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KEEPING AMERICA COMPETITIVE THROUGH INVESTMENTS IN R&D

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

MARCH 6, 2012

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ONE HUNDRED TWELFTH CONGRESS

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KEEPING AMERICA COMPETITIVE THROUGH INVESTMENTS IN R&D

TUESDAY, MARCH 6, 2012

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Subcommittee met, pursuant to notice, at 2:56 p.m. in Room SR–253, Russell Senate Office Building, Hon. Bill Nelson, Chairman of the Subcommittee, presiding.

OPENING STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator NELSON. Good afternoon. Thank you all for coming today. We're looking forward to this hearing. I want to turn to my colleague John, Senator Boozman, for his opening statement first.

STATEMENT OF HON. JOHN BOOZMAN, U.S. SENATOR FROM ARKANSAS

Senator BOOZMAN. Thank you very much, Mr. Chairman, and thank all of you for being here today to help us examine the administration's research and development priorities. I know we have a lot to cover, so I'll try and keep this brief.

Advances in science and engineering are essential to ensuring America's economic growth and global competitiveness, as well as addressing a host of other national priorities such as energy independence, cybersecurity, and health care. I join you today with a great sense of responsibility and concern about how Congress can strengthen our innovation-based economy and take economic growth to the next level.

While prudent investments in research and development are necessary to further our nation's future economic growth, this growth can certainly be foiled by poor decisionmaking on the part of the government. It's our responsibility as policymakers and keepers of the American purse to ensure that we are spending America's hard-earned dollars efficiently and prudently, and I know that we all agree with that.

We must prioritize our nation's precious and limited R&D dollars in a way that gives Americans what they deserve, the biggest bang for their taxpayer buck. But what are the necessary steps? How do we support America's spirit of innovation and entrepreneurship while being realistic that the Federal Government cannot sustain our current level of spending?

First, to encourage entrepreneurial ventures in the scientific and technology community, we must begin bridging the gap in applied research by removing the regulatory and tax burdens that stifle startups here at home. The United States once led the way in developing pro-growth and pro-innovation policies with low tax and a limited regulatory burden. We were the first in the world to offer companies an R&D tax credit and the first to allow universities to patent products originating from Federal R&D grants, R&D funds. Other countries have now caught up and in some cases they have surpassed our effort. In fact, the U.S. R&D tax credit is only incremental. More aggressive countries have gone to a flat tax credit for all R&D expenditures.

And while other nations have adopted and advanced our earlier strategies, we have taken a step backward. We haven't even made our R&D tax credit permanent. We also impose one of the steepest corporate tax rates in the world, 35 percent. Only Japan surpasses this, but Japan is now looking to lower their corporate tax rate, which would give Americans the dubious honor of having the highest tax rate in the world.

Furthermore, there's no doubt that reducing regulatory burdens would speed commercialization of key technologies. For example, innovative nanotechnologies and new materials often undergo dual regulatory processes at the EPA and the Consumer Product Safety Commission. These regulatory processes are slowing down the speed of innovation and raising the cost of commercializing new technologies.

Second, the model for NSF, NASA, and DARPA is excellent. The money is used to support students or scientists in either research or critical missions is especially effective for growth, because not only are you educating scientists; ultimately it is the scientists who are also doing the technology transfer. These students and scientists often end up working at research institutions like the University of Arkansas and then subsequently pursuing a career in the private sector at places like Apple, or at nanotechnology startups. The net result is an immense amount of technology transfer.

It is no surprise that, with these investments in brain power, since 1976 more than 1,300 documented NASA technologies have been commercialized, benefiting American commerce, improving our quality of life, creating jobs for Americans.

Meanwhile, there are other nations around the globe who are pouring money into their R&D systems with the hope of attracting our scientists. We simply cannot let that happen. We must stay focused on training scientists in fundamental research. Our record of success points to a key fact: we must continue to prioritize fundamental research and programs that train the next generation of scientists.

Finally, I'd like to note that this type of success cannot be achieved through mandatory spending on manufacturing research, nor can it be achieved through changing the focus and mission of the NSF and NIST to advanced manufacturing research agencies. Having NIST, NSF, and NASA carry out our manufacturing research based on requests from the private sector is neither prudent investing nor a guarantee of entrepreneurial success.

We must continue the U.S. tradition of investing in a diversity of research that could potentially benefit large swaths of the economy, including but not limited to manufacturing.

In conclusion, we must continue to do what we do best: fundamental research that cannot be carried out by the private sector. This is the tried and true model of success and will ensure that all of our investments are the most efficient and effective use of the taxpayer dollar.

I look forward to hearing from the witnesses about the President's plan for funding these priorities at these key scientific research agencies.

Thank you again, Mr. Chairman.

Senator NELSON. Thank you, Senator.

We are here because innovation is the engine that drives and transforms our economy. You think back to 225 years ago an explorer named John Fitch built the world's first steamboat. Twenty years later, a man named Robert Fulton improved on Fitch's ideas and built a steamboat that was reliable and efficient enough to be used for commercial service. And then, within a few years Fulton was operating steamboats on six rivers and the Chesapeake Bay.

The steamboat allowed people to transport materials and goods across the country. This helped bring about the Industrial Revolution and opened up the entire continent to exploration and settlement.

So inventions here in this country like the steamboat have transformed the U.S. from a small, rugged, frontier nation into what we are today, a global superpower.

In this economic environment, we're having to make tougher decisions about what we can afford, decisions that are going to affect the future and the direction of this country, and it's going to affect the competitiveness of this country in the global economy. Because the Federal resources are precious, we're going to scrutinize every tax dollar and hopefully it's going to be spent responsibly.

There are global competitors that are giving us rising challenges, and some of them are really pushing the R&D and investing heavily in education of their next generation of scientists and engineers. We see American companies increasingly doing their research and development abroad to take advantage of that fact.

I was at a high-tech defense and aerospace firm yesterday. They have 600 openings and they're having to scramble to find the talent to fill those openings.

So if you look back at the historical impact of innovation on our nation's economy, the current fiscal environment and the rising challenges from the global competitors, it provides a backdrop for the hearing today. Of course, we are joined by four of the country's leading experts in research and development—from the Office of Science and Technology, the National Science Foundation, the National Institute of Standards and Technology, and NASA. These organizations are directly responsible for innovations that have improved our quality of life,enhanced our national competitiveness, and have addressed some of the most challenging problems of our time.

So, Dr. Holdren, Dr. Gallagher, Dr. Suresh, and Dr. Peck, Senator Boozman and I look forward to your testimony. Of course, your

written testimony will be entered in the record, so if you would give a summary of it in about five minutes each, we'll get into the questions after that. Dr. Holdren.

STATEMENT OF DR. JOHN P. HOLDREN, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

Dr. HOLDREN. Thank you, Chairman Nelson, Ranking Member Boozman. I'm certainly happy to be here today and especially happy to be here with such a distinguished set of colleagues from NIST, NSF, and NASA, to talk about the state of Federal R&D in the context of the President's 2013 budget proposal, and of course the context of the America COMPETES Act and its reauthorization, in which this subcommittee and the parent committee played such an important role.

The President called on us in his State of the Union speech to create or to help create an American economy that's built to last. He talked about a number of ingredients of that economy. He talked about leading the world in educating our people. He talked about attracting a new generation of high tech manufacturing. He talked about taking control of our own energy. In various ways, his 2013 budget proposal reflects those priorities.

As you mentioned, Mr. Chairman, my written testimony covers the details, so I'm just going to very briefly hit a few highlights here, starting with the proposal for a total of $140.8 billion for Federal R&D, an increase of about 1.4 percent over the enacted 2012 level. When inflation is taken into account, predicted to be about 1.7 percent, it's about flat with the 2012 enacted.

But within that total, the budget proposes almost $65 billion for non-defense R&D and that's actually an increase of 5 percent in current dollars over the 2012 enacted. But of course, that R&D total does have to fit within an overall discretionary budget that would be flat at the 2011 enacted levels for the second year in a row, consistent with the Budget Control Act agreed to by the Congress and the President last August, and to get there we made, obviously, some very tough choices.

And I'd like to say hi to Chairman Rockefeller. Great to be with you, sir, as well as with the other two distinguished gentlemen up there.

The agencies that were marked for increases in this budget included, notably, the NSF, the National Institute of Standards and Technology laboratories, and the DOE's Office of Science. Those three agencies have been widely recognized, including in the COMPETES Act, for their essential contributions to basic research in science and engineering and the importance of that basic research, of course, as you both have commented in your opening remarks, Mr. Chairman and Mr. Ranking Member—essential to the future of economic innovation, as well as the future of our national and homeland security and our quality of life in other dimensions.

Of course, other agencies that in better times would clearly have been found worthy of more money under this budget will endure decreases or be held flat. Among those are NASA, which we propose funding essentially at last year's level, down about half a percent, in a manner consistent with the bipartisan agreement that

was reached between the Congress and the administration that balances the several crucial missions of that very important agency.

Among the priorities of this committee reflected in the budget, of course, is science, technology, engineering, and math education, STEM education. That would be funded at $3 billion, a 2.6 percent increase. And as part of the administration's efforts to make sure that money is spent wisely, and I appreciate your admonitions on that point, my office in December released the most comprehensive summary of an inventory of Federal STEM education efforts ever compiled. We will release later this spring a 5-year Federal STEM education strategic plan.

Also in response to the work of this committee and particularly the COMPETES Act, OSTP recently released a comprehensive national strategic plan for advancedmanufacturing. Per that plan's recommendations, in December the White House created an Office of Manufacturing Policy, to be co-chaired by Commerce Secretary John Bryson and National Economic Council Director Gene Sperling, to drive interagency coordination in this very important advanced manufacturing domain.

We're also working to help agencies take maximum advantage of Section 105 of COMPETES, which was championed by two members of this committee, Senators Pryor and Warner, which granted all Federal agencies broad authority to conduct prize competitions to solve tough problems and advance their core missions. Later this month, OSTP will submit to Congress a full progress report on how the COMPETES prize authority is being implemented across the government.

Finally, reflecting another interest of this committee, OSTP recently conducted two public consultations on public access to the results of federally-sponsored research, and we anticipate delivering to Congress an update on that topic later this month.

As those items I think indicate, this administration, through its proposed 2013 budget and its active implementation of the America COMPETES Act, is working hard to help ensure that America strengthens its position as a global leader in scientific research and technological innovation. I'm certainly looking forward, as I know my colleagues are, to working with this committee to maintain this momentum, and I'll be happy to try to answer any questions you have after our initial statements.

Thank you.

[The prepared statement of Dr. Holdren follows:]

PREPARED STATEMENT OF DR. JOHN P. HOLDREN, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY, EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES

Chairman Nelson, Ranking Member Boozman, and Members of the Committee, it is my distinct privilege to be here with you today to discuss the current state of Federal research and development (R&D) in the context of the President's Fiscal Year (FY) 2013 Budget and the America COMPETES Reauthorization Act of 2010.

Administration Initiatives in Innovation, Education, and Infrastructure

President Obama, in his most recent State of the Union address, called on all of us to help create an American economy that is built to last. He called on us to work toward an America that leads the world in educating its people. An America that attracts a new generation of high-tech manufacturing and high-paying jobs. An America in control of our own energy. He called on us all to do what this Nation

does best—investing in the creativity and imagination of the American people. In order to be globally competitive in the 21st century and create an American economy that is built to last, we must not only put this Nation on a sustainable fiscal path, but also create an environment where invention, innovation, and industry can flourish.

The President's 2013 Budget aims to do exactly that. It includes continuing investment in science and engineering research that can turn ideas into realities. And it provides support for the creation of new technologies, products, businesses, and industries that, despite barely having been imagined a few years ago, promise to become essential and even iconic.

The 2013 Budget recognizes today's difficult economic circumstances and makes tough choices, limiting spending in many areas that in other times would be deemed worthy of greater support. But the Budget also focuses on and shows confidence in the future. By building and fueling America's engines of discovery, it will expand the frontiers of human knowledge, promote sustainable economic growth based in part on a revitalized American manufacturing sector, cultivate an American clean-energy future, improve health-care outcomes for more people at lower cost, address the challenge of global climate change, manage competing demands on environmental resources, and reinforce our national security. This Budget is designed to ensure that America will continue, in the President's words, to "out-innovate, out-educate, and out-build the rest of the world."

As past budgets from this Administration did, the President's new 2013 Budget proposes to invest intelligently in innovation, education, and infrastructure today to generate the industries, jobs, workforce, and environmental and national-security benefits of tomorrow. Obviously, we need the continued support of the Congress to get it done. I say "continued support" because much of the President's Federal research and education investment portfolio enjoyed bipartisan support during the first 3 years of the Administration. We hope to extend this partnership, with both the Senate and the House, across the entire science and technology portfolio represented in the President's budget.

In the remainder of this testimony, I elaborate on the reasons the Administration is most hopeful you'll provide that support.

The Federal R&D Budget

In his State of the Union address, the President outlined a vision of working together to create an economy built on American manufacturing, American energy, and skills for American workers. We can help spur innovation to accomplish these goals by investing in research and development. The President's Fiscal Year 2013 Budget proposes $140.8 billion for Federal research and development (R&D) to do just that—to build American innovation in manufacturing, to promote clean American energy, and to nurture a highly skilled American workforce for the future. To strengthen U.S. leadership in the 21st century's high-tech, knowledge-based economy, the 2013 Budget proposes a substantial increase in non-defense R&D to $64.9 billion, an increase of 5.0 percent over the 2012 enacted level.

(My testimony discusses changes in current dollars, not adjusted for inflation. The latest economic projections show inflation of 1.7 percent between 2012 and 2013 for the economy as a whole, using the GDP deflator.)

This 5 percent increase notwithstanding, the Obama Administration's investments in innovation, education, and infrastructure fit within an overall discretionary budget that would be flat at 2011 enacted levels for the second year in a row, consistent with the Budget Control Act agreed to by Congress and the President last August. The Budget reflects strategic decisions to focus resources on those areas where the payoff for the American people is likely to be highest, while imposing hard-nosed fiscal discipline on areas lacking that kind of promise. For example, the $74.1 billion proposed for development in the 2013 Budget represents a decline compared to the 2012 funding level. Across government, important programs will have to make do with less, as noted in several of the program descriptions below. And the Administration's commitment to making tough choices is not limited to development funding. The total (defense and nondefense) R&D budget would be $140.8 billion, 1.4 percent above the 2012 enacted level but well below the $142.7 billion enacted total for Fiscal Year 2011.

Budgets of Science Agencies

Three agencies have been identified as especially important to this Nation's continued economic leadership by the President's Plan for Science and Innovation, the America COMPETES Act of 2007, the Administration's Innovation Strategy, and the America COMPETES Reauthorization Act of 2010 enacted last January in large part due to the strong leadership of this Committee. Those three jewel-in-the-crown

agencies are the National Science Foundation (NSF), a primary source of funding for basic curiosity-driven academic research which leads to discoveries, inventions, and job creation; the Department of Energy's (DOE's) Office of Science, which leads fundamental research relevant to energy and also builds and operates much of the major research infrastructure—advanced light sources, accelerators, supercomputers, and facilities for making nano-materials—on which our scientists depend for research breakthroughs; and the National Institute of Standards and Technology (NIST) laboratories, which support a wide range of technically and economically essential pursuits from accelerating standards development for health information technology to conducting measurement-science research to enable net-zero-energy buildings and advanced manufacturing processes.

In recognition of the immense leverage these three agencies offer and their key role in maintaining America's preeminence in the global marketplace, Congress and this Administration have worked together to put total funding for these agencies on a doubling trajectory. Funding constraints and new funding levels set in the Budget Control Act of 2011 mean delaying the original target completion date for doubling these budgets. But the 2013 Budget maintains the doubling commitment with a 4.3 percent increase between 2012 and 2013 for the three agencies' combined budgets, totaling $13.1 billion. I want to emphasize that the proposed increases for these agencies are part of a fiscally responsible budget focused on deficit reduction, meaning these increases are fully offset by cuts in other programs.

I now turn to the budgets of individual agencies in a bit more detail. I will focus on the agencies under the jurisdiction of the Committee. Therefore, I will not provide details of the defense R&D portfolio (the Department of Defense and DOE's defense programs) or the budget of the National Institutes of Health (NIH).

National Science Foundation (NSF)

The National Science Foundation (NSF) is the primary source of support for academic research for most non-biomedical disciplines, and it is the only Federal agency dedicated to the support of basic research and education across all fields of science and engineering. NSF has always operated under the belief that optimal use of Federal funds relies on two conditions: ensuring that its research is aimed—and continuously re-aimed—at the frontiers of understanding; and certifying that every dollar goes to competitive, merit-reviewed, and time-limited awards with clear criteria for success. When these two conditions are met, the Nation gets the most intellectual and economic leverage from its research investments. In recognition of the time-proven truth that today's NSF grants are tomorrow's job-creating companies, the 2013 Budget request for NSF is $7.4 billion, an increase of 4.8 percent above the 2012 funding level.

NSF puts the greatest share of its resources into the Nation's colleges and universities. Universities are the largest performers of basic research in the United States, conducting over 50 percent of all basic research. Basic research funding such as that provided by NSF is important not only because it leads to new knowledge and applications but also because it trains the researchers and the technical workforce of the future, ensuring the Nation will benefit from a new generation of makers and doers. In order to maximize this dual benefit to society and NSF's special contribution, the 2013 Budget provides $243 million to sustain the number of new NSF Graduate Research Fellowships at 2,000. The 2013 Budget also includes $64 million for the Advanced Technological Education (ATE) program to promote partnerships between higher-education institutions and employers to educate technicians for the high-technology fields that drive our Nation's economy.

The 2013 Budget expands NSF's efforts in clean-energy research, advanced manufacturing, wireless communications, cyber-infrastructure, and other emerging technologies. NSF proposes to increase research funding to promote discoveries that can spark innovations for tomorrow's clean-energy technologies with a cross-disciplinary approach to sustainability science. The Science, Engineering, and Education for Sustainability (SEES) portfolio will increase to $203 million in the 2013 Budget for integrated activities involving renewable energy technologies, green chemistry, and complex environmental and climate processes. NSF supports job creation in advanced manufacturing and emerging technologies with $257 million in Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) for multidisciplinary research targeted at new materials, smart systems, advanced manufacturing technologies, and robotics technologies. To encourage interdisciplinary research for the bioeconomy of the future, the 2013 Budget provides $30 million for research at the interface of biology, mathematical and statistical sciences, the physical sciences, and engineering in the BioMaPS program. The Cyber Infrastructure Framework for 21st Century (CIF21) portfolio will expand to $106 million in the 2013 budget for accelerating research, workforce development, advanced computing infrastructure, and

new functional capabilities in computational and data-enabled science and engineering. The Budget proposes $51 million for the NSF's Enhanced Access to the Radio Spectrum, or EARS, to support research into new and innovative ways to use the radio spectrum. NSF also proposes $110 million for Secure and Trustworthy Cyberspace (STC), a cybersecurity basic research initiative.

National Aeronautics and Space Administration (NASA)

The 2013 NASA Budget reaffirms the Administration's commitment to a bold and ambitious future for NASA, consistent with the bipartisan agreement between Congress and the Administration regarding the importance of NASA and its many programs. These critical efforts not only advance grand and inspirational undertakings such as space exploration, scientific discovery, and aeronautical research, but also provide an indispensable platform from which to study and understand our planetary home. Moreover, NASA's programs drive new technology development and innovation and help advance new products, services, businesses, and jobs with great potential for economic growth. In keeping with such considerations and the provisions of the 2010 NASA Authorization Act (the Act), the 2013 Budget funds continued development of the Space Launch System (SLS) and Orion Multi-Purpose Crew Vehicle (MPCV) to enable human-exploration missions beyond Earth's orbit; the operation and enhanced use of the International Space Station (ISS), which has been extended through at least 2020; the development of private-sector systems to carry cargo and crew into low Earth orbit, thus re-establishing a U.S. human spaceflight capability and shortening the duration of our sole reliance on Russian launch vehicles for access to the ISS; a balanced portfolio of space and Earth science, including a continued commitment to new satellites and programs for Earth observation; a dynamic space-technology development program; and a strong aeronautics research effort.

Within the context of a difficult budget environment and the Budget Control Act's spending caps freezing discretionary spending at 2011 levels for the second year in a row, NASA's budget request for 2013 is $17.7 billion, a decrease of $58 million from the 2012 enacted level. This budget incorporates difficult choices that honor the priorities of the Act while providing a balanced program of science, research, technology development, safe spaceflight operations, and exploration. The budget for the James Webb Space Telescope (JWST) is $628 million in 2013 in support of a scheduled 2018 launch, thus assuring NASA the opportunity to continue work on this transformative facility, which will expand and deepen our understanding of how the first stars and galaxies formed after the Big Bang, of planets around other stars, and of dark energy. The budget for Mars exploration reflects an integrated strategy that ensures the next steps for the robotic Mars Exploration Program that support science and long-term human exploration goals. The 2013 Budget maintains Earth-science research funding levels consistent with the 2012 Budget. The Budget also provides $1.9 billion in Fiscal Year 2013 funding for the SLS and $1.0 billion for the Orion MPCV, advancing the continued development of these systems that will enable exploration to deep-space destinations beyond today's reach. In these activities NASA will build on the configuration and acquisition decisions that it has made over the last several months. Similarly, the Budget provides a solid foundation for the commercial crew and cargo transportation programs that are necessary to provide safe and cost-effective U.S. access to low Earth orbit, and will allow us to stop paying Russia for astronaut transport to the ISS.

Department of Commerce National Institute of Standards and Technology (NIST)

The hugely complex web of technology that keeps this Nation's equipment and economy running smoothly depends on largely invisible but critical support in the fields of measurement science and standards. The National Institute of Standards and Technology (NIST) laboratories stand at the core of this Nation's unparalleled capacity in these areas, promoting U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology. Reflecting NIST's vital role in supporting the economy and infrastructure, the 2013 Budget of $708 million for NIST's intramural laboratories and construction of research facilities amounts to a 13.8 percent increase over the 2012 enacted level. That increase will support high-performance laboratory research and facilities for a diverse portfolio of investigations in areas germane to advanced manufacturing, nanotechnology, cybersecurity, and disaster resilience. For NIST's extramural programs, the Budget includes $128 million for the Hollings Manufacturing Extension Partnership and $21 million for the Advanced Manufacturing Technology Consortia program, a new public-private partnership that will develop road maps of long-term industrial research needs and will fund research at leading universities and government laboratories directed at meeting those needs. All of these NIST programs are important

components of *A National Strategy Strategic Plan for Advanced Manufacturing,* a comprehensive strategic plan to guide Federal advanced manufacturing R&D investments that was released in February.

Department of Commerce National Oceanic and Atmospheric Administration (NOAA)

NOAA plays a vital role supporting research on the Earth's oceans, atmosphere, and marine habitats which directly and indirectly are enormous sources of economic activity. The NOAA budget of $5 billion allows NOAA to strengthen the scientific basis for environmental decisionmaking; improve critical weather and climate services that protect life and property; invest more heavily in restoring our oceans and coasts to ensure their ongoing ecological stability and commercial vigor; and ensure satellite continuity.

The 2013 Budget provides $1.8 billion to continue the development and acquisition of NOAA's polar-orbiting and geostationary weather satellite systems, as well as satellite-borne measurements of sea level and potentially damaging solar storms. The Budget includes funding to continue work on the instruments and spacecraft for the Joint Polar Satellite System, or JPSS. NOAA will also conduct Arctic research (including bellwether studies of changing conditions), improve regional projections of climate change, and support research on coastal and marine resources and development of marine sensor technologies to address harmful algal blooms and ocean acidification.

Department of Energy (DOE)

The Department of Energy (DOE) 2013 Budget positions the United States to lead in the clean-energy economy of the future with an R&D portfolio that totals $11.9 billion, an increase of $884 million or 8.0 percent over the 2012 enacted level. (This does not include DOE's non-R&D cleanup and energy-deployment programs.) The Administration's clean-energy R&D priorities focus on developing cutting-edge technologies with real-world applications to advance a clean-energy economy, increase energy efficiency in industry and manufacturing, reduce energy use in buildings, and reach the goal of having 1 million advanced technology vehicles on the road by 2015.

The 2013 Budget invests in DOE's clean-energy programs to reduce dependence on oil and to move toward a clean-energy future, including $2.3 billion for Energy Efficiency and Renewable Energy (EERE). Within this total, the Budget provides $290 million to expand activities on innovative manufacturing processes and advanced materials to enable U.S. companies to cut manufacturing costs by using less energy. The Budget also moves closer to the goal of 1 million advanced technology vehicles on the road by investing $420 million within EERE to advance vehicle technologies and to make electric vehicles cost competitive, and by enhancing advanced vehicle tax incentives. The Budget also includes $12 million for DOE as part of a $45-million priority research and development initiative by the Department of Energy, the Department of the Interior's U.S. Geological Survey, and the Environmental Protection Agency to understand and minimize the potential environmental, health, and safety impacts of natural gas development through hydraulic fracturing (fracking).

The 2013 Budget provides $350 million for the Advanced Research Projects Agency—Energy (ARPA–E) within DOE to support transformational discoveries and accelerate solutions in the development of clean energy technology. ARPA–E performs high-risk, high-reward energy research with real-world applications in areas ranging from grid technology and power electronics to batteries and energy storage. First funded as part of the American Recovery and Reinvestment Act (ARRA), ARPA–E is a signature component of the America COMPETES Act, and was reauthorized in the America COMPETES Reauthorization Act.

The 2013 Budget also supports research through Energy Innovation Hubs funded in 2012 to solve specific energy challenges as part of DOE's overall research and development strategy. Each of the five Energy Innovation Hubs focuses top scientific and engineering talent on a specific problem: improving batteries and energy storage, reducing constraints from critical materials, developing fuels that can be produced directly from sunlight, improving energy-efficient building systems design, and using modeling and simulation for advanced-nuclear-reactor operations. The Budget proposes $20 million to create a new Energy Innovation Hub on Electricity Systems to focus on grid systems, emphasizing the interface between transmission and distribution systems. Each of these Hubs will bring together a multidisciplinary team of researchers in an effort to speed research and shorten the path from scientific discovery to technological development and commercial deployment of highly promising energy-related technologies. Complementing the Hubs, the Department plans to continue coordination with the Office of Science's Energy Frontier Research

Centers, which tackle the toughest scientific hurdles to building a new 21st century clean energy economy.

The Department of Energy's Office of Science pursues fundamental discoveries and supports major scientific research facilities that provide the foundation for long-term progress in energy-related domains such as nanotechnology, the physical sciences, advanced materials, high-end computing, energy supply and end-use efficiency, and climate change. The Office stewards 10 DOE National Laboratories and supports the research of more than 25,000 Ph.D. scientists, graduate students, and postdoctoral associates at over 300 universities and national laboratories nationwide. About 26,500 researchers from academe, national laboratories, and industry make use of its advanced scientific user facilities each year, pursuing discoveries at the frontiers of science that enhance the Nation's energy security and strengthen our economic competitiveness. The 2013 Budget of $5.0 billion for the Office of Science, 2.4 percent above the 2012 enacted level, provides support for facilities and cutting-edge research.

Environmental Protection Agency (EPA)

Environmental Protection Agency (EPA) R&D funding totals $576 million in the 2013 Budget, $8 million more than the 2012 funding level. With this investment, EPA will focus on enhancing and strengthening the planning and delivery of science in its restructured research and science programs, making these efforts more integrated and cross-disciplinary. The 2013 Budget supports high-priority research of national importance in such areas as potential endocrine disrupting chemicals, innovative chemical design, green infrastructure, computational toxicology, drinking water, and STEM fellowships. The 2013 Budget proposes a total of $14 million for EPA for the above-mentioned collaboration with USGS and DOE on hydraulic fracturing.

United States Geological Survey (USGS)

The total budget of the United States Geological Survey (USGS), Interior's lead science agency, is $1.1 billion, a $35 million increase from the 2012 enacted level. The 2013 Budget proposes $19 million for USGS for the above-mentioned collaboration with EPA and DOE on hydraulic fracturing. The Budget also sustains USGS funding for water and ecosystems science programs; research to mitigate natural hazards such as earthquakes, landslides, floods, and volcanoes; and climate change science.

Department of Homeland Security (DHS)

Department of Homeland Security (DHS) R&D totals $729 million in the 2013 Budget, up 26.3 percent from the 2012 enacted level in order to partially restore steep cuts enacted in 2012 appropriations. The 2013 Budget funds important R&D advances in cybersecurity, nuclear materials and explosives detection, and biological response systems. The Budget does not fund construction of the National Bio-and Agro-Defense Facility (NBAF) in 2013; rather, DHS will conduct a comprehensive assessment of the requirements for a large animal foreign and emerging disease research and diagnostic laboratory facility in the United States.

Department of Transportation (DOT)

The 2013 Budget provides $1.1 billion for Department of Transportation (DOT) R&D, a $132 million increase compared to the 2012 funding level. The Budget request includes funding for several R&D activities in the Federal Aviation Administration's (FAA) Next Generation Air Transportation System, known as NextGen. The Joint Planning and Development Office coordinates this important interagency effort, which strives to reduce delays, expand capacity, and improve the safety and environmental impact of air transportation. The Federal Highway Administration (FHWA) also manages a comprehensive, nationally coordinated highway research and technology program, engaging and cooperating with other highway research stakeholders. FHWA performs research activities associated with safety, infrastructure preservation and improvements, and environmental mitigation and streamlining.

White House Office of Science and Technology Policy (OSTP)

The 2013 Budget requests $5.85 million for White House Office of Science and Technology Policy (OSTP) operations, above the $4.50 million 2012 enacted funding level but 12.0 percent below the $6.65 million 2011 enacted funding level. OSTP works with the Office of Management and Budget (OMB) to set S&T priorities for all the Executive Branch departments and agencies with S&T and STEM-education missions. OSTP also provides science and technology advice and analysis in support of the activities of the other offices in the Executive Office of the President and sup-

ports me in my role as the Assistant to the President for Science and Technology, with the responsibility to provide the President with such information about science and technology issues as he may request in connection with the policy matters before him. In addition, OSTP coordinates a wide array of interagency research initiatives with significant economic implications through administration of the National Science and Technology Council (NSTC) and serves as the lead White House office in a range of bilateral and multilateral S&T activities internationally. This work is accomplished with approximately 27 full-time equivalent staff supported by the OSTP appropriation, which includes the OSTP Director, four Associate Directors (for Science, Technology, Environment, and National Security and International Affairs), additional technical experts, and a small administrative team. In addition, there are approximately 50 scientific and technical experts detailed to OSTP from all across the Executive Branch along with approximately a dozen other experts brought in under the Intergovernmental Personnel Act or various fellowship arrangements. This mix of personnel allows OSTP to tap a wide range of expertise and leverage a multitude of high-value resources to ensure that the science and technology work of the Federal Government is appropriately supported, coordinated and amplified. The reduced 2012 OSTP funding level required significant reductions in staffing and support levels; the 2013 Budget would return OSTP personnel and support funding closer to historical levels.

Science, Technology, Engineering, and Mathematics (STEM) Education

In his remarks at the second White House Science Fair in early February, the President called for an "all-hands-on-deck" approach to science, technology, engineering, and mathematics (STEM) education. "Let's train more teachers. Let's get more kids studying these subjects. Let's make sure these fields get the respect and attention that they deserve," he said. To support this important effort, the 2013 Budget invests $3.0 billion in programs across the Federal Government on STEM education, a 2.6 percent increase over the 2012 enacted funding level. The 2013 Budget makes disciplined choices guided by drafts of the Federal STEM education strategic plan, cutting back on lower-priority programs to make room for targeted increases and reducing duplication and overlap. The Budget proposes elimination or consolidation of programs that would reduce the total number of Federal STEM education programs to 209 from 235 in Fiscal Year 2012.

In his 2011 State of the Union address, the President called for a new effort to prepare 100,000 effective STEM teachers with strong teaching skills and deep content knowledge over the next decade. That call had roots in a groundbreaking analysis by the President's Council of Advisors on Science and Technology (PCAST) and remains a priority for this Administration in the coming year. As a crucial component of achieving this goal, the 2013 Budget proposes an investment of $135 million through the Department of Education (ED) and NSF to provide effective teachers in every classroom across America who are well qualified in the STEM subjects they teach. This coordinated effort between NSF and ED will help prepare teachers with both strong teaching skills and deep content knowledge. The 2013 Budget in ED proposes setting aside $80 million from the Effective Teachers and Leaders State Grants program to support the expansion of promising and effective models of STEM teacher preparation, which will be an important step toward the President's goal. In NSF, $55 million is proposed for the Robert Noyce Scholarship Program, to encourage talented STEM majors and professionals to become K–12 mathematics and science teachers.

In February, the President announced that the 2013 Budget will also establish undergraduate STEM education reform as a top priority, in part to fulfill PCAST's most recent report on undergraduate STEM education, released last month in conjunction with the second White House Science Fair, calling for the United States to establish a goal of training one million additional STEM graduates over the next decade. Federal agencies will contribute to this goal through programs designed to engage students and improve teaching and learning in STEM fields from early learning through K–12 and undergraduate levels. For example, the 2013 Budget proposes a significant boost in funding at NSF for undergraduate education, and improved coordination between undergraduate STEM education programs at NSF and ED. The Budget proposes $61 million for NSF's Transforming Undergraduate Education in STEM (TUES) program, which will provide research and development funds to design, test, and implement more effective educational materials, curriculum, and methods to improve undergraduate learning and completion rates in STEM for a diverse population. The Budget also proposes $60 million for a jointly administered NSF and ED mathematics education initiative that will allocate funds for early research, development, validation, and scale-up of effective practices. Similar to ED's Investing in Innovation (i3) program, this initiative will support collabo-

rations between researchers and practitioners to develop and test promising approaches and support widespread adoption of practices found to be effective through rigorous evaluations.

These efforts in the 2013 Budget are part of a broader Administration commitment to look carefully at the effectiveness of all STEM programs and find ways to improve them. To further this goal, last year I established a Committee on STEM Education under the NSTC as called for in Section 101 of the America COMPETES Reauthorization Act. In December, the Committee released the most comprehensive inventory of all Federal STEM efforts ever compiled. The work of this Committee is closely aligned with the vision for STEM education outlined by Congress in the America COMPETES Reauthorization Act and has focused on improving the coordination and effectiveness of all Federal STEM education programs. In this spirit, the Administration released a description of a 5-year Federal STEM education strategic plan and an update to the Federal STEM inventory along with the Budget, as called for in the COMPETES reauthorization. The final strategic plan, to be released this spring, will outline a path to increase coordination and collaboration among the 13 agencies that support STEM education and increase the efficiency and impact of the Federal portfolio of STEM education programs.

OSTP looks forward to continuing to work with this Committee on our common vision of improving STEM education for all of America's students in order to build the skilled workforce the Nation needs.

Advanced Manufacturing, Innovation, Entrepreneurship, and Job Creation

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 partnership is a key recommendation of *The Report to the President on Ensuring American Leadership in Advanced Manufacturing,* released by the President's Council of Advisors on Science and Technology (PCAST) in June 2011. The 2013 Budget builds on many of the PCAST report's recommendations and the priorities outlined by the President in his 2012 State of the Union address by proposing $2.2 billion for Federal advanced-manufacturing R&D at NSF, NIST, DOD, DOE, and other agencies. For example, the Budget provides DOE with $290 million to expand R&D on innovative manufacturing processes and advanced industrial materials that will enable U.S. companies to cut the costs of manufacturing by using less energy, while improving product quality and accelerating product development. Also, as part of the broader effort, the Budget invests in the National Robotics Initiative (NRI) to develop robots that work with or beside people to extend or augment human capabilities. Another important component of the broader Federal R&D agenda that contributes to advanced manufacturing is the Materials Genome Initiative: in the same way that the Human Genome Project accelerated a range of biological sciences by identifying and deciphering the human genetic code, this initiative will speed our understanding of the fundamentals of materials science, providing a wealth of practical information that American entrepreneurs and innovators will be able to use to develop new products and processes.

Last year, in response to Section 102 of the America COMPETES Reauthorization Act, we created the NSTC interagency working group on Advanced Manufacturing. This group recently released *A National Strategic Plan for Advanced Manufacturing,* a comprehensive strategic plan to guide Federal advanced manufacturing R&D investments as called for by the COMPETES reauthorization. The plan documents the fundamental importance of advanced manufacturing to the economic strength and national security of the United States and sets forth five objectives for Federal policy: (1) accelerating investment in advanced manufacturing technology, especially by small-and medium-sized manufacturers; (2) making the education and training system more responsive to the demand for skills; (3) optimizing Federal advanced manufacturing R&D investments by taking a portfolio perspective; (4) increasing total public and private investments in advanced manufacturing R&D; and (5) fostering national and regional partnerships among all stakeholders in advanced manufacturing. In December, the White House created an Office of Manufacturing Policy to drive interagency coordination and announced that NIST will host an advanced manufacturing national program office. The duties of the NIST-hosted office will include carrying out a portfolio analysis of the Federal advanced manufacturing R&D investment, as called for by the strategic plan.

Through these efforts in advanced manufacturing, I am confident that the United States will remain the world leader in bringing advanced technologies from initial conception to commercialization in our important manufacturing sector.

In addition to the investments in R&D I have described, the President's 2013 Budget targets other strategic investments to spur innovation in the public and private sectors and to maximize the impact of the Federal R&D investment for innovation, with the goal of transforming the Nation's economy and improving the lives of all Americans.

One way to spur innovation in the public and private sectors and to maximize the impact of the Federal R&D investment for innovation is to use prizes or challenges. Over the past 3 years, OSTP has been leading the Administration's efforts to make prizes a standard tool in every agency's toolbox.

Section 105 of the America COMPETES Reauthorization Act granted all Federal agencies broad authority to conduct prize competitions to spur innovation, solve tough problems, and advance their core missions. By giving agencies a clear legal path, the legislation makes it easier for agencies to use prizes to supplement more traditional R&D funding mechanisms such as grants and contracts. By significantly expanding the authority of all Federal agencies to conduct prize competitions, the legislation is an important step forward that enables agencies to pursue more ambitious prizes with robust incentives.

Over the past year, the Administration has laid the policy and legal groundwork to take maximum advantage of the new prize authority in the years to come. Policy and legal staff in OSTP and the Office of Management and Budget (OMB) jointly developed a Fact Sheet and Frequently Asked Questions memorandum issued in August 2011 to streamline implementation of the new, governmentwide authority. As required by the COMPETES reauthorization, GSA launched a new contract vehicle to allow agencies to more easily tap private-sector prize expertise, in addition to their continued promotion of *Challenge.gov*. In December 2011, the Administration launched a governmentwide Center of Excellence for Collaborative Innovation led by NASA to provide agencies guidance on all aspects of implementing prize competitions. Agencies, such as the Department of Health and Human Services (HHS), have begun to establish strategies and policies to further accelerate widespread use of the new prize authority granted to them through the COMPETES reauthorization.

This month, OSTP will be submitting to Congress a full progress report on how the America COMPETES Reauthorization Act's prize authority is being implemented throughout the Federal Government and how this authority is boosting innovation.

In addition, the Budget proposes a permanent extension of the research and experimentation (R&E) tax credit to spur private investment in R&D by providing certainty that the credit will be available for the duration of the R&D investment. The 2013 Budget proposes to expand and simplify the credit as part of making it permanent.

The 2013 Budget also sustains the Administration's effort to promote regional innovation clusters as significant sources of entrepreneurship, innovation, and quality jobs. These efforts are taking place in several agencies working together, including the Small Business Administration (SBA), DOE, and especially the Economic Development Administration (EDA) within the Department of Commerce. EDA will be pursuing several programs in research parks, regional innovation clusters, and entrepreneurial innovation activities, as authorized in the America COMPETES Reauthorization Act. And as mentioned earlier, the 2013 Budget continues to support the Hollings Manufacturing Extension Partnership (MEP) in NIST to disseminate the latest advanced manufacturing techniques and innovative processes to small-and medium-sized manufacturers around the Nation. It also supports an expansion of NSF's Innovation Corps (I-Corps) program with $19 million to bring together technological, entrepreneurial, and business know-how to move research discoveries toward commercialization. Taken together, these investments will help ensure that Federal investments in innovation, education, and infrastructure translate into commercial activity, real products, and jobs.

In addition to Federal investments, we are also working to build public-private partnerships in innovation and entrepreneurship. The Advanced Manufacturing Partnership (AMP) described above is one such partnership. Also, in late January, the Administration celebrated the 1-year anniversary of Startup America (SUA), a campaign to inspire and accelerate high-growth entrepreneurship throughout the Nation. Earlier this month, SUA unveiled a number of Administration and private-sector actions geared toward expanding access to capital, cutting red tape, and accelerating innovation for small businesses and entrepreneurs. The private sector answered the President's call to action last year by forming the Startup America Partnership, a nonprofit alliance of successful business owners, major corporations, and service providers dedicated to making entrepreneurship more successful in this country. In just 1 year, the Partnership has mobilized over $1 billion in business

resources to serve as many as 100,000 startups over the next 3 years. In February, the Partnership launched nine new entrepreneur-led regional networks across the country—in the District of Columbia, Hawaii, Kansas, Michigan, Missouri, Nebraska, Rhode Island, Virginia, and Vermont—while previously launched Startup Regions celebrated SUA's anniversary in Florida, Iowa, Illinois, Massachusetts, and Tennessee.

Other America COMPETES Reauthorization Act Initiatives

The Administration recognizes that improving access to the results of federally funded research can lead to more rapid dissemination of knowledge to the private sector and the taxpayers who supported that research and can boost innovation. OSTP has been active for some time on issues around access to the results of federally funded scientific research. Section 103 of the America COMPETES Reauthorization Act calls upon OSTP to coordinate agency policies on public access to and long-term stewardship of the results of federally funded unclassified research. OSTP established two interagency policy groups under the NSTC—the Task Force on Public Access to Scholarly Publications and the Interagency Working Group on Digital Data—to identify the specific objectives and public interests that need to be addressed by any policies in these two areas. OSTP had previously conducted a public consultation about policy options for expanding public access to federally funded peer-reviewed scholarly articles in 2009–10. In response to the COMPETES reauthorization, OSTP conducted a second public consultation last November by issuing two Requests for Information (RFI)—one on Public Access to Peer-Reviewed Scholarly Publications Resulting From federally Funded Research and the other on Public Access to Digital Data Resulting From federally Funded Scientific Research.

The public comments resulting from the RFI's are now available on the OSTP website. We had 375 comments on public access to peer-reviewed scholarly publications and 118 on the management of and access to digital data resulting from federally funded scientific research. We are now in the process of analyzing those comments. We expect to deliver a report updating Congress on the status of these efforts and comments in late March. The two NSTC interagency working groups are working to develop policy options in these two areas.

OSTP recognizes that scientific collections are also a vital part of the common infrastructure for science in the United States, and is working with Federal agencies to implement the 2009 NSTC report *Scientific Collections: Mission-Critical Infrastructure for Federal Science Agencies,* which highlights the many ways collections contribute to improving health, enhancing national security, protecting commerce and trade, studying climate and ecosystems, and understanding our environment. In October 2010, I issued a Policy on Scientific Collections memorandum to Federal agencies, and in January 2011 Section 104 of the America COMPETES Reauthorization Act reinforced the memo's call for a coordinated Federal Government policy toward scientific collections. In order to help Federal agencies realize the requirements listed in these documents—to properly assess and realistically project budgets for collections, to share best practices for maintaining collections, and to create an online clearinghouse of information about these collections—the NSTC interagency group on scientific collections has formed three working groups to focus on these tasks. These groups are making progress, and we hope to present the results of their work to Congress in the near future.

Interagency Initiatives

A number of priority interagency S&T initiatives are highlighted in the President's 2013 Budget. These initiatives are coordinated through the NSTC, which as noted above is administered by OSTP.

Networking and Information Technology R&D

The multi-agency Networking and Information Technology Research and Development (NITRD) provides strategic planning for and coordination of agency research efforts in cybersecurity, high-end computing systems, advanced networking, software development, high-confidence systems, information management, and other information technologies. The 2013 Budget provides $3.8 billion for NITRD, an increase of $69 million over the 2012 funding level. This initiative celebrated its 20th anniversary last month.

Networking and computing capabilities are more critical than ever for a range of national priorities, including supporting national and homeland security, reforming the healthcare system, understanding and responding to environmental stresses, increasing energy efficiency and developing renewable energy sources, strengthening the security of our critical infrastructures including cyberspace, and revitalizing our educational system for the jobs of tomorrow. The 2013 Budget includes a focus on research in an area of ever-growing importance: how best to derive value and sci-

entific inferences from unprecedented quantities of data. It also continues to emphasize foundations for assured computing and secure hardware, software, and network design and engineering to address the goal of making Internet communications more secure and reliable.

National Nanotechnology Initiative

The 2013 Budget provides $1.8 billion for the multi-agency National Nanotechnology Initiative (NNI), an increase of $70 million over the 2012 funding level. Research and development in the NNI focuses on the development of materials, devices, and systems that exploit the fundamentally distinct properties of matter at the nanoscale—on the order of a billionth of a meter—and on environmental and health studies relating to nanomaterials. NNI-supported R&D is enabling breakthroughs in disease detection and treatment, manufacturing at or near the nanoscale, environmental monitoring and protection, energy conversion and storage, and the design of novel electronic devices. Participating agencies continue to support fundamental research for nanotechnology-based innovation, technology transfer, and nanomanufacturing through individual investigator awards; multidisciplinary centers of excellence; education and training; and infrastructure and standards development, including openly accessible user facilities and networks. Furthermore, agencies have identified and are pursuing Nanotechnology Signature Initiatives in the national priority areas of nanomanufacturing, solar energy, and nanoelectronics through close alignment of existing and planned research programs, public-private partnerships, and research roadmaps.

The NNI agencies are guided by two strategic documents developed by the Nanoscale Science, Engineering, and Technology Subcommittee of the NSTC. The 2011 NNI Strategic Plan aligns nanoscale science and technology research with the NNI's four goals and includes specific, measurable objectives for each goal. The 2011 NNI Environmental, Health, and Safety Research Strategy delineates a research and implementation framework that will produce the information necessary to protect public health and the environment, foster product development and commercialization, and consider the ethical, legal, and societal issues associated with nanotechnology development.

U.S. Global Change Research Program

The Budget includes an expanded commitment to global change research, with the understanding that insights derived today will pay off with interest in the years and decades ahead as our Nation works to limit and adapt to shifting environmental conditions. Investments in climate science over the past several decades have contributed enormously to our understanding of global climate. The trends in global climate are clear, as are their primary causes, and the investments in this research arena in the 2013 Budget are a critical part of the President's overall strategy to mitigate U.S. greenhouse-gas emissions and move toward a clean-energy economy even as we adapt to those changes that are inevitable. Specifically, the 2013 Budget provides $2.6 billion for the multi-agency U.S. Global Change Research Program (USGCRP)—an increase of 5.6 percent or $136 million over the 2012 enacted level—to continue its important work of improving our ability to understand, predict, mitigate, and adapt to global change, including but not limited to climate change.

The USGCRP was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101–606) to improve understanding of uncertainties in climate science, expand global observing systems, develop science-based resources to support policymaking and resource management, and communicate findings broadly among scientific and stakeholder communities. Thirteen departments and agencies participate in the USGCRP. OSTP and the Office of Management and Budget (OMB) work closely with the USGCRP to establish research priorities and plans to maximize research-dollar efficiencies and ensure that the program is aligned with the Administration's priorities and reflects agency planning.

The 2013 Budget supports the four objectives set forth in USGCRP's new decadal strategic plan, to be released shortly, which are to (1) *Advance Science:* advance scientific knowledge of the integrated natural and human components of the Earth system; (2) *Inform Decisions:* provide the scientific basis to inform and enable timely decisions on adaptation and mitigation; (3) *Conduct Sustained Assessments:* build sustained assessment capacity that improves the United States' ability to understand, anticipate, and respond to global change impacts and vulnerabilities; and (4) *Communicate and Educate:* advance communications and education to broaden public understanding of global change.

Funding in the 2013 Budget will support an integrated and continuing National Climate Assessment of climate-change science, impacts, vulnerabilities, and response strategies, as mandated by Congress.

Conclusion

This Administration's 2013 Budget reflects a clear understanding of the critical importance of science and technology, STEM education, and 21st century infrastructure to the challenges the Nation faces. Recognizing the importance of responsibly reducing projected budget deficits and holding the line on government spending, the Administration has made disciplined choices in order to maintain and in some cases increase critical investments that will pay off by generating the American jobs and industries of the future—all in the context of a discretionary budget that stays flat for a second year in a row. Indeed, the science and technology investments in the 2013 Budget are essential to keep this country on a path to revitalized economic growth, real energy security, intelligent environmental stewardship, better health outcomes for more Americans at lower costs, strengthened national and homeland security, and continuing leadership in space.

As this Committee has long emphasized, and as the America COMPETES Reauthorization Act makes clear, the best environment for innovation in all technologies is a broad and balanced research program for all the sciences. Such a broad base of scientific research will provide the foundation for a cornucopia of multidisciplinary discoveries—some expected and planned, others entirely unexpected—with enormous benefits for our society. This country's overall prosperity in the last half century is due in great measure to America's "innovation system"—a three-way partnership among academia, industry, and government—and that same partnership will allow us to maintain that prosperity in the decades to come.

That is why the Obama Administration believes that leadership across the frontiers of scientific knowledge is not merely a cultural tradition of our nation, but is also an economic and national security imperative. This Administration wants to ensure that America remains at the epicenter of the global revolution in scientific research and technological innovation that promises to generate new knowledge, create new jobs, and build new industries.

I look forward to working with this Committee to make the vision of the President's Fiscal Year 2013 Budget proposal a reality. I will be pleased to answer any questions the Members may have.

Senator NELSON. Thank you.

Dr. Gallagher.

STATEMENT OF PATRICK D. GALLAGHER, PH.D., UNDER SECRETARY OF COMMERCE FOR STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Dr. GALLAGHER. Thank you, Chairman Nelson and Ranking Member Boozman and Chairman Rockefeller. It's a pleasure to be here today to summarize the NIST Fiscal Year 2013 request. This year's request for NIST can really be summarized in two words: "advanced manufacturing." The President's request reflects his very strong commitment to accelerate the pace of innovation and enable the transfer of technologies that help American manufacturers to compete around the world, as Secretary Bryson put it, to make products here and sell them everywhere.

NIST is an agency whose mission, going back more than 100 years and rooted in the U.S. Constitution, is specifically charged with supporting industrial innovation and competitiveness through leading edge measurements, through supporting robust standards development, and supporting tech transfer.

This committee has played an enormous leadership role in positioning NIST to play this role. The America COMPETES Reauthorization Act of 2010 made a number of significant changes to NIST. It made us more efficient, flexible, and in particular engaged with industry, especially the manufacturing sector.

Your support of our restructuring enabled us to work more collaboratively with each other and with industry. The COMPETES Act also established an Innovative Services Initiative within the Manufacturing Extension Partnership program. That has been im-

plemented, and there are other examples where the Act has made us more effective in what we do and how we do it.

This year's request builds upon our past successes and your support of our mission. Our overall discretionary request for 2013 is $857 million. That's an increase of $106 million from the current year. And, to focus on the significance of the manufacturing part, that total represents over $156 million dedicated to areas of advanced manufacturing.

Within the NIST budget there are three primary accounts at NIST. Let me briefly summarize them. The request for the NIST laboratory program, which is the largest program at the agency, is $648 million, an increase of $81 million. Over half of that proposed increase is specifically focused on supporting advanced manufacturing. The remaining proposed increases are targeted for research activities in advanced communications, forensics, disaster resilience, and the National Strategy for Trusted Identities in Cyberspace, as well as the establishment of Centers of Excellence where NIST works in collaboration with industry and academia.

The request for our Industrial Technology Services account is $149 million. That's an increase of $20 million. Within that account is the full $128 million for the Hollings Manufacturing Extension Partnership program and $21 million for the Advanced Manufacturing Technology consortia, or AMTech program. AMTech will support R&D in advanced manufacturing and strengthen long-term U.S. leadership in critical technologies. Our Construction account request is $60 million. This is an increase of almost $5 million. The Construction account funds construction, facility maintenance and operations activities at both of our campuses and specifically includes funds for the renovation of the 60-year-old Boulder Building 1, which is now reaching the end of its original design life and is completely inadequate for our scientific mission.

Also, the request includes discussion of two mandatory accounts. The first would provide funding to address critical barriers in public safety networks. This program was included in the Middle Class Tax Relief and Job Creation Act of 2011, which was just signed into law.

The second account would propose a National Network for Manufacturing Innovation. The President views this one-time investment of a billion dollars as crucial to revitalizing U.S. manufacturing. This program would be a direct collaboration between NIST, the National Science Foundation, the Department of Defense, and the Department of Energy. And since it will require separate legislation, we look forward to working with this committee on that endeavor.

Mr. Chairman, NIST's mission to work with industry to benefit American competitiveness could not be more relevant in my view to today's economic challenges, and I look forward to any questions the Committee will have.

[The prepared statement of Dr. Gallagher follows:]

PREPARED STATEMENT OF PATRICK D. GALLAGHER, PH.D., UNDER SECRETARY OF COMMERCE FOR STANDARDS AND TECHNOLOGY, U.S. DEPARTMENT OF COMMERCE

Chairman Nelson, Ranking Member Boozman, and members of the Subcommittee, thank you for the opportunity to appear before you today to present the President's

Fiscal Year (FY) 2013 budget request for the National Institute of Standards and Technology (NIST). This budget reflects the important role that NIST plays as part of President Obama's *"Blueprint for an America Built to Last."* As the President said recently in Annandale, Virginia, *"[An] economy built to last demands that we keep doing everything we can to . . . keep strengthening American manufacturing."* Secretary of Commerce John Bryson amplifies that message when he tells us that in order to create good paying jobs, we need to help more American businesses *"build it here and sell it everywhere."* The proposed Fiscal Year 2013 budget reflects NIST's critical role in the Administration's efforts to strengthen manufacturing through critical investments in key research and development areas.

The NIST mission is to promote U.S. innovation and industrial competitiveness through measurement science, standards and technology. This mission is very well-aligned with the priority goals as articulated by the President. The Fiscal Year 2013 budget for NIST reflects that alignment.

The NIST budget is comprised of three discretionary spending accounts and two new proposed mandatory spending accounts.

Mr. Chairman, the President's discretionary funding request for NIST is $857 million (excluding transfers), an increase of $106.2 million over Fiscal Year 2012. More than half of the proposed increased funding would be focused on advanced manufacturing research both at NIST laboratories and through a new industry-led consortia program. This budget was carefully crafted to address pressing needs for standards and measurement work in emerging technology areas and provide seed funding to encourage industry and academia to come together to address common technology problems too large for individual institutions to tackle. Moreover, this budget is consistent with the President's Plan for Science and Innovation and the goals of the America COMPETES Reauthorization Act of 2010, both of which call for significant increases in basic Federal R&D funding to make America more competitive.

For the NIST Scientific Research and Technical Services (STRS) account, which funds our laboratory programs, the budget requests $648 million to accelerate the development of standards, technology, and measurement science in areas as diverse as advanced manufacturing technologies, cybersecurity, forensics and interoperable communications. The request reflects a net increase of $81 million over the Fiscal Year 2012 level. The request will help ensure that NIST research laboratories, facilities and service programs continue to work at the cutting edge of science to ensure that U.S. industry, as well as the broader science and engineering communities, have the measurements, data and technologies they need to further innovation and industrial competitiveness.

For the NIST Industrial Technology Services (ITS) account, the budget requests $149 million, an increase of $21 million over the FY12 enacted level. The account includes NIST's external programs: the Hollings Manufacturing Extension Partnership (MEP) program; and the proposed Advanced Manufacturing Technology Consortia (AMTech) program.

The request includes $128 million for the MEP program; a slight decrease from the Fiscal Year 2012 enacted level. The MEP is a Federal-state-industry partnership that provides U.S. manufacturers with access to technologies, resources and industry experts. MEP's more than 1,400 field staff works with small-and mid-sized U.S. manufacturers to help them create and retain jobs, save time and focus on the bottom line to help increase profits. The request also includes $21 million for the AMTech program. This new program will establish industry-led consortia to identify and prioritize research projects supporting long-term industrial research needs. AMTech creates the incentive for manufacturers to share financial and scientific resources with universities, state and local governments and non-profits. The proposed program is a critical component of the Administration's emphasis on advanced manufacturing as a way to accelerate innovation and create high-quality U.S. jobs.

The budget requests $60 million for the Construction of Research Facilities (CRF) account; a $4 million increase over the Fiscal Year 2012 enacted level. Within that request are two components: $48.2 million for NIST's routine maintenance and repair budget; and $11.8 million for the Boulder Laboratories Building 1 Wing 6 Renovation. Critically needed renovations to the 60-year-old Building 1 in Boulder began in Fiscal Year 2010. The building houses the majority of research and measurement laboratories on the NIST-Boulder campus, supporting discovery and development in a number of critical areas, including public safety communications and telecommunications, precision timing, hydrogen energy sources, electromagnetic interference testing, and quantum computing.

The Administration's budget request for NIST also includes two mandatory funding initiatives. The first mandatory proposal is directed toward Public Safety Communications research and was included in the recently passed Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112–96). This legislation makes funds avail-

able from the Public Safety Trust Fund to NIST to help research and develop cutting-edge, interoperable wireless technologies for public safety users—the need for which was clearly demonstrated on September 11, 2001, during the rescue efforts at the World Trade Center towers. I will discuss this program in further detail later in my testimony.

Finally, as part of the Administration's efforts to revitalize manufacturing, the President's budget proposes a $1 billion mandatory account to establish a National Network for Manufacturing Innovation (NNMI), which aims to promote the development of manufacturing technologies with broad applications through collaboration between NIST, the Department of Defense, the Department of Energy, and the National Science Foundation.

Mr. Chairman, also included in this request are scientific and programmatic initiatives that are tied to the overarching themes of this budget: Advanced Manufacturing, Cybersecurity, Advanced Communications, Forensic Science, Disaster Resilience and Technology Transfer. These themes directly relate to the President's Blueprint for an America Built to Last—a blueprint for an economy built on American manufacturing.

Advanced Manufacturing—Building Prosperity Through Innovation

Manufacturing is critical to the U.S. economy. As President Obama said in his 2012 State of the Union address, "*We have a huge opportunity, at this moment, to bring manufacturing back. But we have to seize it.*" "*The blueprint for an economy built to last,*" he said, "*begins with American manufacturing.*" By itself, if the U.S. manufacturing sector were a country, it would be the 9th largest economy in the world.[1] Over 11 million Americans have manufacturing jobs.[2] Many of these are high-quality jobs.[3] Total hourly compensation in the manufacturing sector is, on average, 21 percent higher than that in the services sector.[4] After ranking as the world's largest manufacturer for more than a century, the U.S. is facing some stiff competition and has lost ground to China on total volume of its manufacturing output. It has also slipped below Germany, Korea, and Japan in the rankings of research and development manufacturing intensity, a critical indicator of future job-creating innovation.[5]

However, during the past 2 years of the Obama Administration, we have begun to see positive signs in American manufacturing: the manufacturing sector adding more than 400,000 jobs since December 2009; and more companies "in-sourcing"—bringing jobs back and making additional investments in the United States. We are seeing, for the first time since the late 1990s, an increase in manufacturing jobs.[6]

Even so, today's challenges require stepping up efforts to enhance and strengthen the Nation's underlying technical infrastructure, which is integral to our innovation and advanced manufacturing capabilities. Thus, the NIST Fiscal Year 2013 budget lays out a robust set of initiatives that cover the range of the manufacturing lifecycle spectrum to reduce the gap between cutting-edge science and development and the deployment of advanced manufacturing technologies. Providing the measurement tools and other essential technical assistance that U.S. manufacturers need to invent, innovate, and produce—more rapidly and more efficiently than their competitors—is a top NIST priority.

To reap the economic benefits of our ability to innovate, our Nation's manufacturing sector must be able to renew itself by adopting new technology and developing new markets. The Nation's manufacturers must respond quickly and effectively to an ever-changing mix of requirements, risks, and opportunities, from new regulations to rising energy costs to emerging technologies and markets. The revitalization of the U.S. manufacturing base is critical to driving innovation and job creation in the future, and will play a major role in building an economy that can help raise the standard of living for all Americans.[7]

The recently released *National Strategic Plan for Advanced Manufacturing,* a robust interagency effort led by the Office of Science and Technology Policy in which NIST played a significant role, articulated a number of ways in which we as a Nation can accelerate innovation to benefit advanced manufacturing and bridge the gaps in the present U.S. innovation system, particularly the gap between research and development (R&D) activities and the deployment of technological innovations

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[1] Bureau of Economic Analysis Manufacturing Industry Data Tables 2010.
[2] Bureau of Labor Statistics, 2011 *Employer Costs for Employee Compensation,* Table 6.
[3] NSTC *A National Strategic Plan for Advanced Manufacturing* February 2012 pg 2.
[4] Bureau of Labor Statistics, 2011 *Employer Costs for Employee Compensation,* Table 6.
[5] NSTC *A National Strategic Plan for Advanced Manufacturing* February 2012 pg 5.
[6] *http://www.bradenton.com/2012/02/17/3882196/manufacturing-exporting-showing.html.*
[7] Overview to the National Science Board's *Science and Engineering Indicators 2012;* pp. 16–20.

in domestic production of goods. The plan lays out a robust innovation policy that would help to close these gaps and address the full lifecycle of technology.

The President's Fiscal Year 2013 budget contains several initiatives focused on overcoming manufacturing-related barriers to innovation. We work very closely with numerous other Federal agencies in these efforts, including the Department of Energy's Advanced Manufacturing Office, the National Science Foundation, Department of Defense, and others.

Measurement Science for Advanced Manufacturing

The largest overarching NIST initiative is Measurement Science for Advanced Manufacturing. This $45 million dollar initiative would fund five specific focus areas and is part of a $135 million overall investment in manufacturing research at NIST. The focus under this initiative is under 5 specific areas.

- *Metrology Infrastructure and Standards to Support Biomanufacturing*—Under this $10 million initiative, working closely with industry, the Food and Drug Administration, and standards organizations, NIST will develop the measurement infrastructure needed to gain detailed understanding of biomanufacturing processes and design methods that yield higher-quality therapeutic products. Continuous improvements will enable manufacturing processes that are sufficiently adaptable to accommodate manufacture of next-generation treatments.
- *Measurement Science and Standards to Support Nanomanufacturing*—NIST will invest $10 million to develop measurement methods to help companies overcome technical barriers to cost effective, high-volume manufacturing of materials, devices, and systems that exploit the exceptional properties exhibited at the nanoscale. This initiative includes $2 million for nanotechnology related environmental, health, and safety research to address potential risks of nanotechnology based products.
- *Measurement Science and Standards to Speed Development and Industrial Applications of Advanced Materials*—This $10 million effort will accelerate NIST efforts in support of the national Materials Genome Initiative, an interagency program with the goal of significantly reducing the time from discovery to commercial deployment of new materials. NIST will focus on standard reference data bases, data assessment and validation, standards development and implementation, and modeling and simulation tools.
- *Measurement Science and Standards to Support Smart Manufacturing*—$10 million is slated to support smart manufacturing to exploit advances in sensors, data analytics, modeling, and simulation and integrate these technologies to improve manufacturing performance at all levels, from equipment to factory to supply chain. NIST will develop measurement capabilities and standards for automated in-process quality monitoring and control for factory-level production systems. NIST will also build a testbed to help industry, university, and government collaborators develop an open standards platform for facilitating the simultaneous engineering of the physical and virtual components of manufacturing systems.
- *NIST Manufacturing Fellowships Program*—The Manufacturing Fellowships program will be funded at $5 million to provide opportunities for engineers and scientists to work with NIST staff on the measurement and standards required to create cutting-edge tools for manufacturers. Fellowships will be available to qualified researchers from companies and non-profit organizations, as well as to recent recipients of bachelor's or master's degrees in relevant fields.

While the previous programs are supported under the STRS budget, the President's budget strongly supports manufacturing through the NIST Industrial Technology Services (ITS) programs as well, such as the Hollings Manufacturing Extension Partnership or MEP, and the Advanced Manufacturing Technology Consortia program, or AMTech.

Advanced Manufacturing Technology Consortia Program

The proposed $21 million AMTech program will provide cost-shared funding to industry-led consortia that are focused on developing advanced technologies to address major technical problems that inhibit development and widespread adoption of advanced manufacturing capabilities in the United States. By convening key organizations across the entire innovation lifecycle, AMTech will help to create the infrastructure necessary for more efficient technology transfer. These consortia will identify and conduct precompetitive research to address long-range basic R&D relevant to manufacturing, currently a weak link in the U.S. innovation ecosystem. AMTech will support high-value-added, knowledge-intensive U.S.-made products that re-

spond to new market opportunities and generate high-skilled manufacturing jobs, discover cost-effective methods for making new products that safely exploit nanoscale materials; and develop new types of manufacturing tools and processes that allow cost-effective small batch production and create new market opportunities for small and mid-sized manufacturers.

Hollings Manufacturing Extension Partnership (MEP)

The MEP, a Federal-state partnership, has a national network of MEP Centers located in all 50 states and Puerto Rico. There are over 1,400 technical experts associated with the Centers helping small-and medium-sized manufacturers navigate economic and business challenges and connecting them to public and private resources essential for increased competitiveness and profitability.

Focused on U.S. based manufacturers for the past 20 years, MEP continues to modify its suite of services to better serve America's manufacturing base. In support of the President's manufacturing strategy, MEP has recently developed a Supplier Scouting Program to support the current needs of the manufacturers they serve across the U.S. The Supplier Scouting Program is designed to help identify potential business opportunities for small U.S. manufacturers with specific capabilities and capacities that could be utilized by a larger domestic manufacturer. In response to the *Buy America* requirements of Federal agencies and the supplier requirements of the large manufacturers, MEP leverages its vast knowledge of local manufacturer capabilities to identify and pre-qualify supplier capabilities and capacities, and provide assistance to suppliers as needed. To further support this goal, MEP launched a new, searchable, web-based resource—the National Innovation Marketplace—to assist manufacturers in using emerging technologies and finding market opportunities or to move ideas from research in the labs to products. The site will enable businesses and entrepreneurs across the country to easily identify and contact more than 2,000 public-private organizations and initiatives designed to assist them.

In addition to focusing on manufacturing, the NIST Fiscal Year 2013 budget request also outlines investments that: broaden NIST's collaborations in measurement science with the academia and industry; strengthen and expand programs focused on emerging challenges in secure identification, cybersecurity, and advanced communications technologies; address measurement challenges in forensic science; and provide the measurements and standards to strengthen America's Physical Infrastructure.

NIST Centers of Excellence

The proposed $20 million will fund the NIST Centers of Excellence. The NIST Centers of Excellence support collaboration on the front end of the manufacturing spectrum that builds upon a legacy of successful consortia with universities. With the requested funding, NIST will provide grants to establish four competitively selected Centers of Excellence in measurement science areas defined by NIST. The grants to multi-or single-university centers are envisioned to be for multiple years, contingent upon available resources. Each Center of Excellence will provide an interdisciplinary environment where NIST, academic, and industry researchers would collaborate on basic and applied research focused on innovations in measurement science and new technology development.

NIST's mission to use measurement science and services to support innovation and industrial competitiveness covers an incredible breadth of topics—from pharmaceuticals based on nanotechnology to standards and fire codes for skyscrapers to quantum computers that use individual atoms to store information. To accomplish this mission efficiently, NIST must continually scan the horizons for emerging technologies and maintain excellent ties with both the industry and academic community. Currently, NIST has collaborative research centers—JILA with the University of Colorado, and the Joint Quantum Institute, and the Institute for Bioscience and Biotechnology Research with the University of Maryland. These centers have demonstrated how participation by NIST experts at multiple venues can leverage Federal investments and enhance the value of public funding. Cutting-edge research requires detailed, one-to-one exchange of technical know-how and often familiarity with one-of-a-kind instrumentation. To ensure that NIST's work intersects with the Nation's most productive regional innovation centers, it needs "on the ground" resources near or at those centers.

In addition to making significant discretionary investments to strengthen U.S. manufacturing, the Budget proposes a new, major initiative to catalyze a National Network for Manufacturing Innovation that will support the development of manufacturing technologies with broad applications through one-time mandatory funding of $1 billion. The President views this one-time investment as crucial to revitalizing

U.S. manufacturing. We look forward to working with the Congress on legislation to support this initiative.

Measurement Science and Standards in Support of Forensic Science

NIST has a long history of collaboration in the area of Forensic Science. This $5 million proposed initiative will enable NIST to create a strategic program to broadly address the most critical issues in forensic science today, such as new reference methods and technologies for understanding crime scenes and identifying criminals, including the uncertainty and standards associated with those techniques. A major outcome of this initiative will be to strengthen the utility and reliability of forensic evidence in the courtroom. This work also has the potential for significant cost savings for the U.S. justice system by reducing the number of mistrials or retrials related to questions about forensic analysis. One economic analysis of cost savings from forensic DNA testing alone estimated a cost savings of $35 for every dollar invested.

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. Working with the National Institute of Justice and other agencies, NIST has measurement science research under way in chemical, biological, radiological, and nuclear detection and analysis; fire and explosives analysis; gunshot residue, latent fingerprints, and many other areas. NIST's work in DNA profiling and testing, for example, helped establish the methods now used by all crime laboratories to match individuals to evidence samples. NIST technical expertise would be brought to bear in other areas of forensic science to the benefit of all.

Measurement and Standards for Disaster Resilience and Natural Hazards Risk Reduction

A $5 million initiative will support the measurement and standards for disaster resilience and reduce the risk from natural hazards. With a large percentage of the Nation's buildings and infrastructure clustered in disaster-prone regions, U.S. communities can and do suffer catastrophic losses from extreme events such as hurricanes, tornadoes, wildfires, earthquakes, and flooding. Despite significant progress in disaster related science and technology, natural and technological disasters in the United States are responsible for an estimated $55 billion in costs in 2011 terms of lives lost, disruption of commercial and financial networks, properties destroyed, as well as the cost of mobilizing emergency response personnel and equipment.[8] In 2011, three major incidents: the Joplin, Missouri, tornado; Hurricane Irene; and the Texas wildfires alone resulted in over 200 deaths and well over $10 billion in damages. Critically needed metrics, tools, and standards to ensure community-level resilience currently do not exist. These are needed to enable communities to minimize the impact of such disasters and to recover rapidly from them.

NIST has significant statutory responsibilities in this area, including the National Earthquake Hazards Reduction Program Reauthorization Act of 2004 (P.L. 108–360); the National Construction Safety Team Act (P.L. 107–231); the National Windstorm Impact Reduction Act of 2004 (P.L. 108–360); and the Federal Fire Prevention and Control Act of 1974 (P.L. 93–498).

The requested initiative will fund the development of a public-private partnership program strategy that will work with stakeholder interests in all hazard areas to develop and adopt a national resilience framework and associated resilience models, standards, and policies. Additionally, the funding will help address the R&D gaps to realize the full potential of national resilience. This initiative is focused directly on finding solutions to the six Grand Challenges identified by the President's National Science and Technology Council in June 2005.

Measurement Science to Support Advanced Communications Networks

This $10 million initiative will support the technological infrastructure, including standards, underpinning broadband communications networks, which have become as essential to today's economy as the electrical power grid was to the Industrial Revolution. To compete effectively in this global business environment, communities and companies will need reliable, secure access to huge amounts of data, available anytime, anywhere. However, the U.S. currently lacks the technology to ensure adequate capacity to achieve a large-scale network capable of this vision. There has been a 5,000 percent growth in demand for wireless Internet data in the last 3 years. Currently, 3 percent of wireless smart-phone customers use up to 40 percent of the total available cell-phone bandwidth causing large bottlenecks in mobile broadband access. Services are striving to address the rapid increase in demand, but

[8] *http://www.ncdc.noaa.gov/oa/reports/billionz.html.*

new technologies and approaches are needed. Incremental advances in broadband technology or network capacity will not be sufficient to meet the future needs of a hyper-connected world.

This initiative will help support continued operations of the 700 MHz Public Safety Broadband Demonstration (PSBD) Network and to make modifications to allow additional use as a platform for addressing interoperability and performance questions on non-PS next generation communications technologies. It will address three key areas to enable significant innovation in communications in both the commercial and public safety sectors. Benefits expected from funding of the advanced communications initiative include the development of a U.S. broadband network with greatly expanded capacity that requires only a marginal increase in capital and operating expenditures. In addition, it is expected to establish a testbed and build collaboration with the telecommunications industry to help lay the groundwork for an interoperable public safety communications network that seamlessly delivers voice, data, and video to first responders and other emergency personnel through whatever communication avenues are available.

Public Safety Communications Research and Development

In addition to the Advanced Communications initiative, the Middle Class Tax Relief and Job Creation Act of 2012 (P.L. 112–96) created a mandatory account to help research and develop cutting-edge technologies for public safety users. The September 11 attacks on the World Trade Center highlighted the inadequacies of our communications networks, more than 10 years after September 11, the United States still lacks a wireless interoperable network capable of linking public safety organizations and workers. First responders and other emergency personnel nationwide currently use a patchwork of incompatible technologies and frequency bands. NIST will use the funds to work with industry and public safety organizations on research and development of new standards, technologies, and applications that advance public safety communications. This initiative will establish a competitive grants program designed to support research, development, and demonstration projects. The overriding objective is to build a broadband system to allow first responders and other public safety personnel anywhere in the Nation to send and receive data, voice, and other communications to work together effectively in response to crises.

National Strategy for Trusted Identities in Cyberspace

The Budget provides an increase of $8 million to the National Strategy for Trusted Identities in Cyberspace (NSTIC) which builds upon Fiscal Year 2012 funding of $16.5 million. The initiative envisions an online environment—the "Identity Ecosystem"—that improves on the use of passwords and usernames, and allows individuals and organizations to better trust one another, with minimized disclosure of personal information. The Identity Ecosystem is a user-centric online environment, a set of technologies, policies, and agreed upon standards, that securely support transactions ranging from anonymous to fully authenticated and from low to high value. It would include a vibrant marketplace that allows people to choose among multiple identity providers—both private and public—that would issue trusted credentials that prove identity. Key attributes of the Identity Ecosystem include privacy, convenience, efficiency, ease-of-use, security, confidence, innovation, and choice. Creating this Identity Ecosystem will require input from the private sector, advocacy groups, public sector agencies and others. The request continues and expands existing efforts to coordinate Federal activities needed to implement NSTIC.

Specifically, the Fiscal Year 2013 request funds competitively selected pilot project grants that will enable the private sector to work with state, local, and regional governments to improve acceptance of Identity Ecosystem components. The selected NSTIC pilot programs will demonstrate innovative frameworks that can provide a foundation for more trusted online transactions and tackle barriers that have, to date, impeded the Identity Ecosystem from being fully realized. This initiative is expected to lead to the emergence of privacy-enhancing, trusted authentication solutions that lead to better protections against cybercrime; improved privacy and protection of data; improved security and interoperability of credentials; improve the resilience of data breach recovery; and a self-sustaining, private-sector-led Identity Ecosystem (by 2015) and its Steering Group that brings together all stakeholders—the private sector, advocacy groups, and public-sector agencies—to address authentication challenges and allow continued expansion of the Nation's online economy.

Boulder Laboratories Building 1 Renovation

NIST is requesting $11.8 million in Fiscal Year 2013 for the Construction of Research Facilities account for the renovation of the Boulder (CO) labs—Building 1. This initiative is part of a comprehensive, multi-year plan for the phased construc-

tion of new space and renovation of Building 1. As you may know, Building 1 is nearly 60 years old and houses the majority of NIST research and measurement programs on the agency's Boulder site. However, the aging building is simply inadequate for the kind of high-precision measurement work conducted there.

The poor condition of Building 1 causes an estimated loss in productivity of at least 20 percent due to the need to repeat experiments to produce quality research results and compensate for poor controls in other ways. Even with the completion of Boulder's Precision Measurement Laboratory later this year, many NIST research projects requiring tight environmental controls will need to continue in Building 1. Renovation of Wing 6, the portion of Building 1 addressed with this initiative, includes a number of laboratories engaged in essential research and technical services such as calibrations used for radio, microwave, and optical frequency equipment in the telecommunications, medical, and scientific fields.

Beyond large research inefficiencies, current laboratory conditions in yet to be renovated wings of Building 1 also pose safety concerns. Ventilation systems do not supply adequate fresh air for modern laboratory work, electrical systems contain asbestos and do not meet current codes, lighting is poor, and most of the building is not protected by a fire sprinkler system contributing to potential life and occupational safety hazards. The current Facility Condition Index for Building 1 is "poor." Extensive upgrades are essential to ensure that the Institute can perform the exacting, precision measurements required to meet its mission.

Summary

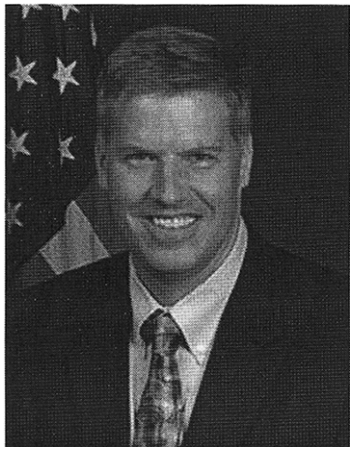
The Fiscal Year 2013 NIST budget request reflects the Administration's recognition of the important role that NIST plays in innovation, as well as the impact that the research and services NIST provides can have on moving the Nation forward by laying the foundation for long-term job creation and prosperity.

More than half of the proposed increased funding in the NIST budget is focused on advanced manufacturing research at NIST laboratories and through new industry-led consortia programs. NIST will continue its mission to work with the private sector to ensure U.S. manufacturers have the research support they need to make the best products in the world and remain globally competitive. The NIST laboratory programs, along with its outreach efforts and standards development work, are dedicated to providing U.S. industry with the tools needed to innovate, compete and flourish in today's fierce global economy.

I look forward to working with you, Mr. Chairman and members of the Committee, and would be happy to answer any questions.

Dr. Patrick D. Gallagher, Director

Dr. Patrick Gallagher was confirmed as the 14th Director of the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) on Nov. 5, 2009. He also serves as Under Secretary of Commerce for Standards and Technology, a new position created in the America COMPETES Reauthorization Act of 2010, signed by President Obama on Jan. 4, 2011.



Gallagher provides high-level oversight and direction for NIST. The agency promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology. NIST's Fiscal Year 2012 resources total $750.8

million from the Consolidated and Further Continuing Appropriations Act of 2012 (P.L. 112–55), with an estimated additional annual income of $62.7 million in service fees, and $128.9 million from other agencies. The agency employs about 2,900 scientists, engineers, technicians, support staff, and administrative personnel at two main locations in Gaithersburg, Md., and Boulder, Colo.

Gallagher had served as Deputy Director since 2008. Prior to that, he served for 4 years as Director of the NIST Center for Neutron Research (NCNR), a national user facility for neutron scattering on the NIST Gaithersburg campus. The NCNR provides a broad range of neutron diffraction and spectroscopy capability with thermal and cold neutron beams and is presently the Nation's most used facility of this type. Gallagher received his Ph.D. in Physics at the University of Pittsburgh in 1991. His research interests include neutron and X-ray instrumentation and studies of soft condensed matter systems such as liquids, polymers, and gels. In 2000, Gallagher was a NIST agency representative at the National Science and Technology Council (NSTC). He has been active in the area of U.S. policy for scientific user facilities and was chair of the Interagency Working Group on neutron and light source facilities under the Office of Science and Technology Policy. Currently, he serves as co-chair of the Standards Subcommittee under the White House National Science and Technology Council.

Senator NELSON. Thank you.

Dr. Suresh.

STATEMENT OF DR. SUBRA SURESH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. SURESH. Chairman Nelson, Ranking Member Boozman, Chairman Rockefeller, good to see you. It's my privilege to be here to discuss the National Science Foundation's Fiscal Year 2013 budget request.

Today science and technology are the new frontiers of American prosperity. Our nation's well-being and global competitiveness depend more than ever before on the steady stream of new ideas and the highly skilled science, technology, engineering, and mathematics talent that the National Science Foundation supports, and especially the young researchers that NSF so skillfully nurtures.

NSF supports the full breadth of science and engineering research and education. We seek emerging ideas with the potential to transform the world, establish new paradigms, and foster new industries. NSF has helped to make the U.S. an undisputed leader, world leader, in science, technology, and innovation. Our universities rank among the best in the world. Our scientists and engineershave led the world in discovery and innovation. Our transformative discoveries have created a vibrant private sector and great jobs.

Worldwide, as the Ranking Member mentioned in his opening remarks, frontier research and technological innovation, driven by a creative and skilled science and engineering workforce, are the new engines of economic growth. Science and technology are improving the prospects for economic prosperity and a rising standard of living around the globe.

It's a measure of our success that other nations are emulating the NSF model. The U.S. can be both a partner and a leader in this global enterprise. Just in the last few months, three very different countries, as different as Nigeria, Indonesia, and India, have established or are in the process of establishing science funding agencies modeled after the National Science Foundation.

The NSF budget request moves America forward by connecting the science and engineering enterprise with benefits for Americans

in areas critical to job creation, a growing economy, and a higher standard of living.

The administration and Congress have conveyed their clear determination to build on the nation's history of success in leading edge discovery and innovation. That is the unmistakable message of the President's 2013 budget request for NSF of $7.373 billion, an increase of 4.8 percent. Bipartisan Congressional support for the 2.5 percent increase in our 2012 budget reinforces that message.

NSF has identified critical funding priorities that will provide long-term benefits for the nation. As good stewards of the public trust, we have also reduced or eliminated lower priority programs, identified opportunities to leverage resources for maximum impact, and held the line on NSF's operating budgets and expenses.

This budget request presents a well-targeted portfolio of innovative investments that provides increased support for fundamental research in all fields of science and engineering. This core research, which constitutes the largest share of NSF expenditures, lays the foundation for progress in science and technology and enhances our ability to address emerging challenges.

NSF investments in advanced manufacturing, clean energy technologies, cybersecurity, and STEM education will support the administration's governmentwide priorities in these critical areas. In 2013, NSF will support cross-agency advanced manufacturing, national robotics, and materials genome initiatives by investing in research that makes manufacturing faster, cheaper, and smarter.

Working in concert with other Federal agencies, NSF will advance research to ensure that the nation's computer and networking infrastructure are secure and reliable, and to support a cybersecurity workforce. NSF will support clean energy research as a component of an initiative to address national challenges to environmental sustainability.

The administration's new K through 16 mathematics education initiative combines NSF's expertise in mathematics education research with the Department of Education's ability to scale up successful programs at state and local levels. NSF's larger suite of educational investments builds on the recognition that science and engineering talent is the foundation of America's future. Areas of educational investments span early learning to college completion. NSF brings its strength in supporting fundamental research in education to each of these broad areas of collaboration.

Mr. Chairman, members of the Subcommittee: I hope my testimony conveys the Foundation's vital role in ensuring that America remains at the epicenter of research, innovation, and learning that's driving 21st century economies. I'll be pleased to answer any questions you may have.

[The prepared statement of Dr. Suresh follows:]

PREPARED STATEMENT OF DR. SUBRA SURESH, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Chairman Nelson, Ranking Member Boozman, and Members of the Subcommittee, it is my privilege to be here with you today to discuss the National Science Foundation's fiscal year (FY) 2013 Budget Request. My name is Subra Suresh, and I am the Director of the National Science Foundation.

I hope to make a clear and compelling case for the continuing vital role NSF's support for science and engineering research and education plays in innovation and economic growth, especially during these times of constrained budgets.

The President's FY 2013 Budget Request reflects wise stewardship of federal funding through innovative, targeted investments. The Request totals $7.373 billion, an increase of $340.0 million (4.8 percent) over the FY 2012 Enacted level. The FY 2013 Request provides increased support for core programs in fundamental research and education in all fields of science and engineering. This investment moves our nation forward by connecting the science and engineering enterprise with potential economic, societal, and educational benefits in areas critical to creating high-quality jobs, growing the economy, and ensuring national security. This follows bipartisan support in the FY 2012 budget for a 2.5-percent increase over the 2011 Enacted level.

NSF is the only federal agency with a mandate to support research and education in every discipline. The results of frontier research have a long record of improving lives and meeting national needs. They are the very bedrock of economic growth; the path to sustainability in energy, agricultural, and environmental domains; the seeds of the next technology revolution; and the foundation for advances in medicine. Sustained momentum in NSF's core programs is essential for progress in science and engineering. NSF's broad scope uniquely positions us to integrate the natural sciences and engineering with social, behavioral, and economic sciences to address the complex societal challenges of today. For all these reasons, the FY 2013 Budget Request provides increased support for the core fundamental research programs across NSF.

NSF: Building a Foundation for Success

NSF has played a significant role in U.S. prosperity, and in the education and development of the nation's science and engineering workforce. For decades, NSF has supported scientists and engineers in their pursuit of world-changing discoveries and innovation that, in turn, created opportunities for private sector growth and for Americans to have good jobs.

Since 1952, the first year that NSF awarded research grants, 196 Nobel Prize recipients have received NSF funding at some point in their careers for their work in physics, chemistry, medicine, and economics. Today, their transformative work addresses society's grand challenges in the areas of energy, environment, and health, as well as national and economic security.

The United States has a long history of investment in and deployment of technological advances derived from advances in basic research facilitated by NSF. For example, research funded by NSF at the National Center for Atmospheric Research and universities was instrumental in the development of Doppler radar, which benefits most Americans regularly through improved weather forecasting. NSF-supported fundamental research in physics, mathematics, and high-flux magnets led to the development of today's magnetic resonance imaging (MRI), employed ubiquitously throughout medicine.

Furthermore, NSF provides a much-needed bridge between research and discovery that would otherwise be neglected and remain untapped by the commercial marketplace. In the 1970s, research on solid modeling by NSF-funded scientists at Carnegie Mellon University led to widespread use of Computer-Aided Design and Computer-Aided Manufacturing, which together have revolutionized much of the U.S. manufacturing industry. NSF was willing to encourage investigations into design problems that neither private firms nor federal mission agencies were willing to address.

While discovery and innovation underpin our global leadership in science and engineering, and consistently provide pathways for entrepreneurs, these activities are also first and foremost human endeavors. Thus, they demand the development of a highly skilled science, technology, engineering, and mathematics (STEM) workforce. NSF strives to ensure that students from diverse backgrounds, including women, underrepresented minorities, and persons with disabilities, have sufficient opportunities to engage in empowering learning experiences and inspiring research, no matter their economic circumstances. Sustaining such a world-class workforce is critical.

Federal investments in fundamental science and engineering and STEM training are increasingly important to help establish U.S. leadership in next-generation technologies, especially as other nations intensify their support of research, development, and education. It is crucial that we continue to lead in the face of this unprecedented global competition for the world-class talent who generate innovative scientific ideas and comprise the technical workforce.

These federal investment priorities in fundamental science and STEM training align with the *America COMPETES Reauthorization Act of 2010,* which paved the way for increased national attention on STEM research and education. NSF appreciates the Committee's support of this important national policy. The provisions of the *COMPETES Reauthorization Act* cover a wide range of NSF activities. The *Act* has underpinned NSF's development of new partnerships with other agencies (e.g., U.S. Agency for International Development–Partnerships for Enhanced Engagement in Research program, K–16 Math Education effort with the Department of Education).

The *COMPETES Reauthorization Act* also calls for the enhancement of undergraduate research as tools that promote careers in STEM fields. The NSF FY 2013 Budget Request has several new programs tailored to this national need. In particular, we thank the members of the Committee and particularly Chairman Rockefeller for their support of the January 19–20, 2012, EPSCoR 2030 Workshop, and we look forward to the strategic priorities and the recommendations that result from the effort. NSF continues to value the EPSCoR program.

Other NSF priorities in the FY 2013 budget are designed to develop a robust innovation ecosystem in line with the Committee's interest in encouraging technology transfer and commercialization. For example, the Innovation Corps (I-Corps) program, described in more detail later, has the potential to leverage public-private partnerships, through professional mentoring, for technology transfer of fundamental research into useful, commercial technological innovation. At present, the first 21 projects are off to a great start. In fact, four of the awardees have graduated to the SBIR (Small Business Innovation Research) track.

The *COMPETES Reauthorization Act* also directed NSF to implement a policy making the Broader Impacts Review Criterion, one of NSF's two merit review criteria, more clearly understood by reviewers and potential grant recipients. Meanwhile, in May of 2010, the National Science Board (NSB) had initiated a review of NSF's review criteria and developed a Task Force on Merit Review. The task force produced a report (*National Science Foundation's Merit Review Criteria: Review and Revisions,* Jan. 10, 2012) that more clearly defined the two merit review criteria and how they relate to one another. NSF is in full agreement with the recommendations of the task force report. Changes to the descriptions of the criteria and the added principles component are intended to enhance and clarify their function. The agency is currently implementing these changes.

Additionally, the NSB evaluated the needs for mid-scale research instrumentation across all disciplines, in accordance with the *Act.* As the Board noted in its recent report to Congress (*NSB Report to Congress on Mid-Scale Instrumentation at the NSF,* Dec. 14, 2011), NSF's current balance of small, medium, and large instrumentation is sound, and the variety of mechanisms by which NSF prioritizes, solicits, evaluates, and supports mid-scale instrumentation—directly and indirectly through large centers and facilities—provides flexibility and vigor to NSF efforts.

NSF will continue its role as the nation's innovation engine as mandated in the *Act.* The fuel for that engine is fundamental research. Scientific research, with its long-term perspective, strong emphasis on disciplinary excellence, and multi-disciplinary interactions, is a critical foundation for both transformational science and economic competitiveness. For all these reasons, the FY 2013 Budget Request provides increased support for the core fundamental research programs across NSF.

The NSF FY 2013 Budget Request

Budget Rationale

The NSF FY 2013 Budget Request presents a carefully-targeted portfolio of innovative investments that provides increased support for fundamental research in all fields of science and engineering. This core research, which constitutes the largest share of NSF expenditures, lays the foundation for progress in science and technology and enhances our ability to address emerging challenges in areas such as advanced manufacturing, clean energy technologies, cybersecurity, and STEM education.

One NSF Framework

A major emphasis in FY 2013 is the OneNSF Framework, which aims to enable seamless operations across organizational and disciplinary boundaries. OneNSF empowers the Foundation to respond to new challenges in a changing global environment, leverages resources and opportunities for maximum impact, and provides leadership to establish innovative practices, programs, and paradigms that advance scientific knowledge and science, technology, engineering, and mathematics (STEM) education. The OneNSF Framework encompasses a set of investments that create new knowledge, stimulate discovery, address complex societal problems, and pro-

mote national prosperity. The OneNSF Framework includes the following investments:

Cyber-Enabled Materials, Manufacturing, and Smart Systems (CEMMSS) is a $257.42-million investment that will transform static systems, processes, and edifices into adaptive, pervasive "smart" systems with embedded computational intelligence that can sense, adapt to, and react to changes in the environment. The smart systems of tomorrow, created through CEMMSS, will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, and usability. CEMMSS brings together researchers and educators from the areas of advanced manufacturing, materials science, cyber-physical systems, and robotics to build an integrated community of interest and stimulate new directions in research.

In the FY 2013 Budget Request, CEMMSS research includes $148.90 million for advanced manufacturing, which includes NSF participation in areas of national importance such as cyber-physical systems and advanced robotics research; materials processing and manufacturing; and advanced semiconductor and optical device design. Advanced manufacturing research invests in emerging technologies that promise to create high quality manufacturing jobs and enhance our global competitiveness. NSF is an agency partner in the President's *Advanced Manufacturing Partnership*.

NSF has a long history of investments in cyberinfrastructure. *Cyberinfrastructure Framework for 21st Century Science and Engineering (CIF21)* aims to more deeply address a highly science-driven integration of cyberinfrastructure (CI), supporting development of new statistical, mathematical, and computational methods, algorithms, and tools, as well as the cultivation of the next generation of computational and data-enabled researchers who prototype, develop, and use CI in all disciplines. In FY 2013, NSF will invest $106.08 million in this program.

The *NSF Innovation Corps (I–Corps)* is a public-private partnership to accelerate the movement of research results from the lab to the marketplace by establishing opportunities to assess the readiness of emerging technology concepts for transitioning into valuable new products. I-Corps will bring together technological, entrepreneurial, and business expertise and mentoring to move discoveries toward commercialization, thus facilitating the downstream development of technologies and processes from NSF-sponsored fundamental discoveries. Initially launched in FY 2011, NSF will invest $18.85 million in FY 2013.

Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) integrates NSF's existing interdisciplinary efforts with a suite of new Foundation wide activities. INSPIRE encourages research that involves multiple disciplines, connects disciplines, or creates new disciplines. It aims to widen the pool of prospective discoveries that may be overlooked by traditional mechanisms. The NSF Request for INSPIRE in FY 2013 is $63.0 million.

Cybersecurity vulnerabilities in our government and critical infrastructure are a risk to national security, public safety, and economic prosperity. *Secure and Trustworthy Cyberspace (SaTC)* is a $110.25 million investment that aligns NSF's cybersecurity investments with the four thrusts outlined in the December 2011 national cybersecurity R&D strategy, *Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity Research and Development Program.* SaTC directly addresses the critical Administration priority of cybersecurity issues by supporting research and education that seeks to protect the nation's critical information technology infrastructure, including the Internet, from a wide range of threats to its security, reliability, availability, and overall trustworthiness. SaTC also addresses the social, behavioral and economic aspects of cybersecurity.

In FY 2013, NSF will invest $355.38 million in *Clean Energy*. NSF's clean energy investments include research related to sustainability science and engineering, such as the conversion, storage, and distribution of diverse power sources (including smart grids), and the science and engineering of energy materials, energy use, and energy efficiency. Some of NSF's investments in clean energy are supported through the FY 2013 NSF investment of $202.50 million in *Science, Engineering, and Education for Sustainability (SEES)*. SEES focuses on targeted programs that promote innovative interdisciplinary research to address pressing societal issues of clean energy and sustainability. Specifically, SEES will address a wide range of highly complex challenges including sustainable energy pathways; agricultural and environmental sustainability; sustainable chemistry, engineering, and materials; water scarcity; ocean acidification; natural disaster prediction and response, and sustainable coastal and Arctic systems.

The Intersection of Research and Education

Efforts to maintain national science and technology preeminence in a fiercely competitive global environment rest upon a highly educated workforce. The NSF FY 2013 Budget Request continues NSF's long history of support for the next generation of leaders in science, technology, and innovation. The suite of educational investments builds on the recognition that science and engineering talent is the foundation of America's future. Areas of educational investments run the spectrum from early learning to college completion.

K–16 Math Education: As part of the nation's strategic plan in STEM education, NSF is partnering with the Department of Education (ED) to launch an evidence-based effort to improve K–16 mathematics education and knowledge building. This new endeavor will support researchers and educators who have the greatest potential to improve mathematics learning. In FY 2013, NSF's Directorate for Education and Human Resources (EHR) and ED will each contribute $30.0 million. EHR's contributions will be through support for the Discovery Research K–12 (DR K–12) and Transforming Undergraduate Education in STEM (TUES) programs.

Transforming Undergraduate Education in STEM (TUES) aims to improve the quality of undergraduate STEM education. TUES research will help undergraduate teaching keep pace with advances in disciplinary knowledge, and underpin the creation of new learning materials, teaching strategies, faculty development, and evaluation to directly impact education in practice. In FY 2013, NSF will invest $61.46 million in TUES.

Expeditions in Education (E^2) is a new $49.0 million interdisciplinary effort that establishes a partnership between the Directorate for Education and Human Resources (EHR) and other research directorates and offices. E^2 aims to ensure that all of NSF's education and workforce investments are drawing on the latest STEM educational theory, research, and evidence. By incorporating cutting-edge science and engineering education, E^2 will improve learning in science and engineering disciplines and enhance the preparation of a world-class scientific workforce.

The *Widening Implementation and Demonstration of Evidence-Based Reforms (WIDER)* program, funded at $20.0 million in FY 2013, is an education research and development program that will modernize the way undergraduate students, including non-STEM majors, are taught and learn general science and mathematics. WIDER will explore how to achieve widespread sustainable implementation of evidence-based undergraduate instructional practices to improve student outcomes.

In FY 2013, NSF will invest $25.0 million to continue to support the *Federal Cyber Service: Scholarship for Service (SFS)* program to increase the number of qualified students entering the fields of information assurance and computer security. SFS will increase the capacity of the United States higher education enterprise to continue to produce professionals in these fields to meet the needs of our increasingly technological society. SFS directly addresses the Nation's increasing need for innovative solutions to cybersecurity concerns.

The *Advanced Technological Education* program focuses on education for high-technology fields, with an emphasis on two-year colleges to produce well-qualified technicians for existing and emerging high-technology fields. For FY 2013, the NSF Request is $64.0 million.

Continued Investment in American Innovation and Entrepreneurship

The Faculty Early Career Development program (CAREER) develops the future scientific and technical workforce through support of young faculty who are dedicated to integrating research with teaching and learning. In FY 2013, NSF will invest $216.49 million to support approximately 40 more CAREER awards than in FY 2012, for a total of 440 new awards. The CAREER portfolio includes projects that range across all fields of science and engineering supported by the Foundation, including high priority fields such as clean energy, climate change, STEM education, and cybersecurity.

The Graduate Research Fellowship program (GRF), funded at $242.98 million in FY 2013, supports the development of students and early-career researchers in order to cultivate the next generation of STEM professionals. In FY 2013, 2,000 new fellowships will be awarded, maintaining the doubling of new fellowship awards achieved in FY 2010. To address inflationary pressures on the long-stagnant GRF stipend level, the FY 2013 Request increases the stipend to $32,000.

Science and Technology Centers (STCs) are funded in FY 2013 at $74.39 million. In FY 2013, a new cohort of STCs will be initiated (totaling $25.0 million) that will continue the tradition of conducting world-class research through partnerships among academic institutions, national laboratories, industrial organizations, and/or other public/private entities, and via international collaborations. STCs provide an

innovative way for researchers to conduct investigations at the interfaces of disciplines and to invest in high-risk, potentially transformative science.

Experimental Program to Stimulate Competitive Research (EPSCoR) assists NSF in its mandate to promote scientific progress nationwide. EPSCoR effects lasting improvements in the research capacity of institutions in participating jurisdictions to promote broader engagement at the frontiers of discovery and innovation in science and engineering. The FY 2013 investment for EPSCoR is $158.19 million.

Enhancing Access to the Radio Spectrum (EARS), begun in FY 2012, continues to partner the Directorates for Engineering; Computer and Information Science and Engineering; Mathematical and Physical Sciences; and Social, Behavioral and Economic Sciences in supporting the basic research that funds research and development of spectrum-sharing technologies. NSF proposes an investment of $50.50 million for FY 2013.

World Class Scientific Infrastructure

The world-class equipment and facilities that NSF supports are essential to the task of discovery. All of the projects in the Major Research Equipment and Facilities Construction account undergo major cost and schedule reviews, as required by NSF guidelines. In FY 2013, NSF will continue support for the construction of the following four projects.

Advanced Laser Interferometer Gravitational-Wave Observatory (AdvLIGO). A planned upgrade of the existing Laser Interferometer Gravitational-Wave Observatory (LIGO), AdvLIGO will be ten times more sensitive, powerful enough to approach the ground-based limit of gravitational-wave detection. The FY 2013 investment is $15.17 million.

Advanced Technology Solar Telescope (ATST). ATST will enable study of the sun's magnetic fields, which is crucial to our understanding of the types of solar variability and activity that affect Earth's civil life and may impact its climate. The FY 2013 investment is $25.0 million.

National Ecological Observatory Network (NEON). NEON will consist of geographically distributed field and lab infrastructure networked via cybertechnology into an integrated research platform for regional to continental scale ecological research. The FY 2013 investment is $91.0 million.

Ocean Observatories Initiatives (OOI). OOI will enable continuous, interactive access to the ocean via multiple types of sensors linked by cutting-edge cyberinfrastructure, which will produce never-before-seen views of the ocean's depths. The FY 2013 investment is $65.0 million.

Excellence in Operations

NSF emphasizes the agency's desired outcome of attaining excellence in all aspects of its operations. Thus, performing as a model organization, one of NSF's three strategic goals, underpins NSF programmatic activities and encompasses all the agency's management activities. The Model Organization goal also includes support for the activities of the Office of Inspector General (OIG) and the National Science Board (NSB), which are provided in separate appropriations.

Workforce Development. The FY 2013 budget request includes $209.47 million, or $6.56 million over the FY 2012 Estimate, for funding NSF's federal workforce. The Request will support 1,352 full-time equivalents (FTE), an increase of 25 over the FY 2012 Estimate allocation of 1,327 FTE.

iTrak. FY 2013 is the first year of iTRAK implementation. iTRAK will transition NSF from its legacy financial and property management systems to a fully integrated financial management solution. In FY 2013, the total Request for iTRAK is $11.70 million.

Efficient Management

NSF's FY 2013 Request follows a thorough examination of programs and investments across NSF to determine where the potential exists for more innovative investments. As good stewards of the public trust, we have reduced or eliminated lower priority programs, identified opportunities to leverage resources for maximum impact, and held the line on NSF's operating expenses.

This Request includes several recommended cuts and consolidations.

Computer and Information Science and Engineering Research Programs: Three programs within the Directorate for Computer and Information Science and Engineering (CISE) are eliminated since they have reached their planned endpoints and have achieved their original goals. These programs are: Network Science and Engineering (NetSE); Social-Computational Systems; and the Interface between Computer Science and Economic & Social Sciences (ICES). Support for these research areas will be absorbed into CISE core programs.

Cyber-Enabled Discovery and Innovation (CDI): NSF eliminates funding for the agency-wide CDI program, as the program has reached its planned conclusion and has achieved many of its original goals. Funding in FY 2013 will be redirected to support new efforts in two NSF cross-agency investments (CEMMSS and CIF21) that will build on the accomplishments made in the CDI program.

Mathematical and Physical Sciences Research Programs: Four programs within the Directorate for Mathematical and Physical Sciences (MPS) are eliminated because they overlap with larger core disciplinary programs or they have achieved their original goals. Two programs are eliminated as they are no longer needed as stand-alone programs: Mathematical Physics and Grid Computing. Research conducted under the third program, Cultural Heritage Science, will be funded through regular MPS disciplinary programs. Lastly, the CHE–DMR–DMS Solar Energy Initiative (SOLAR) will be subsumed within the broader framework of NSF's SEES investment through the Sustainable Energy Pathways solicitation.

Nanoscale Science & Engineering Centers (NSECs): NSF reduces support for the NSEC program because the state of the research in this area has matured significantly and the research should advance more rapidly in a different, more use-inspired research center program. Several NSEC grants may transition to the Nanosystems Engineering Research Centers (NERCs) as the nano-devices and processes created at graduating NSECs move to the systems level and potential commercialization. NSF will continue to support eleven continuing NSECs in FY 2013 including the Nanomanufacturing ERC.

Public Outreach terminations: NSF eliminates two small stand-alone public outreach programs because they lack rigorous evaluation and are duplicative of the larger, well-established peer-reviewed Advanced Informal STEM Learning program (formerly, the Informal Science Education program). The eliminated programs are: Communicating Science Broadly and Connecting Researchers with Public Audiences.

Conclusion

With intense global competition for knowledge and talent, we must focus our attention on finding the sophisticated solutions that will ensure a prosperous, secure, and healthy future for the nation and the world. Robust NSF investments in fundamental science and engineering research and education have returned exceptional dividends to the American people, expanding knowledge, improving lives, and ensuring our security. To keep those benefits flowing, we need to constantly replenish the wellspring of new ideas and train new talent while serving as good stewards of the public trust. That is the fundamental and continuing mission of NSF.

Mr. Chairman and members of the Subcommittee, I hope my testimony explains how the Foundation plays a vital role in ensuring that America remains at the epicenter of the ongoing revolution in research, innovation, and learning that is driving 21st century economies. More than ever, the future prosperity and well-being of Americans depend on sustained investments in our science and technology. NSF has been and continues to be central to this endeavor. The FY 2013 Budget Request for NSF clearly acknowledges NSF's pivotal role in ensuring America's future STEM leadership and economic wellbeing.

This concludes my testimony. I thank you for your leadership, and I will be pleased to answer any questions you may have.

Senator NELSON. Thank you.

Dr. Peck.

STATEMENT OF DR. MASON PECK, CHIEF TECHNOLOGIST. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. PECK. Chairman Nelson, Ranking Member Boozman, and members of the Committee: Thanks for the opportunity to appear today to discuss NASA's research and development activities, with a focus on the agency's efforts in space technology. I look forward to working with each of you and the Committee on enactment of the President's Fiscal Year 2013 budget request for NASA and specifically in advancing technology and innovation at NASA.

With the help of the Committee's leadership, NASA and the nation are embarking on an ambitious program of space exploration

that builds on new technologies as well as proven capabilities as we expand humanity's reach into the solar system.

Now, you'd agree NASA is part of the basic and applied research investments being made by the Federal Government across the nation as recognized by Congress in section 201 of the America COMPETES Reauthorization Act—I'll read it here for context: "A renewed emphasis on technology development would enhance current mission capabilities and enable future missions, while encouraging NASA, private industry, and academia to spur innovation."

So focus on innovation and technology is essential, both to enable efficient and low-risk approaches to NASA's current missions, but also to allow the agency to pursue entirely new missions. NASA established the Office of Chief Technologist to reenergize NASA's technology development engine to ensure that the advanced technologies required for NASA's future missions will be in place by the time they're needed.

The National Research Council, the NRC, emphasized the importance of a stable technology enterprise at the agency. They reviewed NASA's draft space technology roadmaps just this past year. The NRC wrote in their February 2012report that "Success in executing future NASA space missions will depend on advanced technology developments that should already be under way." The space technology program addresses this technology deficit.

If NASA and the nation are to reach the goals set for us by this Congress, we must drive to innovate and we must elevate innovation to a high priority.

My office works with all the NASA mission directorates and centers to ensure that NASA makes available agency-developed technologies, processes, discoveries, and knowledge to the private sector. Following up on Senator Boozman's comments, we are doing what we can to eliminate those roadblocks. The technology transfer and commercialization is conducted through a variety of means. That includes releasing licenses, forming partnerships, and through other cooperative activities.

These transferred technologies are used to create products, services, cascading innovations, those that build on one another, and other discoveries to fuel the Nation's economic engine, creating jobs right here on Earth and improving our quality of life. For example, solar and wind-generated energy, the cameras found in many of today's cellphones, improved biomedical applications, including advanced medical imaging, just to name a very few, they've all benefited from our nation's investment in aerospace technology.

The Office of the Chief Technologist is responsible for coordinating and monitoring and evaluating all the agency's prizes and design challenges that we conduct across the mission directorates. The agency has realized the value of prizes and challenges and we're one of the early adopters of this idea across the many research and technology domains that we're involved with. We engage the nation's citizen-inventors through our prize-based Centennial Challenges program in areas like satellite launch systems, advanced robotics, energy storage, greenaviation, advanced materials, wireless power generation, and the list goes on.

The Office of the Chief Technologist also coordinates the agency's technology programs and manages specifically the space technology

program. The good news here is that the program is up and running. We're putting Americans to work conceiving and testing the technology that will guarantee our future in space.

The broadly relevant technologies that NASA pursues within the space technology program span a range of discipline areas and technology readiness levels, what we call TRL, from concept study all the way to flight demonstration, including technology demonstrations that are conducted on the International Space Station. Space technology development takes place using NASA centers, academia, and industry, and through partnerships with other government agencies, which we engage whenever we can, and also international partners. In all, the space technology program has funded roughly a thousand technology projects since its recent inception—that was 2011—and many of these projects have already got hardware to test and fly in 2013. So we're making real progress.

In closing, let me just leave you with a couple of quick final thoughts. As a professor at Cornell University, I've had the honor of working with verytalented faculty and students over the years who share my passion for space. For most of the past decade, though, very few of us who have wanted to contribute to the Nation's civil space program have had the opportunity to do so through an academic environment. But since the Office of the Chief Technologist was established, NASA's been able to tap into the enormous enthusiasm for the agency's mission that we see from academia, industry, and the public.

The desire to engage with NASA is really overwhelming, and we see this in the fact that NASA receives thousands more proposals to our space technology solicitations than it can possibly afford to fund.

Our nation's future economic success is tied to our ability to outinnovate the rest of the world. NASA is an important part of this future. America expects boldness from NASA and we're now returning to our innovation roots, taking the long-term view of technological advancement that's essential for accomplishing our missions. The space program is just the kind of pursuit that inspires Americans to innovate.

Mr. Chairman, thank you for your support and that of this committee. I'd be glad to respond to any questions you and the other members may have.

[The prepared statement of Dr. Peck follows:]

PREPARED STATEMENT OF DR. MASON PECK, CHIEF TECHNOLOGIST, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Committee, thank you for the opportunity to testify on NASA's research and development efforts. Under the President's leadership, NASA and the Nation are embarking on an ambitious program of space exploration that builds on new technologies as well as proven capabilities as we expand humanity's reach into the solar system. While reaching for new heights in space, NASA is creating new jobs right here on Earth—especially for the next generation of American scientists and engineers—by supporting cutting edge aeronautics and space technology innovations, research and development that will help fuel the Nation's economy for years to come.

Despite tough economic times, the Fiscal Year 2013 budget continues to implement the space science and exploration program agreed to by the President and a bipartisan majority in Congress, laying the foundation for remarkable discoveries

here on Earth and in deep space, including new destinations such as an asteroid and Mars. We have made tough, but sustainable, choices to provide stability and continuity to existing priority programs and set the pace for opening the next great chapter in exploration.

On a personal note, I am honored to be at NASA serving as its Chief Technologist. As the NASA Administrator's top advisor on technology, I am responsible for guiding strategic Agency investments in technology; facilitating technology transfer, partnerships and commercialization activities across the Agency; advocating externally on behalf of NASA's R&D programs; demonstrating and communicating societal impacts of NASA technology investments; as well as, the management and budget of the Space Technology Program. I come from Cornell University, where I also served on the faculty in the School of Mechanical and Aerospace Engineering and teach in Cornell's Systems Engineering Program. My background in aerospace technology, with nearly 20 years in both industry and academia, will help me to ensure NASA's technology portfolio addresses the near-term, mission-driven and the long-range, transformative technologies required to meet our Nation's far-reaching exploration goals.

As requested, I am going to speak about NASA's prize programs and technology efforts and the activities of the Space Technology Program, in which I play a direct role, as well as technology activities throughout NASA in which I have an advisory role. Administrator Bolden will be discussing details of the Fiscal Year 2013 Budget request for NASA in his testimony to this committee tomorrow.

NASA provides America with unique capabilities simply because of how we ask questions about our universe. By taking humans to inhospitable places we learn a little bit more about how Earth sustains us, because we have to recreate that environment for our astronauts to survive. NASA solves difficult technical problems and thereby inspires Americans to invent technologies that make life better right here on Earth.

As recognized by Congress in Section 201 of the America COMPETES Reauthorization Act of 2010 (P.L. 111–358), "a renewed emphasis on technology development would enhance current mission capabilities and enable future missions, while encouraging NASA, private industry, and academia to spur innovation." A focus on innovation and technology is essential, both to enable fresh approaches to NASA's current missions and to allow the Agency to pursue entirely new missions. NASA is fully engaged in support of the National Science and Technology Council and the Office of Science and Technology Policy to implement the crosscutting requirements of the Act. NASA has completed one of three NASA-specific reporting requirements and is on track to complete the remaining requirements in the June timeframe.

Developing technological solutions stimulates the growth of the innovation economy. The safety, security, and convenience provided by weather and navigational spacecraft, efficiency improvements in both ground and air transportation, super computers, solar-and wind-generated energy, the cameras found in many of today's cell phones, improved biomedical applications including advanced medical imaging and even more nutritious infant formula, as well as the protective gear that keeps our military, firefighters and police safe, have all benefited from our Nation's investments in aerospace technology.

Those benefits are hard to quantify, but we know they are real. We see this with companies like GreenField Solar who developed PhotoVolt solar cells through cooperation with NASA's Glenn Research Center. When paired with StarGen solar concentrator which tracks and captures the sun's rays throughout the day, this system can concentrate sunlight up to 900 times its normal intensity. GreenField solar is now generating grid-scale solar power at a lower cost per kilowatt-hour than most existing photovoltaic systems. Bernard Sater, the GreenField Solar founder and former scientist at the NASA Glenn Research Center in Ohio, retired early from NASA in 1994 to develop this solar cell. He continued research in the lab at NASA Glenn, collaborating with experts through the development and testing phases of the process. The resulting technology has led to several Ohio demonstration projects, including the Rockefeller Park Greenhouse in Cleveland. U.S. job opportunities will increase as GreenField ramps up its commercialization efforts. NASA discoveries benefit every aspect of our lives. We see this in our smartphones, our cars, our airports, and even in my children's toothpaste. Thanks to this Administration and the Congress working together, the Agency will continue to ask the bold questions that lead to these technology benefits, or "spinoffs" as we call them at NASA.

Investments in space and aeronautics technology stimulate the economy and contribute to the Nation's global competitiveness through the creation of new products and services, new business and industries, and high quality, sustainable jobs. According to the 2011 Aerospace Industries Association Year End Review, the U.S. aerospace industry experienced its eighth consecutive year of growth and main-

tained the largest trade surplus of any manufacturing industry. A technology-driven NASA will maintain the Nation's aerospace community as a global technological leader for many years to come. NASA innovation also serves as an inspiration for young people to pursue science, technology, engineering, and mathematics (STEM) education and career paths.

Each NASA mission takes years of planning and development to ensure its success. And every NASA mission has been made possible by pushing the technology envelope. NASA established the Office of the Chief Technologist to re-energize NASA's technology development engine to ensure the advanced technologies exist for NASA's future missions. The National Research Council (NRC) emphasized the importance of a stable technology enterprise at the Agency in its review of NASA's Space Technology Roadmaps. The NRC wrote in their February 2012 report, "The productivity and the effectiveness of technology development programs are diminished when the direction, content, and/or funding of those programs abruptly change from year to year." If NASA and this Nation are to reach the goals set for us by this Congress, we must drive to innovate. The NRC made a stark observation, "Success in executing future NASA space missions will depend on advanced technology developments that should already be underway." The Space Technology Program addresses this technology deficit. It reaches beyond today's missions to develop and demonstrate technology for infusion into future missions. In doing so, it also benefits the aerospace industry and other government agencies. At the same time, NASA's Mission Directorates continue to develop "pull" technologies, which are those solutions that target specific, near-term missions. With this balanced approach of near and farther-term investments, NASA is now able to meet the needs of today's missions while investing in the revolutionary advancements that will enable even more amazing achievements in our future.

The space technology roadmapping effort that the NRC just finished reviewing aids NASA in formulating a balanced, cross-agency, technology investment perspective by identifying technology needs and overlaps, which will better ensure infusion of technologies into future missions conducted by NASA, industry or other Government users. The NRC engaged broad and crosscutting segments of our external stakeholders and the report's findings and recommendations represent a true consensus of the aerospace community. The NRC's final report provides guidance for future competitive and guided technology investments. NASA is investing, at some level, in all 16 of the high-priority research technologies referenced in the report. In 2012, OCT will lead an Agency-wide analysis and coordination effort to inform NASA's future technology investments on the basis of the NRC report. In addition, OCT will continue to work with NASA Mission Directorates and cross-Agency working groups to identify broadly applicable technology needs.

Space Technology

The Office of the Chief Technologist (OCT) coordinates the Agency's technology programs, one of which is the Space Technology Program. The Fiscal Year 2013 budget requests $699 million for the Space Technology Theme. This request is driven by the needs of existing projects as teams across the Nation ready hardware to fly and test in Fiscal Year 2013. OCT identifies development needs, prioritizes those needs according to stakeholder input, and reduces duplication to ensure that the Agency's resources are used wisely. By coordinating technology programs across NASA, OCT facilitates infusion of available and new technology into operational systems that ultimately advance specific human-exploration missions, science missions, and aeronautics capabilities.

Within the Partnership Development and Strategic Integration account within Space Technology, OCT engages the larger aerospace community, including other Government agencies to develop partnerships and leverage shared resources and expertise, efficiently developing breakthrough capabilities. The Fiscal Year 2013 budget request includes $29.5 million to develop these partnerships, lead the Agency strategic roadmapping efforts as described above, and to manage NASA's technology transfer and commercialization. OCT works with all NASA Mission Directorates and Centers to ensure NASA makes available Agency-developed technologies, processes, discoveries, and knowledge to the private sector. Technology transfer and commercialization is conducted through various means including releasing licenses, forming partnerships, and through cooperative activities. These transferred technologies are used to create products, services, cascading innovations, and other discoveries to fuel the Nation's economic engine and improve our quality of life.

OCT is also responsible for coordinating, monitoring and evaluating all Agency prizes and design challenges conducted by NASA mission directorates using the authority seen in the America COMPETES Reauthorization Act of 2010. Since enacted, the Agency has realized the value of prizes and challenges across many of

NASA's research and technology domains. For example, public innovators have improved our abilities to determine the shape of galaxies; identified algorithms to better process remote sensing data; and developed algorithms to aid NASA in quickly identifying and detecting impact craters within large volumes of data.

OCT engages the Nation's "citizen inventors" through prize-based challenges in areas such as satellite launch systems, advanced robotics, energy storage, green aviation, advanced materials, and wireless power transmission. Prize authority from Section 304 of the Space Act facilitates the highly successful Centennial Challenge program. In 2011, the Green Flight Centennial Challenge drove advancement in aerodynamics, aircraft configuration design, power plants, and flight path planning leading to dramatic increases in the State of the Art for fuel efficiency and noise. Current Centennial Challenges include: Sample Return Robot, Night Rover and Nano-Satellite Launch.

By offering prize awards NASA is acquiring technology and fostering innovation for the agency, dramatically increasing the number and diversity of minds tackling tough problems, and engaging a broad non-traditional community of innovators ranging from professionals and small companies to backyard garage inventors.

In managing the Space Technology Program (STP) this Committee authorized, OCT employs a portfolio approach, investing in both crosscutting and human exploration specific technology needs for the Agency. The broadly relevant technologies being pursued within STP span a range of discipline areas and technology readiness levels (TRL) from concept study to flight demonstration, including technology demonstrations conducted on the ISS. Space Technology development takes place using NASA centers, academia and industry, and through partnerships with other Government agencies and international partners. NASA also participates in national technology-development initiatives such as the National Robotics Initiative and the Advanced Manufacturing Partnership to increase opportunities for collaborative technology development. Investments include both competitively awarded and strategically guided activities to address long-term Agency technology priorities and technology gaps identified within the previously discussed Agency's space technology roadmaps.

The development, testing, and evolution of an array of space technologies for human missions beyond low Earth-orbit (LEO), include propulsion, logistics and resupply, life sciences and human systems, communications, and many other areas, to safely extend human presence to multiple destinations throughout the solar system robustly, sustainably and affordably. Space Technology funds these technology efforts through Exploration Technology Development for which the budget request includes $202 million. Using these funds, NASA is working toward a Fiscal Year 2016 flight demonstration to test long-term storage and transfer capabilities for cryogenic fluids. Improved capabilities in this area, in combination with the Space Launch System heavy-lift vehicle, will bring deep-space exploration closer to reality. In addition, Boeing and a team of engineers from four NASA centers are working together to develop two large-scale, lightweight composite cryogenic propellant tanks for validation testing in Fiscal Year 2013 that promise to achieve weight and cost savings as compared to traditional aluminum lithium tanks and may be used on future heavy-lift launch vehicles. The NASA Glenn Research Center is accelerating work on in-space propulsion, space power generation, and storage ground-based technology development efforts required to reduce risk for a future planned solar electric propulsion demonstration. These capabilities will enable efficient deep-space transportation that is required for deep-space human and scientific exploration.

In addition, Space Technology invests in crosscutting technologies that could benefit human exploration, and also change the way science missions are conducted. These activities are funded through this theme's Crosscutting Space Technology Development account for which the request is $293.8 million.

Crosscutting technology work in development includes several high priority efforts including the following activities:

- at the Goddard Space Flight Center (GSFC) in Maryland, a team is developing a laser-based, deep space communications system that will revolutionize the way we send and receive data, video and other information, using lasers to encode and transmit data at rates 10 to 100 times faster than today's systems, which will be needed for future human and robotic space missions.
- at the Jet Propulsion Laboratory (JPL) in California, a team is developing a Deep Space Atomic Clock, which utilizes a key component from the Johns Hopkins Applied Physics Laboratory. When fully developed, this technology will dramatically improve navigation and guidance in future deep-space missions and may lead to an improved Global Positioning System (GPS) for use on Earth.In partnership with the Human Exploration and Operations Mission Di-

rectorate, a team at GSFC is pioneering the technologies required for satellite servicing. When matured, this technology will allow robotic spacecraft to repair, refuel, relocate and service existing orbiting spacecraft; and

- Space Technology is working with a L'Garde Inc. in Tustin, CA to develop the largest solar sail ever flown. Once developed, this propellant-free propulsion system will enable the next generation space weather monitoring system.

Space Technology is working closely with the Science and Human Exploration and Operations Mission Directorates on an integrated strategy for Mars exploration that will support science as well as human exploration goals. Entry, descent and landing (EDL) technology is one opportunity where collaborative development can enable future scientific and human planetary missions. Dramatic improvements must be made with EDL technologies to enable delivery of large science payloads to the polar regions of Mars, or to deliver critical infrastructure needed for extended human missions. Currently, at JPL and the Langley Research Center in Virginia, engineers are working to develop lightweight planetary entry systems that will enable large mass, high elevation and pinpoint landing capabilities required for Mars and other planetary destinations. These advanced technologies will be tested through balloon and rocket flights managed by the Wallops Flight Facility in Virginia. Also in Fiscal Year 2013, the Space Technology EDL teams will be analyzing the data returned from the instrumentation package installed in the heatshield of the Mars Science Laboratory entry vehicle after making its flight through the Martian atmosphere this August.

The Space Technology theme also includes $173.7 million for the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR), which encourage small business owners to provide technical innovations. SBIR and STTR continue to support early stage research and development performed by small businesses through competitively awarded contracts. These programs produce innovations for both Government and commercial applications. SBIR and STTR provide the high-technology small business sector with an opportunity to develop technology for NASA, and commercialize that technology in order to provide goods and services that address other national needs based on the products of NASA innovation.

In all, the Space Technology Program has funded roughly 1,000 technology projects and engaged thousands of engineers and technologists since its inception in 2011. Many of these projects have hardware ready to test and fly in Fiscal Year 2013 as they mature their technology for infusion into a future mission or capability.

International Space Station

The International Space Station is fully complete. Many consider it to be one of humanity's greatest technological achievements. Its state-of-the-art research facilities support a wide variety of research disciplines. Examples include high-energy particle physics, Earth remote sensing and geophysics experiments, protein crystallization experiments, human physiology research (including bone and muscle research), radiation research, plant and cultivation experiments, combustion research, fluid research, materials science experiments, and biological investigations. The three major science laboratories aboard the ISS—the U.S. Destiny, European Columbus, and Japanese Kibo facilities, along with external test beds—enable astronauts to conduct experiments in the unique, microgravity and ultra-vacuum environment of LEO, experiments that simply cannot be conducted on Earth. The range of research disciplines that ISS supports means that R&D conducted aboard Station promises new discoveries not only in areas directly related to NASA's exploration efforts, but in fields that have terrestrial applications, as well. The ISS will provide these opportunities to scientists, technologists and engineers through at least 2020. For example, a Space Technology team at the Johnson Space Center in Texas is working to build on the Robonaut 2 demonstration on ISS and further the Agency's development of next-generation tele-robotics systems. In addition, Space Technology is using the SPHERES satellites on ISS to demonstrate autonomous rendezvous and docking techniques and liquid slosh dynamics which serves to validate mission design for both spacecraft and launch vehicles.

In the NASA Authorization Act of 2010 (P.L. 111–267), Congress directed that the Agency enter into a cooperative agreement with a not-for-profit organization to manage the activities of the ISS National Laboratory. Last fall, NASA finalized an agreement with the Center for the Advancement of Science in Space (CASIS) to manage the portion of the ISS that operates as a U.S. National Laboratory. CASIS will be located in the Space Life Sciences Laboratory at the NASA Kennedy Space Center. This independent, nonprofit, research-management organization will help

ensure the Station's unique capabilities are available to the broadest possible cross-section of U.S. scientific, technological and industrial communities.

CASIS will develop and manage a varied R&D portfolio based on U.S. national needs for basic and applied research, establish a marketplace to facilitate matching research pathways with qualified funding sources, and stimulate future interest in using this national lab for research and technology demonstrations and as a platform for science, technology, engineering and mathematics education. The goal is to support, promote and accelerate innovations and new discoveries in science, engineering and technology that will improve life on Earth.

In addition to the direct research benefits to be gained by the ISS as a National Laboratory, this innovative arrangement also supports NASA's effort to promote the development of a LEO space economy. National Lab partners can use the unique microgravity environment of space and the advanced research facilities aboard Station to enable investigations that may give them the edge in the global competition to develop valuable, high technology products and services. Furthermore, the demand for access to the ISS will support the providers of commercial crew and cargo systems. Both of these aspects of the ISS as a National Laboratory will help establish and demonstrate the market for research in LEO beyond the requirements of NASA.

Technology in Human Exploration

Consistent with NASA's technology roadmaps, the Advanced Exploration Systems (AES) Program within the Agency's Human Exploration and Operations Mission Directorate (HEOMD) is pioneering new approaches for rapidly developing prototype systems, demonstrating key capabilities, and validating operational concepts for future human missions beyond Earth orbit. AES activities are uniquely related to crew safety and mission operations in deep space, and are strongly coupled to vehicle development in the immediate future. While the Space Technology programs are focused on demonstrating particular technologies, AES focuses on early integration and testing of prototype systems. Both Space Technology and AES activities seek to reduce risk and improve affordability of exploration mission elements. The prototype systems developed in the AES program will be demonstrated in ground-based test beds, field tests, underwater tests, and flight experiments on the ISS. Successful prototypes will evolve into larger integrated systems and mission elements that will be tested on ISS before we venture beyond Earth orbit.

In addition to developing building blocks for future missions, the AES and Space Technology programs are exploring innovative ways to drive a rapid pace of progress, streamline project management, and use NASA's resources workforce more effectively. By using small, focused projects to rapidly develop and test prototype systems in house, NASA expects to greatly reduce lifecycle costs and minimize the risk of incorporating new technologies into system designs.

The AES and the Space Technology Programs work closely together to incorporate and integrate new technologies and innovations as they are matured to the point of infusion. The AES Program is also working closely with NASA's Science Mission Directorate to pursue a joint program of robotic precursor activities that will acquire critical data on potential destinations for future human missions such as the Moon and Mars and its moons. This program builds upon the successful collaboration between science and exploration on the Lunar Reconnaissance Orbiter mission.

NASA Aeronautics Technology

NASA continues to lay the foundation for the future of flight by exploring new ways to manage air traffic, build more fuel-efficient and environmentally friendly airplanes, and ensure aviation's outstanding safety record. Through the research we conduct and sponsor with universities and industry, we help to develop the technology that enables continuous innovation in aviation.

Aviation is an integral part of our daily lives, a critical part of the foundation of our economy, and a source of strength in the global market. Technological superiority has been a key enabler for the U.S. aerospace manufacturing industry to be the world leader in the aviation sector. In this time of continuing economic challenge, the aviation industry provides high-tech, highly rewarding, and high-paying jobs that Americans are proud to have.

U.S. companies currently enjoy strong positions in the global commercial aerospace market, including manufacturers of large civil aircraft, engines, business jets and helicopters, as well as structures, components and electronics. NASA-developed technologies are in the DNA of many of the civil and military aircraft the U.S. industry has developed and marketed to date. Boeing, General Electric and Pratt & Whitney have all introduced highly competitive products in the last 2 years. With the introduction of these new products, the U.S. manufacturers appear to be well

positioned in the large commercial transport market for some time to come. However, this is not a guarantee and careful attention to aeronautics investment is required to maintain U.S. leadership in this area.

We continue to invest in aeronautics Research and Development, recognizing its potential to address emerging challenges and enable innovative capabilities in the next generation of products. These new capabilities could result in substantially more energy-efficient, significantly less polluting, and considerably quieter subsonic transport through completely new designs.

NASA is investing in cutting edge research to accelerate implementation and enhance the capabilities of the Nation's Next Generation Air Transportation System (NextGen) in partnership with the FAA and other Joint Planning and Development Office partners. With our partners, we are investing in critical areas of research such as new air traffic management concepts for new fuel-efficient arrival procedures. And we are leading the country with a vision and revolutionary capabilities for the Nation's future air transportation system, researching concepts and technologies that may provide the foundation for future commercial products and services brought to the market.

We transfer the results of fundamental and systems-level aeronautics research to the aerospace community through dissemination of research results, concepts, and design methods. In some instances, companies may build on specific technologies and capabilities developed through NASA research, investing their own research and development dollars to take those last steps to become a commercialized product. In other instances, NASA provides design methods and understanding used by companies in developing new products. By maturing new technologies and validating design methods, NASA research can decrease the risk of incorporating new technologies and systems in aircraft, shortening the path through safety certification in the Federal Aviation Administration and speeding the transition of new technologies into the fleet.

U.S. companies are well positioned to build on discoveries and knowledge resulting from NASA research, turning them into commercial products, benefiting the quality of life for our citizens, providing new high-quality engineering and manufacturing job opportunities, and enabling the United States to remain competitive in the global economy. Concept simulations and field trials in real flight environments of NASA developed technologies have demonstrated the potential for significant monetary savings to airspace users through reduction in flight delays and fuel usage.

Technology Research & Development to Enable Scientific Discovery

NASA's Science Mission Directorate (SMD) develops and operates innovative space missions that push out the frontiers of scientific knowledge of the Earth, the Sun, our solar system, and the universe beyond. In Earth Science, the challenge is to be able to detect a small but influential signal of change against a background of much larger short-term variability. Through technological advances we have been able to measure millimeter changes in global ocean surface height, and distinguish the influence of solar variability from other factors driving atmospheric warming. In Heliophysics, we have been able to do what your mother told you never to do—stare at the Sun—to observe the connections between coronal mass ejections and aurorae over Earth's poles. In Planetary Science, development of Advanced Stirling Radioisotope Generators promise to power spacecraft operating in deep space with one-sixth the amount of plutonium–238 as conventional radioisotope power systems. In Astrophysics where the challenge is to peer ever deeper into the universe and farther back in time, large segmented mirrors, sensitive optics that operate at 40 Kelvin, and a host of other technologies are enabling us to build the James Webb Space Telescope. These missions require technologies that in many cases would not be developed otherwise—some of which find applications not imagined by their inventors.

The technologies SMD develops and employs span the full range of the process of scientific discovery, from theory and mission design to science data processing and distribution. They include spacecraft components and systems, scientific instruments, and advanced information technologies. Spacecraft technology has advanced sufficiently that we can acquire standard spacecraft buses for many Earth observing missions from industry, and our technology focus here is on areas such as on-board data processing, formation flying, and autonomous operations that enhance scientific productivity and operational utility. For planetary exploration and astrophysics, however, spacecraft and instruments are much more integrated and more specialized, requiring technology advances in power, propulsion, stability, deployment, communications, and radiation protection, among others. For all SMD science areas, science instruments are "the pointy end of the spear" of space missions, and

technology advances are continually required on all fronts. This is the largest area of SMD technology investment. To enable instrument technology development, SMD uses suborbital research platforms (sounding rockets, aircraft, and balloons) to test instruments as prototypes of those that will eventually fly in space. Advanced information technologies include high-end computing (where software must be written to make effective use of industry's leading supercomputers), and data mining capabilities to enable knowledge to be efficiently derived from enormous data sets.

SMD develops technologies for its science missions largely through open, competitive solicitations to garner the best ideas from industry, academia, and other government laboratories. SMD's annual Research Opportunities in Space and Earth Sciences (ROSES) solicitation includes specific, scheduled calls for technology development proposals in defined areas of need. In addition, targeted technology investments are made in such areas as Advanced Stirling Radioisotope Generators (ASRGs) when specific partnerships are required. Generally, SMD develops technologies outside of mission projects, and mission projects are not confirmed to proceed to development until required technologies are sufficiently mature. In addition, SMD uses the attached payload accommodations on ISS to provide the environment and resources for science experiments making specific atmospheric, Sun-Earth interaction, and astrophysics observations compatible with ISS's orbital inclination and altitude. Technology is the great enabler of NASA science missions, and thus of discovery in the Earth and space sciences and NASA's impact on our Nation's economy, environment, and education goals.

Conclusion

America is beginning an exciting revolutionary new chapter in human space exploration and scientific discovery. This chapter centers on full use of the International Space Station, maturation of multiple American vehicles for delivering astronauts and cargo to low-Earth orbit, and development of a crew vehicle and an evolvable heavy-lift rocket—two essential building blocks for our Nation's future in deep-space exploration. NASA is moving forward with the James Webb telescope and will be exploring Mars later this year with the highly capable Curiosity rover. The rapid development and infusion of new in-space technologies is critical to advancing our future in space. They will enable explorers to safely venture into deep space for the first time.

Pushing the boundaries of aeroscience and taking informed-risks, NASA and our Nation remain at the cutting-edge. By making steady investments in technology, we will enable future human and robotic exploration of near-Earth asteroids, the Moon, and Mars just as current and past mission successes were supported by decades of vital technology investments.

Investments in research and development enable new missions, stimulate the economy, contribute to the Nation's global competitiveness and inspire the Nations' next generation of scientists, engineers and explorers. As a professor at Cornell University, I have had the honor of working with talented faculty and students who share my passion for space. For most of the past decade, very few of us who have wanted to contribute to the Nation's civil space program have had the opportunity to do so. Since OCT was established, NASA is tapping into the enormous enthusiasm for the Agency's mission we see from academia, industry, and the public. The desire to engage with NASA is overwhelming. We see this in the fact that OCT receives thousands more proposals to its solicitations than it can afford to fund. And I have seen it personally, in the hundreds of students who have worked with me on two university-built satellite projects.

NASA must continue to cast a wide net to bring in the best ideas, wherever they may be found. A NASA focused on advancing technology helps ensure that high-tech jobs will be available for these young people when they complete their studies. And in sponsoring this sort of research and development, it will do its part to encourage the next generation of aerospace engineers, ensuring that our Nation retains the critical capabilities in advanced technology that will ensure its economic competitiveness.

Two weeks ago the Nation celebrated the 50th anniversary of Senator John Glenn's historic orbital flight. Only a few months before the historic flight of *Friendship 7,* President Kennedy gave the Nation a grand challenge to land a human on the Moon and return them safely back to Earth. It was a bold goal that would provide the ultimate challenge to our Nation, and forced us to "organize and measure the best of our energies and skills." It required NASA to tackle enormous technological unknowns by utilizing American ingenuity and innovation. In accomplishing the goal, a whole generation of engineers and scientists introduced the term "rocket science" into American popular culture and made a lasting imprint on the economic, national security and geopolitical landscape.

America can do the same today. Our Nation's future economic success is tied to our ability to out-innovate the rest of the world. NASA is an important part of this future. America expects boldness from NASA. We are now returning to our innovation roots, taking the long-term view of technological advancement that is essential for accomplishing our missions. America expects no less.

Mr. Chairman, thank you for your support and that of this Committee. I would be pleased to respond to any questions you or the other Members of the Committee may have.

Senator NELSON. Thank you all.

Mr. Chairman, your questions, please.

STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM WEST VIRGINIA

Senator ROCKEFELLER. Am I allowed to ask them or should I just hand them to you?

Let me say first of all that the reason I'm actually not here because I'm somewhere else, but I couldn't not be here with the four of you here. I mean, starting with this guy right over here, John Holdren, just all the way through—absolutely the top of all of our science and technology and innovation agencies, probably leaving one or two out. But I just had to be here for that.

Having said that and having agreed that America COMPETES as an Act had three kind of goals and one was the doubling of Federal R&D investments in science and education, and second strengthening STEM education, and developing a research and innovation infrastructure—so that in my short time here, Dr. Suresh, makes me want to ask you a question. That's about cybersecurity. Cybersecurity is very interesting. Olympia Snowe and I came out with our bill, not alone, 3 years ago, and it's still being—that and other bills, common sense, et cetera, are still being talked about.

The point is we haven't done anything. I think it's always pretty easy to look at Congress as a reason that nothing's gotten done, because we've been in something of a turmoil recently.

But I want to make sure that the National Science Foundation is involved, and I am interested in what you think that you can do to help tackle cybersecurity. And then I have a follow up question for that.

Dr. SURESH. I'm very happy to answer, Chairman Rockefeller. In the 2013 budget request, we have a program that is a broad umbrella, STC, "Secure and Trustworthy Cyberspace" that invests about $110 million and involves several directorates within NSF: the Computer and Information, Science and Engineering directorate, the Social, Behavioral, and Economic Sciences directorate, the Engineering directorate, the Office of Cyber Infrastructure, and several others. It funds basic research that keeps the enormous amount of activity that we have in cyberspace secure.

That, coupled with CNCI, the Comprehensive National Cybersecurity Initiative, which is funded to the tune of about $57 million in partnership with other agencies, including the Department of Homeland Security, provides an opportunity for us to look at how we can make the cyberspace secure with the kinds of things that NSF does.

So these investments are on the research frontiers, creating new knowledge, new mechanisms, so that we can always stay a step ahead of those who want to make the cyberspace less secure. In ad-

dition to that, NSF for the last decade has been funding a program called Scholarship for Service. This is a program which two years ago was funded at a level of $15 million per year. The objective of this program is to train people who will go into professional service for the Federal Government, who can be participants in—who can be our champions—for cybersecurity.

Since 2001, about 1,200 students have graduated from this program, and I'm told that more than 90 percent of them have joined Federal service. In 2013, our request is for $25 million to support this program.

So those are examples of activities that we have. Cyberinfrastructure Framework for the 21st Century is one of the flagship programs at NSF, which started in Fiscal Year 2012, and we are placing a significant emphasis on it for Fiscal Year 2013.

Dr. HOLDREN. Could I add something to Dr. Suresh's answer?

Senator ROCKEFELLER. Please, Dr. Holdren.

Dr. HOLDREN. The networking and information technology R&D program is a program under the National Science and Technology Council that actually links the work of 15 Federal agencies in the cyber domain. The cybersecurity part of that effort, which includes some of what Dr. Suresh was talking about, is actually up in the President's 2013 request to $667 million from $590 million in Fiscal Year 2012. That increase involves increases at NSF for the programs that Dr. Suresh was talking about, a $12 million increase at DOD, a $24 million increase at DARPA, $18 million at Department of Homeland Security.

We're really putting effort into this. We released in December of last year, December 2011, a Federal strategic R&D plan for cybersecurity and information assurance, called "Trustworthy Cyberspace: Strategic Plan for the Federal Cybersecurity R&D Program," which really lays out a roadmap for what we need to do, again including but far from limited to what Dr. Suresh was talking about.

There really is a lot going on in this domain. Of course, we are grateful for your having introduced, with some others, some cyber legislation. We're very eager to work with you on advancing legislation that will help us move this whole agenda forward.

Senator ROCKEFELLER. Thank you. Thank you very much, Dr. Holdren.

Nevertheless, with what you say about what NSF is doing, it is specifically not included in something that interests me, which I don't know enough about, in the President's budget request related to, quote, "science of security and the science of cybersecurity" for the networking and information technology R&D program.

Now, I want you to explain to me why this is, if you feel that way, not helpful. I believe that NSF should be using its resources to push advances in both science of security and science of cybersecurity. So what's your read on that?

Dr. SURESH. My understanding, Chairman, is that the definitions for "science of security" in that particular chapter that you are referring to arose because of semantic differences. So NSF is doing a lot of work—in fact, I'm told that in a later section NSF's activities are indeed included. So I'll be happy to get back to you with more detail on that.

Senator ROCKEFELLER. I may be worrying about nothing?

Dr. SURESH. If not, we'll make sure we'll fix it.

Senator ROCKEFELLER. Good, because I have the word "not" circled in black and red.

Dr. SURESH. My understanding is that a lot of this hinges on semantics issues. So I'll be able to get back to you with a specific answer.

Senator ROCKEFELLER. Good, good. I'm very grateful for that.

[The information submitted by NSF follows:]

NSF plays an important role in Science of Security R&D, and its areas of research are included under the Cross-Cutting Foundations subheading under *Science of Security* (see page 19, *NITRD Supplement to the President's FY 2013 Budget*). NSF's FY 2013 Budget Request to Congress also outlines these cybersecurity investments within its Secure and Trustworthy Cyberspace activities (see page NSF–Wide Investments—38).

We appreciate that the structure of the presentation in the *NITRD Supplement to the President's FY 2013 Budget* (pages 18–19) does appear to understate NSF's role under the Science of Security subheading. The first section under this subheading lists only those agencies that have specific programs with "*Science of* . . ." in the titles of the programs; those listed are "Science for Cybersecurity," "Science of Security," and "Science of Information Assurance." Within the same section, however, under the Cross-cutting Foundations subheading, NSF's role in advancing the scientific foundations of cryptography, models, and foundations of trust research is mentioned, and these research areas are considered to be part of the Science of Cybersecurity. As noted above, these areas also provide the framework for the proposed FY 2013 activities under NSF's Secure and Trustworthy Cyberspace investment.

Senator ROCKEFELLER. I have lots of questions I'd like to ask.

Senator NELSON. Please.

Senator ROCKEFELLER. No, no.

Senator NELSON. Go ahead.

Senator ROCKEFELLER. No, no. I've basked in the glory of these four wonderful people and the subject.

Senator NELSON. Well, please stay because your questions are excellent.

By the way, Senator Rockefeller and I have the privilege of being on the Intelligence Committee and cybersecurity is an enormous concern. The amounts that you mentioned, Dr. Holdren, seem paltry by virtue of what we have to do. Now, basically our national security computers are secure, but tomorrow at that witness table, I will be asking General Bolden about intrusions into NASA's computer systems, and it's happened in other agencies as well. But it happened in NASA about 6 years ago as well, including the theft of rocket designs.

This isn't even getting to the private sector. You get to the private sector, the banking system, the electrical systems, the water systems, whatever it is. And of course, it's not just state actors out there that are the threats. It's also these rogue people that are quite good at cyber intrusion.

So this is a real problem and, Mr. Chairman, thank you for raising it.

Senator Boozman.

Senator BOOZMAN. Thank you, Mr. Chairman.

I have a question for you, Secretary Suresh, that I have mentioned to our full chairman, Chairman Rockefeller. As you know, Arkansas in conjunction with many other States such as West Vir-

ginia benefits tremendously from the EPSCoR program. The program allows research institutions in my State and other smaller States to have a fair chance at competitive research grants from the NSF and NASA.

Will this program continue to be a priority, and what benefits to NSF's research mission has EPSCoR provided?

Dr. SURESH. The EPSCoR program, I personally believe, and this is one of the aspects of the EPSCoR program, is that good ideas happen everywhere and we want to make sure that good ideas are captured and nurtured and supported. This is the spirit behind NSF's program.

Currently we have 29 EPSCoR territories, 27 states, the U.S. Virgin Islands, and Puerto Rico, which are supported by this. In fact, under Chairman Rockefeller's leadership recently, we held a visioning exercise called EPSCoR 2030. As part of this effort, we've been looking at how to make the EPSCoR program really strong. There are a number of responses that I can give you. Let me just give a few examples. Many of these EPSCoR states also have activities, including community colleges, that reside in areas where underrepresented groups come from. We want to make sure, given the future need for scientific workforce in the country, that we make enough opportunities available to these groups. So the EPSCoR program is a very important part of NSF's activities and we look forward to the report from the EPSCoR 2030 symposium that was just held. Dr. Holdren and I participated in that symposium just about a month or so ago, and we want to make sure that the recommendations that emerge are looked at, and within NSF we'll try to integrate them into many of our activities.

Senator BOOZMAN. Good. I think the comment that you alluded to, that good ideas come from everyplace, is certainly true.

Secretary Gallagher, as I mentioned in my opening statement, I am concerned regarding the mandatory spending in NIST budget. In particular, there's $1 billion being spent for the national network for manufacturing innovation. The details, though, regarding as to how the program would work are sketchy. So I'd like for you to elaborate on that a little bit.

Then also, could you provide more detail as to why the program was proposed as a mandatory funding mechanism?

Dr. GALLAGHER. Thank you. I'm going to try to answer your question, but I'm going to confess I may not fully satisfy your curiosity.

The mandatory program for a National Network of Manufacturing Innovation is proposed as a mandatory because I believe it is a one-time investment, rather than an ongoing appropriation. The focal point of that effort is really to try to catalyze private sector investment in R&D-intensive industry. So the details, the reason they are sparse is because the program hasn't been fully announced, and we're expecting that to be done very shortly. So what I will promise to do is get right back with you with those details as soon as that comes out.

Senator BOOZMAN. Let me ask you also, from your agency's viewpoint, what is the greatest challenge to maintaining the NIST labs' technical preeminence—and it is preeminent—in standard-setting?

Dr. GALLAGHER. The preeminence at NIST really comes from two things, I think. One is a commitment to doing forefront measurement science, and I think our mission really gives us the mandate to operate in that environment. So that has the advantage of being very attractive to the top scientists in the world who want to come work with us.

But the other ingredient that we have is the relevance. It's actually—it sounds corny—but it's the public service. It's the application of that science to make a difference. We find over and over again that even in areas where we are not competitive with salary structures or other incentives that are being given to these scientists, that they still choose to come to NIST and in many cases stay at NIST. Our three Nobel Prize winners, I find not only was that a remarkable achievement for three Federal employees to win Nobel Prizes, but they all elected to stay at NIST after those Nobel Prizes, in spite of very aggressive efforts to recruit then elsewhere—and I believe when I talked to them it was because of the importance of the work and the support they received to do it. So I think that's been the most essential aspect of our ability to operate effectively.

Senator BOOZMAN. Thank you, Mr. Chairman.

Senator NELSON. Mr. Chairman, you had another question.

Senator ROCKEFELLER. Actually, I do.

I think you said that 90 percent—and now you have to tell me of what group—stayed in public service, because I want to explore that with you. I'm so happy about that.

Dr. SURESH. It is a program that's offered through our EHR directorate at NSF, called Scholarship for Service. The program in 2011 was a $15 million program. In 2012 it was increased to $45 million. In 2013 we have requested $25 million, for a variety of strategic reasons, which I'll be able to give you if you're interested.

This program has been in existence for about ten years. If my memory about numbers serves me correctly, we've had about 1,200 graduates of this program, and I'm told that the vast majority of them—again, I don't know the exact number—something on the order of 90 percent or so, chose to go into Federal service. This is part of the mission of the program itself.

Senator ROCKEFELLER. You see, I think that it is so interesting and so important to put that on the record. I was in a Finance Committee meeting this morning because we were discussing tax loopholes and this kind of thing. What came out, to my surprise, is that people need jobs and there are so many jobs that can be filled.

Now, if there are people who have your skills then it's much more elite. You get much more loyalty and you get much more reward for it, even in the public. It's kind of an "honored by the Nation" type of thing.

But I was surprised when they told me that—we were discussing tax credits for bringing companies, encouraging them to train their workers, like Toyota does. They have a very big plant in my state that keeps expanding. Once they discovered West Virginia was not still a part of Virginia and they built a plant there—that took years—it's never stopped expanding.

These are people who don't have—they're not your folks. They're just hard-working people that are young enough, in their 20s and 30s, maybe early 40s, to be taught. They bring with them the computer skills, but not the beyond-that skills to make a Lexus engine, which they do there. I mean, that's a very advanced type of work.

And they tend to be very loyal. On the other hand, Toyota makes sure of that because they really invest in on-the-job training. They want it to be done the Toyota way, which is fine with me since that's the name of the company, and they take people for a month, a month and a half, two weeks, over to Japan and run them through their training programs over there which they've set up for American workers.

But this ferocious desire to see people get trained on the job, it really pays off for Toyota. They don't lose people. That's one reason they keep expanding, because they can count on that workforce.

On the other hand, if you take that across the American business enterprise world, they told me that, you know, the average job, the turnover would come somewhere after 6 years, which surprised me because I would think that people would want to hold onto jobs. And then they said that really, they didn't really do worker training, upgrading their skills, because they didn't think they were going to hold onto the workers long enough to make it worth their while, which is—you talk about two totally different philosophies. There's that and there's what you're talking about.

Dr. Holdren, I just think that's a wonderful problem to be solved by OSTP. I don't know how it's done, but in a job-poor country, but a job opportunity-rich country, increasingly so, people should be hungry for this. They go into your fields, they bring with them the confidence and the high standards of magnificent training and brains and all of those things which are part of your esprit de corps.

But it's just the comparison. I'm not really asking for an answer. But have you ever thought about that, Dr. Holdren? It just bothers me enormously. The assumption by corporate America that their people aren't going to stay fulfills itself because of things that they decline to do.

Dr. HOLDREN. Well, Chairman Rockefeller, we are actually working on that. We're aware of it. We're troubled by it, as you are, and we're working with the leadership of a lot of American corporations, who actually are recognizing their workforce problem. I mean, they understand now that they have difficulty recruiting the technical talent and the technically skilled workforce that they need to manufacture their products, and they are taking an introspective look at why that is.

And we're working with them, including on getting them together with community colleges to develop community college curricula that are matched to the needs of the employers in the region, which we think will increase retention very substantially.

Senator ROCKEFELLER. OK, that's good.

It was interesting also—and I apologize, Mr. Chairman—I think one-half of all of the companies that put to use the research and development tax credit, which I would like to see front-loaded, but the economists tell me that would not be productive, I'm not persuaded by that yet—but they just said that they couldn't get them

interested. It's a little bit like, it's the major kind of internal problem facing working Americans, just as the cybersecurity threat is the major problem facing living Americans everywhere and the rest of the world.

We recognize it, we're working on it, but we haven't done anything about it. And I hope that all comes to a halt soon. And again, thank heavens for all of you.

Dr. HOLDREN. May I offer an addition on the cybersecurity, because I want to make clear that the $667 million I mentioned is for unclassified research and development in cybersecurity. The classified R&D number is not published. The total amount of activity in operations and deployment of cybersecurity defenses is also not published. We don't know what that, what thattotal is.

But I didn't want to leave the misimpression that $667 million is the total that the United States is spending on cybersecurity. It's not. That's just the unclassified R&D.

Senator ROCKEFELLER. Duly noted.

Dr. HOLDREN. And we are looking very carefully on the classified side at the adequacy of what we're doing and whether there are breakthrough ideas that could be brought to bear that would improve the situation, because we very much share the concern of the Committee that this is a very big threat.

Senator ROCKEFELLER. That's the cyber side, but on the other side, manufacturing is so much of what the America COMPETES Act is about. And there you have a record which is not as good. It's a little bit like—and I really promise to leave after this sentence—like the movie "Too Big to Fail" or the book, that we gave these nine banks $125 billion—I voted for it—through TARP, and the idea was they were going to help with mortgages. That was the idea, that's what they'd spend it on.

And there were just all these conniptions back and forth passing that. It just barely, barely got through. The House voted it down, then voted it up 3 days later. And at the end of the day, these nine big banks receiving $125 billion—they didn't need cash. They had that. They didn't need assets. But the point was for them to sort of shield smaller banks so that the financial system as a whole would not collapse.

They succeeded in the second, but they spent not a dime on housing mortgage problems. It all went into compensation. And that's what's so discouraging, I think, and I think that's so much the opposite of what kind of people and habits that you all are talking about.

So, with that Confucian thought, I depart.

Senator NELSON. Thank you, Senator Rockefeller.

Senator Pryor.

STATEMENT OF HON. MARK PRYOR,
U.S. SENATOR FROM ARKANSAS

Senator PRYOR. Thank you, Mr. Chairman, and thank all three of you for your leadership on these issues. It's very important.

If I may, I'd like to start with Dr. Holdren, and I want to thank you for your little shout-out in your opening statement about prizes and the prize authority, and I appreciate that. Can you give the Subcommittee here some examples or at least one example of how

the prize authority is being used today, and also if you have any suggested changes to improve the program?

Dr. HOLDREN. Well, thank you very much, Senator Pryor. Again, I think thanks are due to you and to Senator Warner particularly for being so instrumental in providing prize authority, expanded prize authority across theagencies.

We actually have made a lot of progress. Although this COMPETES prize authority is only a year old, a lot has already happened. The most ambitious project launched by any agency under that prize authority is the Health and Human Services Investing in Innovation Initiative, which is a $5 million program to spur innovation in health information technology.

Senator PRYOR. Is that one $5 million prize or is it a series of prizes?

Dr. HOLDREN. I believe that it's divided into a number of prizes. I'd have to get back to you on the details.

The Veterans Administration has been very active in that, in that domain. There have been some extremely interesting actual results of prize competitions. The Air Force Research Laboratory had a design competition to stop fleeing vehicles, which has been a vexing problem for a very long time, and a 66-year-old retired mechanical engineer in Lima, Peru, came up with the winning idea, which is a remarkable device that accelerates from zero to well over 100 miles an hour within 3 seconds, positions itself under a fleeing car, and inflates a giant air bag to lift it off the ground and then bring it to a stop.

NASA has been—I really should let Dr. Peck talk about this, but NASA has been very energetic and successful with prize competitions. They had a prize competition to demonstrate a super-fuel efficient full-scale aircraft. Two winning teams exceeded the performance requirements by a factor of two, both flying more than 200 miles on the energy equivalent of half a gallon of gasoline, averaging 100 miles an hour and carrying two people.

The potential in this prize domain is enormous. It reaches a much greater reservoir of creativity than our traditional approaches to funding. It brings interdisciplinary teams into being that compete for these things. You pay only for results, and in a number of these competitions—there was an efficient vehicle competition that was completed a year ago with the Department of Energy in which basically for $10 million in prizes $100 million was invested by the competing teams. Numerous entries approached or exceeded the goal of 200 miles per gallon equivalent.

So I think this whole prize domain is enormously fruitful.

Senator PRYOR. Well, good. Thank you.

Mr. Gallagher, let me ask you, if I may, you mentioned in your opening statement or maybe in an answer to one of the questions that the national network of advanced manufacturing centers will need Congressional legislation. What specifically legislation do you need and why?

Dr. GALLAGHER. Thank you. My understanding is that a mandatory program like that requires, since it's outside of the appropriations process, requires a separate specific piece of legislation to authorize the program. But we also anticipate that that would pre-

sumably be where any special authorities that are required to execute this multiagency approach would also be incorporated.

Senator PRYOR. I look forward to working with you on that.

Dr. GALLAGHER. Thank you.

Senator PRYOR. As you are working on that, I'd love to consider being part of that.

Also, Mr. Gallagher, if I may, if you don't know about it, Senator Wicker and I have co-sponsored legislation called S. 1948. I don't know if you've heard of it, but it's called the Win Jobs Act. Basically what it does is—we had this legislation before the State of the Union, but the President mentioned trying to connect job skills with jobs. In Arkansas we've done a very good job of using our two-year colleges, and our 4-year colleges, but primarily the 2-year colleges, to connect people with jobs and to do a lot of job training and really tailor those programs for manufacturers, et cetera, in the area.

I was wondering if you've had a chance or if you even know about the Win Jobs Act, and also what role you think apprenticeship programs and other of those type skill level programs will play in our economy in the future?

Dr. GALLAGHER. I was aware of the Act, but I will confess to not being fully aware of all the details in there. I would very much like to work with you on this, because I think this issue of skills, the skills gap, this jobs gap that we keep hearing about, is occurring with every manufacturing company I talk to.

I think what's happened is the nature of these jobs has shifted and we haven't moved along with it to provide the infrastructure to give people those opportunities to pick up the skills. So I think there are a couple of opportunities. One thing that's happening right now is within the NIST MEP program we actually are working with the National Association of Manufacturers so that on the skills side, manufacturers can identify skill sets through a certified list process. That will create the demand for two-year training, community colleges and other institutions provide that type of training opportunity to provide those skill sets.

I think that's an appealing process because that can scale then right away. That becomes independent of a case-by-case basis.

The other opportunity that's happening right now that's under way is under Dr. Holdren's leadership when PCAST released their report last summer on advanced manufacturing, the President asked for an advanced manufacturing partnership, where all of these, both academic organizations and industry leaders, came together to work alongside with us to lay out a set of priorities.

Well, this workforce issue has risen to the top. It's one of the key workstreams. And they're in the process of finalizing a set of recommendations. So that provides yet another basis for us to work closely with you on some of the policy options that are coming from our industry and university participants in that area.

Senator PRYOR. Great.

Mr. Chairman, thank you. One last thing. On the Win Jobs Act, one of the ways we do it in Arkansas is just—it is, like he said, more of a case-by-case basis, where an industry will want to come to our state or want to expand and they tell us, they tell the local Chamber of Commerce, the Governor, the two-year college, what-

ever it is, however they're working, and they'll say look, this is what we want to do, but this is what we need.

So we've been very successful in having the two-year college—usually it's a two-year college—go in there and tailor-make a training program specifically for them. It's just paid huge dividends for us. I think the state of Arkansas is one of the few that actually added manufacturing jobs during the recession.

So we're doing some things right there. It takes a lot of attention and focus and leadership to do it. But thank you for your interest in it and I'd love for you to look at that bill, would love to get your comments on it.

Thank you, Mr. Chairman.

Senator NELSON. Thank you, Senator Pryor.

Gentlemen, Dr. Holdren, I noticed there's a 25 percent cut in the President's request on NASA's education budget. Why is that?

Dr. HOLDREN. Well, as I mentioned, Chairman Nelson, we did an inventory of all the STEM education programs across the agencies. We found upwards of 200. And we looked, together with the agencies, at the opportunities for consolidation, the opportunities for improving efficiency. Of course, within NASA, as I know Dr. Peck would attest, there were a lot of tough choices made overall, but NASA did a particularly good and energetic job of looking at their education programs and figuring out how they could get greater bang for the buck, and I believe they're going to do that.

Senator NELSON. Isn't it the mesmerizing possibility of space travel that excites kids so much to want to get into math and science and technology? And we're making NASA clamp down on their educational efforts?

Dr. HOLDREN. I don't think we're making NASA clamp down. I completely agree with you that the excitement of space is important. It excited me and was a major factor in what pushed me into science and technology. So I'm all in favor of it.

But I think what NASA has done with its own intensive internal review of its programs is figured out how to do better. And some of the efforts that are being devoted to STEM education across the government, including in the Education Department and in NSF, are focused at figuring out how to make programs more effective going forward. Some of the benefits of that research, which is spread across a number of different agencies, are ultimately going to be felt in NASA as well.

I think what you're going to see is when the strategic plan for STEM education comes out a little later this spring it will be clearer how all this fits together. But you should not look at it as a retreat. We continue to be excited about the potential of space, cosmology, astronomy, exploration, Earth observation from space, to excite young people and get them into these fields.

Senator NELSON. Well, Dr. Peck, what say you? If you're going to whack 25 percent of the education budget, how are you going to inspire all of this next generation of scientists and engineers?

Dr. PECK. Senator, you're absolutely right that this is just the sort of thing that inspires the next generation of scientists and engineers. It's true, all the way from K through 16 and even at the graduate level. NASA's education, as Dr. Holdren explained, is working closely with other government agencies and with the

OSTP-led Committee on STEM Education, COSTEM, to ensure that we have a coordinated and effective student and teacher set of opportunities.

It is one of the tough choices that NASA had to make in the current austere economic environment. But we remain committed to STEM education. The thing is that across the agency there is support for the academic community through other forms of sponsorship. So there is a silver lining here. Within the Office of Chief Technologist particularly, we have a number of programs that are not STEM specifically, but support the academic community through sponsoring graduate students and faculty and university researchers to conduct technology research that supports NASA's mission. And there's a trickle-down effect where—and I can tell you as a former faculty member myself that having a vibrant program in technology and space does a lot to inspire students to take on this kind of activity.

Senator NELSON. Give me an example of one of those programs.

Dr. PECK. One of them is the NASA Space Technology Research Fellowships program, NSTRF. We just started that program last year. We inducted its inaugural class of 80 graduate students across the nation. Those students will be conducting research with faculty sponsors and with NASA mentors that directly benefits NASA's technology agenda.

So I would say it's indirectly about education. It's not an education program per se, but it does directly benefit the academic community.

Senator NELSON. Dr. Holdren, would you like to have the R&D tax credit permanent?

Dr. HOLDREN. Yes, I would, sir.

Senator NELSON. How much of an increase in R&D spending would you expect from that?

Dr. HOLDREN. Well, I think it depends on the details, sir. The President's budget has a specific proposal for simplifying it, increasing it, and making it permanent. But obviously there is going to be a discussion with the Congress about that, and I would hesitate to make a specific prediction without knowing where we're going to end up in the details.

But we are all aware, I think, that today nearly 70 percent of the funding for all R&D in the country comes from the private sector, less than 30 percent comes from the Federal Government. And there is no way we are going to get the total R&D portfolio increasing as we need it to be if we don't provide, I think, additional incentives for the private sector to continue to step up.

Senator NELSON. Do you think that we ought to target R&D tax credits to certain areas that would make us more competitive in the global marketplace?

Dr. HOLDREN. Well, we are targeting, of course, a lot of our Federal applied R&D investment in that way. We've talked about the advanced manufacturing. The total budget proposal for advanced manufacturing in the 2013 President's budget is $2.2 billion. One of the reasons for that obviously is our sense of the high leverage that that provides in global competitiveness.

We are increasing the budgets of the basic research agencies because we understand that basic research is the foundation of all

applied research and development that follows, and we think, while you can't predict where the next big breakthrough that has a large economic impact is going to come, we have to seed that field in order to get it.

But I think as far as the tax credit is concerned, to answer your question directly, I personally would not recommend a lot of fine-tuning trying to pick winners. What we have found historically is that picking winners is a dicey business, the private sector is better at doing that than the government is, and the complexities added by having arguments about where the greatest promise is in terms of constructing a tax credit I think would be difficult to overcome.

Senator NELSON. Dr. Suresh, give me some examples of technology transfer where Federal research has led to a successful commercial venture?

Dr. SURESH. I can give a number of examples, Mr. Chairman. Let me start with manufacturing. In the 1970s NSF funded research in the area of mathematical and process modeling that at that time was seen as a purely academic and theoretical exercise both by industry and even some mission agencies. That directly contributed to something calledrapid prototyping, a technology that played a huge role in our manufacturing prowess, if you will, in the late 1970s, 1980s, and 1990s.

That's one example. In partnership with the Department of Defense, in the 1960s onward, we funded a lot of research for GPS, mathematics, physics, and engineering research. Who would have thought in the 1960s that you and I will be using GPS in our mobile devices today, and how many industries it has led to?

In the 1990s we funded two young graduate students on the West Coast to do purely mathematical research. Their names are Sergey Brin and Larry Page. NSF cannot take complete credit for Google, but we played some catalytic role in the creation of that.

More recently, when President Clinton announced the National Nanotechnology Initiative at Cal Tech in 1999, NSF was one of the first agencies to fund basic research in nanoscience and nanoengineering centers. Since 1999 NSF funded nanoscience and nanoengineering centers alone, purely for scientific research. They were not funded for commercialization of technology. These centers have resulted in 180 startups that involved 1,200 corporations.

NSF was the first Federal agency to start Small Business Innovation Research, the SBIR program. Now there are 11 Federal agencies. There are hundreds and hundreds of success stories. Qualcomm is a wonderful success story. The two founders of Qualcomm, Dr. Irwin Jacobs and Andy Viterbi, both received funding from NSF at a time when they could not get funding from anywhere else, and I don't need to say any more about how successful Qualcomm is.

So these are examples, in very different areas, of the role that basic science at NSF has played in creating innovation, technology, jobs, and economic impact.

Senator NELSON. Senator Boozman.

Senator BOOZMAN. Well, thank you, Mr. Chairman.

I guess just one further question, Director Suresh. A lot of the scientific research today is interdisciplinary, with new innovations and ideas coming from those types of collaborations. I guess I'd like

to know if you agree with that trend and specifically how does the proposed NSF budget reflect the trend?

Dr. SURESH. It's a very important question, Senator. It's something that we've been paying a lot of attention to. We believe at NSF that increasingly we have greater and greater interdisciplinary research, which creates new ideas and new opportunities for discoveries at the intersections of traditional disciplines. But we also feel that disciplinary excellence in basic areas like mathematics, physics, chemistry, and astronomy is necessary for interdisciplinary excellence. So we try to balance that very, very carefully.

With respect to your question, we have a number of activities that are in place. Two of our flagship programs cut through every corner of NSF. Science, Engineering, and Education for Sustainability is an activity that's highly interdisciplinary in nature. One of the focal areas is to prepare the research community and the education community for both natural and human-made disasters. It's sustainability in the broadest sense of the word, from rising sea levels to ocean acidification, a variety of activities, climate change, global change, et cetera.

So that's one part of it. Another area of interdisciplinary research is Cyberinfrastructure Framework for 21st Century Science and Engineering. This is an area again that is highly interdisciplinary. A specific program started in Fiscal Year 2012, called INSPIRE. It's an interdisciplinary effort to make sure that, given the organizational structure of NSF, the universities, and the research communities, we don't miss transformative new ideas that may fall outside conventional wisdom.

So we have unconstrained mechanisms to foster new ideas and support them, and that's the goal of INSPIRE. We launched it in 2012 with about $20 million, and in 2013 our budget is $63 million.

Senator BOOZMAN. Very good.

Thank you all for being here. That's really all the questions I have. I do want to thank you, and I appreciate your hard work. And you've got such an important job. I think one of the keys to America's success is research and you play such an important role with that. I know I can speak for both sides of the Committee in saying that we want to help you any way we can. So we do appreciate your hard work and look forward to working with you in the future.

Thank you.

Senator NELSON. You are certainly speaking for both of us, and thank you for that, Senator Boozman.

Dr. Peck, the NRC recently released their evaluation of NASA's technology roadmaps. There are no new starts in the President's budget, just a continuation of existing projects. So how are you going to address the gaps that the NRC found in your technology portfolio?

Dr. PECK. Senator, you're correct that there are no new starts in our 2013 budget. The request is $699 million to cover existing programs and to cover the phased sequence of activities associated with the technology demonstration missions that we're taking on, as well as SBIR or STTR.

The basis of much of our program in space technology is in fact a competitive one. We have competitive solicitations. New solicitations appear each year. Also, across the agency as Chief Technologist I have the responsibility of coordinating the agency's technology portfolio. So in combination here, first with the competitive solicitations that we offer and through coordinating across the agency, we believe that we can use the 2013 budget and then what we expect for 2014 to respond to the NRC's prioritization.

That assessment was very valuable for us. It provides us, first, a ratification of our technology approach, which is to say a technology program that is based first in competitive solicitations and also one that looks at cross-cutting technologies of relevance to multiple missions. They ratified our approach to building the program and they also offered a prioritization of technologies. Among those are 16 highest of the high priorities, and I'm glad to report to you that we are in fact investing in all 16 already. Now, the balance among those 16 is something we'll adjust in 2013 and going forward.

Senator NELSON. Dr. Gallagher, a year ago we talked about the disconnect between the standards-setting process for electronic medical records and the fact that many hospitals were already using some form of that technology. I had asked for a timetable for when those standards would be ready, which you provided for this hearing. Why don't you give us an update on this standards-setting process, and the Networking and Information Technology Research and Development program, which has a new health IT senior steering group. Are they taking the leadership role, and what activities are planned for the future?

Dr. GALLAGHER. Thank you. The health information technology area and standard-setting has been very active. The High-Tech Act, which laid out the approach to take, actually took the unusual step of putting the standards in the framework of performance of the system. So rather than a set of technical specifications on file formats and interoperability and security, it was instead cast as what would the system do if it was put into use? And we call that the meaningful use approach, and it was actually, working with HHS, laid out in three phases.

Stage one is complete and under way. Those standards are out there. Systems are being certified to those standards now. I was talking with the national coordinator yesterday and apparently there's been billions of dollars of direct reimbursement to physicians and practices for those certified systems already. So that's well under way.

There's a notice for proposed rulemaking that covers stage two, which goes into yet higher level functionality, and then a stage three is envisioned.

The interesting part about that approach, very popular now in industry, where you take use case-based design, is that the technology now is underneath it and it comes in, naturally, so, how does it support a doctor being able to meaningfully manage its patients caseload? It requires the medical records to be able to be exchanged securely and satisfy HIPPA requirements and have various search functionalities and capabilities.

So the NIST role has been to develop the test suites so that we can support the certification and third party test infrastructure. It's very active, it remains very active. You mentioned the NITR-D effort as well. That's really the mechanism, this 20-year-old interagency process where we set priorities on the R&D side. And like any domain area using information technology today, there are key questions about how do we secure and meet privacy requirements and secure the system.

So I'm very pleased that we have this parallel effort that's laying out the R&D agenda. It's really a longer range agenda, so it doesn't replace the standard-setting. It really helps provide some of the gaps in our current understanding, so that the standards processes, which frankly I never envision stopping—I mean, they have to keep moving with the technology—are also supported by the coordinated R&D agenda.

Senator NELSON. Dr. Suresh, you started an Innovation Corps, and its purpose is to develop commercially viable technology and scientific ideas. So tell us about its progress.

Dr. SURESH. The Innovation Corps is based on the notion that basic science and engineering research is a necessary precursor for technological innovation. So we support that basic research through about $6 billion a year of research funding at NSF. In 2013 we expect to support 285,000 individuals. All the activities that we support with respect to research pretty much lead to wonderful publications in journals. Many of them lead to patents.

So we wanted to ask the question, what more can we do so that we can milk the most use or output out of NSF-funded activities even beyond what we already do in a fairly successful manner, and what are the impediments to doing that within the NSF context? NSF has always funded activities in innovation. I mentioned SBIR; that goes back more than 30 years. In the mid-1980s we started a program called Engineering Research Centers. Also, in the late 1980s, we started Science and Technology Centers.

More recently, we have programs such as Industry-University Collaborative Research Centers, IUCRCs, Partnerships for Innovation, Accelerating Innovation Research, et cetera.

But one of the key components that we found that was missing was the following. We fund 1,900 institutions in the country, but the vast majority of them, with the exception of a few institutions on either coast of the country or a few institutions in the middle of the country, may not have the fully developed ecosystem to tap into the national innovation enterprise.

So what do I mean by that? A technology licensing office in a university campus; mentorship which is extraordinarily critical; access to a small amount of money for a short period of time right after a scientific discovery.

So we asked the question: What is it that NSF can do, without taking precious research dollars out of basic research, but using our reach and stature on a national scale and with the wealth of experience that we bring to this as a 61-year-old agency to foster innovation so that we can get the biggest bang for the buck? That's essentially the goal of Innovation Corps, or I-Corps, which we launched last year, with Dr. Holdren participating in the launch.

I'll give you the key ingredients of I-Corps. We want to start small, so by design the first year funding is only about $7 million, on top of a $6 billion research budget. So it's really a drop in the bucket, one-thousandth of our research expenditure.

But our goal is to create a national virtual infrastructure that provides opportunities for mentorship, training in entrepreneurship, because university professors may not have the background to take a successful scientific discovery and convert it to an idea that will succeed in the marketplace. How do we do this? There is a wealth of experience at a number of universities. So mentorship is key. The educational part is key.

Creating national nodes is an activity that we are looking into. So our goal for the first year is 100 programs. Our goal for the second year is to scale it up to 300. It's a public-private partnership, so we have two nonprofit foundations that have a lot of experience in this space who are partnering with NSF to offer their expertise and experience.

So this is something that I'm pleased to say appears to have been off to a very good start, and we are monitoring it very carefully to see how we can take it to the next level, to a steady-state level.

Senator NELSON. Are you finding that the new patent bill is helping you as you try to take a scientific discovery to an idea? To get it to market, you need that patent process working in order to protect the inventor. Do you have any comment on that?

Dr. SURESH. Well, it's too early for us to say how much it's helping. But on the other hand, anything that makes the patent process more efficient would definitely help the innovation ecosystem for us.

We are even talking about before the patent process, how do we help our NSF-funded scientists identify, first of all, what is patentable, what is worth pursuing beyond publication. Some of the PIs are very good at this, their institutions are very good at this, but not uniformly across the country. This is one of the goals of the I-Corps program.

Senator NELSON. Dr. Gallagher, do you want to tell us about your proposed centers of excellence?

Dr. GALLAGHER. Yes, Senator. The Centers of Excellence would be an expansion of something NIST has been doing for about 50 years. These would basically be collaborations between NIST and other academic or nonprofit organizations. The idea is to create through a partnership an expansion of our capability.

As you know, NIST is quite hybridized. About half the technical workforce that are on our campuses are non-NIST employees, so they have a large presence on our site. But we've learned through things like the JILA partnership at the University of Colorado or the Joint Quantum Institute, University of Maryland, and through some similar interactions, that for certain carefully posed areas combining sort of the best of academic organizations with the NIST mission creates some unique opportunities. This program is specifically designed to provide a funding vehicle for us to pursue those because, frankly, the demand to enter into these kinds of arrangements far exceeds any capacity we have to do that.

Senator NELSON. And you think the universities will have the demand to host these new centers?

Dr. GALLAGHER. Yes, sir. I know for a fact that in any given particular technology area where we've been reaching out and talking to the universities—so for example in advanced biotechnology—there's probably at least a dozen universities who are routinely calling to see whether we could establish some type of joint institute. Of course, that would be appealing for me if I could do that because that's an area where NIST does not have a long track record or a very large-scale internal capacity itself. But through a partnership with leading academic organizations, we could then actually have access to some of the strongest researchers in that particular area and yet also have right alongside it work focused on the NIST mission of advancing measurement in that area.

So it's a recipe that's very appealing, not just to us, but also to many of these organizations. We have a long list of topic areas where those kinds of discussions have been under way.

Senator NELSON. Senator, do you have further questions?

Senator BOOZMAN. No, thank you, Mr. Chairman. I don't.

Again, thank you all for being here. We'll have a couple more that we'd like to submit to the record, with your permission. Don't worry, we've asked the hard ones. These are the easy ones.

Again, thank you, Mr. Chairman.

Senator NELSON. Thank you all for what you do. It's important to the future of this country. And thank everybody for participating and to the staff that has prepped for this hearing, thank you very much.

The meeting is adjourned.

[Whereupon, at 4:32 p.m., the hearing was adjourned.]

A P P E N D I X

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO DR. JOHN P. HOLDREN

Question 1. This proposed Federal investment to revitalize manufacturing is spread over multiple agencies and targets different stages in the process of bringing successful research ideas to the marketplace. Are there particular programs that the Administration considers high priority or essential for the overall investment to achieve its goals?

Answer. One key objective of the Administration's proposed investment is to achieve a "cohesive approach to research, development, and deployment" in advanced manufacturing, as stated in the recently released *Strategic Plan for Advanced Manufacturing.* Accordingly, we seek to take a portfolio perspective that balances investments across technologies and stages of the innovation process, including demonstration and improvements of technologies in use. The Advanced Manufacturing National Program Office, which is hosted at the National Institute of Standards and Technology (NIST) and is supported by key agencies from across the Federal Government involved in advanced manufacturing, has the responsibility of assessing this portfolio in light of both agency missions and national needs. In addition, the President has proposed that the Federal Government co-invest with industry, educational institutions, and the states to create a National Network for Manufacturing Innovation (NNMI). This Network would fill a critical gap in the current portfolio by accelerating innovation in industrially relevant manufacturing technologies with broad applications.

Question 2. On OSTP's budget: OSTP's budget was hit significantly when the Fiscal Year funding of $6.7 million was reduced to an appropriation of $4.5 million in Fiscal Year 2. The President has requested $5.9 million for Fiscal Year 3. Dr. Holdren, how is the Fiscal Year funding level impacting OSTP's operations, and will the $5.9 million requested, if enacted, be enough to fully operate an organization tasked with coordinating science and technology policy across the entire government?

Answer. We are doing all we can to adjust to our diminished budget, but the impacts are substantial. OSTP has frozen all hiring, a move that will result in an almost 20 percent reduction in personnel. Travel was reduced by two thirds. All equipment and software replacements and upgrades have been canceled or postponed. The Fiscal Year appropriation leaves OSTP with no "surge" capability and no flexibility to hire personnel with the expertise that may be required. While we are doing the best we can to cover our myriad responsibilities, some of these responsibilities will necessarily suffer as staff are pulled away to address urgent topics. OSTP will remain focused on those areas most relevant to creating jobs, improving our competitiveness, and expanding our economy.

The requested budget increase for 2013 would put OSTP back on a healthy financial footing after the substantial reduction in 2012. Restoring OSTP's budget is critical to OSTP's continued ability to work with Congress, the agencies, and the President and his senior advisors to ensure that the Nation's science and technology investments are appropriately sized, targeted, and coordinated. The first priority for restored funding would be to ensure that OSTP has the proper mix of scientific and technical expertise on board to address the Nation's science and technology challenges.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. BILL NELSON TO DR. JOHN P. HOLDREN

Question 1. I am pleased to see the proposed 2.4 percent increase in funding for the Department of Energy's Office of Science, consistent with the continued efforts to double the funding for key science research agencies.

- Given the overall increase what led to the decision to cut funding in several key areas, including nuclear physics and high energy physics?
- With the decrease proposed for these programs, in particular for high energy physics, how does DOE propose to support ongoing research aimed at meeting the Grand Challenges related to these fields?

Answer. I appreciate your support for the Department of Energy's Office of Science in the 2013 Budget. I believe strongly that the 2013 Budget sustains the legacy of American leadership in fundamental research. As I noted in my testimony, within a budget proposal that holds discretionary spending flat for the second year in a row, as agreed to by Congress and the President last year in the Budget Control Act, the Administration has prioritized continuing increases in Federal support for key science-research agencies. Even within difficult funding constraints, the President's Budget has prioritized R&D, and DOE's Office of Science would receive, as you note, a 2.4 percent increase to $5.0 billion in the 2013 Budget proposal. The 2013 Budget proposes to direct these additional resources to Administration priorities through fundamental research on energy, support of leading-edge advanced computing research, and through fundamental research to address critical biological and environmental challenges. The need to address these critical national needs in a constrained budget environment necessitated some difficult choices. Some of the decreases proposed for other DOE Office of Science programs are due to planned transitions in facilities, such as the end of Tevatron operations after a long and productive lifespan and a shutdown of the Fermilab accelerator complex for half of Fiscal Year 2013 while the accelerator upgrades for the NuMI OffAxis Neutrino Appearance (NOvA) project are completed. During and after these transitions, DOE will continue to support research at the frontiers of discovery.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. MARK PRYOR TO DR. JOHN P. HOLDREN

Question 1. The National Nanotechnology Initiative is entering its 12th year as a Federal Government R&D program. Cumulative Federal funding is almost $18 billion counting the Fiscal Year budget request of $1.8 billion. When will we see commercial products based on these breakthrough nano-technologies and what will some of these products look like?

Answer. We already see commercial products based on nano-technologies resulting from National Nanotechnology Initiative (NNI) investments. The Woodrow Wilson Center's Project on Emerging Nanotechnologies does an excellent job of inventorying nanotechnology-enabled products from U.S. companies. The purpose of NNI was to build R&D infrastructure and foster innovation in this area, and these types of products are the fruits of that endeavor. The Center's continually updated inventory is available at *http://www.nanotechproject.org/inventories/consumer/*.

The NNI National Coordination Office (NCO), which OSTP oversees, has a similarly excellent inventory of existing products and products just over the horizon. These products already include higher-efficiency appliances, clean-energy materials, medical devices, and advanced batteries, to give just a few examples. The continually updated inventory is available at *http://www.nano.gov/you/nanotechnology-benefits*.

Question 2. Section 101 of the America COMPETES Reauthorization Act requires "the teaching of innovation and entrepreneurship as part of STEM education." Many colleges and universities have started entrepreneurship programs in conjunction with their science courses. The reason for this provision in the Act is to make STEM education relevant to these students. What is the Federal Government doing to encourage entrepreneurship as part of STEM education?

Answer. The Administration is taking steps to encourage entrepreneurship education. In my testimony I described the Administration's year-old Startup America initiative, a Federal-private partnership to inspire and accelerate high-growth entrepreneurship throughout the Nation. This effort includes student and other young entrepreneurs in its activities. For example,

—The Startup America partnership connects young entrepreneurs with mentors and other resources to help them start and grow their businesses.

—The National Science Foundation (NSF) launched a $10 million National Center for Teaching Innovation and Entrepreneurship in Engineering to reach engineering students in 350 engineering schools around the Nation.

—The Department of Energy (DOE) recently awarded $2 Million in the National University Clean Energy Business Challenge to create and administer a

network of student-focused business creation competitions and inspire young entrepreneurs to found innovative, clean energy companies.

—In October 2011, President Obama announced new executive actions to make it easier for Americans to manage student loan debt, including a proposal to let upcoming graduates cap their monthly Federal loan payments at 10 percent of their income, with any remaining debt balance forgiven after 20 years. This improved "Pay As You Earn" plan is great news for the estimated 1.6 million borrowers who could benefit from reduced or more flexible student loan payments, especially would-be entrepreneurs who will have increased flexibility to try an entrepreneurial path.

—And the Departments of Education and Labor are teaming up to advance a youth entrepreneurship agenda that infuses entrepreneurship education into a range of existing education programs. I am enclosing an Education-Labor fact sheet on this effort, which can be found at *http://www.ed.gov/sites/default/files/ed-labor-fact-sheet-entrepreneurship.doc*.

Question 3. Regional Innovation. Regional innovation involves the cooperation among academic institutions, manufacturers and the supply chain. I have long been a proponent of science parks and technology incubators as a location for performing applied and translational research and development. The Fiscal Year budget requests $25 million for this program through the Economic Development Administration (EDA) including $7 million to be used for science park loan guarantees.

- How do you think the regional innovation ecosystem needs to develop in the United States? Are there models from other countries that the U.S. should be following?
- Is this the right amount of funding for such an important initiative?
- What regional innovation clusters have been recently established, how has the private sector invested in their creation, and what competitive benefits have been realized by clustering?

Answer. The Department of Commerce's Economic Development Administration (EDA) has been the lead Federal agency in supporting regional innovation programs, including providing support for regional innovation clusters and science parks, as authorized in COMPETES. The 2013 Budget supports these ongoing EDA efforts, and I understand that EDA is actively working to develop the other new authorities granted in COMPETES, including the innovative manufacturing loan guarantees and science parks loan guarantees. EDA is not alone in supporting these efforts. Other Federal agencies are supporting regional innovation efforts also. I am excited that one of DOE's Energy Innovation Hubs, the Energy-Efficient Buildings System Design Hub in Pennsylvania, is the core of the Greater Philadelphia Innovation Cluster (GPIC) for Energy-Efficient Buildings, a collaboration among DOE, the Department of Labor, NSF, EDA, the National Institute of Standards and Technology (NIST), and the Small Business Administration (SBA) to create jointly a regional innovation cluster in greater Philadelphia centered around energy efficiency with co-investments from academic institutions and community colleges, private-sector industry partners, and regional economic-development agencies.. By bringing together cutting-edge R&D, local economic-development resources, firms, and educational institutions in one place, this and other regional innovation clusters improve the odds of innovations from Federal research transitioning from the laboratory to the marketplace and resulting in job creation.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON MARK PRYOR TO PATRICK D. GALLAGHER, PH.D.

Question 1. Last month the Executive Office of the President issued the report "*A National Strategic Plan for Advanced Manufacturing*" as required by the America COMPETES Reauthorization Act. The Administration has already initiated several of the recommendations in the report. For example, the Advanced Manufacturing Partnership and the Department of Commerce Advanced Manufacturing Program Office have been established. What program elements of the National Strategic Plan and the President's budget request for Advanced Manufacturing do you believe need to be authorized by Congress?

Answer. NIST is able to conduct all the manufacturing initiatives proposed in its 2013 Budget using existing authorities, with the exception of the proposal to provide $1 billion in mandatory, one-time funding to catalyze the creation of a National Net-

work for Manufacturing Innovation. We look forward to working with the Congress on NNMI authorizing legislation

Question 2. The President's Fiscal Year 2013 budget proposes a substantial $2.2 billion investment spread across seven agencies to enhance the competitiveness of the U.S. manufacturing sector. Some public-private partnerships, such as SEMATECH, have been successful in helping companies perform pre-competitive research and development. Most have not been successful. How can the Federal Government get better proposals for public-private partnerships?

Answer. High-quality proposals are essential for establishing effective public-private partnerships to enhance the competitiveness of the U.S. manufacturing sector. Four aspects of the proposal solicitation process drive the quality of proposals: evaluation criteria, stakeholder engagement, stakeholder investment, and solicitation timeframe. First, the evaluation criteria must help proposal developers to establish a credible plan aligned with the goal of the partnership. Such a plan should include a progression of measureable milestones that identify elements of technical and business risks to define a clear pathway to partnership success. Second, the stakeholder engagement must effectively communicate the evaluation criteria and the programmatic goals of the proposal solicitations to a broad audience to coalesce and catalyze partnership participation from stakeholders with the greatest potential for success. Third, stakeholder investment must demonstrate a compelling level of investment from partnership participants to ensure firm commitment to the success of the partnership. Fourth, the time-frame of the solicitation must allow sufficient time for stakeholder partnerships to be formed and for a high quality proposal to be developed.

Question 3. Should the proposals be tied to Federal agency mission needs?

Answer. Yes. The responsibility for effectively establishing these ties is shared by the agencies and the proposal developers. The agencies must define how the proposal solicitations connect to specific legal authorities and corresponding mission needs through the funding opportunity scope, requirements, and evaluation criteria. In turn, the proposal developers must show how their proposed activities satisfy the funding opportunity and therefore connect to agency legal authorities and mission needs.

Question 4. Do you believe public-private partnerships between education institutions, businesses, and the government is an effective mechanism to address our country's growing shortage of skilled workers, particularly in the advanced manufacturing sector?

Answer. Yes. Partnerships have been demonstrated to be an effective mechanism for addressing advanced manufacturing workforce needs through several programs identified in Appendix D of the NSTC Report "*A National Strategic Plan for Advanced Manufacturing*." These programs include the *Manufacturing Skills Certification System* supported by the NIST Manufacturing Extension Partnership, The Department of Education's *National Career Clusters Framework,* the Department of Labor's *Registered Apprenticeship* and *Workforce Investment Act* programs, and the National Science Foundation's *Advanced Technological Education* program.

Question 5. The Administration Fiscal Year 2013 budget requests $1 billion to create a new National Network of Manufacturing Innovation Centers. What are the goals for this Network?

Answer. The Network aims to help to make our manufacturers more competitive and encourage investment in the United States. As an interconnected, collaborative whole, the network of Institutes will generate national and regional benefits in addition to serving their primary roles of bridging the gap between laboratories and markets, solving cross-cutting manufacturing challenges, and supporting the translation and scaling of innovative manufacturing technologies in the U.S., including:

- Identifying and diffusing best practices among the institutes in the network for building and running partnerships, including cooperative arrangements, intellectual-property management, etc;
- Facilitating sharing of workforce training successes among the institutes in the network that address industry needs for skilled manufacturing workers;
- Serving as a focal point across the network to cross-fertilize technical ideas and technical career opportunities; and
- Supporting complementary and synergistic regional development of shared assets of value to many businesses.

Question 6. What are the purposes of the Centers and how would they operate?

Answer. The purpose of each Institute will be to integrate capabilities and facilities required to address cross-cutting manufacturing challenges that have the poten-

tial to retain or expand industrial production in the United States on an economically viable basis. The Institutes will each have a well-defined technology focus to address industrially relevant manufacturing challenges on a large scale and to provide the capabilities and facilities required to reduce the cost and risk of commercializing new technologies. The Institutes provide a collaborative, precompetitive environment for enhanced technology development and transfer, and will be a magnet for companies that are looking to build long-term assets—knowledge, skills, and technology.

Activities of the Institutes to fulfill this purpose will include:

- applied research and demonstration projects that reduce the cost and risk of commercializing new technologies or solve generic industrial problems,
- education and training,
- development of innovative methodologies and practices for supply chain integration, and
- engagement with small and medium-sized manufacturing enterprises (SMEs).

The Administration's proposal envisions that in order to operate, each Institute will:

- Be self-managed, with activities and priorities driven by industry and the flexibility to meet the needs of its associated communities;
- Be hosted by a strong research-oriented entity, such as a U.S. university, not-for-profit research center, or Federal research facility;
- Mobilize industry, states and other partners to co-invest with Federal agencies, including active sponsorship from large manufacturers and strong participation from small and medium-sized manufacturers;
- Engage extensively with local, state, and regional economic development authorities, industry associations, labor unions, and other stakeholders; and
- Aggressively seize opportunities that can lead to major advances in industrial production capabilities that are too risky for companies to tackle on their own

Question 7. How many years would each Center be funded?

Answer. The budget proposes creation of a mandatory account that would make available $1 billion in Fiscal Year 2013 in a one-time investment. A portion of the Federal investment in each center would fund startup capital expenses. Subsequent Federal support will be contingent on demonstrating co-investment and progress to sustainable operations. The Institutes will be required to become financially self-sustaining in a period of no less than 7 years.

Question 8. Will the Centers be geographically dispersed so that states in the middle of the country, such as Arkansas, have an opportunity to compete?

Answer. Stakeholders in all states, regardless of geographic location, will have an equal opportunity to host and participate in Institutes, leverage regional strengths in manufacturing, and compete for Institute awards based upon peer review of submitted proposals. The proposal evaluation criteria will include factors affecting the likelihood of success of the proposed Institute, which would include the ability of stakeholders in the state and the region to effectively engage and leverage Institute activities.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. OLYMPIA J. SNOWE TO PATRICK D. GALLAGHER, PH.D.

Question 1. The Hollings Manufacturing Extension Partnership (MEP) is a successful Department of Commerce program that assists small-and medium-sized manufacturers with technical assistance projects, training, and long-term strategic support. Regrettably, this program has an unnecessarily restrictive cost-share requirement, as the MEP is the only initiative out of the 80 programs funded by the Department of Commerce that is subject to a statutory cost share exceeding 50 percent.

While it has always been a difficult burden in the past for MEP centers to satisfy the high cost share requirements, it is even more difficult now in this trying economy. State governments, facing shortfalls, are reducing the amount they provide to these centers, and private entities are as well. As a result, MEP centers must spend an increasing amount of time fundraising and less time focused on providing services to America's small manufacturers.

In the National Institute of Standards and Technology (NIST), MEP July 2010 report titled "Renewing the U.S. Commitment to a Strong Manufacturing Base," one

of the ways listed to "leverage and maximize the Federal investment" in the program is reducing the cost-share requirement. Furthermore, legislation in the last year encourages NIST to restructure the program's cost-share requirement—and provides the authority to do so. Why has NIST not taken this simple, cost-neutral and yet critically timely action to provide relief to these centers that have a significant impact in aiding thousands of small and medium sized manufacturers nationwide?

Answer. We are completing our analysis of this issue and will update the Committee once it is concluded. We share the Committee's goal of making sure that MEP continues to be an effective, sustainable program.

Question 2. As a longtime MEP supporter, I am pleased to see this vital program receive a significant increase in funding over the last 4 years, including the President's recent request of $128 million for Fiscal Year (FY) 2013. Specifically, the program's funding has increased from $89 million in Fiscal Year 2008 to $128 million in Fiscal Year 2012. Can you provide further details on how the MEP's increase of nearly $40 million over the last 4 years is being allocated? How much of this funding increase is going directly to the centers that provide the services to America's manufacturers?

Answer. Historically, MEP program funding has been on average around $106 million (with the exception of an anomaly in Fiscal Year 2008). The $22 million increase over historic funding levels has enabled MEP centers to focus on development of new tools, services and related staff training, as well as for "next generation" innovation strategies for their client firms. These growth strategies include workforce development, technology acceleration, sustainability, supply chain development, and continuous improvement.

In Fiscal Year 2012, the NIST MEP program appropriation was $128.4 million and of that total amount $114 million (89 percent) was allocated to centers to provide services to America's manufacturers. Roughly $90 million was provided to MEP centers for base operations. Another $7 million was provided as a result of competitive awards to Centers, groups of Centers and non-profit organizations to develop Center services in the five targeted growth areas. And $17 million was provided as centralized support to centers—professional development of center staff, development of tools/services and the associated training of center staff to be able to provide all these services to their clients. The remaining appropriated funds were used to support cooperative agreement management, center reporting and evaluation, and to conduct the congressionally mandated peer reviews of the MEP centers.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN BOOZMAN TO PATRICK D. GALLAGHER, PH.D.

Question 1. In your National Strategic Plan for Advanced Manufacturing, you mention accelerating investment by small and medium sized enterprises as a key objective. In addition, there is the President's Advanced Manufacturing Partnership (AMP) that was announced in June 2011. What alternative funding mechanisms have you explored for pursuing and encouraging advanced manufacturing?

Answer. Funding mechanisms for pursuing and encouraging advanced manufacturing include investments by both the private sector and the public sector. Private sector investments are a vital strategic component that is broadly influenced by a broad range of government policies, including but not limited to tax, trade, science, and technology policies. The Administration's position on tax and trade policies is covered in other reports. The Administration's position on science and technology policy is covered in the National Strategic Plan for Advanced Manufacturing and calls for a focus on innovation policy.

The National Strategic Plan for Advanced Manufacturing covers the full range of public-sector investment mechanisms, including the role of the government as a major purchaser of goods and the role of the government as a major investor in research, development, and deployment (RD&D).

Question 2. Why do you think they will not work?

Answer. When applied appropriately, each funding mechanism can work. The challenge lies in identifying which mechanism is most appropriate for which need.

Question 3. Also, how can we insure that we do not pick "winners or losers" in the administration's proposed programs?

Answer. The Administration's focus on innovation policy for advanced manufacturing specifically avoids picking "winners or losers" by identifying challenges in technology infrastructure that cut across multiple industry sectors and technology

applications. As such, pursuit of innovation policy benefits from successes in individual sectors and applications without depending on any one of them.

Question 4. What specific metrics are you using to judge the success or failure of this program?

Answer. The National Strategic Plan for Advanced Manufacturing identifies long term metrics for success through a variety of economic, employment, and tax statistics that are actively tracked by the Federal Government together with more specific short term metrics that will be used to judge progress toward long term success.

Question 5. Please provide specific details?

Answer. As an example, the number of participants in advanced manufacturing job training programs that successfully enter the advanced manufacturing workforce provides a short term metric toward long term success in ensuring that the available workforce meets the needs of domestic production facilities.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO DR. SUBRA SURESH

Question 1. The National Science Foundation supports two different research grants for graduate students: the Graduate Research Fellowships and the Integrative Graduate Education and Research Traineeship (IGERT) program. The Graduate Research Fellowships are awarded to individual graduate students and transferable to any university in the country; the IGERT fellowships are awarded to universities and can be used as a recruiting tool to bring in the top students to do cutting edge, interdisciplinary research at that university. The America COMPETES Reauthorization mandated equal treatment for both fellowship programs such that funding increases or decreases at the same rate. Yet, NSF has proposed an increase of over 10 percent for the Graduate Research Fellowships to support a stipend increase and a new class of 2,000 fellows with no corresponding increase for IGERT. What is the justification for increasing funding for Graduate Research Fellowships, but not the IGERT fellowships?

Answer. NSF is deeply committed to strategically advancing its multifaceted portfolio by supporting science, technology, engineering, and mathematics (STEM) education through its workforce programs. There are three reasons for the proposed funding increase for the Graduate Research Fellowship (GRF) program:

(1) An increase in the amount of ongoing commitments due to an increase in the total number of GRF fellows resulting from the doubling of new fellowship awards from 1,000 to 2,000 beginning in Fiscal Year 2010;

(2) An increase, in Fiscal Year 2012, in the cost-of-education allowance from $10,500 to $12,000; and

(3) An increase in the dollar amount of the GRF stipend, which has not been raised since Fiscal Year 2004, from $30,000 to $32,000. The stipend increase will be implemented in Fiscal Year 2013.

The Graduate Research Fellowship program is one important mechanism for developing the future workforce in STEM research and education. NSF also invests in traineeships, another important mechanism, through the Integrative Graduate Education and Research Traineeship (IGERT) program and other directorate-specific programs (*e.g.,* NSF centers such as the Science and Technology Centers and Engineering Research Centers).

In considering the spirit of the America COMPETES Reauthorization Act of 2010, NSF's Division of Graduate Education (DGE) is focusing NSF-wide attention on the various modes in which the Foundation supports graduate students including traineeships, fellowships, and research assistantships. DGE is exploring the best ways to ensure that graduate students' experiences prepare them well for careers in higher education, fundamental and applied research, or other sectors of the advanced research workforce. In 2013, NSF will review the IGERT program and do so in the context of the full range of opportunities for graduate student support to determine the most productive directions going forward.

Question 2. Scientific collections, held in hundreds of museums and universities throughout the country as well as around the world, are an integral part of the Nation's scientific infrastructure and an essential research resource. While OSTP is directing agency efforts across the Federal Government to preserve and maintain government science collections, the Administration's Fiscal Year 2013 budget proposal places funding for support of non-governmental biological collections at risk. The budget request for the National Science Foundation proposes to change the competi-

tion for support under the Collections in Support of Biological Research (CSBR) program from annual to biennial, effectively cutting funding for the program in half.

What alternatives does NSF see for continued support of these collections if this budgets cut comes to pass? What types of critical science research may be lost if the collections are unable to be maintained?

Answer. NSF funds several programs that support biological collections and biodiversity research: these are the Dimensions of Biodiversity (DoB) and the Advancing Digitization of Biological Collections (ADBC) programs, supported through the Directorate for Biological Sciences (BIO) at an annual level of nearly $30 million combined.

Over the past few years, two reports were issued based on results of surveys of federally supported collections: first, the 2008 National Science and Technology Council (NSTC) Interagency Working Group on Scientific Collections (for federally held collections) report; and second, the 2009 NSF Scientific Collections Survey (for non-Federal collections supported by Federal funds). In response, the collections community developed a strategic plan to establish a network of integrated biocollections which was issued in July 2010.

In response to this strategic plan, NSF issued a solicitation for the ADBC program to establish the central coordinating body of a national resource and to begin to fund projects that will digitize collections based on grand research problems in biology. A year later, in 2011, NSF's Geosciences (GEO) directorate joined the effort to begin to integrate the paleontological collections online.

Challenging financial times often translate into hard decisions for funding priorities. BIO strives to sustain support for disciplinary programs, since they are the foundation of the biological sciences and the source of some of its most innovative and transformative discoveries; however, they have also chosen to support important new priorities such as DoB and ADBC. To accomplish this, BIO has staggered and/or reduced some non-core research competitions, such as Collections in Support of Biological Research (CSBR). BIO is optimistic that in the long run, support via ADBC will secure essential knowledge from biological collections while at the same time providing broader access via data portals. It will also expand access for learning activities for K–12 through college classes. Creative management of BIO's resources will help insure that the biological research supported by the NSF remains strong, vibrant, and always at the leading edge.

Question 3. The National Radio Astronomy Observatory (NRAO) runs domestic facilities, such as the Green Bank Telescope in West Virginia, that serve all of the U.S. astronomy community. In conjunction with the National Science Foundation, NRAO is also building the ground-breaking international Atacama Large Millimeter Array (ALMA) in Chile with international partners. By operating ALMA and domestic facilities in an integrated fashion, NRAO ensures that ALMA and these facilities maximize their scientific return for American researchers. How are you ensuring that these investments both leverage and contribute to our critical domestic science facilities?

Answer. Valuable synergies exist among ALMA and the domestic radio astronomy facilities operated by Associated Universities, Incorporated (AUI/NRAO), especially in the areas of critical personnel expertise, shared user and technical support and software tool development. For example, the Karl G. Jansky Very Large Array (JVLA) and ALMA use the same archive system for data storage as well as the same suite of software for data processing and analysis by users and for data quality assessment. The engineers and technicians responsible for designing and manufacturing the ALMA receivers are also responsible for fabrication and support of the JVLA receivers. Both sets of receivers have been designed and produced at the shared development laboratory at NRAO.

The National Science Board is also interested in this topic and is urging that the next competition for the management and operation of the North America contributions to ALMA be separated from that for the domestic NRAO facilities. NSF will complete the next cooperative agreement(s) for NRAO and ALMA through an open, merit-based review process. In preparation for the competition, NSF is assessing the merit and cost of the Board's suggested approach.

Question 4. Many currently operating NSF astronomical facilities are proposed to have funding cuts in Fiscal Year 2013. NRAO domestic facilities in West Virginia, New Mexico, and Virginia are proposed to be cut by 5 percent, resulting in the need to lay off 25 full time employees and potentially scale back scientific services at one of the telescopes so that it would no longer operate as a general use facility for the benefit of the whole U.S. astronomical community. How will these cuts impact researchers' access to critical infrastructure and the retention of core U.S. scientific capabilities?

Answer. The NSF Division of Astronomical Sciences (AST) in the Directorate for Mathematical and Physical Sciences continually assesses the balance of funding among new and operating facilities and research and education grants to maximize the scientific return on investment. A key element of this assessment is AST's Portfolio Review process. Scheduled for release in the fall of 2012, this review will recommend the balance of funding across all elements of AST's investment portfolio in the context of science priorities articulated in the Astronomy and Astrophysics Decadal Survey, issued in 2010 (*www.nap.edu/catalog.php?record_id=12951*). In advance of these recommendations, NSF's Fiscal Year 2013 request for astronomical facilities will maintain critical infrastructure and scientific capabilities while sustaining grant support for the U.S. research community.

In response to the proposed budget in Fiscal Year 2013, Associated Universities, Incorporated (AUI/NRAO), the managing entity of NRAO, has prioritized the transformative capabilities of ALMA and the Karl G. Jansky Very Large Array (VLA) and has targeted reductions for the Green Bank Telescope (GBT) and the Very Long Baseline Array (VLBA). NSF has encouraged AUI/NRAO to consult with the community on delivering the greatest scientific return from these facilities within current budget scenarios. With NSF's encouragement, AUI/NRAO is also actively searching for outside funding and partnerships to support GBT and VLBA operations.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN BOOZMAN TO DR. SUBRA SURESH

Question 1. Regarding the EPSCoR program, do you have any current plans to change the scope or mission of the program? What are the principle economic benefits of the EPSCoR program to the entire nation? Do you think supporting the EPSCoR program is in the best interests of our nation?

Answer. The Experimental Program to Stimulate Competitive Research (EPSCoR) assists the National Science Foundation (NSF) in its statutory mandate "to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education." Supporting the EPSCoR program promotes the development of each eligible jurisdiction's science and technology resources through partnerships involving universities, industry, local government, and Federal research and development agencies. There are no current plans to change the mission of the NSF EPSCoR program. NSF is seeking, however, input through the following two program evaluations:

- The Science and Technology Policy Institute (STPI) is performing an in-depth, life-of program assessment of NSF EPSCoR activities and their outputs and outcomes. Based on this assessment, STPI will provide recommendations for better targeting funds to those jurisdictions for which the EPSCoR investment can result in the largest incremental benefit to their research capacity. This evaluation focuses on progress in research competitiveness, infrastructure development, broadening participation in science and engineering, and science, technology, engineering, and mathematics (STEM) workforce development within EPSCoR jurisdictions. The anticipated completion date of the report is December 2013.
- The National Academy of Sciences is performing a study of EPSCoR and EPSCoR-like programs as directed in Section 517 of P.L. 111–358: the America COMPETES Reauthorization Act of 2010. Agencies with active programs are the Department of Energy, the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Institutes of Health, NSF, and the United States Department of Agriculture. The output for this evaluation will provide recommendations that may have policy implications for Federal agencies that have EPSCoR and EPSCoR-like programs. The expected completion date for this evaluation is August 2013.

Economic benefits to the Nation are as varied as the EPSCoR jurisdictions themselves. The EPSCoR program provides key resources to strengthen the physical, human, and cyber infrastructure needed to ensure the sustained development of such a workforce. EPSCoR investments also provide pathways for diverse underrepresented groups in STEM to more fully participate in the Nation's science and technology enterprise. For example, Arkansas' EPSCoR project strengthens research in areas with major economic development potential. Integral parts of the project are entrepreneurial training, support for commercialization, and an educational outreach program that targets the technology workforce. A patent application has been submitted based on research stemming from Arkansas' project that centers on plant

derivatives with potential applications to human pain mitigation, Parkinson's disease, and certain cancers. When results such as this are compiled for all of the 29 EPSCoR jurisdictions, individually and collectively, the EPSCoR jurisdictions contribute significantly to key national priorities in energy, rural health, nanotechnology, homeland security, sustainability, computational science, and knowledge-based economic development.

Question 2. In order to stimulate more innovative scientific research, we need to make sure that we sustain future investigator workforce. For example, it is my understanding that the National Institutes of Health is emphasizing grants to new investigators and putting more scrutiny to existing investigators with more than $1.5 Million in grant support. It is my understanding that the NSF is also doing something similar. What specific plans do you have in place to implement such a policy? How effective is this plan?

Answer. It is an important part of NSF's mission to stimulate and support a workforce of future scientists and engineers. New and early career investigators are supported both through grants from NSF's CAREER program (Faculty Early Career Development program) and through grants from NSF's broad portfolio of research programs. All NSF program officers strive to fund a balanced portfolio that includes awards to new investigators. The number of new investigators funded by NSF is tracked regularly and reported annually in the Merit Review Report. While the funding rates of both "new PIs" (individuals who have not served as the PI or co-PI on an NSF award -with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, conferences, symposia, and workshops) and "Prior PIs" (individual that have served as a PI or Co-PI on an NSF award) have decreased over the past decade, the ratio has remained relatively stable. In Fiscal Year 2011, the funding rate for new investigators was 15 percent, and for prior investigators it was 25 percent.

Although NSF always carefully scrutinizes the budgets proposed by investigators, NSF does not impose specific *a priori* limits on the number of awards or the amount of funding a researcher may receive. Such limits could impede the Foundation's ability to fund creative ideas for bold, complex research, including research that involves interdisciplinary teams. It is important to note that relatively few awardees receive large amounts of NSF research funding. In Fiscal Year 2011, less than 1.5 percent of NSF-funded principal investigators (PIs) had over $1.0 million in active research award funding. Only 4.4 percent of PIs had more than two active research awards.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. MARK PRYOR TO DR. MASON PECK

Experimental Program to Stimulate Competitive Research (EPSCoR)

Question. NASA's budget request for EPSCoR barely keeps the doors open. Even more troubling is NASA's request for only $24M for the Space Grant program.

Just last month both Dr. Holdren and Dr. Suresh attended a workshop in this room on the EPSCoR program. Several years ago DoD ended their EPSCoR program. I am very concerned that the Federal Government is headed in the wrong direction with respect to funding EPSCoR.

- Is NASA's Education Program committed to funding EPSCoR and the Space Grant Program?
- What does the Congress need to do to make EPSCoR a higher priority for Federal research agencies such as NASA?

Answer. The Fiscal Year 2013 President's Budget, and notional out-year budgets through Fiscal Year 2017, request $33M for the Aerospace Research and Career Development (ARCD) program, which consists of the National Space Grant College and Fellowship Program (Space Grant) and the Experimental Program to Stimulate Competitive Research (EPSCoR). The Office of Education proposes to allocate 33 percent of its funding in support of these programs.

The Aerospace Research and Career Development program strengthens the research capabilities of the Nation's colleges and universities and provides opportunities that attract and prepare increasing numbers of students for NASA-related careers. The student programs serve as a major link in the pipeline for addressing NASA's human capital strategies. The programs build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high-performing workforce needed to meet the current and emerging needs of NASA and the Nation. The research conducted contributes to the research needs of NASA's Mission Directorates and the Of-

fice of the Chief Technologist, and advances the Nation's scientific and technology innovation agendas.

Though the Office of Educations funding is being reduced to focus limited funds, NASA remains committed to advancing high quality STEM education using NASA's unique capabilities, and to leveraging our contributions with Federal and other partners as they tackle the STEM challenges we face. NASA will align the activities conducted by each of these programs with the priorities identified in the 5-year STEM strategic plan issued by the National Science and Technology Council's Committee on STEM Education and with the NASA Strategic Plan. The Agency will coordinate the education activities within NASA's Office of Education, Mission Directorates, the Office of the Chief Technologist, and Centers, to ensure that the educational activities are synergistic with the programs proposed to be funded in this account.