint Research Centre.

- Energy Research: Establish and coordinate research efforts with the National Renewable Energy Laboratory and NIST (Physical Measurement Laboratory, Material Measurement Laboratory, NIST Center for Neutron Research): on second generation sustainable biofuels with a primary focus on understanding fundamental interactions at the molecular level and their impact on the composition and usability of the finished fuel; and on materials issues with advanced electrodes to improve efficacy, manufacturability, and quality.

2. Standards Coordination Office (SCO)

The SCO advises NIST leadership on policy and strategy as they relate to NIST's statutory role and responsibilities in standardization and serves as a normative standards and conformity assessment related multi-functional resource for NIST and U.S. government staff. In particular, the SCO addresses issues at the intersection of technology, standards, trade and innovation.

The Standards Coordination Office carries out the following programmatic functions:

- Standards Policy Coordination: Formulates and implements NIST policy regarding standards and conformity assessment, including product testing, certification practices, and laboratory accreditation to promote U.S. technology and support international competitiveness; cooperates with domestic organizations in the private sector, state and local governments, Federal agencies, and with domestic foreign, and international organizations in matters related to standardization and conformity assessment; carries out standards policy and information functions established by Congress or as otherwise directed; recommends Federal policies regarding the development, approval, and use of voluntary standards, and the development and implementation of conformity assessment policy; chairs the Interagency Committee on Standards Policy (ICSP) which coordinates actions by which Federal agencies implement standards-related policies; coordinates domestic and international standards-related activities; monitors the global standards and conformity assessment landscape and represents NIST at relevant domestic and international fora; administers and reports on the quality system for NIST measurement services; conducts training for NIST assessors and quality managers; oversees and reviews NIST divisions' quality systems assessments; and represents the U.S. and NIST at the SIM Quality System Task Force.

- Standards Guidance: Provides standards and conformity assessment related technical support to other U.S. government agencies to assist with both technical and policy issues. Provides early warning about emerging standards and conformity assessment related issues that can help NIST managers make decisions about preparing for and addressing these issues. Assists NIST staff in bridging the technical, standards and trade policy aspects in issues with the potential to impact U.S. competitiveness and ability to innovate. Provides unique standards and conformity assessment policy expertise relating to key trading partners. Assists U.S. government agencies and private sector organizations with the implementation of Mutual Recognition Agreements (MRAs) such as the APEC Tel and CITEL MRAs.

- Standards and Information Dissemination and Outreach: Operates the National Center for Standards and Certification Information, and the World Trade Organization, Technical Barriers to Trade related Inquiry Point and Notification Authority providing unique standards, conformity assessment and technical regulations related information to NIST staff, U.S. government employees, U.S. exporters, and foreign trading partners. Provides standards and conformity assessment related outreach and training to stakeholders. Analyzes impact and effectiveness of NIST participation in standards and conformity assessment related activities.

- Laboratory Accreditation: Operates the National Voluntary Laboratory Accreditation Program (NVLAP) for the U.S.; provides accreditation to testing and calibration laboratories based on evaluation of their technical qualifications and competence to perform certain types of tests in specified fields using internationally accepted guides and standards; designs and implements procedures for accrediting laboratories for their capability to provide calibrations traceable to national standards and for ability to conduct such important tests as those for asbestos fibers and electromagnetic telecommunications; provides evaluation and recognition of testing performance, especially in response to Congressional mandates and requirements of other Federal agencies, to domestic and foreign laboratories, state and local governments, and commercial interests.

Examples of Accomplishments:

- Standards Policy Coordination: Coordinated the development and publication of a report by the National Science and Technology Council's Subcommittee on Standards, on Federal Engagement in Standards Activities to Address National Priorities, and supported the development of a memorandum from the White House on the principles for Federal Engagement in Standards. The report included proposed policy recommendations currently under consideration in the Executive Office of the President.

- Standards Guidance: Designed and implemented the inspection and provisional authorization (certification) system used by the General Services Administration (GSA) for cloud service providers as part of the cloud first policy. This program has accredited more than 15 third party assessment organizations (inspection bodies) that assess the implementation of security controls in cloud service providers systems and granted provisional authorization to several cloud service providers. The program leverages private sector resources to provide a sustainable and competitive market for inspection services and reduces the resources needed by Federal agencies to use cloud services in their information systems.

- Worked with the Department of Homeland Security to develop, ASTM E2885 – 13, and ASTM E2933 - 13 Standard Specifications for Chemical Vapor Detectors for Homeland Security Applications. This first of their kind standards will allow first responders and other users of detection equipment for toxic industrial chemicals and chemical warfare agents to make more informed procurement decisions.

- Standards and Information Dissemination and Outreach: Provided training on documentary standards, conformity assessment and related topics to over 950 Federal agency staff, including 100 in FY13, from more than 40 government agencies. This effort supports NIST's role under the National Technology Transfer and Advancement Act.

- Laboratory Accreditation: Under a program requested by the U.S. Department of Homeland Security, NVLAP accredited the first biometrics testing laboratories that perform conformance testing, interoperability testing, technology testing, scenario testing, operational and usability testing for biometrics products. Also, in response from a request from the Office of the National Coordinator for Health IT, NVLAP established a program to accredit laboratories that perform functional and conformance testing of electronic health record (EHR) technology products.

Priority Objectives for FY 2015:

- Standards Policy Coordination: Coordinate implementation of White House-issued principles for enhancing Federal engagement in standards activities with the private sector to address national priorities. Continue to work with OMB's Office of Information and Regulatory Affairs on supplementary guidance for agency use of standards to enhance the efficiency and effectiveness of government programs. SCO will support OMB's revision of Circular A-119 and support Federal agencies implementation of the revised guidance on participation and use of standards.

- Standards Guidance: Issue updated guidance to agencies on conformity assessment and coordinate agency implementation. Further explore identification of external standards needs and priorities for NIST, examining standards needs and priorities in the context of potential impacts in specific priority technology areas, such as cyber-physical systems, nanotechnology, cybersecurity and forensics; and the organization and execution of opportunities for technology leaders to relate their future standards-related challenges. Work with the Department of Justice on the development and implementation of a documentary standards based quality infrastructure for forensic science. Work with the Department of Labor, Occupational Safety and Health Administration to develop approaches to leveraging private sector accreditation activities to enhance the operation of the Nationally Recognized Testing Laboratory program. Work with the Department of Health and Human Services, National Personal Protective Technology Laboratory in developing approaches to optimize their testing and certification activities for respiratory protective equipment and a develop a framework to carry out their responsibilities for non-respiratory personal protective equipment. Work with the Environmental Protection Agency and the General Services Administration on standards and ecolabeing issues related to green products.

- Standards and Information Dissemination and Outreach: Operate the National Center for Standards and Certification Information, and the World Trade Organization, Technical Barriers to Trade related Inquiry Point and Notification Authority providing unique standards, conformity assessment and technical regulations related information to NIST staff, U.S. government employees, U.S. exporters, and foreign trading partners. Provide standards and conformity assessment related outreach and training to stakeholders. Analyze impact and effectiveness of NIST participation in standards and conformity assessment related activities. Develop a plan in collaboration with the National Archives and Record Administration and the Government Printing Office to streamline the process to provide public access and increase the utility of a data base identifying standards incorporated by reference in the Code of Federal Regulations.

- Laboratory Accreditation: Continue to provide fee supported laboratory accreditation services to testing and calibration laboratories in support of Federal agency regulation, mandates, and industry needs.

PROGRAM CHANGE:

1. Forensic Science: Measurement Science and Standards for Forensic Science Infrastructure (Base Funding: $7.6 million and 24 FTE; Program Change: +$3.5 million +7 FTE).

NIST requests an increase of $3.5 million and 7 FTE for a total of $ 11.1 million to enable the development of a scientific underpinning for forensics in the US.

Proposed Actions: Enable A Scientific Underpinning for Forensics in the U.S.

The current scientific measurement basis and the state of standardization of forensic science are widely acknowledged as needing significant improvement. The goals of this initiative are to develop science based standards, measurement methods, tests and validation studies that will underpin reliable, accurate, interoperable and validated forensic analysis. Forensic disciplines to be investigated include: human identification (DNA, fingerprints, palm prints, face & voice recognition, scars-marks-tattoos, bite marks), controlled substances, trace evidence (microbial identification, fiber, coatings, soil, glass, gunshot residue), toxicology, impression evidence (tire marks, shoe prints, firearms, etc.), digital forensics, multimedia forensics (video, audio, images) and fire/arson investigation. Prioritization of NIST efforts in forensic science would be supported by the Scientific Area Groups made up of practitioners, academics, and other experts in the field of forensic science that were established under the DOJ-NIST Memorandum of Understanding on Forensic Science. The main focus of the planned initiative would include:

Action 1: Develop, test, evaluate, and publish new reference methods and technologies for identifying criminals and understanding crime scenes.

As new demands of forensic analysis continue to emerge, there will be an ongoing need to introduce new methods and technologies to keep pace with the evolving challenges. Those new methods and technologies will need to be brought from the discovery stage to a state where they can be reliably applied in case work, through well-structured test and evaluation protocols, and subsequently made available for public access. NIST will develop test and evaluation approaches that rigorously address the performance required in an operational forensic laboratory.

Action 2: Develop and apply statistical foundations for forensic science, including uncertainty measurement, error rates, precision, uniqueness, bias, and human errors.

The interpretation and utility of forensic data is critically dependent on a scientifically defensible expression of uncertainty. This area is of concern in both the uniqueness of an identification of a fingerprint, DNA, or shell casing, and in the assessment of error rates, operator bias, and human errors. The need to bring statistical foundations that have been developed to support other fields, and the challenge of developing meaningful statistical analysis for unique forensic scenarios, is central to a judicial system as it enters an age of ever increasing data. With robust and validated statistical methods the courts will be positioned to make decisions based on evidence of well-established levels of confidence.

Action 3: Improve the accuracy, reliability, and interoperability of forensic methods, technologies and data through research in underlying science, rigorous testing, and methods for assessing conformance to standards.

A number of broadly adopted forensic methods and technologies and data in use today have not had the benefit of a thorough scientific assessment of their accuracy, reliability or interoperability. Their utility in the court room will become limited unless efforts are invested in understanding and improving on the current limits of accuracy, reliability and interoperability. NIST will develop methods for comparison of analysis performed in different laboratories (inter-laboratory studies) allowing current forensic methods to establish their equivalency. NIST will also assess the underlying scientific principles to extend and improve upon the performance of forensic methods.

Action 4: Develop calibration systems, reference materials and databases, technology test beds, challenge problems, and conduct evaluations in support of reliable and accurate forensic practice.

The viability of countless forensic analysis methods hinges on the availability of appropriate reference materials and databases for the results to be sound and trustworthy. Calibration system and test beds also play a key role in providing assurance that measurements provide results that are independent of the operator and organization making the measurement. As a metrology organization, NIST can build on a strong foundation in measurement science infrastructure that will be required to move into new capabilities appropriate to the needs of the forensic science community.

Action 5: Work with national and international Standards Development Organizations, academia, instrument manufacturers, database creators, technology developers, and the user communities to encourage adoption of scientifically rigorous and well characterized standards and practices.

The Organization of Scientific Area Committees that NIST and DOJ established in 2014 will engage the broad forensic scientific community in a standards development process that will support Federal, state, and local authorities, while also protecting the rights of the innocent. NIST will engage with appropriate SDOs to assist in the standards development process, as well as engaging with forensic science practitioners, to realize the development and adoption of robust measurement science in forensics.

Statement of Need and Economic Benefits:

"The simple reality is that the interpretation of forensic evidence is not always based on scientific studies to determine its validity. This is a serious problem." -*Strengthening Forensic Science in the United States: A Path Forward, 2009, Page 8* ·

In 2009, the National Research Council of the National Academies (NRC) released a report titled *Strengthening Forensic Science in the United States: A Path Forward.* This technically rigorous examination of forensic science expresses concern over the lack of peer-reviewed and published validation of the scientific underpinnings of forensic science disciplines, the lack of uniform standards, and the highly fragmented state of forensic science in the U.S.

The current scientific measurement basis and the state of standardization of forensic science are widely acknowledged as needing significant improvement. Forensic science is intended to provide the justice system with nonbiased, independent scientific evidence analysis and expert testimony: aiding police in catching criminals; understanding crime scenes; identifying suspects; and helping to correctly ascertain guilt or innocence. However, the reliability and scientific validity of forensic science has been called into question, with a number of critical issues identified by scientific and legal communities. This initiative in forensic science comprehensively addresses many of the issues identified by a number of stakeholders, including the National Academies, public policy organizations, Congress, and the Administration.

NIST is perfectly positioned to provide measurement science support to the forensic science community through the research and development of standard materials, reference data, and calibration systems. The NIST laboratories have partnerships with professional associations, standards developing organizations, government, industry, and academia, which will enable NIST to strengthen and expand efforts to advance measurement quality for forensic science. The NIST laboratories have complementary expertise that will further enable research to characterize and improve the accuracy and efficacy of many forensic approaches, aiding practitioners by providing tools for crime scene investigation, laboratory analysis, and courtroom use of this evidence.

One example of the national leadership role NIST has assumed in the forensic science community is the creation in 2014 of a new national Organization of Scientific Area Committees (OSAC) to begin to supplant the current Scientific Working Groups (SWGs) formerly supported by agencies within the US Department of Justice. With the formal announcement in 2013 by DOJ and NIST of a bilateral agreement (MOU) to improve forensic science, DOJ and NIST agreed for NIST to establish an organization ultimately designed to strengthen forensic science through a coordinated effort to build a strong quality infrastructure to develop standards and improve technology for more than twenty forensic science disciplines. Building upon the standards and guidelines developed over the past decade by the SWGs, the new organization will bring together forensic science practitioners with specialists in measurement science, statistics and research from academia, government and the private sector to strengthen the scientific foundation of the methods utilized in the practice of forensic science in the laboratory and the quality, validity, reliability and impact of forensic science evidence in the courtrooms of America.

Specifically, this initiative impacts two major areas:

1. Validity and reliability of evidence used in the U.S. justice system

Forensic science is one of the major structural elements of the U.S. justice system. Forensic science provides an objective, science and fact-based approach to understand crime scenes, identify suspects and overcome human bias in investigation and execution of the justice system. Improving the accuracy and reliability of forensic science directly impacts the trust in the system. As the impacts of this initiative are promulgated throughout the country, we expect that more criminals will be correctly identified and prosecuted and fewer innocent citizens will be accused or convicted of criminal activities.

2. Cost to the U.S. justice system

Tremendous cost savings are anticipated if the goal of this initiative (i.e., to produce sound scientific measurement tools for use in the forensic science community and to facilitate their implementation through the OSAC) is fully realized. Providing certainty and accuracy to measurements in criminal laboratories will reduce the number of wrongful convictions and mistrials, impacting the number of criminal court cases. For those individuals who may be exonerated based on a reexamination of physical evidence such as DNA analysis, there is a cost savings to the penal system and an impact on that individual's quality of life. Further contribution to the potential cost savings from exonerating those falsely convicted of criminal offenses is brought about by redirecting criminal investigations toward the true pertetrators and removing them from society where they are free to continue to prey on other victims of property crime and violent crime. Another consideration is the cost of preventing future crimes: because rapists and serial killers are often repeat offenders, the societal value of conviction after the first offense using accurate forensic methodology should also be considered a benefit. One economic analysis of cost savings from forensic DNA testing in sexual assault cases alone estimated a cost savings of $35 for every dollar invested; the same analysis predicted that if DNA testing were fully utilized the U.S. could expect a $12.9 billion annual savings in prevented crime.

Base Resources Assessment:

NIST has a long history of providing innovative solutions to technological forensic science challenges like those described in the 2009 NRC report. One example is the development at NIST of truncated DNA polymerase chain reaction primers to detect and accurately identify DNA short tandem repeats (STRs) in highly decomposed and partially incinerated human remains recovered from Ground Zero at the World Trade Center in 2001.

NIST measurement science capabilities are broadly applicable to a number of forensic science disciplines and challenges. As a result of funding from other agencies (e.g., DOJ) on a short-term directed task basis, NIST has developed a limited number of forensic science-related areas of expertise. In addition, NIST has an established core capability in a number of forensic science areas. For example, NIST research in human identity and forensic DNA testing, developed in collaboration with the National Institute of Justice (NIJ/DOJ), has resulted in the development of Standard Reference Materials, new testing methods, inter-laboratory validations, and the creation of training materials. The successful development of this core competency in DNA testing is a product of technical expertise along with a commitment to and engagement with the forensic community to develop relevant products. The forensic science initiative empowers NIST to leverage this success in DNA testing, by continuing efforts in forensic DNA while also using the DNA testing successes as a model to establish strengths in other forensic specialty areas within NIST.

In the area of forensics, NIST invested a total of $ 7.6 million in base STRS funds in FY 2014.

Schedule and Milestones:

Action 1: Develop, test, evaluate, and publish new reference methods and technologies for identifying criminals and understanding crime scenes.

- Develop new approaches for measuring the quality of forensic data so that better methods and tools can be developed to acquire and analyze the data.

- Develop new approaches to bring the analysis and technology to the crime scene, yielding immediate answers to investigators. This involves real-time and in-the-field analyses in all the relevant forensic disciplines.
- Develop new methods and technologies to analyze digital evidence dealing with criminal cyber-attacks on computer and network systems.
- In addition, acquire digital evidence in mobile devices as well as remote, virtual and cloud computing environments.

Action 2: Develop and apply statistical foundations for forensic science, including uncertainty measurement, error rates, precision, uniqueness, bias, and human errors.

- Perform work-flow studies of practitioners to develop sources of human bias and error.
- Develop methods and technologies for enhancing usability of forensic practices and tools.
- Determine forensic error rates for the various forensic disciplines by developing metrics and methodology, and performing empirical studies and technology evaluations.
- Develop improved approaches for measuring uncertainty in the various forensic disciplines.
- Develop validated statistical tools to aid researchers and practitioners.

Action 3: Improve the accuracy, reliability, and interoperability of forensic methods, technologies and data through research in underlying science, rigorous testing, and methods for assessing conformance to standards.

- Perform research in measurement science to develop new approaches for measuring reliability, accuracy and validity in the various forensic disciplines. The results will be used to perform scientific validation of forensic methods, as well as to establish scientifically validated methodologies for measurements used in forensic practices.

Action 4: Develop calibration systems, reference materials and databases, technology test beds, challenge problems, and conduct evaluations in support of reliable and accurate forensic practice.

- Foster innovation by organizing challenge problems to focus the forensic research community on specific gaps and solutions.
- Test/evaluate effectiveness (throughput, accuracy, usability, interoperability) of technologies.
- Test proposed standards, guidelines, validation methods, and human interfaces.

Action 5: Work with national and international Standards Development Organizations, academia, instrument manufacturers, database creators, technology developers, and the user communities to encourage adoption of scientifically rigorous and well characterized standards and practices.

- Promote awareness of advances in measurement science that offer new approaches to current challenges in the forensic laboratory.
- Explore and promote the extension of validated standards and practices to forensic disciplines that would benefit from improved methods.

Deliverables:

- New reference materials, reference databases, and documentary standards created.
- Protocol validation studies completed and published.

- Standards that incorporate NIST technical content adopted by the forensic science community.
- NIST publications describing new reference methods and technologies.
- NIST statistical tools adopted by the forensic science community.
- Grants provided to key academic partners and forensic institutions.
- Improved quality of Federal, state, and local laboratory results (i.e., accuracy, validity, precision, reliability, and reproducibility).
- New innovative forensic science technologies.
- Increased use of documentary standards and measurement services by the forensic community.

Performance Goals and Measurement Data:

Performance Goal: **Performance Measure:** Reference materials and databases	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	3	4	5	6	6
Without increase	3	3	3	3	3
Description: Number of new forensic science reference materials, reference databases, and documentary standards created.					

Performance Goal: **Performance Measure:** Protocol Validation	**FY 2015 Target**	**FY 2016 Target**	**FY 2017 Target**	**FY 2018 Target**	**FY 2019 Target**
With Increase	3	4	5	6	6
Without Increase	2	2	2	2	2
Description: Number of protocol validation studies complete and published.					

Performance Goal: **Performance Measure:** Forensic Standards	**FY 2015 Target**	**FY 2016 Target**	**FY 2017 Target**	**FY 2018 Target**	**FY 2019 Target**
With Increase	2	4	5	6	6
Without Increase	2	3	3	3	3
Description: Number of standards based on NIST technical content adopted by the forensic community					

PROGRAM CHANGE PERSONNEL DETAIL

(Dollar amount in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Laboratory Programs
Program Change: Forensic Science

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Program Manager	Gaithersburg	ZP V	1	124,966	124,966
Assistant Program Manager	Gaithersburg	ZP IV	2	106,263	212,526
Physical Scientist	Gaithersburg	ZA III	2	75,621	151,242
Students/Graduate students	Gaithersburg	ZP II	4	75,621	302,484
Administrative/technical supprt	Gaithersburg	ZA II	1	52,146	52,146
Total			10		843,364
Less Lapse		25%	3		210,841
Total full-time permanent (FTE)			7		632,523
2015 Pay Adjustment (1%)					6,325
TOTAL					638,848

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	7
Other than full-time permanent	0
Total	7
Authorized Positions:	
Full-time permanent	10
Other than full-time permanent	0
Total	10

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Standards Coordination and Special Programs
Program Change: Forensic Science

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$639	$15,496
11.3	Other than full-time permanent	0	619
11.5	Other personnel compensation	0	2,961
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	639	19,076
12	Civilian personnel benefits	199	5,066
13	Benefits for former personnel	0	0
21	Travel and transportation of persons	59	1,117
22	Transportation of things	2	64
23.1	Rental payments to GSA	0	9
23.2	Rental Payments to others	0	2
23.3	Communications, utilities and miscellaneous charges	256	4,578
24	Printing and reproduction	4	48
25.1	Advisory and assistance services	0	403
25.2	Other services	733	10,123
25.3	Purchases of goods & services from Gov't accounts	94	1,650
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	250	2,378
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	53	865
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	105	1,484
31	Equipment	106	2,096
32	Lands and structures	0	151
33	Investments and loans	0	0
41	Grants, subsidies and contributions	1,000	19,103
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	3,500	68,213
	NIST Transfer to Working Capital Fund	0	0
	Total increase requested	3,500	68,213

2. Lab-to-Market: Enable laboratory to market strategies to accelerate commercialization of Federal technologies and collaboration (Base Funding: 0 FTE; Program Change: +$6.0 million and +10 FTE).

NIST requests an increase of $6.0 million and 10 FTE for a total of $6.0 million to enable the development and deployment of laboratory to market strategies to accelerate commercialization of federal technologies and collaboration.

Proposed Actions: Enable the Development of Laboratory to Market Strategies to Accelerate Federal Agency Collaboration for Commercialization of Federal Technologies

The America COMPETES Reauthorization Act of 2010 created the position of Undersecretary for Standards and Technology that included Federal government-wide responsibilities for technology transfer. These include analysis, planning, coordination, reporting and general oversight of technology transfer responsibilities under Section 5 of the Federal Technology Transfer Act of 1986, the Bayh-Dole Act of 1980, and Executive Orders 12591 and 10096. These duties include coordinating Federal agency activities for the commercialization of technology developed at Federal laboratories, monitoring of agency use of cooperative agreements as a means of increasing the efficiency of transferring Federally funded technology to the private sector, and the preparation of related reports. In October of 2011, the President issued the Presidential Memorandum -- Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses that directed agencies to establish goals, measure performance, streamline administrative processes, and facilitate local and regional partnerships to facilitate R&D commercialization. Pursuant to this Presidential Memorandum, NIST (in accordance with functions delegated by the Secretary of Commerce) has assumed a leadership role in collecting, analyzing and reporting the performance of Federal agencies in implementing the directions articulated in the memorandum. Accelerating technology transfer and commercialization from Federal laboratories and from federally-sponsored research is for the Department of Commerce and the Administration. Leveraging our national investment in Federal research and development is essential to U.S. leadership in global innovation, business development, and job creation in cutting-edge industries. NIST coordinates Federal technology transfer policy development activities and provides reporting and analysis, including economic analysis, on performance and outcomes related to technology transfer. This initiative will strengthen NIST and Federal Technology Transfer activities through the following efforts:

Action 1: Developing human capital.

NIST will coordinate strategic development and implementation of policies to increase the performance of Federal labs in the use of sources of external human capital. This includes evaluating and coordinating practices across agencies for leveraging the expertise of individuals with effective private-sector experience in technology transfer who serve within the research agencies for limited-term fellowships and "Entrepreneur in Residence" engagements or similar activities with a goal of increasing access and understanding of new technologies to increase commercialization. NIST will coordinate with others to evaluate and recommend ethics-based policy guidelines that enable and encourage federal researchers to work outside government for limited periods on industrial/entrepreneurial developmental assignments, as appropriate; and increase the opportunities for experiential entrepreneurship education among both students and investigators who work on federally-funded R&D projects.

Action 2: Empowering effective collaborations.

NIST will lead cross agency efforts to develop and implement new policies that further streamline and promote technology transfer collaborations between Federal agencies and from Federal agencies to the private sector. These activities include developing strategies to promote an increased priority level of R&D commercialization activities and outcomes at Federal laboratories, consistent with agency mission and commercialization strategy. NIST will lead efforts to optimize technology transfer authorities and best practices across Federal laboratories in order to remove barriers to collaboration with external entities including streamlining wherever possible Cooperative Research and Development Agreements (CRADA) authorities, updated intellectual property (IP) policies, identifying ways to increasing the impact of technology transfer activities by fully utilizing existing authority for all research agencies to co-fund joint projects between agencies. NIST will utilize a number of mechanisms including efforts through the Hollings Manufacturing Extension Partnership program to work with external partners and will participate in regional technology innovation clusters. Specific actions include but are not limited to collecting industry needs (market and technology), identifying and qualifying technology sources able to meet those needs, validating market and technology demand and facilitating the creation of the collaborations needed to meet those needs.

Action 3: Opening access to tangible and intangible assets.

NIST will work with the Federal Laboratory Consortium (FLC), the National Technical Information Service, and offices within the Executive Office of the President (EOP), including the use of the EOP Presidential Innovation Fellows program to implement a national framework for all intellectual property developed by Federal laboratories. This framework will enable easy discovery, simplify understanding, and accelerate licensing of Federal lab-developed intellectual property by U.S. entrepreneurs and innovators, wherever appropriate. NIST will coordinate the cross agency effort to reduce the time, cost, and complexity of executing IP licenses, by adopting the most innovative and effective approaches from industry, universities, and Federal agencies and work with university stakeholders to achieve these outcomes to the maximum extent possible for university inventions as well as Federal laboratory inventions, with an emphasis on the broad-based economic and social impact of federally funded R&D. NIST will coordinate efforts to build upon the FLC's "Available Technologies" data base to help make information available to third party systems and coordinate with university programs such as the Association for University Technology Managers and other technology focused organizations.

NIST will coordinate efforts to improve the capabilities of Federal laboratories to work with private industry, especially small business partners, to support continued commercialization of collaboration results through mechanisms such as identifying opportunities to transfer excess/surplus federal property to innovators and entrepreneurs to further accelerate business development, and support manufacturers' scale-up. Additional NIST through ongoing programs will work with external partners to share the expertise of federal laboratories with business and participate in regional technology clusters. NIST will facilitate the creation of regional collaborations able to take best advantage of the access to federal laboratories. NIST will work with the FLC and other agencies to simplify the ability of partners to locate and use appropriate laboratory facilities and equipment at federal labs.

NIST will work with university stakeholders to develop better tools to support technology transfer from federally funded work under the Bayh-Dole Act.

Action 4: Evaluating impact.

NIST will build on the implementation of the 2011 Presidential Memorandum, which includes new metrics tracking commercialization, developing additional metrics that track the goals set forth in this executive memorandum. NIST will continue to evaluate and implement metrics to provide for improved performance analysis for technology from both Federal laboratories and that of federally funded R&D. This analysis will include economic policy analysis to characterize and estimate the importance of technologies and supporting technical infrastructure to U.S.-based industries within and across different sectors of the economy and develop policy response options that support Federal innovation policy. NIST will conduct cross-cutting strategic planning, economic impact, and economic role/policy studies to support new technology transfer strategies. NIST will collect, evaluate, and report on technology transfer metrics. NIST will coordinate the collection and analysis of new metrics in intergovernmental technology transfer as noted in 15 U.S.C. 3710 (g) and in response to the Presidential Memorandum as incorporated into OMB Circular A-11 as well as information reported on extramural technology under the Bayh-Dole Act. NIST will continue to evaluate and implement metrics to provide for improved performance analysis. This analysis will include economic policy analysis to characterize and estimate the importance of technologies and supporting technical infrastructure to U.S.-based industries within and across different sectors of the economy and develop policy response options that support Federal innovation policy. NIST will conduct cross-cutting strategic planning, economic impact, and economic role/policy studies to support new technology transfer strategies.

Statement of Need and Economic Benefits:

A wide range of life-changing commercial technologies were nurtured by Federally funded research and development (R&D), from the Internet, to the global positioning system (GPS), to leading-edge vaccines. The Federal R&D enterprise must continue to support fundamental research that is motivated primarily by our interest in expanding the frontiers of human knowledge, and diffusing this knowledge through easy to access data and publications. At the same time, 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 U.S. Federal approach has been to typically support pre-commercialization and early stage research and leverage the strength and expertise of the private sector to commercialize and deploy many of these research, science and technology outcomes into real world and daily life applications. Thus, while the Federal government has forged an effective partnership with the private sector, there is still significant scope for improving and further enhancing this relationship to further strengthen U.S. competitiveness and provide economic benefit to the U.S.

These actions will be taken to accelerate and improve the transfer of new technologies from the laboratory to the commercial marketplace, building on the Administration's Startup America initiative to promote high-growth entrepreneurship, as well as the ongoing implementation of the Presidential Memorandum of October 28, 2011 (Accelerating Technology Transfer and Commercialization of Federal Research in Support of High-Growth Businesses), which directed agencies to establish goals, measure performance, streamline administrative processes, and facilitate local and regional partnerships to facilitate R&D commercialization.

Actions will require coordination across all Executive departments and agencies that fund research and development, both intramurally and extramurally consistent with each agency's mission. Implementation, includes the preparation of government-wide plans and will be coordinated with Executive offices and the Interagency Workgroup on Technology Transfer, established pursuant to Executive Order 12591 of April 10, 1987.

Base Resource Assessment:

In order to support technology transfer and economic policy coordination and analysis, NIST is requesting $6.0 million to provide staffing and services. These efforts are currently not supported out of base resouces and thus the resources currently available to accomplish this important set of responsibilities is limited. NIST currently chairs interagency workgroups to develop and coordinate policies in technology transfer across government agencies for both intramural and extramural programs and has authority to develop regulations in the area of Federal technology transfer. NIST also serves as the host agency for the Federal Laboratory Consortium for Technology Transfer. This leadership position makes NIST the ideal place to implement these programs and to further strengthen NIST's role in enabling coordination and cooperation across the federal enterprise.

There is a greater need than ever to diffuse new and best practices across federal agencies to fully benefit from the roughly $140.0 billion annual Federal government investment in R&D. Coupled with the responsibility to increase technology transfer is improved measurement, analysis and reporting to help ensure that these investments are being effectively utilized and leveraged. The current literature that provides detailed analysis of Federal efforts in this area is fairly sparse. Future decision-making requires more robust data and conclusions to better direct current and future efforts to connect Federal research with American businesses. Economic analysis will explain government roles in economic terms based on industry underinvestment analyses, identify efficient policy instruments, facilitate optimal resource allocations for each targeted category of investment, support efficient research program execution, promote effective technology transfer activities, and demonstrate economic impact. These activities are limited due to the current constrained budgetary environment.

Schedule and Milestones:

Action 1: Developing human capital.

- Coordinate policies for "entrepreneur in residence" or similar actions across agencies to promote commercialization of federal inventions.
- Evaluate and recommend ethics based policy guidelines that enable and encourage federal researchers to work outside government for limited periods on industrial/entrepreneurial detail, as appropriate; and increase the opportunities for experiential entrepreneurship education among both students and investigators who work on Federally funded R&D projects.
- Promote prioritization of technology transfer at Federal laboratories.
- Coordinate with stakeholders at universities and the private sector to identify and integrate best practices.

Action 2: Empowering effective collaborations.

- Examine standard CRADA usage across agencies to provide more consistency and streamline administrative burden for CRADAs on private partners.
- Develop on-line solutions to promote more standardized development and use of CRADA terms.
- Identify and develop new and more efficient pathways for collaborations and partnerships with Federal laboratories.
- Coordinate agency actions to support commercialization of research from extramural research under the Bayh-Dole Act.
- Facilitate the development of regional collaborations, consisting of Federal laboratories, local intermediary organizations, universities, community and technical colleges, state government

agencies and the private sector, to better identify needed technologies and move them to commercial practice.

Action 3: Opening access to tangible and intangible assets.

- Develop and or promote systems to easily search available Federal intellectual property.
- Coordinate data with third parties to further extend the availability of IP and collaboration opportunities.
- Work with the executive branch leadership and congressional staff to explore and recommend or develop changes that can promote the best use of government assets to support commercialization and collaboration.
- NIST will work with the FLC and other agencies and organizations to simplify the ability of partners to locate and use appropriate laboratory facilities and equipment at Federal labs.

Action 4: Evaluating Impact.

- NIST will conduct cross-cutting strategic planning, economic impact, and economic role/policy studies to support new technology transfer strategies.
- NIST will collect, evaluate, and report on technology transfer metrics.
- Develop robust economic analysis capabilities to evaluate performance of technology transfer from laboratories and its impact of American businesses.
- Develop an online, centralized repository of Federal technology transfer reports, impact assessment studies, and supporting data that will facilitate access, minimize data collection costs and avoid redundancy in related assessment studies, promote effective designs of impact studies, including data collection techniques and assessment methods, based on the scale and scope of target markets, and the expected size, duration and type of impact.
- Develop outcome metrics that capture easy to understand, long-term economic impacts (e.g., dollars of follow-on capital attracted, revenue generated, jobs created, and new products developed by companies commercializing Federally funded R&D).

Deliverables:

Action 1: Developing human capital.

- Conduct a study on entrepreneurial policies and develop recommendations for further action.
- Coordinate with Office of Government Ethics (OGE) and others to examine ethics issues and identify new strategies.

Action 2: Empowering effective collaborations.

- Coordinate the evaluation of standard CRADA terms across agencies and identify potential areas to streamline.
- Develop an on-line source for agencies to obtain standardized CRADA language and material and exchange best practices.
- Develop and populate roadmaps of key cross-agency issues and identify key points for collaboration.
- Better identify and collect information from inventions resulting from extramural research.
- Work with universities and businesses to modernize regulations and procedures under the Bayh-Dole Act.

- Develop regional collaborations able to take best advantage of Federal- and university-based technologies.

Action 3: Opening access to tangible and intangible assets.

- Provide on-line search tool for agency facilities and equipment.
- Work with agencies to implement streamlined licensing of inventions.
- Provide platforms to streamline transfer of IP and work to reduce barriers to deployment and collaboration for development of IP.

Action 4: Evaluating impact.

- Annually prepare technology transfer report on government-wide activities.
- Prepare economic analysis reports that support understanding and evaluation of government technology transfer efforts.
- On-line repository for economic analysis reports.
- Work with other agencies to improve the collection and reporting of extramural R&D data.

Performance Goals and Measurement Data:

Performance Goal: Number economic impact analysis reports	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	3	3	3	3	3
Without increase	0	0	0	0	0
Description: Perform economic impact studies of the downstream outcomes of technology transfer to provide feedback on effectiveness and guide future efforts.					

Performance Goal: Deploy new technology transfer tools	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Increase	2	2	2	2	2
Without Increase	0	0	0	0	0
Description: Based on studies of best practices and needs, develop and deploy systems to aid Federal and private partners in identifying opportunities for greater technology transfer.					

PROGRAM CHANGE PERSONNEL DETAIL

(Dollar amount in thousands)

Program Measurement Science, Services, and Programs
Subprogram Standards Coordination and Special Programs
Program Change: Lab to Market

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Supervisory Scientist	Gaithersburg	ZP V	1	124,996	124,996
Economist/Physical Scientist	Gaithersburg	ZP IV	7	106,263	743,841
Business Specialist	Gaithersburg	ZA IV	1	106,263	106,263
Business Specialist	Gaithersburg	ZA III	2	75,621	151,242
Administrative assistant	Gaithersburg	ZS III	1	38,363	38,363
Administrative/technical supprt	Gaithersburg	ZA II	1	52,146	52,146
Total			13		1,216,851
less Lapse		25%	3		304,213
Total full-time permanent (FTE)			10		912,638
2015 Pay Adjustment (1%)					9,126
TOTAL					921,765

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	10
Other than full-time permanent	0
Total	10
Authorized Positions:	
Full-time permanent	13
Other than full-time permanent	0
Total	13

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Measurement Science, Services, and Programs
Subprogram: Standards Coordination and Special Programs
Program Change: Lab to Market

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$922	$15,496
11.3	Other than full-time permanent	0	619
11.5	Other personnel compensation	0	2,961
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	922	19,076
12	Civilian personnel benefits	287	5,066
13	Benefits for former personnel	0	0
21	Travel and transportation of persons	53	1,117
22	Transportation of things	5	64
23.1	Rental payments to GSA	0	9
23.2	Rental Payments to others	0	2
23.3	Communications, utilities and miscellaneous charges	638	4,578
24	Printing and reproduction	3	48
25.1	Advisory and assistance services	0	403
25.2	Other services	2,198	10,123
25.3	Purchases of goods & services from Gov't accounts	97	1,650
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	1,472	2,378
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	72	865
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	69	1,484
31	Equipment	34	2,096
32	Lands and structures	150	151
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	19,103
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Direct obligations	6,000	68,213
	NIST Transfer to Working Capital Fund	0	0
	Total obligations	6,000	68,213

Department of Commerce
National Institute of Standards and Technology
Standards Coordination and Special Programs
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Department of Defense			
Navy	$25	0	0
Other, Department of Defense	19	0	0
Subtotal, Department of Defense	44	0	0
Department of Commerce	0	$1,000	$2,500
Dept. of Homeland Security	1,756	3,940	4,700
Department of Justice	0	200	0
Subtotal, Other Agency	1,800	5,140	7,200
Technical & Advisory Services	4,062	4,035	4,235
Subtotal, Other Reimbursables	4,062	4,035	4,235
Total, Reimbursable Program	5,862	9,175	11,435
Equipment Investments	23	31	15
IE Amortization	(11)	(14)	(15)
Total, WCF Investments	12	17	0
Total, Reimbursable Program and WCF Investments	5,874	9,192	11,435

Object Class

Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
11	Personnel compensation					
11.1	Full-time permanent	$210,767	$227,750	$232,952	$235,474	2,522
11.3	Other than full-time permanent	17,147	17,147	17,321	17,147	(174)
11.5	Other personnel compensation	5,432	5,432	5,432	5,432	0
11.9	Total personnel compensation	233,346	250,329	255,705	258,053	2,348
12.1	Civilian personnel benefits	68,045	73,094	79,281	75,499	(3,782)
13	Benefits for former personnel	52	52	52	52	0
21	Travel and transportation of persons	8,977	10,235	9,906	10,235	$329
22	Transportation of things	814	1,041	1,056	1,121	65
23.1	Rental payments to GSA	77	82	83	82	(1)
23.2	Rental payments to others	1,770	1,770	1,823	1,798	(25)
23.3	Communications, utilities, and miscellaneous charges	21,769	29,755	25,456	32,776	7,320
24	Printing and reproduction	344	435	441	505	64
25.1	Advisory and assistance services	1,157	741	584	573	(11)
25.2	Other services	53,974	83,657	47,262	57,341	10,079
25.3	Purchases of goods and services from Government accounts	22,184	25,195	28,116	26,715	(1,401)
25.5	Research and development contracts	4,508	16,158	16,384	20,480	4,096
25.7	Operation and maintenance of equipment	13,630	14,701	14,907	15,092	185
26	Supplies and materials	29,065	32,964	33,549	34,739	1,190
31	Equipment	35,052	40,253	42,306	42,893	587
32	Land and structures	0	400	400	550	150
41	Grants, subsidies, and contributions	87,835	103,246	103,246	106,146	2,900
42	Insurance claims and indemnities	2	0	0	0	0
43	Interest and dividends	1	0	0	0	0
99	Total Obligations	582,602	684,108	660,557	684,650	24,093

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
99	Total Obligations	582,602	684,108	660,557	684,650	24,093
	Less Prior Year Recoveries	(4,688)	(1,000)	(1,000)	(1,000)	0
	Less Prior Year Refunds	(500)	0			
	Less Prior Year Unobligated Balance	(18,439)	(29,408)	0	0	0
	Plus Unobligated Balance, End of Year	29,408	0			
	Plus Unobligated Balance, Expired	35	0			
	Unobligated Balance Transfer to WCF	0	3,700			
	Total Budget Authority	588,418	657,400	659,557	683,650	24,093
	Transfer to NIST Working Capital Fund	0	0	0	1,250	1,250
	Transfer from Election Assistance Commission	(2,607)	(1,900)	0	(1,900)	(1,900)
	Transfers from DoJ for Office of Law Enforcement	(6,040)	(4,500)	0	(3,000)	(3,000)
	Appropriation	579,771	651,000	659,557	680,000	20,443

Personnel Data

	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Full-time equivalent employment:					
Full-time permanent	1,946	2,119	2,145	2,199	54
Other than full-time permanent	212	212	212	212	0
Total	2,158	2,331	2,357	2,411	54
Authorized Positions:					
Full-time permanent	2,201	2,318	2,318	2,390	72
Other than full-time permanent	48	48	48	48	0
Total	2,249	2,366	2,366	2,438	72

Exhibit 33

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For necessary expenses of the National Institute of Standards and Technology,

15 U.S.C. 272; 273; 278b-j; p
15 U.S.C. 290b-f
15 U.S.C. 1151-52
15 U.S.C. 1454(d-e)
15 U.S.C. 1511, 1512
15 U.S.C. 3710a-d
15 U.S.C. 3711a
15 U.S.C. 7301-7313
15 U.S.C. 7406
15 U.S.C. 7506(a)

15 U.S.C. 272; 273; 278b-j; p provides basic authority for the performance of the functions and activities of the National Institute of Standards and Technology, authorizes appropriations for these purposes to be provided to the general public and specific institutions, governments, firms, and individuals, and requires the notification of Congress of a reprogramming of funds that exceeds a limit specified in public law.

15 U.S.C. 290b-f directs the Secretary of Commerce to provide for the collection, compilation, critical evaluation, publication, and dissemination of standard reference data and the authority to establish a non-agricultural technology office.

15 U.S.C. 1151-1152 establishes within the Department of Commerce, a central clearinghouse for technical information useful to American business and industry and provides for the dissemination of this technical, scientific information via the National Technical Information Service.

15 U.S.C. 1454(d-e) provides NIST with the authority to request that manufacturers and distributors of a commodity participate in voluntary product standards when there is undue proliferation of weights, measures, and quantities. Reports and recommendations to Congress are to be made upon industry failure to adopt these standards.

15 U.S.C. 1511, 1512 specifies that all bureaus of the Department of Commerce come under the authority of the Secretary of Commerce and that such bureaus including NIST shall be subject to the authority of the Secretary of Commerce.

15 U.S.C. 3710a-d provides the authority to enter into CRADAs, to make cash awards to scientific personnel for inventions, to retain royalties and to distribute royalties for inventions, and to communicate and coordinate for the Offices of Research and Technology Applications in Federal laboratories.

15 U.S.C. 3711a provides the authority for the Baldrige National Quality award.

15 U.S.C. 7301-7313 establishes National Construction Safety Teams within NIST to respond to building and structural emergencies.

15 U.S.C. 7406 provides authority for NIST to conduct Cyber Security Research and Development to minimize security risks associated with computer systems used by the Federal government.

15 U.S.C. 7506(a) provides for the establishment of a nanotechnology research and development program within NIST.

P.L. 110-143 121 STAT 1809 provides NIST to assist in developing a research program to establish guidelines for the remediation of former methamphetamine laboratories in the United States as well as developing new detection technologies and appropriate Standard Reference Materials for methamphetamine detection testing.

2. $680,000,000, to remain available until expended,

   no specific authority

3. of which not to exceed $9,000,000 may be transferred to the "Working Capital Fund." 15 U.S.C. 278b

   15 U.S.C. 278b provides in part: "The National Institute of Standards and Technology is authorized to utilize in the performance of its functions the Working Capital Fund".

4. Public Law 110-69, America Competes Act, 121 Stat 572, passed August 9, 2007 reauthorizes the Scientific and Technical Research and Services appropriation through 2010. Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, passed January 4, 2011 reauthorized the Scientific and Technical Research and Standards appropriation through 2013. In addition, an Emergency Communication and Tracking Technologies Research initiative and a Green Manufacturing and Construction initiative were authorized to develop advanced technologies in these areas.

5. Public Law 111-5 American Recovery and Reinvestment Act of 2009 appropriates $220,000,000 for the Scientific and Technical Research and Services appropriation from FY 2009 to FY 2010 and makes available by reimbursable agreement $10,000,000 from the Department of Energy for the development of Smart Grid Technology by reference to Public Law 110-140, the Energy Independence and Security Act of 2007, and makes available by reimbursable agreement $2,230,186 for a service level agreement with the National Telecommunications and Information Administration. In addition, $20,000,000 is transferred from the Department of Health and Human Services for continued work on advancing health care information enterprise integration.

Exhibit 34

Department of Commerce
National Institute of Standards and Technology
Scientific and Technical Research and Services
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2013 Actual	FY 2014 Estimate	FY 2015 Estimate
Management and professional support services	$663	$250	$90
Studies, analyses, and evaluations	256	253	245
Engineering and technical services	238	238	238
Total	1,157	741	573

Significant Activities

Advisory and assistance services funded by the STRS appropriation include the review and evaluation of the technical functions and operations of NIST by the Board on Assessment of the National Academy of Sciences. The Evaluation Panels consider the importance and relative priority of projects, quality of staff, equipment needs, and finances, and the relation of the programs to the mission of NIST.

Need for Advisory and Assistance Services:

The need for advisory and assistance services stems from the NIST role in dealing with the private sector, professional organizations, and the public sector. Inputs must be obtained from consultants who can bring their individual expertise to bear and help NIST in assessing its program plans to meet the needs of its customers. The alternative to utilizing these services is to make no attempt to have expertise from sources outside NIST and risk degradation of the working and professional relationship with those in the business of using the products and services offered by NIST.

Industrial
Technology Services

Exhibit 5

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2014 Enacted	85	87	$143,000	$165,956	$143,000
less: Unobligated balance from prior year			0	(18,956)	0
2015 Adjustments to base:					
Other Changes:					
Annualization of positions financed in FY 2014	0	1	0	0	0
TIP shutdown	0	(2)	0	0	0
plus: Uncontrollable cost changes	0	0	718	718	718
less: Estimated recoveries 2014	0	0	0	(4,000)	0
2015 Base Request	85	86	143,718	143,718	143,718
plus: 2015 Program changes	5	4	18,000	18,000	18,000
less: Inflationary adjustment	0	0	(718)	(718)	(718)
2015 Estimate	90	90	161,000	161,000	161,000

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Comparison by program/sub-program:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Technology innovation program											
Technology innovation program	Pos./Approp	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	6	$1,391	2	$6,520	0	0	0	0	0	0
Advanced manufacturing technology consortia											
Advanced manufacturing technology consortia	Pos./Approp	2	10,544	4	15,000	4	$15,042	4	$15,000	0	($42)
	FTE/Obl.	0	3,031	3	19,513	4	15,042	4	15,000	0	(42)
Hollings manufacturing extension partnership											
Hollings manufacturing extension partnership	Pos./Approp	84	123,030	81	128,000	81	$128,676	81	141,000	0	12,324
	FTE/Obl.	74	117,915	82	139,865	82	128,676	82	141,000	0	12,324
Manufacturing innovation institutes coordination											
Manufacturing innovation institutes coordination	Pos/Approp	0	0	0	0	0	0	5	5,000	5	5,000
	FTE/Obl.	0	0	0	0	0	0	4	5,000	4	5,000
Baldrige performance excellence program											
Baldrige performance excellence program	Pos./Approp	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	9	0	58	0	0	0	0	0	0
TOTALS	Pos./Approp	86	133,574	85	143,000	85	143,718	90	161,000	5	17,282
	FTE/Obl.	80	122,346	87	165,956	86	143,718	90	161,000	4	17,282

Comparison by program/sub-program:	2013 Actual Personnel	2013 Actual Amount	2014 Enacted Personnel	2014 Enacted Amount	2015 Base Personnel	2015 Base Amount	2015 Estimate Personnel	2015 Estimate Amount	Increase/ (Decrease) Over 2015 Base Personnel	Increase/ (Decrease) Over 2015 Base Amount
Adjustments for:										
Recoveries		(3,782)		(4,000)		0		0		0
Refunds		(99)		0		0		0		0
Unobligated balance, start of year		(6,847)		(18,956)		0		0		0
Unobligated balance, end of year		18,956		0		0		0		0
Budget Authority		130,574		143,000		143,718		161,000		17,282
Financing from transfers:										
Transfer to BIS		3,000		0		0		0		0
Appropriation		133,574		143,000		143,718		161,000		17,282

Adjustments
to Base

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

	FTE	Amount
Adjustments:		
A base reduction of 2 FTE reflects the shutdown of the Technology Innovation Program (TIP).	(2)	0
Other Changes:		
Annualization of 2014 pay raise	0	26

A pay raise of 1 percent is assumed to be effective January 1, 2014.

Total cost in FY 2015 of 2014 pay raise	$104,000
Less amount requested in FY 2014	(78,000)
Less amount absorbed in FY 2014	0
Amount requested in 2015 to provide full-year cost of 2014 pay raise	26,000

	FTE	Amount
2015 Pay increase and related costs	0	78

A general pay raise of 1.049 percent is assumed to be effective January 1, 2015.

Total cost in FY 2015 of pay increase	$78,000
Less amount absorbed in FY 2015	0
Amount requested for FY 2015 pay increase	78,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2015 pay increase	78,000

Annualization of positions financed in FY 2014	1	0

NIST requires an additional 1 FTE to staff FY 2014 requested increases at their full operating level in FY 2015.

New positions in 2014	5
Less 5 percent lapse	(0)
Full-Year FTE	5
Less FTE Funded in 2014	(4)
Annualization of Positions/FTE in 2015	1

Personnel benefits	0	154

Civil Service Retirement System (CSRS)	(11)
Federal Employees' Retirement System (FERS)	119
Thrift Savings Plan (TSP)	10
Federal Insurance Contribution Act (FICA) – OASDI	10
Health Insurance	21
Employees' Compensation Fund	5

Civil Service Retirement System (-$11,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees' Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 7 percent in FY 2014 to 5.0 percent in FY 2015. The contribution rate will remain at 7.0 percent in FY 2015.

Payroll subject to retirement systems ($8,056,854)	
Cost of CSRS contributions in FY 2015 ($8,056,854 x .050 x .07)	$28,199
Cost of CSRS contributions in FY 2014 ($8,056,854 x .070 x .07)	39,479
Total adjustment to base	(11,280)

Federal Employees' Retirement System ($119,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 93.0 percent in FY 2014 to 95.0 percent in FY 2015. On October 1, 2013, the Board of Actuaries of the FERS retirement system recommended changes to long term economic and demographic assumptions changing the contribution rate. As transmitted to agencies by OMB, plans are increased by 1.3 percentage points from 11.9 percent of pay to 13.2 percent.

Payroll subject to retirement systems ($8,056,854)	
Basic benefit cost in FY 2015 ($8,056,854 x .950 x .132)..	$1,010,329
Basic benefit cost in FY 2014 ($8,056,854 x .930 x .119)..	891,652
Total adjustment to base..	118,677

Thrift Savings Plan ($10,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate increased from 4.57 percent in FY 2014 to 4.61 percent in FY 2015.

Thrift plan cost in FY 2015 ($8,056,854 x .950 x .0461)	$352,850
Thrift plan cost in FY 2014 ($8,056,854 x .930 x .0457)	342,424
Total adjustment to base..	10,426

Federal Insurance Contributions Act (FICA) - OASDI (10,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. In FY 2015, the maximum salary subject to OASDI tax will remain at $119,100 in FY 2015. The OASDI tax rate for employers remains at 6.2 percent in FY 2015.

FERS payroll subject to FICA tax in 2015 ($8,056,854 x .950 x .904 x .062).........	$428,992
FERS payroll subject to FICA tax in 2014 ($8,056,854 x .930 x .903 x .062).........	419,496
Increase (FY 2014-FY 2015)	9,496

OTP payroll subject to FICA tax in 2015 ($151,146 x .950 x .904 x .062)	8,048
OTP payroll subject to FICA tax in 2014 ($151,146 x .930 x .903 x .062)	7,870
Increase (FY 2014-FY 2015)	178
Total adjustment to base	9,674

Health insurance ($21,000) – Effective January 2013, NIST's contribution to Federal employees' health insurance premiums increased by 3.6 percent. Applied against the FY 2014 estimate of $578,000, the additional amount required is $20,808

Employees' Compensation Fund ($5,000) – The Employees' Compensation Fund bill for the year ending June 30, 2012 is $4,716 higher than for the year ending June 30, 2012.

Communications, utilities, and miscellaneous charges		0	(241)
Electricity rate decrease	(78)		
Natural Gas rate decrease	(163)		

The electricity ATB amount was derived using a year to year comparison of the cost per kilowatt hour. In analyzing the 12 months ended February 2013 and 2012, the per kilowatt hour rate decreased 7.4 percent (from .103 to .095) for Gaithersburg, Maryland; increased 1.9 percent (from .426 to .434) for Kauai, Hawaii; decreased 5 percent (from .071 to .067) for Boulder, Colorado; and increased .8 percent (from .090 to .091) for Ft. Collins, Colorado for a net decrease of $78,000.

The natural gas ATB amount was derived using a year to year comparison of the average cost per therm. In analyzing the 12 months ended February 2013 and 2012, the per therm rate decreased 37.4 percent (from .772 to .483) and decreased 60.5 percent (from 1.526 to .603) for Gaithersburg and Boulder respectively resulting in a net decrease of $163,000.

HMEP Center Salaries	0	450

This request funds salary and benefit inflationary cost increases for non-federal employees of the Hollings Manufacturing Extension Centers using employment cost indices provided by the Bureau of Labor Statistics (BLS) to maintain a high level of service to the public.

General pricing level adjustment	0	251

This request applies the OMB economic assumptions of 1.4 percent for FY 2015 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: communications, utilities, and miscellaneous charges \$5,894; printing \$1,246; other services \$229,670; supplies \$8,652; and equipment \$4,564.

Subtotal Other changes	1	718
Total Adjustments to base	(1)	718

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APPROPRIATION ACCOUNT: Industrial Technology Services (ITS)

NIST requests $161.0 million for the ITS appropriation, which consists of three extramural programs, the Hollings Manufacturing Extension Partnership (MEP), the Advanced Manufacturing Technology Consortia program (AMTech), and a newly proposed Manufacturing Innovation Institutes Coordination program. The request is an increase of $18.0 million above the FY 2014 enacted level.

SIGNIFICANT ADJUSTMENTS-TO-BASE (ATBs):

NIST will fund inflationary costs to current programs from administrative efficiencies. These costs include a 2015 Federal Pay Raise and inflationary increases for non-labor activities. ITS ATBs in FY 2015 total $0.718 million.

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Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Technology innovation program
Sub-program: Technology innovation program

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Program Activity		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Technology innovation program	Pos./Approp	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	6	$1,391	2	6,520	0	0	0	0	0	0

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Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Advanced manufacturing technology consortia
Sub-program: Advanced manufacturing technology consortia

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Program Activity		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Advanced manufacturing technology consortia	Pos./Approp	2	$10,544	4	$15,000	4	$15,042	4	$15,000	0	($42)
	FTE/Obl.	0	3,031	3	19,513	4	15,042	4	15,000	0	(42)

BUDGET PROGRAM: Advanced Manufacturing Technology Consortia (AMTech)

For FY 2015, NIST requests $15.0 million for AMTech, the same as the FY 2014 enacted level.

PROGRAM JUSTIFICATION:

AMTech Overview

The Advanced Manufacturing Technology Consortia (AMTech) program 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.

In June 2011, the President launched the Advanced Manufacturing Partnership (AMP), a national effort that brings together industry, universities, and the Federal government to invest in emerging technologies that will create high-quality manufacturing jobs and enhance our global competitiveness. The Advanced Manufacturing Technology Consortia (AMTech) program is an example of the kind of public-private partnership envisioned by AMP to address common technological needs. Specifically, AMTech provides cost shared funding to consortia that are focused on developing advanced technologies to address major technical problems that inhibit the growth of advanced manufacturing in the U.S. AMTech consortia develop detailed road maps of long-term technology needs. The AMTech program provides incentives for addressing multiple components of the innovation cycle, from discovery to commercialization, and also provides funding to address the precompetitive R&D needs identified by the consortia members in order to accelerate the pace of innovation throughout various industrial sectors.

The AMTech model demonstrates how the Federal government may leverage resources for a greater societal and commercial outcome by producing research that fits into industry roadmaps. The AMTech program fills a critical gap by providing resources for directed basic and measurement research that is seen as too long-term and has too much market uncertainty for industry to invest in on its own. Research challenges addressed by an AMTech consortium are pre-competitive: all industry members will benefit from the R&D outcomes and the partnerships are built on open access to intellectual property. AMTech provides a mechanism to leverage agency investment in order to launch breakthrough technologies that will collapse the timescale of innovation.

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. The AMTech program is an important element of the Administration's emphasis on advanced manufacturing. A number of studies point to industry-led consortia as a meaningful tool to drive directed basic research in areas of critical need. The AMTech program was singled out in the President's Council of Advisors on Science and Technology (PCAST) "Report to the President on Ensuring American Leadership in Advanced Manufacturing" (June 2011) as a public-private partnership model that is needed to catalyze American excellence in advanced manufacturing. AMTech provides a framework to support the Advanced Manufacturing Partnership (AMP), an initiative that was launched by the President in response to PCAST recommendations. AMP is a national effort bringing together industry, universities, and Federal agencies, including NIST, to invest in the emerging technologies that will create high quality manufacturing jobs and enhance global competitiveness. The AMTech program provides cost shared funding to consortia that are focused on developing advanced technologies to address major technical problems that inhibit the growth of advanced manufacturing in the U.S. AMTech consortia develop detailed road maps of long-term technology needs. The AMTech program provides incentives for addressing multiple components of the innovation cycle, from discovery to commercialization, to accelerate the pace of innovation throughout various industrial sectors.

Resources for AMTech enable NIST to ensure laboratory resources targeting Advanced Manufacturing are maintained at an optimum level, while still maintaining the AMTech Program as part of NIST's comprehensive portfolio of programs addressing challenges in Advanced Manufacturing. The funding request continues to allow the AMTech program to more closely leverage the increased investment in Advanced Manufacturing at NIST, and ensure that the research focus of AMTech can still have a positive impact on industry in a reduced funding environment.

Priority Objectives for FY 2015:

Schedule and Milestones:

- In FY 2015 the number of planning awards ($500,000 or less) may be commensurate with or exceed the number of large ($1-5 million) implementation awards to established consortia for targeted research following their technology roadmap. Implementation awards will be allocated for a duration of three to five years each.

- In FY 2015 - FY 2018, NIST will support and continually monitor newly established research consortia to track outputs and progress. R&D outputs will be assessed for relevance to the long-term roadmaps created by the consortia at its inception. New awards will be made as funds become available.

Deliverables/Outputs:

- In FY 2015, each planning awardee is expected to produce a technology roadmap (or be on a short term track to complete) which reflects the needs of consortia members representing industry, small business, and other stakeholder groups.

- Recipients of larger implementation awards will be expected to report on R&D outputs, which potentially include metrics such as:

    - direct funding of research activities and support for graduate and post-doctoral researchers,
    - production of new scientific knowledge and pre-competitive technology,
    - attraction of industry and state funding for directed basic research,
    - attraction of state and venture funds to support commercialization, and
    - creation of new companies and jobs in high value-added sectors.

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Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Hollings manufacturing extension partnership
Sub-program: Hollings manufacturing extension partnership

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Program Activity		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Hollings manufacturing extension partnership	Pos./Approp	84	$123,030	81	$128,000	81	$128,676	81	$141,000	0	$12,324
	FTE/Obl.	74	117,915	82	139,865	82	128,676	82	141,000	0	12,324

BUDGET PROGRAM: Hollings Manufacturing Extension Partnership Program (MEP)

For FY 2015, NIST requests $141.0 million for the Hollings Manufacturing Extension Partnership Program (MEP). This funding includes an increase of $13.0 million.

PROGRAM JUSTIFICATION:

Hollings Manufacturing Extension Partnership Program (MEP) Overview

The Hollings Manufacturing Extension Partnership Program (MEP) is a Federal-state-industry partnership that provides U.S. manufacturers with access to technologies, resources, and industry experts. The MEP program consists of Manufacturing Extension Partnership Centers located across the country that work directly with their local manufacturing communities to strengthen the competitiveness of our Nation's domestic manufacturing base. Funding for the MEP Centers is a cost-sharing arrangement consisting of support from the Federal government, state and local government/entities, and fees charged to the manufacturing clients for services provided by the MEP Centers.

MEP's mission is to act as a strategic advisor to promote business growth and connect manufacturers to public and private resources essential for increased competitiveness and profitability. In doing so, MEP supports NIST's mission of promoting U.S. innovation and industrial competitiveness, while also advancing the goals of the U.S. Department of Commerce to maximize U.S. competitiveness and enable economic growth for U.S. industries, workers, and consumers.

A strong domestic manufacturing base is essential to supporting our Nation's middle class, our national security, and our economy. To continue to foster the economic resurgence, we need strong, innovative manufacturing businesses that are expanding markets and creating good jobs. With Centers in every state and in Puerto Rico, MEP is positioned to connect manufacturers with the opportunities being made available through Federal and state governments to invest in environmentally sustainable manufacturing practices, develop innovative products, and diversify into new markets. MEP Centers know their communities and understand their local manufacturing industries. Across the country, they serve as trusted advisors to their manufacturing clients and help them navigate economic and business challenges, capitalize on opportunities and develop pathways leading to profitable growth.

- In FY 2015 MEP will maintain its national network, continuing to serve as a resource for manufacturing and innovation by leveraging resources to couple cost reduction strategies with profitable client company growth through new product development, technology adoption, and market expansion. MEP will continue to expand efforts to help manufacturers develop innovative practices designed to create ideas for new products, processes and services necessary to grow business opportunities. MEP will leverage the knowledge, information and connections from across the MEP system of centers and partner organizations. MEP will continue to identify areas for future investment and expansion across the MEP network to support the diverse needs of U.S. manufacturers, including workforce development, technology transfer, and manufacturing scale-up. Technology acceleration, supplier development and environmental sustainability strategies represent the several current areas necessary to generate increased profit, create jobs, and bolster our Nation's long-term competitive position. MEP will work to support the tools, services and trained MEP Center field staff who are equipped to help firms innovate and create new sales, enter into new markets and adopt new technologies that build competitive advantage.

- The MEP program has a strong culture of partnership. At the state and local level, MEP Centers are often closely tied to state universities, community colleges, government economic development offices, as well as workforce development organizations. MEP Centers collaborate with third party resources and partner organizations to ensure clients receive the most effective advice and assistance. At the Federal level, MEP has ongoing partnerships with several agencies including the Department of Energy, the Environmental Protection Agency, Department of Transportation, Department of Defense, National Aeronautics and Space Administration, the Small Business Administration and the Department of Labor. Within the Department of Commerce, MEP works closely with the International Trade Administration, the Economic Development Administration and the U.S. Patent and Trademark Office.

Examples of Accomplishments:

Each year the program tracks the impact of the MEP system. The most recent data based on services provided in FY 2012 and FY 2013, have MEP clients reporting significant impacts, including:

• New Sales	$2.2 billion
• Retained Sales	$6.2 billion
• Cost Savings	$1.2 billion
• New Client Investment	$2.6 billion
• Jobs Created	18,789
• Jobs Retained	43,914

The MEP network continues to use and expand partnerships and connections to work with companies to stabilize operations, diversify their customers, and create new business plans for moving towards a stronger future – saving jobs and helping firms identify new strategies for innovation and growth. The MEP continues to play an important role in the Administration's efforts to strengthen U.S. manufacturing, as evidenced in the various advanced manufacturing and "Make it in America" initiatives.

Priority Objectives for FY 2015:

The broad reach and extensive manufacturing knowledge of the MEP network puts the program in the position to strategically disseminate and implement Federal level initiatives and priorities throughout the country. MEP's connection to local manufacturing communities is unique and far-reaching. MEP will work to further leverage its network of Centers to focus on innovation and export opportunities for manufacturers, connect U.S. manufacturers to new technologies and commercialization opportunities, and lay the foundation for a clean energy economy that would keep jobs in the U.S., strengthen national security, and revitalize American communities. Priorities in FY 2015 include:

- <u>Manufacturing Technology Acceleration Centers (M-TAC):</u> MEP will build upon the pilot M-TAC programs started in FY 2014 and use MEP's strategic guidance and performance measurement system to deploy these tools and techniques through the existing national network of Centers to address critical national needs in manufacturing among small and medium enterprises (SME's) including supply chain competitiveness.

- <u>Environmental Sustainability:</u> MEP will continue to support its partnership with the Department of Energy and the Environmental Protection Agency focused on implementing sustainable manufacturing business practices through the Economy, Energy, and Environment (E3) community activities that result from a partnership between five Federal agencies and the Green Supplier Network (GSN).

- Technology Acceleration and Deployment: MEP program's strategic focus on technology acceleration and technology scouting through universities and Federal labs enables MEP Centers to work with manufacturing firms to innovate and increase business opportunities to address new markets, develop new products and expand services. Identifying and accelerating technology development and deployment for and with manufacturing firms is a key element of MEP's innovation strategy.

- Export: Through partnership with the International Trade Administration, MEP will continue to work with manufacturers to help them expand into overseas markets. This addresses a high priority of the Administration's National Export Initiative.

- Partnerships: MEP will continue to identify partnership opportunities, at all levels of government, to leverage the Federal investment in support of the tools, services, and information needed by the manufacturing industry. Through these partnerships, MEP will continue to support the "Make it in America" activities by identifying manufacturers with current or future capabilities to address the procurement opportunities of the Federal government and original equipment manufacturers.

The MEP network has proved, through client reported impact metrics and long-standing Federal, state, and local partnerships, to be a valuable resource to America's manufacturers. As investments are being made in renewable energy, technology innovation, and export programs initiatives - investments in MEP programmatic resources will ensure that these initiatives reach the targeted manufacturing community and that these firms are connected with the opportunities at the Federal and state level. In a number of ways, investing in MEP increases the effectiveness of multiple Federal initiatives, programs, and investments.

PROGRAM CHANGES:

Hollings Manufacturing Extension Partnership Program (+$13.0 million and 0 FTE).

A strong manufacturing base is critical to the financial and national security of the U.S. Manufacturers are facing new and significant challenges. Technology and globalization have fundamentally changed many manufacturing companies and products. Manufacturing increasingly depends on access to customers and the infrastructure needed to support the constant reinvention of the manufacturers' products and processes. The challenge is clear: increasing global competition, coupled with the changing nature of innovation and exacerbated by the economic downturn of late, demands that the U.S. proactively support its domestic manufacturing base.

Sustaining and strengthening the U.S. manufacturing industry requires an efficient and progressive Federal role, partnering with state and local governments, to supply high-quality unbiased information, advice, and assistance that help firms respond to new challenges. For over 25 years, MEP has successfully provided services that reduce manufacturers' bottom-line expenses, increase efficiencies, and build capacity. Through strategies built upon core competencies, the MEP program works to provide services to support the diverse needs of the U.S. manufacturing industry.

Proposed Actions:

In FY 2013, MEP began a broad based strategic planning process and developed an operational reform agenda intended to optimize program effectiveness, enhance administrative efficiency, and provide greater financial accountability. In FY 2014 NIST management directed MEP to initiate a carefully planned, systematic, multi-year re-competition of the national system of Centers.

In support of these reforms, the Administration urges Congress to consider the potential benefits of adjusting the cost share requirement from the current 2:1 ratio of non-federal to federal funds, in order to provide greater flexibility and incentives to develop innovative tools, increase service to young, entrepreneurial and rural firms, and secure greater impact and accountability.

With an increase in its Federal resources, MEP will focus on providing targeted services to reach additional U.S. manufacturers and increase the impact on the nation's manufacturing sector. In FY 2014, MEP instituted a broad based strategic planning process and implemented operational reforms intended to optimize program effectiveness, enhance administrative efficiency, and provide greater financial accountability. In accord with policies implemented in FY 2014, MEP carefully scrutinizes all expenses to maximize the investments in MEP Center services to the manufacturing community. This includes holding Federal FTE's constant at the national program office and evaluating all third party program development activities.

Further, in accordance with recommendations provided in GAO's 2014 audit of MEP expenditures, in FY 2015, the MEP program will review cooperative agreement award amounts to take into account variations in the number of target manufacturing firms in a region, (as well as other factors), to ensure that Centers are adequately equipped and funded to address the needs of their manufacturing communities. This investment supports a robust MEP system that is positioned to:

- Provide additional manufacturers with the tools and services needed to respond to the rapid global change of technology and business systems advances to create opportunities for growth;
- Respond to manufacturers' workforce challenges;
- Accelerate the adoption of technologies into commercialized products;
- Improve manufacturers' competitive advantage through reduced environmental costs and impact;
- Help manufacturers build strong, stable businesses that provide good, middle class jobs; and
- Foster innovative partnerships with industry, academia, and local, state, and Federal governments that are focused on meeting the increased challenges facing U.S. manufacturers.

Statement of Need and Economic Benefits:

The MEP program generates a positive return on the Federal investment. MEP measures the impact of the system and the most recent data from clients receiving services between FY 2012 and FY 2013 demonstrate significant impacts, including:

- New Sales $2.2 billion
- Retained Sales $6.2 billion

•	Cost Savings	$1.2 billion
•	New Client Investment	$2.6 billion
•	Jobs Created	18,789
•	Jobs Retained	43,914

In FY 2015, MEP will continue to support the nationwide system of MEP Centers and build on the knowledge and technical services provided by the only Federal program uniquely designed to directly support the needs of U.S. manufacturers. The increased funding requested will allow MEP to build on the efforts started in FY 2014 to re-set the funding levels of the MEP centers.

The increased appropriation will also continue mission-appropriate MEP efforts to support national priorities such as the deployment of tools developed in FY 2014 by pilot programs that strengthen the MEP system's ability to help manufacturers to enhance domestic supply chain competitiveness and for workforce development activities.

With additional Federal resources, the MEP network could broaden its reach and increase the effectiveness of our MEP centers, creating stronger companies and more middle-class jobs. As national investments are being made in advanced manufacturing and technology transfer, an optimally funded network of MEP centers will ensure that these initiatives reach the manufacturing community and that businesses are connected with new technologies and market opportunities, also using innovative tools such as business-to-business (B2B) connectivity.

Performance Goals and Measurement Data:

Note: The targets listed below are only rough estimates for the incremental funding received. These represent new measures for MEP.

Performance Goal Performance Measure: Number of firms receiving in-depth technical assistance from MEP Centers	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	1,312	1,378	1,446	1,519	1,595
Without increase	0	0	0	0	0

Performance Goal Performance Measure: Percentage of MEP clients receiving in-depth technical assistance that increase their competitiveness	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	2%	2%	2%	1%	1%
Without increase	0	0	0	0	0

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Hollings Manufacturing Extension Partnership Program
Subprogram: Hollings Manufacturing Extension Partnership Program
Program Change: Hollings Manufacturing Extension Partnership Program

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$0	$7,179
11.3	Other than full-time permanent	0	518
11.5	Other personnel compensation	0	155
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	0	7,852
12	Civilian personnel benefits	0	2,302
13	Benefits for former personnel	0	1
21	Travel and transportation of persons	0	525
22	Transportation of things	0	9
23.1	Rental payments to GSA	0	7
23.2	Rental Payments to others	0	0
23.3	Communications, utilities and miscellaneous	64	806
24	Printing and reproduction	0	22
25.1	Advisory and assistance services	0	195
25.2	Other services	38	13,836
25.3	Purchases of goods & services from Gov't	9	346
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	0	0
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	7	167
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	7	284
31	Equipment	3	238
41	Grants, subsidies and contributions	12,872	114,410
44	Refunds	0	0
99	Total obligations	13,000	141,000

Department of Commerce
National Institute of Standards and Technology
Hollings Manufacturing Extension Partnership
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Department of Defense			
Subtotal, Department of Defense	0	0	0
Department of Energy	$124	0	0
Dept. of Homeland Security	15	0	0
Department of Transportation	142	$510	0
Environmental Protection Agency	2	0	0
Subtotal, Other Agency	283	510	0
Subtotal, Other Reimbursables	0	0	0
Total, Reimbursable Program	283	510	-
Subtotal, WCF transfer	0	0	0
Equipment Investments	20	27	13
IE Amortization	(9)	(12)	(13)
Total, WCF Investments	11	15	0
Total, Reimbursable Program and WCF Investments	294	525	0

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Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Manufacturing innovation institutes coordination
Sub-program: Manufacturing innovation institutes coordination

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Program Activity		Per- sonnel	Amount	Per- sonnel	Amount	Per- sonnel	Amount	Per- sonnel	Amount	Per- sonnel	Amount
Manufacturing innovation	Pos./Approp	0	0	0	0	0	0	5	$5,000	5	$5,000
institutes coordination	FTE/Obl.	0	0	0	0	0	0	4	5,000	4	5,000

BUDGET PROGRAM: Manufacturing Innovation Institutes Coordination (MIIC).

The Manufacturing Innovation Institutes Coordination program is newly proposed in FY 2015.

PROGRAM JUSTIFICATION:

The President's Budget request is $5 million in a new activity for coordination of manufacturing innovation institutes. The funds would coordinate the four institutes already launched and the five institutes that the Administration has committed to funding, led by the Department of Energy, Department of Defense, and Department of Agriculture. The efforts support the National Network for Manufacturing Innovation (NNMI) with up to 45 manufacturing innovation institutes across the Nation. *The purpose of the institutes is to create a place, or "industrial commons" led by U.S. industry to close the gap between early-stage research and development and the deployment of technology innovations by U.S. manufacturers.* With these resources NIST will provide coordination among the evolving network of institutes, enabling sharing of best practices, reduction of the development of redundant start-up operations, and strengthening cross-institute collaborations.

PROGRAM CHANGES:

Manufacturing Innovation Institutes Coordination (Base Funding: $0 million and 0 FTE; Program Change: +$5.0 million and +4 FTE).

NIST requests an increase of $5.0 million and 4 FTE for a total of $ 5.0 million to enable the design, establishment and coordination of a network of manufacturing institutes in the National Network of Manufacturing Innovation.

Proposed Actions: Design, establish, and coordinate network aspects of the manufacturing innovation institutes

The initiative is to provide coordination of the new manufacturing innovation institutes. The funds would support the President's proposed National Network for Manufacturing Innovation (NNMI) and the institutes that have been funded by federal partners such as the Department of Energy (DOE) and Department of Defense (DOD). In FY 2014, a network of four individual manufacturing innovation institutes was established by federal partners and the President announced an additional five institutes would be established. This action provides coordination and support for these and any additional institutes. The purpose of the institutes is to create a place, or "industrial commons," led by U.S. industry, to close the gap between early-stage research and development and the deployment of technology innovations by U.S. manufacturers. The coordination of the manufacturing innovation institutes and NNMI will be managed by the NIST Advanced Manufacturing Office (AMO), in collaboration with the Hollings Manufacturing Extension Partnership, pro-actively engaging with small and mid-sized manufacturers, enabling sharing of best practices, reduction of the development of redundant start-up operations and policies, and strengthening cross-institute collaborations.

Action 1: Convene senior management of existing manufacturing innovation institutes.

The management of the various institutes will be convened approximately quarterly for sharing of best practices and ideas on sustainability of the institutes after sun setting of federal support. The NIST AMO will facilitate discussions on start-up strategies, intellectual property practices, performance metrics, and other critical topics, with concepts developed in Action 2. Best practices recommended by the leadership of the institutes will be collected and annotated by the NIST AMO.

Action 2: Develop policy documents for use by the Institutes.

A number of broad policy guidance documents will be developed for use by the institutes. These documents will include guidance on intellectual property, qualifications for membership, metrics for institute performance, and workforce development, among others. These documents will be reviewed and modified periodically based on lessons learned as the institutes are stood up and learn most effective practices. Lessons learned from surveying practices in manufacturing innovation networks in competing industrialized countries will be used as input.

Action 3: Convene technical working groups in areas of technical overlap.

As multiple Institutes are stood up with a variety of technical focus areas, there will be benefits in identifying areas of technical overlap and areas of close complementary research. The NIST AMO will work with the management of the Institutes to identify both types of relationships, and propose areas where the Institutes would benefit by regular discussions and sharing of facilities, equipment, staff, and research results.

Statement of Need and Economic Benefits:

Numerous recent reports have documented how critical U.S. manufacturing is to innovation,[1] productivity,[2] jobs,[3] the economy,[4] exports,[5] ,[6] and national security.[7] Specific actions have been proposed designed to make our manufacturing sector more competitive and to encourage more investment in the United States. Together, these actions encompass sound tax policies, enforcement of trade laws, and investments in innovation, advanced technology, education, and infrastructure. The NNMI is designed to address the last four of these needs in a way that provides synergism between development of advanced manufacturing processes for broad industry sectors while providing an exquisite venue for both academic research and workforce training, as follows.

As a major initiative focused on strengthening the innovation performance, competitiveness, and job-creating power of U.S. manufacturing, the NNMI network will help to address a damaging inconsistency in U.S. economic and innovation policies. Unlike other industrialized countries, the Federal government does very little to address the high risk activity of taking fundamental discoveries and inventions and transforming them into manufacturable products. Underpinning this wealth-creating transformation to commercialization are new production processes that often are needed by entire industries, but usually are too risky for an individual company to develop alone.

[1] President's Council of Advisors on Science and Technology (2011), *Report to the President on Ensuring Leadership in Advanced Manufacturing.*
[2] Bureau of Labor Statistics (2012), *Industry Labor Productivity Trends from 2000 to 2010*
[3] Bureau of Labor Statistics, *2011 Employer Costs for Employee Compensation, Table 6.*
[4] Bureau of Economic Analysis, *2010 U.S. Economic Accounts by Industry*, see http://www.bea.gov/industry/index.htm.
[5] Bureau of Economic Analysis, *Industry-by-Industry Total Requirements Table*, see http://www.bea.gov/industry/iotables/prod/
[6] Bureau of Economic Analysis and Census, *U.S. International Trade in Goods and Services*
[7] The Case for a National Manufacturing Strategy, http://www2.itif.org/2011-national-manufacturing-strategy.pdf

The Federal investment in the National Network for Manufacturing Innovation (NNMI) serves to create an effective manufacturing research infrastructure for U.S. industry and academia to solve industry-relevant problems. The NNMI will consist of linked Institutes for Manufacturing Innovation with common goals, but unique concentrations. In an Institute, industry, academia, and government partners leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization.

As sustainable manufacturing innovation hubs, institutes will create, showcase, and deploy new capabilities, new products, and new processes that can impact commercial production. They will build workforce skills at all levels and enhance manufacturing capabilities in companies large and small. Institutes will draw together the best talents and capabilities from all the partners to build the proving grounds where innovations flourish and to help advance American domestic manufacturing.

For the most effective outcome of the investment in the NNMI, coordination among the Institutes is essential. NIST is ideally positioned to provide coordination, as host to the interagency Advanced Manufacturing National Program Office with participation from all the key agencies involved in advanced manufacturing.

Base Resources Assessment:

This initiative is new for FY 2015.

Schedule and Milestones:

Action 1: Convene senior management of existing manufacturing innovation institutes.

- Plan and convene meetings of the senior management of existing Institutes.
- Define topics and structure for agendas that maximize coordination and sharing of best practices.

Action 2: Develop policy documents for use by the Institutes.

- Work with relevant agencies to develop policy documents for intellectual property, performance metrics, intellectual property, qualifications for membership, metrics for institute performance, and workforce development approaches.
- Update policy documents based on successful practices of the Institutes.

Action 3: Convene technical working groups in areas of technical overlap.

- Identify areas of technical overlap and areas of close complementary research among Institutes.
- Work with the management of the Institutes to identify and propose areas where the Institutes would benefit by regular discussions and sharing of facilities, equipment, staff, and research results.

Deliverables:

- Convening of Institute managers for effective sharing of best practices

- Policy documents on intellectual property, performance metrics, intellectual property, qualifications for membership, metrics for institute performance, workforce development approaches, and other areas as needed.

- Updates of policy documents based on lessons learned within the institutes.

- Establishment of technical working groups to collaborate on areas of overlapping or complementary research.

- Meetings of technical working groups on common areas of interest.

Performance Goals and Measurement Data:

Performance Goal: **Performance Measure:** Meetings among Institute managers	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With increase	4	4	4	4	4
Without increase	0	0	0	0	0
Description: Number of meetings of senior management of Institutes for sharing of best practices					

Performance Goal: **Performance Measure:** Cross-Institute technical working groups	**FY 2015 Target**	**FY 2016 Target**	**FY 2017 Target**	**FY 2018 Target**	**FY 2019 Target**
With Increase	2	4	6	8	8
Without Increase	0	0	0	0	0
Description: Number of cross-institute technical working groups with active research activities.					

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amount in thousands)

Program: Manufacturing Innovation Institute Coordination.
Subprogram Manufacturing Innovation Institute Coordination
Program Change: Manufacturing Innovation Institute Coordination

Title:	Location	Grade	Number of Positions	Annual Salary	Total Salaries
Program Manager	Gaithersburg	ZP V	2	124,996	249,992
Assistant Program Manager	Gaithersburg	ZP V	1	124,996	124,996
Administrative Assistant	Gaithersburg	ZS IV	1	47,212	47,212
IT Specialist	Gaithersburg	ZS IV	1	106,263	106,263
					0
Total			5		528,463
less Lapse		25%	1		132,116
Total full-time permanent (FTE)			4		396,347
2015 Pay Adjustment (1%)					3,963
TOTAL					400,311

Personnel Data	Number
Full-Time Equivalent Employment	
Full-time permanent	4
Other than full-time permanent	0
Total	4
Authorized Positions:	
Full-time permanent	5
Other than full-time permanent	0
Total	5

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Program: Manufacturing Innovation Institute Coordination.
Subprogram Manufacturing Innovation Institute Coordination
Program Change: Manufacturing Innovation Institute Coordination

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	$400	$400
11.3	Other than full-time permanent	0	0
11.5	Other personnel compensation	0	0
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	400	400
12	Civilian personnel benefits	125	125
13	Benefits for former personnel	0	0
21	Travel and transportation of persons	50	50
22	Transportation of things	5	5
23.1	Rental payments to GSA	0	0
23.2	Rental Payments to others	0	0
23.3	Communications, utilities and miscellaneous charges	653	653
24	Printing and reproduction	5	5
25.1	Advisory and assistance services	0	0
25.2	Other services	2,448	2,448
25.3	Purchases of goods & services from Gov't accounts	1,108	1,108
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	0	0
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	112	112
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	65	65
31	Equipment	29	29
32	Lands and structures	0	0
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	0
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Direct obligations	5,000	5,000
	NIST Transfer to Working Capital Fund	0	0
	Total obligations	5,000	5,000

Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Baldrige performance excellence program
Sub-program: Baldrige performance excellence program

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Program Activity		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Baldrige performance	Pos./Approp	0	0	0	0	0	0	0	0	0	0
excellence program	FTE/Obl.	0	$9	0	$58	0	0	0	0	0	0

Department of Commerce
National Institute of Standards and Technology
Baldrige Performance Excellence Program
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Technical & Advisory Services	$36	$40	$50
Total, Reimbursable Program and WCF Investments	36	40	50

Object Class

Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
11	Personnel compensation					
11.1	Full-time permanent	$7,966	$7,825	$7,755	$8,079	$324
11.3	Other than full-time permanent	516	518	523	518	(5)
11.5	Other personnel compensation	173	155	155	155	0
11.9	Total personnel compensation	8,655	8,498	8,433	8,752	319
12.1	Civilian personnel benefits	2,523	2,497	2,629	2,579	(50)
13	Benefits for former personnel	1	1	1	1	0
21	Travel and transportation of persons	451	644	644	644	0
22	Transportation of things	9	12	12	17	5
23.1	Rental payments to GSA	5	7	7	7	0
23.2	Rental payments to others	0	0	0	0	0
23.3	Communications, utilities, and miscellaneous charges	772	2,635	2,352	3,304	952
24	Printing and reproduction	22	89	90	94	4
25.1	Advisory and assistance services	188	395	401	395	(6)
25.2	Other services	11,975	26,442	14,988	17,313	2,325
25.3	Purchases of goods and services from government accounts	360	623	602	1,715	1,113
25.5	Research and development contracts	0	327	229	226	(3)
25.7	Operation and maintenance of equipment	165	489	497	608	111
26	Supplies and materials	282	625	628	690	62
31	Equipment	244	335	330	358	28
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	96,694	122,337	111,875	124,297	12,422
99	Total Obligations	122,346	165,956	143,718	161,000	17,282

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
99	Total Obligations	122,346	165,956	143,718	161,000	17,282
	Less Prior Year Recoveries	(3,782)	(4,000)	0	0	0
	Less Prior Year Refunds	(99)	0	0	0	0
	Less Prior Year Unobligated Balance	(6,847)	(18,956)	0	0	0
	Plus Unobligated Balance End of Year	18,956	0	0	0	0
	Total Budget Authority	130,574	143,000	143,718	161,000	17,282
	Plus Transfer to BIS	3,000	0	0	0	0
	Appropriation	133,574	143,000	143,718	161,000	17,282

Personnel Data

Full-time equivalent employment:					
Full-time permanent	72	83	84	88	4
Other than full-time permanent	8	4	2	2	0
Total	80	87	86	90	4
Authorized Positions:					
Full-time permanent	81	80	80	85	5
Other than full-time permanent	5	5	5	5	0
Total	86	85	85	90	5

Exhibit 18

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 1 - 2014 Structure
(Dollar amounts in thousands)

Program/Sub-program	2015 Direct Obligations	Proposed Changes
Technology innovation program		No change
Technology innovation program	0	No change
Avanced manufacturing technology consortia		No change
Advanced manufacturing technology consortia	$15,000	No change
Hollings manufacturing extension partnership		No change
Hollings manufacturing extension partnership	141,000	No change
Manufacturing innovation institutes coordination		New program
Manufacturing innovation institutes coordination	5,000	New sub-program
Baldrige performance excellence program		No change
Baldrige performance excellence program	0	No change
Total ITS direct obligations	161,000	

NIST-221

Exhibit 19

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ACTIVITY/SUBACTIVITY CHANGE CROSSWALK
Part 2 - 2012 Structure
(Dollar amounts in thousands)

Program/Sub-program	2011	2012	2013	2014	2015
Technology innovation program					
Technology innovation program	$74,170	$4,373	$1,391	$6,520	0
Avanced manufacturing technology consortia					
Advanced manufacturing technology consortia	0	0	3,031	19,513	$15,000
Hollings manufacturing extension partnership					
Hollings manufacturing extension partnership	128,593	129,055	117,915	139,865	141,000
Manufacturing innovation institutes coordination					
Manufacturing innovation institutes coordination	0	0	0	0	5,000
Baldrige performance excellence program					
Baldrige performance excellence program	8,558	2,061	9	58	0
Total ITS Direct Obligations	211,321	135,489	122,346	165,956	161,000

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For necessary expenses of the Industrial Technology Services appropriation of the National Institute of Standards and Technology,

15 U.S.C. 271 et seq.
15 U.S.C. 272(b)(1) and (b)(4)
15 U.S.C. 278b
15 U.S.C. 278k
15 U.S.C. 278l
15 U.S.C. 278n
15 U.S.C. 7506(a)(2)

15 U.S.C. 271 et seq. provides NIST's organic authorities.

15 U.S.C. 272(b)(1) authorizes the Secretary, through the Director of NIST, to assist industry in the development of technology and procedures needed to improve quality, to modernize manufacturing processes, to ensure product reliability, manufacturability, functionality, and cost-effectiveness, and to facilitate more rapid commercialization, especially by small- and medium-sized companies throughout the United States, of products based on new scientific discoveries in fields such as automation, electronics, advanced materials, biotechnology, and optical technologies.

15 U.S.C. 272(b)(4) authorizes the Secretary, through the Director of NIST, to enter into contracts, including cooperative research and development arrangements and grants and cooperative agreements, in furtherance of the purposes of the NIST Act.

15 U.S.C. 278b provides for a Working Capital Fund to support NIST activities.

15 U.S.C. 278k directs the Secretary, through the Director of NIST, to provide assistance for the creation of Regional Centers for the Transfer of Manufacturing Technology.

15 U.S.C. 278l provides authority for technical assistance to State technology programs.

15 U.S.C. 278n established the Advanced Technology Program within NIST to assist U.S. businesses in applying generic technology and research results to commercialize scientific discoveries and refine manufacturing technologies. Public Law 110-69 signed on August 9, 2007 has now abolished the Advanced Technology Program (ATP).

15 U.S.C. 7506(a)(2) instructs the NIST Director to utilize the Manufacturing Extension Partnership program to the extent possible to ensure that basic research on issues related to the development and manufacture of nanotechnology, including metrology; reliability and quality assurance; processes control; and manufacturing best practices reaches small- and medium-sized manufacturing companies.

2. $141,000,000, is provided for the Hollings Manufacturing Extension Partnership to remain available until expended.

   $15,000,000 is provided for the Advanced Manufacturing Technology Consortia Program to remain available until expended.

   $5,000,000 is provided for Manufacturing Innovation Institutes Coordination to remain available until expended.

3. Public Law 110-69, America Competes Act, 121 Stat 572, enacted August 9, 2007 reauthorized the Industrial Technology Services appropriation through 2010. In addition, it eliminated the Advanced Technology Program (ATP) and established the Technology Innovation Program (TIP) which provides grants to eligible companies or joint ventures whose proposed technology has strong potential to address critical national needs. It also amended 15 U.S.C. 3711 by changing the name of the National Medal of Technology from "Technology Medal" to "Technology and Innovation Medal".

Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, enacted January 4, 2011 reauthorized the Industrial Technology Services appropriation through 2013 to include the Manufacturing Extension Partnership Program (MEP) and the Malcolm Baldrige National Quality Award program. In addition, authorization is provided for an Innovative Services Initiative to assist small and medium-sized manufacturers within the MEP program.

Public Law 112-55, Consolidated and Further Continuing Appropriations Act, 2012, 125 Stat 552, enacted November 18, 2011 did not contain funding for the Technology Innovation Program (TIP) and the Baldrige Performance Excellence Program (BPEP).

Department of Commerce
National Institute of Standards and Technology
Industrial Technology Services
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2013 Actual	FY 2014 Estimate	FY 2015 Estimate
Management and professional support services	$188	$195	$75
Studies, analyses, and evaluations	0	200	0
Engineering and technical services	0	0	0
Total	188	395	75

Significant Activities

Advisory and assistance services funded by the Industrial Technology Services appropriation are used to conduct evaluations of the programmatic outcomes, service delivery efficiency, and internal infrastructure requirements of the Hollings MEP Program.

Need for Advisory and Assistance Services:

The need for advisory and assistance services stems from the role of NIST's extramural programs with its outside partners and small businesses to relate to the private sector, professional organizations, and the public sector. Inputs must be obtained from consultants who can bring their individual expertise to bear and help NIST in assessing its program plans to meet the needs of its customers. The alternative to utilizing these services is to make no attempt to have expertise from sources outside NIST and risk having a poorer working and professional relationship with those in the business of using the products and services offered by NIST. These services provide for economic assessment and external evaluation of NIST's extramural programs.

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Construction of
Research Facilities

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations	Appro-priation
2014 Enacted	76	76	$56,000	$73,527	$56,000
less: Unobligated balance from prior year	0	0	0	(17,527)	0
2015 Adjustments to base:					
plus: Uncontrollable cost changes	0	0	684	684	684
2015 Base Request	76	76	56,684	56,684	56,684
2015 Program changes	0	0	3,000	3,000	3,000
Inflationary adjustment	0	0	(684)	(684)	(684)
2015 Estimate	76	76	59,000	59,000	59,000

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
Comparison by program/sub-program:		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Construction and major renovations											
Construction and major	Pos/Approp	89	$55,970	76	$56,000	76	$56,684	76	$59,000	0	$2,316
renovations	FTE/Obl.	66	73,825	76	73,527	76	56,684	76	59,000	0	2,316
Adjustments for:											
Prior year recoveries			(941)		0		0		0		0
Unobligated balance, start of year			(34,441)		(17,527)		0		0		0
Unobligated balance, end of year			17,527		0		0		0		0
Appropriation			55,970		56,000		56,684		59,000		2,316

Exhibit 6

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM AND PERFORMANCE: REIMBURSABLE OBLIGATIONS
(Dollar amounts in thousands)

Comparison by program/sub-program:		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		Increase/ (Decrease) Over 2015 Base	
		Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount	Per-sonnel	Amount
Construction and major renovations											
Safety, Capacity, Maintenance and Major Repairs	Pos./BA	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	$1,171	0	$1,371	0	0	0	0	0	0

Exhibit 7

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Total Obligations	$74,996	$74,898	$56,684	$59,000	$2,316
Financing:					
Offsetting collections from:					
Federal funds	0	0	0	0	0
Non-Federal sources	(1,371)	0	0	0	0
Total offsetting collections	(1,371)	0	0	0	0
Adjustments for:					
Prior year recoveries (Direct)	(941)	0	0	0	0
Unobligated balance, start of year (Direct)	(34,441)	(17,527)	0	0	0
Unobligated balance, start of year (Reimbursable)	(1,171)	(1,371)	0	0	0
Unobligated balance, end of year (Direct)	17,527	0	0	0	0
Unobligated balance, end of year (Reimbursable)	1,371	0	0	0	0
Budget Authority	55,970	56,000	56,684	59,000	2,316
Financing:					
Transfer to other accounts	0	0	0	0	0
Transfer from other accounts	0	0	0	0	0
Appropriation	55,970	56,000	56,684	59,000	2,316

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Exhibit 9

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
JUSTIFICATION OF ADJUSTMENTS TO BASE
(Dollar amounts in thousands)

		FTE	Amount
Other Changes:			
Annualization of 2014 pay raise		0	30

A pay raise of 1 percent is assumed to be effective January 1, 2014.

Total cost in FY 2015 of 2014 pay raise	$ 120,000
Less amount requested in FY 2014	(90,000)
Less amount absorbed in FY 2014	0
Amount requested in 2015 to provide full-year cost of 2014 pay raise	30,000

		FTE	Amount
2015 Pay increase and related costs		0	60

A general pay raise of 1.049 percent is assumed to be effective January 1, 2015.

Total cost in FY 2015 of pay increase	$60,000
Less amount absorbed in FY 2015	0
Amount requested for FY 2015 pay increase	60,000
Payment to Departmental Management Working Capital Fund	0
Total adjustment for FY 2015 pay increase	60,000

Personnel benefits		0	114

Civil Service Retirement System (CSRS)	($9)
Federal Employees' Retirement System (FERS)	91
Thrift Savings Plan (TSP)	8
Federal Insurance Contribution Act (FICA) - OASDI	8
Health Insurance	16

Civil Service Retirement System (-$9,000) – The number of employees covered by the Civil Service Retirement System (CSRS) continues to drop as positions become vacant and are filled by employees who are covered by the Federal Employees Retirement System (FERS). The estimated percentage of payroll for employees covered by CSRS will decrease from 7 percent in FY 2014 to 5.0 percent in FY 2015. The contribution rate will remain at 7.0 percent in FY 2015.

Payroll subject to retirement systems ($6,204,566)	
Cost of CSRS contributions in FY 2015 ($6,204,566 x .050 x .07)	$21,716
Cost of CSRS contributions in FY 2014 ($6,204,566 x .070 x .07)	30,402
Total adjustment to base	(8,686)

Federal Employees' Retirement System ($91,000) – The number of employees covered by FERS continues to rise as employees covered by CSRS leave and are replaced by employees covered by FERS. The estimated percentage of payroll for employees covered by FERS will increase from 93 percent in FY 2014 to 95.0 percent FY 2015. On October 1, 2013, the Board of Actuaries of the FERS retirement system recommended changes to long term economic and demographic assumptions changing the contribution rate. As transmitted to agencies by OMB, plans are increased by 1.3 percentage points from 11.9 percent of pay to 13.2 percent.

Payroll subject to retirement systems ($6,204,566)	
Basic benefit cost in FY 2015 ($6,204,566 x .950 x .132)	$778,053
Basic benefit cost in FY 2014 ($6,204,566 x .930 x .119)	686,659
Total adjustment to base	91,394

Thrift Savings Plan ($8,000) – The cost of agency contributions to the Thrift Savings Plan will also rise as FERS participation increases. The contribution rate increased from 4.57 percent in FY 2014 to 4.61 percent in FY 2015.

Thrift plan cost in FY 2015 ($6,204,566 x .950 x .0461)	$271,729
Thrift plan cost in FY 2014 ($6,204,566 x .930 x .0457)	263,700
Total adjustment to base	8,029

Federal Insurance Contributions Act (FICA) - OASDI ($8,000) – As the percentage of payroll covered by FERS increases, the cost of OASDI contributions will increase. In FY 2015, the maximum salary subject to OASDI tax will remain at $119,100 in FY 2015. The OASDI tax rate for employers will remain at 6.2 percent in FY 2015.

FERS payroll subject to FICA tax in 2015 ($6,204,566 x .950 x .904 x .062)	$330,366
FERS payroll subject to FICA tax in 2014 ($6,204,566 x .930 x .903 x .062)	323,053
Increase (FY 2014-FY 2015)	7,313
OTP payroll subject to FICA tax in FY 2015 ($166,434 x .950 x .904 x .062)	8,862
OTP payroll subject to FICA tax in FY 2014 ($166,434 x .930 x .903 x .062)	8,666
Increase (FY 2014-FY 2015)	196
Total adjustment to base	7,509

Health insurance ($16,000) – Effective January 2013, NIST's contribution to Federal employees' health insurance premiums increased by 3.6 percent. Applied against the FY 2014 estimate of $443,000, the additional amount required is $15,948.

General pricing level adjustment	0	480

This request applies the OMB economic assumptions of 1.4 percent for FY 2015 where the prices that the government pays are established through the market system. Factors are applied to sub-object classes that result in the following adjustments to base: communications, utilities, and miscellaneous $2,548; other services $448,196; supplies and materials $24,752; and equipment $4,046.

Subtotal, Other changes	0	684
Total Adjustments to base	0	684

Exhibit 10

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
PROGRAM AND PERFORMANCE: DIRECT OBLIGATIONS
(Dollar amounts in thousands)

Program: Construction and major renovations
Sub-program: Construction and major renovations

		2013 Actual		2014 Enacted		2015 Base		2015 Estimate		(Increase/ Decrease) Over 2015 Base	
Program Activity		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
Construction and major renovations	Pos/Approp	7	$11,800	0	$11,800	0	$11,800	0	$14,800	0	$3,000
	FTE/Obl.	5	23,547	0	16,255	0	11,800	0	14,800	0	3,000
Safety, Capacity, Maintenance and Major Repairs	Pos/Approp	81	44,170	76	44,200	76	44,884	76	44,200	0	(684)
	FTE/Obl.	60	50,020	76	55,068	76	44,884	76	44,200	0	(684)
External Projects	Pos/Approp	1	0	0	0	0	0	0	0	0	0
	FTE/Obl.	1	258	0	2,204	0	0	0	0	0	0
Total	Pos/Approp	89	55,970	76	56,000	76	56,684	76	59,000	0	2,316
	FTE/Obl.	66	73,825	76	73,527	76	56,684	76	59,000	0	2,316

APPROPRIATION ACCOUNT: CONSTRUCTION OF RESEARCH FACILITIES (CRF)

BUDGET PROGRAM: CONSTRUCTION AND MAJOR RENOVATIONS

For FY 2015, NIST requests a total of $59.0 million and 76 FTE for Construction and Major Renovations. This funding includes an increase of $3.0 million and 0 FTE.

BASE JUSTIFICATION:

CRF Overview

The CRF program funds new construction and renovation of NIST facilities.

Specifically, the Safety, Capacity, Maintenance, and Major Repairs (SCMMR) program funds the maintenance, repair, improvements, and construction of facilities occupied or used by NIST in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii to meet current and future measurement and research needs for the Nation.

Aging and deteriorating buildings and infrastructure threaten NIST's ability to meet its mission. Failure to properly maintain, repair, improve, and construct facilities used by NIST will cause reductions in measurement capabilities, impairing NIST's ability to meet its measurement and standards missions, and thus reducing U.S. innovation and industrial competitiveness. Other negative impacts include possible damage to staff and visitor safety and health, and reductions in staff productivity.

State-of-the-art facilities are essential to the capabilities of NIST's laboratories. NIST measurement capabilities must be maintained at the highest levels of precision and accuracy to meet the increasingly stringent needs of their users. Also, facilities must be compliant with various health and safety regulations. Other major considerations for facilities are to increase the capacity of facilities, to improve access for people with disabilities, and to safeguard the utility infrastructure of existing buildings.

NIST prioritizes its efforts to improve and upgrade its facilities to address its highest priority SCMMR projects. If major facilities-related emergency situations arise, previously planned facilities work is reprioritized as appropriate.

SIGNIFICANT ADJUSTMENTS-TO-BASE (ATBs):

NIST will fund $684,000 and 0 FTEs in inflationary adjustments to current programs for CRF activities. This includes the estimated 2015 Federal pay raise of one percent and inflationary increases for non-labor activities, including service contracts and utilities.

SUB-PROGRAM: SCMMR

The objectives of the SCMMR sub-program are to:

- continue the repair and upgrade of facilities that have a high impact on staff and visitor safety;
- continue abatement of hazardous materials from site buildings and structures;

- continue facilities modifications to comply with the Access to Federal Buildings Act and the Americans with Disabilities Act;

- continue repairs/replacements of utility systems, exhaust and air filtration systems, mechanical-electrical systems, and site alarm fire safety systems that are failing at an accelerated rate because they are over 40 to 50 years old;

- continue site infrastructure upgrades and repairs, to include roads, loading docks, pedestrian walk areas, and storm water drainage;

- enable or maintain building environmental conditions required for meeting scientific requirements;

- continue to reduce the backlog of deferred maintenance projects; and

- intensify targeted energy conservation, water efficiency, and building system upgrades to facilitate meeting sustainability requirements stipulated in Executive Orders 13423 and 13514.

PROGRAM CHANGES:

1. Building 1 Renovation Decrease (-$11.8 million, -0 FTE):

NIST requests a decrease in the amount of $11.8 million to reflect the completion of the Building 1 renovations accomplished with funding received in fiscal year 2014.

PROGRAM CHANGE PERSONNEL DETAIL
(Dollars in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Building 1 Renovation Decrease

No change in FTE is required.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Building 1 Renovation Decrease

	Object Class	FY 2015 Decrease	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	0	$6,217
11.3	Other than full-time permanent	0	0
11.5	Other personnel compensation	0	154
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	0	6,371
12	Civilian personnel benefits	0	1,881
13	Benefits for former personnel	0	4
21	Travel and transportation of persons	0	29
22	Transportation of things	0	13
23.1	Rental payments to GSA	0	3
23.2	Rental Payments to others	0	0
23.3	Communications, utilities and miscellaneous charges	0	1,880
24	Printing and reproduction	0	7
25.1	Advisory and assistance services	0	5
25.2	Other services	0	35,175
25.3	Purchases of goods & services from Gov't accounts	0	156
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	0	0
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	0	417
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	0	1,776
31	Equipment	0	293
32	Lands and structures	($11,800)	10,990
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	0
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	(11,800)	59,000

2. Building 1 Renovation Increase (+$11.1 million, +0 FTE):

NIST requests an increase of $11.1 million to move forward with the next phase of the multi-year interior renovations of Boulder's Building 1. The increase will fund the first phase of the interior and exterior renovation of Wing 4. The remaining renovations will be completed with future funding requests.

The FY 2014 appropriation funded $7.9 million to complete the renovations in Wings 3 and 6 and the balance of the funding, $3.9 million, will be used to construct swing space for the programs located in Wing 4.

The FY 2015 funding for Wing 4 will be used to complete the seismic reinforcement that is interior and exterior to the wing. Remediation of the hazardous materials will also be completed along with the construction of a new building envelope and service galley. Utilities, which include chilled water, steam, and compressed air, will be connected to the site utility distribution system.

Statement of Need and Economic Benefits – Cost Benefit Analysis

Aging laboratory facilities at NIST Boulder substantially hinder NIST's mission of fostering innovation and ensuring U.S. competitiveness. Scientific work at the NIST Boulder laboratories supports national priorities such as energy, environment, manufacturing, health care, physical infrastructure, information technology, and many other areas. However, this work is significantly impaired by aging facilities that cannot provide the control of temperature, vibration, humidity, and air cleanliness required for world-leading research and measurement to support 21st century innovation and competitiveness. The 60-year-old facilities cause a productivity loss of at least 20 percent[1], and prevent NIST from performing the most demanding measurement research needed by industry and the scientific community. Even for the limited range of work that can be attempted, current laboratory conditions create significant inefficiencies, and the aging facility systems present safety concerns. In terms of lost productivity, many measurements can only be conducted sporadically when environmental conditions are temporarily stable and much experimental data and construction of nanoscale devices becomes worthless because of corruption due to poor laboratory conditions. The types of high precision research and measurement planned for the future will not be possible without the planned facility upgrades.

The successful improvement of the NIST Boulder facilities – through construction of the Precision Measurement Facility (PML) and the extensive renovation of parts of the existing facilities – will enable NIST to support scientific discovery and technical development of transformational technology in homeland security, telecommunications, nanotechnology, precision timing, hydrogen energy sources, precision electrical standards, biotechnology, applications of lasers, electromagnetic interference testing, quantum computing and quantum communications, and other national needs.

The Building 1 Renovation (B1R) in Boulder is a phased project to modernize this 60-year-old facility that is no longer meeting the needs of the research community. The facility houses approximately 70 percent of NIST laboratory space in Boulder, most of which is below Level 1 (L1) performance level. The Facility Condition Index for the building rates as poor. Therefore, upgrades are essential to provide Level 1 (L1) through Level 3 (L3) General Laboratory performance requirements necessary for the 21st century research and measurement supporting U.S. innovation and economic security. The project is the continuation

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[1] *NIST Boulder Facilities Review Team, Report on NIST Boulder Laboratory Facilities: Findings and Recommendations on Possible Renovation of Existing Facilities and Possible Construction of New Laboratory Facilities, January 31, 2006.*

of the long-range revitalization plan for the NIST laboratories at Boulder following the completion of construction of the high-performance (L4) PML.

The B1R renovation project will address the deterioration of this critical building by accomplishing specific SCMMR-type improvements. In planning for the B1R, NIST identified infrastructure projects related to air cleanliness, temperature, vibration and humidity control, plumbing systems, electrical distribution, and life safety systems. Examples of areas affected by those facility conditions include research to enable next generation optical atomic clocks for improved timekeeping, advanced spectroscopies for non-invasive medical diagnostics and chemical detection, and development of "NIST-on-a-chip" technologies to bring ultraprecise NIST measurements into end user applications. Failures and poor performance of the building infrastructure severely impact this research in these critical technologies. Much of the research completed in Wings 3, 4, 5, 6, and Spine is not scheduled to relocate to the PML. Therefore, renovation of Wings 3, 4, 5, 6 and Spine is crucial to the science described above. The Building 1 Renovation will provide the necessary infrastructure and environmental performance necessary to sustain these services in Building 1. Finally, the identified renovations will reduce the backlog of maintenance, repair and replacement issues identified in the 2008 Boulder Facility Condition Assessment by an estimated $15.3 million or almost 60 percent for Building 1.

Base Resources Assessment

There are no base resources associated with the Construction and Major Renovations program. Funding is requested each year for useable segments of the renovation or construction project.

Schedule and Milestones:

- FY 2015 – Award the next phase of renovation at Building 1, for the first construction phase of the interior and exterior renovation of Building 1, Wing 4.

Deliverables:

- FY 2015 – Award a construction contract for the first construction phase of the interior and exterior renovations at Building 1, Wing 4.

Performance Goals and Measurement Data:

Performance Goal: Percent of Renovations Complete	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
With Change	10% completion of the first construction phase of Wing 4; 100% completion of Wing 4 swing space and A/E design; 100% completion of Wing 3 interiors renovation; 100% completion of Wing 6 interiors renovation	100% completion of the first construction phase of Wing 4	N/A	N/A	N/A

Performance Goal: Percent of Renovations Complete	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target	FY 2019 Target
Without Change	100% completion of Wing 4 swing space and A/E design; 100% completion of Wing 3 interiors renovation; 100% completion of Wing 6 interiors renovation	N/A	N/A	N/A	N/A
Description: With funding received in FY 2015, NIST can complete portions of the renovations to Building 1. Building 1 Renovations are planned as severable phases to the multi-wing building.					

Multi-Year Budget Information ($ in thousands)

Major Cost Categories	FY 2014 and Prior	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Building 1 Renovation Design and Renovation of Building 3	12,000					
Exterior Renovations	14,876					
Wing 3 Interior Renovation	15,000					
Wing 6 Interior Renovation	15,700					
Wing 4 Interior and Exterior Renovation	3,900	11,100	12,000			
*Total:	61,476	11,100	12,000			
FTE's (Initiative)	0	0	0			

* *The remaining wing renovations will be completed with future funding requests.*

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amounts in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Building 1 Renovation Increase

Existing staff will be used to manage the Building 1 Renovation project and therefore no new FTE are required for this initiative.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Building 1 Renovation Increase

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	0	$6,217
11.3	Other than full-time permanent	0	0
11.5	Other personnel compensation	0	154
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	0	6,371
12	Civilian personnel benefits	0	1,881
13	Benefits for former personnel	0	4
21	Travel and transportation of persons	0	29
22	Transportation of things	0	13
23.1	Rental payments to GSA	0	3
23.2	Rental Payments to others	0	0
23.3	Communications, utilities and miscellaneous charges	$55	1,880
24	Printing and reproduction	0	7
25.1	Advisory and assistance services	0	5
25.2	Other services	32	35,175
25.3	Purchases of goods & services from Gov't accounts	8	156
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	0	0
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	6	417
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	6	1,776
31	Equipment	3	293
32	Lands and structures	10,990	10,990
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	0
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	11,100	59,000

3. Radiation Physics Building 245 Modernization (+$3.7 million +0 FTE):

NIST requests an increase of $3.7 million to begin efforts to improve the condition of the Radiation Physics Building 245 on the NIST Gaithersburg site to meet the research requirements of its occupants and their stakeholders. The FY 2015 funding provides for the initiation of planning, programming, acquisition and concept development, of the preferred option upon identification and approval during the Department's Scalable Acquisition Project Management Framework Project Definition Phase.

The Radiation Physics Building 245 Modernization Project is necessary to ensure that NIST's radiation physics measurements and research is not compromised due to the condition of the facility or the inadequate or inappropriate space in which the research is conducted. Built in 1964, Building 245 is a highly specialized facility with concrete shield walls nearly 10 feet thick and large subterranean program areas located in the basement and subbasement levels for radiation physics measurements and research. The building is 208,000 gross square feet and was the first research facility built on the NIST Gaithersburg site. A recent study was conducted that identified numerous architectural, mechanical, plumbing, electrical and life safety/fire code deficiencies. Many of the building's infrastructure systems are beyond their useful life and will need to be replaced over the course of the next 5 to 20 years. The aged facility, with its obsolete infrastructure systems, can no longer adequately support the environmental requirements of the twenty-first century research program housed within it. Current calibration services are jeopardized, efficiency of ongoing research is significantly impacted, and the ability to expand into new areas of research within the nuclear medicine program and for homeland security applications are constrained due to poor environmental conditions and lack of appropriate laboratory space. There is also a potential for loss of customers and a resulting loss of revenue.

A modernization of Building 245 is needed to strengthen and expand NIST's research capabilities as well as provide increased support to critical stakeholders and customers. All of the Radiation Physics programs are currently compromised by the conditions within the existing facility. For example, the nuclear medicine program is unable to expand into any new areas of research such as positron emission tomography and magnetic resonance (PET/MR) or metrology for radiolabeled biomarkers. New equipment is more precise and requires much tighter tolerances in environmental conditions for proper operations. NIST Radiation Physics develops, maintains and disseminates measurement standards for electromagnetic radiation and radioactivity in the United States. NIST also provides user facilities for radiometry measurements and calibration services and transfer standards for electromagnetic radiation. Research is ongoing to pursue advances in many aspects of metrology including those related to nuclear medicine, environmental radioactivity, medical imaging, advanced manufacturing, homeland security, and regulatory requirements for environmental stewardship. The stakeholders and customers include: the Department of Homeland Security (DHS); the National Aeronautics and Space Administration (NASA); the Defense Advanced Research Projects Agency (DARPA); the National Oceanic and Atmospheric Agency (NOAA); the American National Standards Industry (ANSI); and clients in the semiconductor industry and in the fields of medical imaging and nuclear medicine.

NIST believes that the risks and opportunities of pursuing this initiative are more beneficial for the Department than the risks and opportunities of not pursuing the initiative. The risks of not proceeding with the modernization or replacement of Building 245 include: the inability to provide calibration services; the inability to develop test methods and validation of standards for radiation detection equipment as required by the Department of Homeland Security (Safe Port Act); increased sample degradation/contamination and research inefficiencies; inability to provide mandated measurement and calibration services to NASA, NOAA and other Federal Agencies; and potential failure of building equipment and systems. The risks of pursuing the initiative are those inherent to any major construction or renovation project, including: project funding not made available in coordination with the project plan and the potential disruption to the research programs. The benefit, or necessity, of pursuing the project significantly outweighs the overall risk.

The Building 245 NIST Project Team and Integrated Product Team (IPT) has identified and reviewed potential risks at a level appropriate for the Department's Scalable Acquisition Project Management Framework Conceptual Phase. The Department's Enterprise Risk Management Framework was used to assign severity and likelihood to the risks. This data was presented and approved in the Initial Risk Report document for the Conceptual Phase.

Statement of Need and Economic Benefits – Cost Benefit Analysis

A cost/benefit analysis will be performed during the development of the next phase, which is the Project Definition Phase of the Scalable Acquisition Project Management Framework.

Base Resources Assessment:

There are no base resources associated with the Construction and Major Renovations program. Funding is requested each year for useable segments of the renovation or construction project.

Schedule and Milestones:

Preliminary Project Timeline

- May 29, 2013 – Deputy Secretary of Commerce approval of the Scalable Acquisition Project Management Framework Conceptual Phase and Milestone 1.
- Summer 2014 – Completion of the Feasibility Study and Scalable Acquisition Project Management Framework Project Definition Phase documents.
- Summer 2014 – Completion of the Scalable Acquisition Project Management Framework Project Definition Phase Milestone 2 approval.
- FY 2015 – Planning and programming efforts predicated upon funding for design in the FY 2015 and FY 2016 budget.
- FY 2017 – Begin construction phase (modernization would necessitate construction in several phases).

Deliverables:

- FY 2015 - Award an architectural and engineering contract for planning and programming.

Additional deliverables will be defined during the Scalable Acquisition Project Management Framework Project Definition Phase as the analysis of alternatives and concept of operations are developed. More detail will become available once a preferred alternative is selected and as the Project Management Plan is developed.

Performance Goals and Measurement Data:

Performance Goals will be defined during the Scalable Acquisition Project Management Project Execution Phase for the preferred alternative selected during the Project Definition Phase to ensure that contract work meets specifications and that the mission need is being addressed. Measurement data will be monitored during the Project Execution Phase and thereafter.

Multi-Year Budget Information ($ in thousands)

Major Cost Categories	FY 2014 and Prior	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019
Design	0	3,700	TBD	TBD	TBD	TBD
Construction	0	0	0	TBD	TBD	TBD
*Total:	0	3,700	TBD	TBD	TBD	TBD
FTE's (Initiative)	0	0	0	0	0	0

** Out year costs will be determined once the preferred alternative is identified and approved as part of the Scalable Acquisition Project Management Framework Project Definition Phase.*

PROGRAM CHANGE PERSONNEL DETAIL
(Dollar amounts in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Radiation Physics Building 245 Modernization

Existing staff will be used to manage the Radiation Physics Building 245 Modernization project and therefore no new FTE are required for this initiative.

PROGRAM CHANGE DETAIL BY OBJECT CLASS
(Dollar amounts in thousands)

Budget Program: Construction and Major Renovations
Sub-program: Construction and Major Renovations
Program Change: Radiation Physics Building 245 Modernization

	Object Class	FY 2015 Increase	FY 2015 Total Program
11	Personnel compensation		
11.1	Full-time permanent	0	$6,217
11.3	Other than full-time permanent	0	0
11.5	Other personnel compensation	0	154
11.8	Special personnel services payments	0	0
11.9	Total personnel compensation	0	6,371
12	Civilian personnel benefits	0	1,881
13	Benefits for former personnel	0	4
21	Travel and transportation of persons	0	29
22	Transportation of things	0	13
23.1	Rental payments to GSA	0	3
23.2	Rental Payments to others	0	0
23.3	Communications, utilities and miscellaneous charges	$18	1,880
24	Printing and reproduction	0	7
25.1	Advisory and assistance services	0	5
25.2	Other services	3,674	35,175
25.3	Purchases of goods & services from Gov't accounts	3	156
25.4	Operation and maintenance of facilities	0	0
25.5	Research and development contracts	0	0
25.6	Medical care	0	0
25.7	Operation and maintenance of equipment	2	417
25.8	Subsistence and support of persons	0	0
26	Supplies and materials	2	1,776
31	Equipment	1	293
32	Lands and structures	0	10,990
33	Investments and loans	0	0
41	Grants, subsidies and contributions	0	0
42	Insurance claims and indemnities	0	0
43	Interest and dividends	0	0
44	Refunds	0	0
99	Total obligations	3,700	59,000

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Object Class

Exhibit 16

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
SUMMARY OF REQUIREMENTS BY OBJECT CLASS

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
11	Personnel compensation					
11.1	Full-time permanent	$6,207	$6,217	$6,288	$6,217	($71)
11.3	Other than full-time permanent	0	0	0	0	0
11.5	Other personnel compensation	154	154	154	154	0
11.9	Total personnel compensation	6,361	6,371	6,442	6,371	(71)
12.1	Civilian personnel benefits	1,861	1,881	2,014	1,881	(133)
13	Benefits for former personnel	4	4	4	4	0
21	Travel and transportation of persons	9	29	29	29	0
22	Transportation of things	13	13	13	13	0
23.1	Rental payments to GSA	3	3	3	3	0
23.2	Rental payments to others	0	0	0	0	0
23.3	Communications, utilities, and miscellaneous charges	1,807	1,807	1,809	1,880	71
24	Printing and reproduction	7	7	7	7	0
25.1	Advisory and assistance services	5	5	5	5	0
25.2	Other services	38,514	44,079	31,909	35,175	3,266
25.3	Purchases of goods and services from government accounts	145	145	147	156	9
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	409	409	415	417	2
26	Supplies and materials	1,768	1,768	1,793	1,776	(17)
31	Equipment	289	289	294	293	(1)
32	Land and structures	22,629	16,198	11,800	10,990	(810)
41	Grants, subsidies, and contributions	0	519	0	0	0
43	Interest and dividends	1	0	0	0	0
99	Total Obligations	73,825	73,527	56,684	59,000	2,316

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
99	Total Obligations	73,825	73,527	56,684	59,000	2,316
	Less Prior Year Recoveries	(941)	0	0	0	0
	Less Prior Year Refunds	0	0	0	0	0
	Less Prior Year Unobligated Balance	(34,441)	(17,527)	0	0	0
	Plus Unobligated Balance End of Year	17,527	0	0	0	0
	Total Budget Authority/Appropriation	55,970	56,000	56,684	59,000	2,316

Personnel Data

	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Full-time equivalent employment:					
Full-time permanent	65	76	76	76	0
Other than full-time permanent	1	0	0	0	0
Total	66	76	76	76	0
Authorized Positions:					
Full-time permanent	89	76	76	76	0
Other than full-time permanent	0	0	0	0	0
Total	89	76	76	76	0

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
APPROPRIATION LANGUAGE AND CODE CITATIONS

1. For construction of new research facilities, including architectural and engineering design, and for renovation and maintenance of existing facilities, not otherwise provided for the National Institute of Standards and Technology, as authorized by 15 U.S.C. 278c-278e.

   15 U.S.C. 278c authorizes that the Secretary of Commerce to acquire land for such field sites as are necessary for the proper and efficient conduct of the activities authorized.

   15 U.S.C. 278d authorizes that the Secretary of Commerce to undertake such construction of buildings and other facilities and to make such improvements to existing buildings, grounds, and other facilities as are necessary for the proper and efficient conduct of authorized activities.

   15 U.S.C. 278e provides that in the performance of the functions of the National Institute of Standards and Technology the Secretary of Commerce is authorized to undertake: the care, maintenance, protection, repair, and alteration of Institute buildings and other plant facilities, equipment, and property.

2. $59,000,000 to remain available until expended.

3. Public Law 110-69, America Competes Act, 121 Stat 572, passed August 9, 2007 reauthorizes the Construction of Research Facilities appropriation through 2010. It also provided for the Retention of Fees to the Construction of Research Facilities account. "The Director is authorized to retain all building use and depreciation surcharge fees collected pursuant to OMB Circular A-25. Such fees shall be collected and credited to the Construction of Research Facilities Appropriation Account for use in maintenance and repair of the Institute's existing facilities". Public Law 111-358, America Competes Reauthorization Act, 2010, 124 Stat 3982, passed January 4, 2011 reauthorized the Construction of Research Facilities appropriation through 2013.

4. Public Law 111-5, American Recovery and Reinvestment Act of 2009 appropriated $360,000,000 to the Construction of Research Facilities appropriation from FY 2009 to FY 2010.

Exhibit 34

Department of Commerce
National Institute of Standards and Technology
Construction of Research Facilities
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2013 Actual	FY 2014 Estimate	FY 2015 Estimate
Management and professional support services	$5	$0	$0
Studies, analyses, and evaluations	0	0	0
Engineering and technical services	0	0	0
Total	5	0	0

Significant Activities

Professional support and engineering and technical services are obtained when required to support the construction and major repairs and renovations of NIST's physical infrastructures in Gaithersburg, Maryland, and Boulder, Colorado. Strategies and action plans are also developed to further ensure structural building safety when the need arises.

Need for Advisory and Assistance Services

NIST uses outside professional support and engineering and technical services whenever necessary expertise is not available in-house to ensure the safety of NIST staff and visitors.

Working
Capital Fund

Exhibit 5

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Obligations
2014 Enacted	682	700	0	3,700
Reduction in transfers from prior STRS program changes	0	0	0	(3,700)
2015 Base	682	700	0	0
Transfer from STRS program changes for equipment investments	0	0	$1,250	$1,250
2015 Estimate	682	700	1,250	1,250

Exhibit 6

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF REIMBURSABLE OBLIGATIONS
(Dollar amounts in thousands)

Comparison by activity:	2013 Actual FTE	2013 Actual Amount	2014 Enacted FTE	2014 Enacted Amount	2015 Base FTE	2015 Base Amount	2015 Estimate FTE	2015 Estimate Amount	Increase/ (Decrease) Over 2015 Base FTE	Increase/ (Decrease) Over 2015 Base Amount
Laboratory programs										
WCF transfer		0		$3,700		0		$1,250		$1,250
Reimbursables	555	$127,772	617	141,581	618	$127,897	618	127,897	0	0
WCF investments	0	32,529	0	6,910	0	0	0	0	0	0
Subtotal	555	160,301	617	152,191	618	127,897	618	129,147	0	1,250
Corporate services										
WCF transfer		0		0		0		0		0
Reimbursables	0	2,576	0	3,016	0	3,016	0	3,016	0	0
WCF investments	0	3,199	0	(285)	0	0	0	0	0	0
Subtotal	0	5,775	0	2,731	0	3,016	0	3,016	0	0
Standards coordination and special programs										
WCF transfer		0		0		0		0		0
Reimbursables	58	5,862	58	9,175	58	11,435	58	11,435	0	0
WCF investments	0	12	0	17	0	0	0	0	0	0
Subtotal	58	5,874	58	9,192	58	11,435	58	11,435	0	0
Hollings manufacturing extension partnership										
WCF transfer		0		0		0		0		0
Reimbursables	1	283	1	510	0	0	0	0	0	0
WCF investments	0	12	0	15	0	0	0	0	0	0
Subtotal	1	295	1	525	0	0	0	0	0	0
Baldrige performance excellence program										
WCF transfer		0		0		0		0		0
Reimbursables	24	36	24	40	24	50	24	50	0	0
WCF investments	0	0	0	0	0	0	0	0	0	0
Subtotal	24	36	24	40	24	50	24	50	0	0
Total, National Institute of Standards and Technology										
WCF transfer		0		3,700		0		1,250	0	1,250
Reimbursables	638	136,529	700	154,322	700	142,398	700	142,398	0	0
WCF investments	0	35,752	0	6,657	0	0	0	0	0	0
Grand Total	638	172,281	700	164,679	700	142,398	700	143,648	0	1,250

Exhibit 7

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Total Obligations	$172,281	$164,679	$142,398	$143,648	$1,250
Offsetting collections from:					
Federal funds	(78,333)	(107,058)	(94,884)	(94,884)	0
Non-Federal sources	(60,287)	(53,921)	(47,514)	(47,514)	0
Total offsetting collections	(138,620)	(160,979)	(142,398)	(142,398)	0
Unobligated balance, start of year	(135,484)	(93,574)	(93,574)	(93,574)	0
Unobligated balance transferred		(3,700)			
Unobligated balance, end of year	93,574	93,574	93,574	93,574	0
Change in uncollected customer payments - Federal	8,249	0	0	0	0
Budget Authority	0	0	0	1,250	1,250
Financing:					
Transfer from other accounts	0	0	0	(1,250)	(1,250)
Appropriation	0	0	0	0	0

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Department of Commerce
National Institute of Standards and Technology
Working Capital Fund

This Working Capital Fund (WCF) reflects the full-time equivalent (FTE) employment and reimbursable obligations associated with the reimbursable work performed by NIST for other agencies and the public, and WCF investments. NIST's reimbursable services consist of technical work performed for other Federal agencies, state and local governments, and the private sector, including calibrations and special tests, advisory services, the sale of Standard Reference Materials (SRMs) and Baldrige Performance Excellence Program (BPEP) fees. The unique measurement and standards expertise developed with appropriated funding gives NIST the capability to perform these services on a reimbursable basis. NIST accepts other agency work based on an established set of criteria which include: (1) the need for traceability of measurements to national standards; (2) the need for work which cannot or will not be addressed by the private sector; (3) work supported by legislation that authorizes or mandates certain services; (4) work which would result in an unavoidable conflict of interest if carried out by the private sector or regulatory agencies; and (5) requests by the private sector for NIST action or services.

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Object Class

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
11	Personnel compensation					
11.1	Full-time permanent	0	0	0	0	0
11.3	Other than full-time permanent	0	0	0	0	0
11.5	Other personnel compensation	0	0	0	0	0
11.9	Total personnel compensation	0	0	0	0	0
12.1	Civilian personnel benefits	0	0	0	0	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	0	0	0	0	0
22	Transportation of things	0	0	0	0	0
23.1	Rental payments to GSA	0	0	0	0	0
23.2	Rental payments to others	0	0	0	0	0
23.3	Communications, utilities, and miscellaneous charges	0	0	0	0	0
24	Printing and reproduction	0	0	0	0	0
25.1	Advisory and assistance services	0	0	0	0	0
25.2	Other services	0	0	0	0	0
25.3	Purchases of goods and services from Government accounts	0	0	0	0	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and maintenance of equipment	0	0	0	0	0
26	Supplies and materials	0	0	0	0	0
31	Equipment	0	$3,700	0	$1,250	$1,250
32	Land and structures	0	0	0	0	0
41	Grants, subsidies, and contributions	0	0	0	0	0
99	Total Obligations	0	3,700	0	1,250	1,250

Personnel Data	2013 Actual	2014 Enacted	2015 Base	2015 Estimate	Increase/ (Decrease) Over 2015 Base
Full-time equivalent employment:					
Full-time permanent	574	636	636	636	0
Other than full-time permanent	64	64	64	64	0
Total	638	700	700	700	0
Authorized Positions:					
Full-time permanent	652	652	652	652	0
Other than full-time permanent	30	30	30	30	0
Total	682	682	682	682	0

Exhibit 34

Department of Commerce
National Institute of Standards and Technology
Working Capital Fund
ADVISORY AND ASSISTANCE SERVICES
(Obligations in thousands of dollars)

	FY 2013 Actual	FY 2014 Estimate	FY 2015 Estimate
Management and professional support services	$77	$20	$20
Studies, analyses, and evaluations	444	46	46
Engineering and technical services	0	0	0
Total	521	66	66

Significant Activities

Advisory and assistance services funded by the Working Capital Fund represent services funded by reimbursable funds in support of reimbursable work conducted at NIST.

Need for Advisory and Assistance Services

Advisory and Assistance services have been necessary to obtain additional expertise for conducting activities like the technical evaluation of the World Trade Center collapses, for example.

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Summary of National Institute of Standards and Technology (NIST)

The operations of the NIST Working Capital Fund are reported in a program and financing schedule printed in the President's Budget, as well as reflected in the reimbursable amounts throughout this budget. The fund finances the initial costs of work performed by NIST and is reimbursed by applicable appropriations and advances or reimbursements from other agencies. A detailed cost accounting system is used to ensure that the actual cost of work performed for each job or task is recorded and identified with the appropriate source of financing. In addition to its function as a revolving fund, the Working Capital Fund is also used to handle annual and sick leave on an accrued basis, to acquire equipment as an investment to be recovered through amortization charges to programs, to distribute indirect costs to programs as overhead, to carry the recoverable costs associated with the production of Standard Reference Materials, and to carry supply inventories until issued for program use.

The table below summarizes the total NIST program, according to the source of financing. Following this table is a summary of the NIST reimbursable program by sponsor and source of support.

Summary of Total NIST Discretionary Program
(Obligations in thousands)

	FY 2013			FY 2014			FY 2015			
Source and Use of Funds Spent	Perm. Pos. [1]	FTE	Oblig.	Perm. Pos. [1]	FTE	Oblig.	Perm. Pos. [1]	FTE	Oblig.	Approp. Requested
Direct Funding										
Scientific and technical research and services	2,249	2,158	$582,062	2,366	2,331	$684,108	2,438	2,411	$684,650	$680,000
Industrial technology services	86	80	122,345	85	87	165,956	90	90	161,000	161,000
Construction of research facilities	89	66	73,825	76	76	73,527	76	76	59,000	59,000
Gifts and bequests	0	0	4,415	0	0	4,843 [3]	0	0	4,844 [3]	0
Total, direct funding	2,424	2,304	782,647	2,527	2,494	928,434	2,604	2,577	909,494	900,000
Reimbursable Funding and WCF Investments										
Construction of research facilities - building surcharge	0	0	1,171	0	0	1,371	0	0	0	
Research, development and supporting services:										
Federal government	417	389	86,622	417	427	107,058	417	427	94,884	
Calibrations and tests, technical and advisory services:										
Federal government	35	33	5,971	35	36	5,898	35	36	5,898	
Public and non-federal government	139	130	23,359	139	143	23,075	139	143	23,073	
Subtotal, Services	174	163	29,330	174	179	28,973	174	179	28,971	
National Voluntary Laboratory Accreditation Program	25	24	4,268	25	26	4,204	25	26	4,404	
Standard reference materials (SRMs):										
SRM Sales:										
Federal government	1	1	350	1	1	304	1	1	307	
Public and non-federal government	65	61	15,776	65	67	13,783	65	67	13,832	
Subtotal, SRM sales	66	62	16,126	66	68	14,087	66	68	14,139	
SRM investment adjustment	0	0	183	0	0	0	0	0	0	
Subtotal, SRM	66	62	16,309	66	68	14,087	66	68	14,139	
Total, Reimbursable program	682	638	137,700 [2]	682	700	155,693 [2]	682	700	142,398	
WCF Investments and Operating Adjustments										
WCF investments	0	0	30,576	0	0	22,885	0	0	17,247	
WCF transfers	0	0	0	0	0	3,700	0	0	1,250	
WCF operating adjustments	0	0	17,418	0	0	0	0	0	0	
Total, WCF Investments and operating adjustments	0	0	47,994	0	0	26,585	0	0	18,497	
Total, NIST program	3,106	2,942	968,341	3,209	3,194	1,110,712	3,286	3,277	1,070,389	
Offsetting adjustment for amortization of equipment	0	0	(12,242)	0	0	(16,228)	0	0	(17,247)	
Adjusted total, NIST program	3,106	2,942	956,099	3,209	3,194	1,094,484	3,286	3,277	1,053,142	

[1] Most NIST scientists and engineers are not engaged solely on one research project. Individuals may divide their time between two or more projects financed by different sources of support. Also, salary costs of many staff members are charged to an overhead account and subsequently prorated to all directly funded projects. For these reasons, it is not possible to report employment directly for any source of financing. The Permanent Positions above are statistically-derived numbers, based on the estimated work years distribution for NIST programs.

[2] Total reimbursable numbers are different from the next page due to inclusion of CRF reimbursable obligations.

[3] Estimate support from Foundation for the Malcolm Baldrige National Quality Award, Inc. to Baldrige Performance Excellence Program.

Department of Commerce
National Institute of Standards and Technology
REIMBURSABLE PROGRAM AND WORKING CAPITAL FUND INVESTMENTS
(Dollar amounts in thousands)

	FY 2013 Actual	FY 2014 Enacted	FY 2015 Estimate
Department of Defense			
Air Force	$7,569	$8,499	$8,275
Army	1,559	1,321	1,270
Navy	891	683	650
Other, Department of Defense	11,625	14,920	13,018
Subtotal, Department of Defense	21,644	25,423	23,213
Department of Agriculture	206	100	100
Department of Commerce	16,348	18,576	20,076
Department of Energy	6,427	7,808	4,875
Dept. of Health & Human Services	3,788	5,787	2,911
Dept. of Homeland Security	17,946	22,815	22,134
Department of Justice	6,439	11,569	7,481
Department of Transportation	558	976	566
Department of Veterans Affairs	210	199	150
Environmental Protection Agency	76	50	50
General Services Administration	52	65	65
National Aeronautics & Space Admin.	2,508	3,432	3,225
National Science Foundation	2,761	2,844	2,840
Nuclear Regulatory Commission	2,211	1,875	1,875
Other	5,448	5,539	5,323
Subtotal, Other Agency	86,622	107,058	94,884
Calibrations & Testing	8,524	8,379	8,443
Technical & Advisory Services	25,074	24,798	24,932
Standard Reference Materials	16,309	14,087	14,139
Subtotal, Other Reimbursables	49,907	47,264	47,514
Total, Reimbursable Program	136,529	154,322	142,398
Equipment Transfers	0	3,700	1,250
Equipment Investments	30,576	22,885	17,247
IE Amortization	(12,242)	(16,228)	(17,247)
WCF Operating Adjustments	17,418	0	0
Total, WCF Investments	35,752	6,657	0
Total, Reimbursable Program and WCF Investments	172,281	164,679	143,648

Exhibit 35

Department of Commerce
National Institute of Standards and Technology
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL SERVICES
(Obligations in thousands)

	2012 Actual	2013 Actual	2014 Estimate	2015 Estimate
Periodicals	$3	$0	$0	$0
Pamphlets	19	20	25	25
Audiovisuals	13	34	34	35
Total	35	54	59	60

NIST produces one periodical a year: *The Journal of Research of the National Institute of Standards and Technology*. The final paper production was issued in January 2012 and the periodical is now issued electronically. *The Journal of Research of the National Institute of Standards and Technology* reports NIST research and development in metrology and related fields of physical science; engineering; applied mathematics; statistics; biotechnology; and information technology.

Department of Commerce
National Institute of Standards and Technology
AVERAGE SALARY

	2013 Actual	2014 Estimate	2015 Estimate
Average ES salary	$170,143	$171,844	$173,647
Average scientific and professional	169,087	170,778	172,569
Average Career Path Salary	107,176	108,248	109,384
Average salary of ungraded positions	56,615	57,181	57,781

FY 2014 average salaries reflects the 1.0% payraise and FY 2015 reflects the 1.049% payraise.

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
Budget Estimates, Fiscal Year 2015
President's Submission

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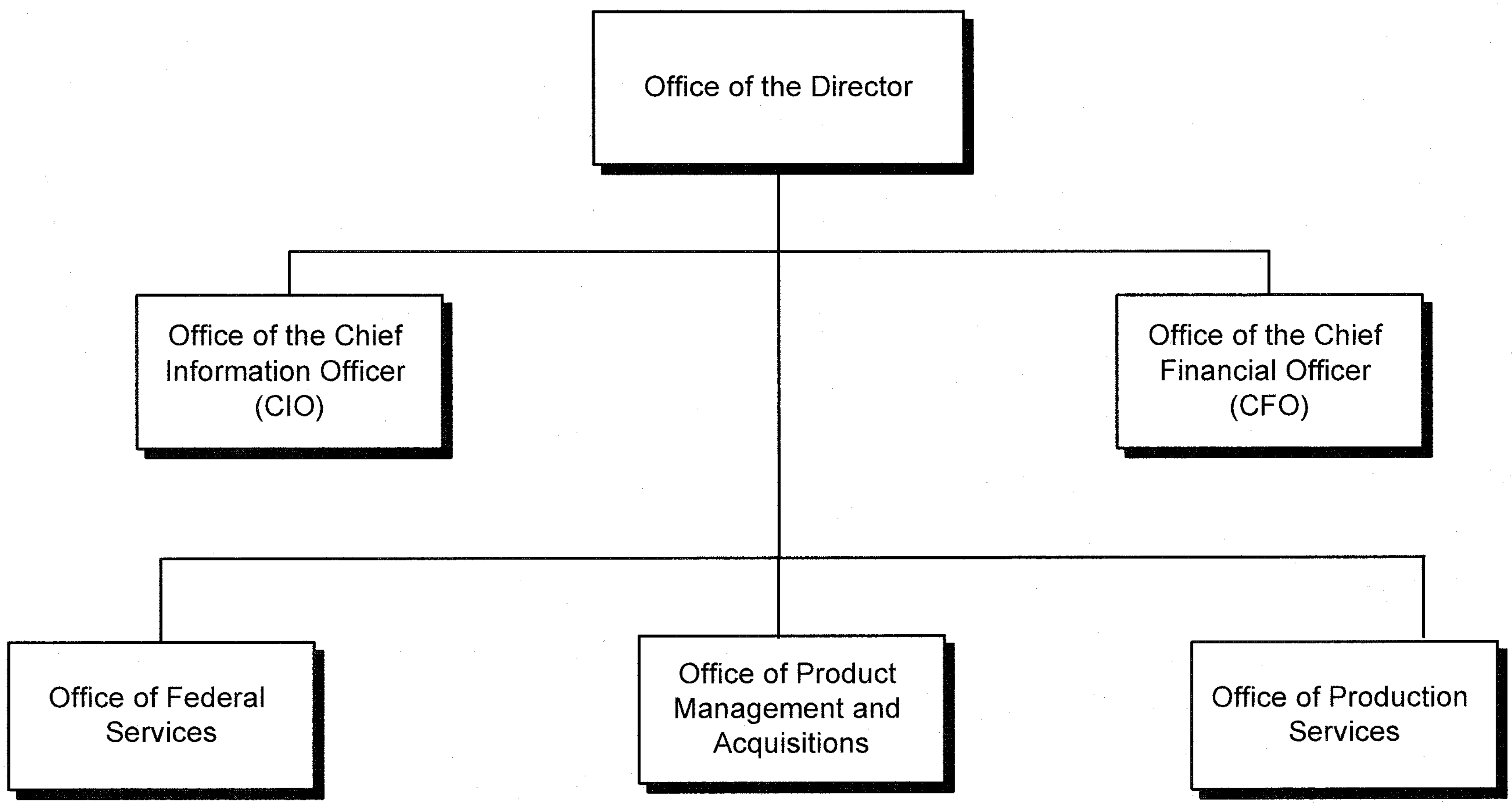
Exhibit 2

U.S. Department of Commerce
National Technical Information Service



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Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
Budget Estimates, Fiscal Year 2015
President's Submission

General Statement

Goals of the Program

The National Technical Information Service (NTIS) seeks to promote innovation and economic growth by (a) collecting, classifying, coordinating, integrating, recording and cataloging scientific and technical information from whatever sources, domestic and foreign, that may be available, (b) disseminating this information to the public, and (c) providing information management services to other Federal agencies that help them interact with and better serve the information needs of their own constituents, and to do all without appropriated funds.

Statement of Objectives

NTIS' principal objective supports the Department's strategic plan to promote U.S. innovation and industrial competitiveness by providing business and industry, academia and the general public easy access to scientific and technical research and to ensure that such research is permanently available to future generations of researchers. To this end, NTIS acquires information products from agencies; abstracts, catalogs and indexes them so that they can easily be identified and merged into NTIS' permanent bibliographic database; and physically stores them or scans them into electronic image for reproduction on demand by customers.

NTIS' objectives are to (a) make it easier for the general public to locate federal technical information electronically; (b) build an array of collaborative working arrangements with private sector partners; (c) help other federal agencies meet their own information management and dissemination requirements; and (d) meet objectives in the most cost effective and efficient manner possible.

NTIS has demonstrated innovative achievements in its information dissemination activities as provided in the National Technical Information Act of 1988, codified in 15 U.S.C. 3704b. This Act directed NTIS to "implement new methods or media for the dissemination of scientific and technical, and engineering information." Supporting this directive, NTIS, as part of its base program and without appropriations, made its bibliographic database since 1990 available on the Internet, making the collection more widely available to the public and allowing customers to download products electronically. During FY 2015 those efforts will continue to be expanded and refined as analysis of the activities warrant. In this continuing effort, NTIS continues to follow all Administration policies restricting access to information that could be used improperly.

Summary of Performance and Resources

NTIS continues to make substantial progress in improving its service to the public. NTIS collects approximately 30,000 scientific and technical reports annually that are added to its permanent collection. NTIS also makes available to the public another 987,866 items in the form of articles, updates, advisories, etc. that are contained in various subscription products and/or databases it distributes. NTIS' activities and accomplishments continue to support its basic public purpose of serving as a comprehensive point of access and dissemination to federally-funded scientific, technical and related information.

The explosive growth of the Internet has provided NTIS with a unique opportunity to expand its information dissemination activities. Information products are disseminated in a variety of formats, including paper, microfiche, diskettes, audio-visual, CD-ROM, database leases, web site hits and electronic downloads. NTIS estimates it will provide approximately 52.9 million information items to the public in FY 2015.

NTIS plans to obligate $85,500,00 of earned revenue in FY 2015.

(Dollar amounts in thousands)

	2013	2014	2015
National Technical Information Service:			
Reimbursement from offsetting collections:			
Information clearinghouse program	$85,298	$66,500	$85,500
Total, NTIS	$85,298	$66,500	$85,500

Note: Reimbursable Budget Authority, receipt and obligation data are estimates. Actuals will vary depending on products and services sold.

APP / Exhibit 3A Format

FY 2013 Annual Performance Report / FY 2015 Annual Performance Plan

National Technical Information Service

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Part 1 Summary Information

Section 1 Overview

- Mission Statement

The National Technical Information Service (NTIS) seeks to support the nation's economic growth and technology use by bringing scientific and technical information to U.S. business and industry. NTIS promotes innovation and economic growth for U.S. business by (1) collecting and cataloging scientific and technical information from a variety of sources, foreign and domestic; (2) disseminating this information to the public; and (3) providing information management services to other federal agencies that help them interact with and better serve the information needs of their own constituents, and to accomplish this without appropriated funds.

- Organizational Structure

This is shown in Exhibit 2

- Description

NTIS provides the American public with permanent and ready access to scientific, technical, and business research through the acquisition, organization, and preservation of data added to its permanent collection. NTIS collects, classifies, coordinates, integrates, records, and catalogs scientific and technical information from whatever sources, foreign and domestic, that may stimulate innovation and discovery and then disseminates that information to the public. In an effort to provide the American public with increased access to the vast collection of government information, NTIS utilizes advanced e-commerce channels, including providing downloads of any item in its collection that is in electronic format for a single low fee or at no charge if under five pages. NTIS also helps other Federal agencies interact with and better serve the information needs of their own constituents by providing information management services.

- FY 2013 Accomplishments

NTIS has demonstrated innovative achievements in its information dissemination activities as provided in the National Technical Information Act of 1988, codified in 15 U.S.C. 3704b. This Act directed NTIS to "implement new methods or media for the dissemination of scientific and technical, and engineering information." Supporting this directive, NTIS, as part of its base program and without appropriations, made its bibliographic database since 1990 available on the Internet, making the collection more widely available to the public and allowing customers to download products electronically. Those efforts will continue to be expanded and refined as analysis of the activities warrant. In this continuing effort, NTIS continues to follow all Administration policies restricting access to information that could be used improperly. The explosive growth of the Internet has provided NTIS with a unique opportunity to expand its information dissemination activities. Information products are disseminated in a variety of formats, including paper, diskettes, audio-visual, CD-ROM, database leases, web site hits and electronic downloads.

Section 2 Corresponding DoC Strategic Themes, Goals, and Objectives

According to the structure of the new strategic plan, state the goals, objectives, objective numbers and the title and office of the person responsible for achievement of a given objective to which the bureau's programs apply in the form of a table as shown below. Program names should not be stated here.

Goal	Objective Number	Objective Name	Leader: [Title, Organization/Activity]
Generate and communicate new, cutting-edge scientific understanding of technical, economic, social and environmental systems	4.1	Transform the Department's data capacity to enhance the value, accessibility and usability of Commerce data for government, business and the public.	Access to Federal STEI, Bruce Borzino, NTIS Director

NTIS' principal objective supports the Department's strategic plan to promote U.S. innovation and industrial competitiveness by providing business and industry, academia and the general public easy access to scientific and technical research and to ensure that such research is permanently available to future generations of researchers. To this end, NTIS acquires information products from agencies; abstracts, catalogs and indexes them so that they can easily be identified and merged into NTIS' permanent bibliographic database; and physically stores them or scans them into electronic image for reproduction on demand by customers.

NTIS' objectives are to (a) make it easier for the general public to locate federal technical information electronically; (b) build an array of collaborative working arrangements with private sector partners; (c) help other federal agencies meet their own information management and dissemination requirements; and (d) meet objectives in the most cost effective and efficient manner possible.

Part 2 Performance Results and Plans

Section 1: FY 2013 Summary Description of Performance by Objective

FY 14-18 Strategic Goal: Data

FY 14-18: Strategic Objective: Transform the Department's data capacity to enhance the value, accessibility and usability of Commerce data for government, business and the public.

Benefits: Describe the benefits that it provides to the American public. Benefits should focus on both FY 2013 and on what the bureau provides in the future to the American public. Past sources of ideas for benefits include previous PARs and any other documents the bureaus want to work from.

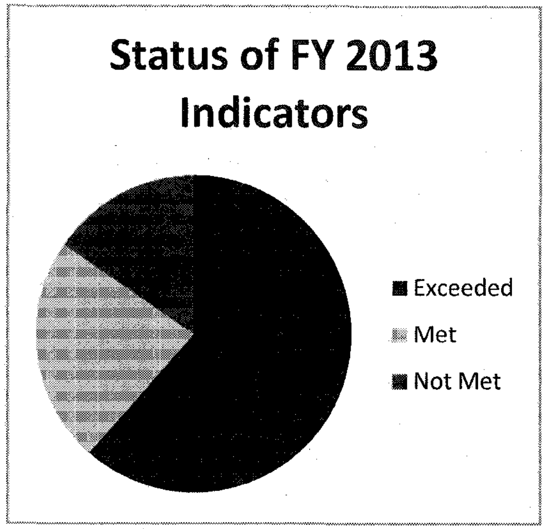
Recurring Indicators

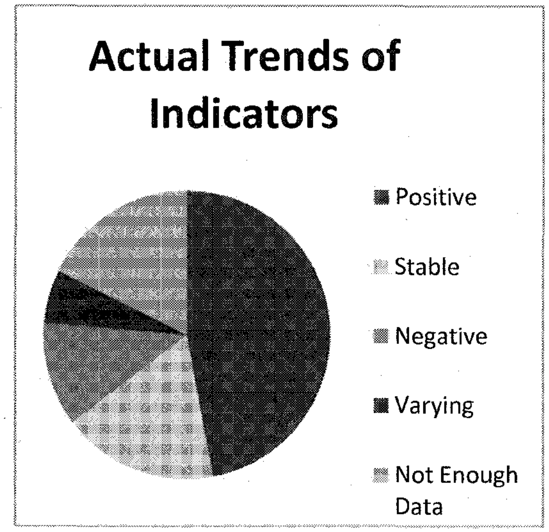
The following table should be used for indicators that are reported on in FY 2013 and recur in FY 2014 onward.

FY2013 Summary

Indicator	Target	Actual	Status	Trend
Measure 1A Number of Updated Items Available (Annual)	892,500	987,866	Exceeded	Positive
Measure 1B Number of Information Products Disseminated (Annual)	50,875,560	68,938,571	Exceeded	Positive
Measure 1C Customer Satisfaction	95%-98%	98.5%	Exceeded	Positive

All FY 2013 Indicators:





Section 2: Detailed Description of Past and Future Performance by Objective

New or Recurring Indicators

The following table should be used for indicators that first appear in FY 2014 or FY 2015 or recur from FY 2013 onward. Note if any indicators are part of an Agency Priority Goal.

Indicator	MEASURE 1A. NUMBER OF UPDATED ITEMS AVAILABLE							
Description	DESCRIBE THE INDICATOR INCLUDING HOW THE INDICATOR REFLECTS THE BUREAU'S PROGRAM. IT MAY BE THAT THERE ARE SIGNIFICANT CHANGES BETWEEN YEARS AS A RESULT OF ADDITIONAL FUNDING IN A GIVEN YEAR. NOTE THAT CHANGE IN THE DESCRIPTION.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	725,000	745,000	765,000	825,000	875,000	892,500	910,350	920,500
Actual	813,775	893,138	969,473	836,579	978,871	987,866		
Status	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded		
Trend	POSITIVE							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	N/A							

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
NTIS operates and maintains internal systems for collection acquisition statistics.	Data is available daily. Reports are produce monthly.	All data is stored within NTIS systems	NTIS' accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal and independent auditor reporting.	Output only	None

Exhibit 3A

Indicator	MEASURE 1B. NUMBER OF INFORMATION PRODUCTS DISSEMINATED (ANNUAL)							
Description	DESCRIBE THE INDICATOR INCLUDING HOW THE INDICATOR REFLECTS THE BUREAU'S PROGRAM. IT MAY BE THAT THERE ARE SIGNIFICANT CHANGES BETWEEN YEARS AS A RESULT OF ADDITIONAL FUNDING IN A GIVEN YEAR. NOTE THAT CHANGE IN THE DESCRIPTION.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	32,100,000	32,850,000	33,000,000	47,800,000	48,878,000	50,875,560	51,893,071	52,910,932
Actual	32,267,167	49,430,840	50,333,206	48,958,993	54,592,481	68,938,571		
Status	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded	Exceeded		
Trend	POSITIVE							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	N/A							

Validation and Verification					
Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
A modified commercial order processing system and standard Web analysis software package used by industry..	Internal management activity reports are produced daily, summaries are produced monthly.	All data is stored within NTIS systems	NTIS' accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal and independent auditor reporting.	Output only	None

Exhibit 3A

Indicator	MEASURE 1C. CUSTOMER SATISFACTION							
Description	DESCRIBE THE INDICATOR INCLUDING HOW THE INDICATOR REFLECTS THE BUREAU'S PROGRAM. IT MAY BE THAT THERE ARE SIGNIFICANT CHANGES BETWEEN YEARS AS A RESULT OF ADDITIONAL FUNDING IN A GIVEN YEAR. NOTE THAT CHANGE IN THE DESCRIPTION.							
	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
Target	95-98%	95-98%	95-98%	95-98%	95-98%	95-98%	95-98%	95-98%
Actual	98%	98%	98%	99.5%	98.4%	98.5%		
Status	Met	Met	Met	Exceeded	Exceeded	Exceeded		
Trend	POSITIVE							
Explanation (if not met in FY 2013)	N/A							
Actions to be taken / Future Plans	N/A							
Adjustments to targets	N/A							
Information Gaps	N/A							

Validation and Verification

Data Source	Frequency	Data Storage	Internal Control Procedures	Data Limitations	Actions to be Taken
A modified commercial order processing system.	Internal management activity reports are produced daily, summaries are produced monthly.	All information is stored within NTIS systems.	NTIS' accounting and budget offices analyze and report performance data to management. Data verification is provided through regular internal and independent auditor reporting.	None	None

Non-Recurring Indicators

NTIS did not discontinue any indicators beginning in FY 2014..

Part 3 - Resource Requirements Table

	FY 2008 Actual	FY 2009 Actual	FY 2010 Actual	FY 2011 Actual	FY 2012 Actual	FY 2013 Actual	FY 2014 Estimate	FY 2015 Base	Increase / Decrease	FY 2015 Request
National Technical Information Service										
Total Funding										
Direct										
Reimbursable	$50,416	$42,000	$42,500	$65,000	$65,500	$66,500	$66,500	$85,500	$0	$85,500
Total										
Total FTE	150	150	150	150	150	150	150	150	0	150

Part 4 Agency Priority Goals

NTIS has no DoC priority

Part 5 Other Information

Section 1 None
Section 2 Cross-Agency Priority Goals / Collaborations – NTIS is not involved in any cross-agency collaborations."
NTIS is not a leader of or a participant in any Cross-Agency Priority Goals."
Section 3 Program evaluations – None
Section 4 Hyperlinks to any other more detailed plans or evaluations. None
Section 5 Data Validation and Verification – The FY 2013 Summary of Performance will include in the Secretary's Statement, an assessment of the reliability and completeness of the Department's performance data

Department of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF RESOURCE REQUIREMENTS
(Dollar amounts in thousands)

	Positions	FTE	Budget Authority	Direct Obligations
President's Budget, 2015	0	0	0	0
Plus 2015 Adjustments to base:	0	0	0	0
less: Obligations from prior years	0	0	0	0
2015 Base	0	0	0	0
Plus: 2015 Program changes	0	0	0	0
2015 Estimate	0	0	0	0

Comparison by activity/subactivity:		2013 Actual		2014 Currently Available		2015 Base		2015 Estimate		Increase/(Decrease) over 2015 Base	
		Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount	Personnel	Amount
National Technical Information Service:	Pos./BA	0	0	0	0	0	0	0	0	0	0
Organization, Preservation and Public Access to Techical Information	FTE/Obl.	0	0	0	0	0	0	0	0	0	0
TOTALS	Pos./BA	0	0	0	0	0	0	0	0	0	0
	FTE/Obl.	0	0	0	0	0	0	0	0	0	0
Adjustments for:											
Recoveries		0	0	0	0	0	0	0	0	0	0
Unobligated balance, start of year		0	0	0	0	0	0	0	0	0	0
Unobligated balance, end of year		0	0	0	0	0	0	0	0	0	0
Financing from transfers:											
Transfer from other accounts (-)		0	0	0	0	0	0	0	0	0	0
Transfer to other accounts (+)		0	0	0	0	0	0	0	0	0	0
Appropriation		0	0	0	0	0	0	0	0	0	0

Department of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF REIMBURSABLE OBLIGATIONS
(Dollar amounts in thousands)

Activity: National Technical Information Service
Subactivity: Information Clearinghouse Program

Line Item	2013 Actual FTE	2013 Actual Amount	2014 Currently Available FTE	2014 Currently Available Amount	2015 Base FTE	2015 Base Amount	2015 Estimate FTE	2015 Estimate Amount	Increase/ (Decrease) over 2015 Base FTE	Increase/ (Decrease) over 2015 Base Amount
National Technical Information Service:										
Information Clearinghouse Program	101	$ 85,298	150	$ 66,500	150	$ 85,500	150	$ 85,500	0	0
TOTALS	101	$ 85,298	150	$ 66,500	150	$ 85,500	150	$ 85,500	0	0

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
SUMMARY OF FINANCING
(Dollar amounts in thousands)

	2013 Actual	2014 Currently Available	2015 Base	2015 Estimate	Increase (Decrease) over 2015 Base
Total Obligations	$85,298	$66,500	$85,500	$85,500	$0
Offsetting collections from:					
Federal funds	(74,814)	(52,700)	(71,700)	(71,700)	0
Trust funds	0	0	0	0	0
Non-Federal sources	(10,484)	(13,800)	(13,800)	(13,800)	0
Recoveries	0	0	0	0	0
Unobligated balance, start of year	(7,407)	(10,749)	(10,749)	(10,749)	0
Unobligated balance transferred	0	0	0	0	0
Unobligated balance, end of year	10,749	10,749	10,749	10,749	0
Budget Authority	0	0	0	0	0
Financing:					
Transferred from other accounts (-)	0	0	0	0	0
Transferred to other accounts (+)	0	0	0	0	0
Appropriation	0	0	0	0	0

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Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

APPROPRIATION ACCOUNT: NTIS Revolving Fund

BUDGET ACTIVITY: Organization, Preservation and Public Access to Technical Information

For FY 2015, the National Technical Information Service plans to continue to operate on a self-supporting reimbursable basis, which will include estimated obligations of $85,500,000 and 150 FTE.

BASE JUSTIFICATION FOR FY 2015:

NTIS' basic authority is to operate a permanent clearinghouse of scientific and technical information, codified as chapter 23 of Title 15 of the United States Code (15 U.S.C. 1151-1157). This chapter also established NTIS' authority to charge fees for its products and services and to recover all costs through such fees "to the extent feasible."

Operating on a reimbursable basis NTIS acquires information products; abstracts, catalogs and indexes them so that they can easily be identified and merged into NTIS' permanent bibliographic database; and physically stores them or scans them into electronic image for reproduction on demand by customers. These information products are disseminated in a variety of formats, including paper, diskettes, audio-visual, CD/DVD media, and through subscription and database lease services offered by NTIS and private sector partners.

NTIS also provides information management services to other federal agencies that help them interact with and better serve the information needs of their own constituents. These activities include: web based e-Training, digitization, distribution and archive services..

All activities are funded through the NTIS Revolving Fund, without direct appropriation.

Significant Adjustments-to-Base (ATBs):

- None

Department Of Commerce
National Technical Information Service
NTIS Revolving Fund
JUSTIFICATION OF PROGRAM AND PERFORMANCE

PROGRAM CHANGES FOR FY 2015:

None

Deliverables:

Performance Goals and Measurement Data

Performance Measure: Number of updated items available	FY 2013 Actual	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target
Total	987,866	910,350	928,500	947,070	966,011	1,912,701
Description: The number of information items available to the public includes scientific, technical, and engineering information products added to the permanent collection, as well as items made available through online electronic subscriptions. Continually expanding and refining efforts to acquire new scientific and technical information products is reflected in future targets.						

Performance Measure: Number of information products disseminated (annual)	FY 2013 Actual	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target
Total	68.9M	51.8M	52.9M	54M	55.1M	56.2M
Description: This measure represents the volume of information products disseminated to the public and includes compact discs, diskettes, tapes, online subscriptions, web site pages, as well as the traditional paper products. NTIS recently deployed its new Next Generation 2.0 website and has initiated the use of Social Media technology as part of its Outreach and Education activities to further the success of this goal.						

Performance Measure: Customer Satisfaction	FY 2013 Actual	FY 2014 Target	FY 2015 Target	FY 2016 Target	FY 2017 Target	FY 2018 Target
Total	98.5%	95%-98%	95%-98%	95%-98%	95%-98%	95%-98%
Description: This measure represents the percentage of NTIS customers that are satisfied with the quality of their order, the ease of order placement, and they timely processing of that order. Orders for NTIS' vast collection of scientific and technical information are received by phone, fax, mail and online, and are filled in a variety of formats. Customer satisfaction is key to NTIS' successful operation.						

Object Class

Department of Commerce
National Technical Information Service
NTIS Revolving Fund - Reimbursable Obligations
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2013 Actual	2014 Currently Available	2015 Base	2015 Estimate	Increase/ (Decrease) over 2015 Base
11.1	Full-time permanent (Compensation)	$ 12,500	$ 13,609	$ 13,750	$ 13,750	0
11.3	Other than full-time permanent	150	150	150	$ 150	0
11.5	Other personnel compensation	700	116	116	$ 116	0
11.8	Special personnel services payments	0	0	0	0	0
11.9	Total personnel compensation	13,350	13,875	14,016	14,016	0
12.1	Civilian personnel benefits	4,500	4,725	4,725	$ 4,725	0
13	Benefits for former personnel	0	0	0	0	0
21	Travel and transportation of persons	200	200	200	$ 200	0
22	Transportation of things	3,000	3,250	3,250	$ 3,250	0
23.1	Rental payments to GSA	1,919	1,947	1,950	$ 1,950	0
23.2	Rental payments to others	1,000	1,000	1,000	$ 1,000	0
23.3	Communications, utilities and miscellaneous charges	1,800	1,800	1,800	$ 1,800	0
24	Printing and reproduction	4,000	4,000	4,000	$ 4,000	0
25.1	Consulting services	100	100	100	$ 100	0
25.2	Other services	48,429	28,603	47,459	$ 47,459	0
25.3	Purchases of goods and services from Government accounts	1,500	1,500	1,500	$ 1,500	0
25.4	Operation of GOCOs	0	0	0	0	0
25.5	Research and development contracts	0	0	0	0	0
25.7	Operation and Maintenance of Equipment	500	500	500	$ 500	0
26	Supplies and materials	3,000	3,000	3,000	$ 3,000	0
31	Equipment	2,000	2,000	2,000	$ 2,000	0

Department of Commerce
National Technical Information Service
NTIS Revolving Fund - Reimbursable Obligations
SUMMARY OF REQUIREMENTS BY OBJECT CLASS
(Dollar amounts in thousands)

	Object Class	2013 Actual	2014 Currently Available	2015 Base	2015 Estimate	Increase/ (Decrease) over 2015 Base
41	Grants, subsidies and contributions	0	0	0	0	0
42	Insurance claims and indemnities	0	0	0	0	0
43	Interest and dividends	0	0	0	0	0
44	Refunds	0	0	0	0	0
99	Total Obligations	85,298	66,500	85,500	85,500	0
	Earned Revenue/Reimbursable Obligations	85,298	66,500	85,500	85,500	0
	Total Obligations	85,298	66,500	85,500	85,500	0

	2013 Actual	2014 Currently Available	2015 Base	2015 Estimate	Increase/ (Decrease) over 2015 Base
Personnel Data					
Full-Time equivalent Employment:					
Full-time permanent	104	145	145	145	0
Other than full-time permanent	1	5	5	5	0
Total	105	150	150	150	0
Authorized Positions:					
Full-time permanent	190	190	190	190	0
Other than full-time permanent	10	10	10	10	0
Total	200	200	200	200	0

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
CONSULTING AND RELATED SERVICES
(Obligations in thousands)

	2013 Actual	2014 Estimate	2015 Estimate
Consulting Services	$25	$100	$100
Management and professional services	0	0	0
Special studies and analysis	0	0	0
Management and Support Services for research and development	0	0	0
Total	$25	$100	$100

Department of Commerce
National Technical Information Service
NTIS Revolving Fund
PERIODICALS, PAMPHLETS, AND AUDIOVISUAL PRODUCTS
(obligations in thousands)

	2013 Actual	2014 Estimate	2015 Estimate
Periodicals	$1	$2	$2
Pamphlets	0	0	0
Audiovisuals	0	0	0
Total	$1	$2	$2

DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
NTIS Revolving Fund
AVERAGE GRADE AND SALARIES

	2013 Actual	2014 Estimate	2015 Estimate
Average GS/GM Grade	10.8	10.10	10.10
Average GS/GM Salary	$70,825	$87,930	$87,930

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