REAUTHORIZATION OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

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C O N T E N T S

March 11, 2020

REAUTHORIZATION OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

WEDNESDAY, MARCH 11, 2020

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 10:18 a.m., in room 2318, Rayburn House Office Building, Hon. Haley Stevens [Chairwoman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

Reauthorization of the National Institute of Standards and Technology

March 11, 2020
10:00 a.m.
2318 Rayburn House Office Building

PURPOSE

On Wednesday, March 11, 2020 at 10:00 am, the Subcommittee on Research and Technology of the Committee on Science, Space, and Technology will hold a hearing to explore the major areas of research under the National Institute of Standards and Technology (NIST) laboratory programs, the agency's role in working with industry to advance U.S. competitiveness, and key facilities construction and maintenance issues on the NIST campuses in Maryland and Colorado. The Subcommittee will also review the President's Fiscal Year 2021 budget proposal for NIST.

WITNESS

- **The Honorable Walter G. Copan**, Undersecretary of Commerce for Standards and Technology and Director, National Institute of Standards and Technology

KEY QUESTIONS

- What is the role of NIST in advancing U.S. economic competitiveness and national security?
- What would be the impact of the proposed FY 2021 budget on NIST's ability to carry out its mission? What analysis did the Administration use in deciding what programs to prioritize and what to eliminate?
- What is the state of facilities on the two NIST campuses and how does it relate to NIST's ability to carry out its mission?
- What additional resources and policy changes are needed to improve NIST's capacity to achieve its mission across its laboratories and other programs?

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY PROGRAMS

NIST is a non-regulatory agency within the Department of Commerce with a mission to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards,

and technology. The President's FY 2021 budget proposal provides a total of $718 million to NIST, a roughly 31 percent decrease from the FY 2020 enacted level.[1]

Figure 1: Budget comparison across FY 2019, FY 2020, and FY 2021 request.

	FY 2019 Enacted ($M)	FY 2020 Enacted ($M)	FY 2021 Request ($M)	FY 2021 Request +/(-) over FY 2020 Enacted ($M)	FY 2021 Request % Over FY 2020 Enacted
STRS	**$724.5**	**$754.0**	**$652.0**	**($102.0)**	**-13.5%**
ITS	**$155.0**	**$162.0**	**$25.3**	**($136.7)**	**-84.4%**
Hollings Manufacturing Extension Partnership	140.0	$146.0	$0.0	($136.7)	-100.0%
Manufacturing USA	15.0	$16.0	$25.3	9.3	58.1%
Construction	**$106.0**	**$118.0**	**$40.6**	**($77.4)**	**-65.6%**
Total, NIST Discretionary	**$985.5**	**$1,034.0**	**$717.9**	**(316.1)**	**-30.6%**

LAB PROGRAMS

The Scientific and Technical Research and Services (STRS) account funds NIST's laboratory research, including collaborative research with industry. The Administration proposes a budget for STRS of $652 million for FY 2021, a decrease of $102 million, or 14 percent from FY 2020.

NIST operates five laboratories and two national user facilities in carrying out these activities. These include two metrology laboratories, the Material Measurement Laboratory (MML) and the Physical Measurement Laboratory (PML), which focus on driving innovation through measurement science. There are also three technology laboratories that focus on the adoption and development of advanced technology solutions, including the Engineering Laboratory (EL), the Information Technology Laboratory (ITL), and the Communication Technology Laboratory (CTL). Finally, NIST has two national user facilities: The Center for Nanoscale Science and Technology and the NIST Center for Neutron Research. Across each of these laboratories and user facilities, NIST addresses national R&D efforts for a variety of emerging technologies.

METROLOGY LABORATORIES

Material Measurement Laboratory—MML is the United States' reference laboratory for measurements in the chemical, biological, and materials sciences. Its research focuses on the composition, structure, and properties of industrial, biological, and environmental materials and processes, as well as the development and dissemination of tools to help to ensure measurement quality. The Administration proposes a $43.5 million, or 30 percent, cut for advanced manufacturing and material measurement in its FY 2021 budget. These cuts would eliminate NIST's efforts related to structural materials challenges, including reliability testing for bridges

[1] All facts, figures, and other information in this document are available through the President's FY 2021 Budget Request Congress for the National Institute of Standards and Technology, at www.nist.gov.

and pipelines, as well as energy and environmental challenges, such as efforts related to recycling and reuse of plastics.

NIST's work at the MML also supports the underlying technologies and measurements for precision medicine, medical imaging, synthetic biology, genomics, and more. For example, the NIST Genome Editing Consortium addresses measurements and standards for genomic editing technologies and the NIST-Stanford Joint Initiative for Metrology in Biology develops measurement capabilities for produces and services in the bioeconomy.[2] The bipartisan *Engineering Biology Research and Development Act,* which passed the House in December 2019, would authorize much of the biosciences work at NIST.[3] The President's budget request would cut these programs by $2.1 million, or nearly 6 percent.[4]

Physical Measurement Laboratory—PML is focused on increasing the accuracy of physical parameters that underpin our society by disseminating technologies to standardize these parameters and conducting research to advance measurement approaches and standards. The NIST Boulder campus has four PML divisions devoted to Applied Physics, Quantum Electromagnetics, Sensor Sciences, and Time and Frequency, as well as a fifth division, Quantum Physics, located at the University of Colorado, Boulder. In Maryland, PML houses the four divisions devoted to Engineering Physics, Quantum Measurement, Radiation Physics, and Weights and Measures. One program, called "NIST-on-a-Chip," seeks to create prototypes for a new generation of ultra-compact, inexpensive measurement tools for various quantities—such as time and force—that will allow users to make precise measurements anywhere.[5]

PML plays a key role in advancing the fundamental science that underpins several industries of the future. Under the *National Quantum Initiative Act* [P.L. 115-368], NIST is one of three agencies charged with supporting and expanding quantum information science and technology research and development of standards. The President's budget request for FY 2021 proposes a $40.3 million budget to invest in a portfolio of quantum related research.

TECHNOLOGY LABORATORIES

Information Technology Laboratory— ITL develops and deploys standards, testing, and metrics to make the Nation's information systems more secure, usable, interoperable, and reliable. ITL supports a range of areas vital to our nation, including applied and computational mathematics, internet of things (IoT), quantum information science, and cybersecurity and privacy.

In the area of cybersecurity, ITL catalogues and publishes known vulnerabilities, produces standards and guidelines for cybersecurity risk management, and addresses major cybersecurity challenges, such as cryptographic systems that can resist quantum computers. ITL published the "Framework for Improving Critical Infrastructure Cybersecurity" in 2014, a document that

[2] NIST Genome Editing Consortium. NIST. accessed February 18, 2019.
[3] The Engineering Biology Research and Development Act. H.R.4373. 116th Cong. (2019).
[4] "President's FY 2021 Budget Request to Congress for the National Institute of Standards and Technology." NIST. February 2020.
[5] "NIST-on-a-Chip Portal." NIST. Accessed February 18, 2020.

provides flexible ways to manage cybersecurity risk.[6] ITL updated the framework in 2018, and is creating additional tailored guidance on application of the framework to several different sectors and circumstances. ITL also manages the National Cybersecurity Center of Excellence (NNCoE), where researchers define cybersecurity issues, develop technical descriptions of security problems, and engage with vendors to improve the security of their products.[7] Recently, ITL has expanded this work to include data privacy, publishing a framework for improving privacy through enterprise risk management in January 2020.[8] The President's budget request for FY 2021 includes a $1.9 million, or 2.5 percent increase, for cybersecurity and privacy.

Another major area of research for ITL is artificial intelligence (AI). In response to Executive Order 13859 released in February 2019, ITL created a plan to support innovation, public trust, and public confidence in AI systems and develop international standards to promote and protect these priorities.[9] The report promotes research on the trustworthiness of AI systems, offers Federal guidance for AI standards development, calls for AI-related public-private partnerships, and highlights tools that could support AI. The budget proposal would increase NISTs work on AI technologies by $25 million, but these increases come at the expense of other important information technology challenges, such as voting technologies and smart grid interoperability.

Communications Technology Laboratory – CTL supports standards and metrology in the area of advanced communications technologies, funding important research related to IoT devices, 5G wireless communications, and wireless spectrum sharing technologies. CTL also supports public safety communications, serving as future technology lead for the First Responder Network Authority (FirstNet), the U.S. public safety broadband network. The President's FY 2021 budget request would reduce funding to CTL by $36 million (or 52 percent).[10]

In 2015, the CTL jointly created the National Advanced Spectrum and Communications Test Network (NASCTN), with both the National Telecommunications and Information Administration and Department of Defense, to organize a network of test facilities to support spectrum-related testing, modeling, and analysis. NASCTN primarily works on pressing spectrum challenges as they are identified by industry or other federal agencies. The small staff is not equipped to independently select and pursue "hot button" spectrum issues, such as debates around future spectrum allocation decision.[11]

Engineering Laboratory – EL supports smart manufacturing, construction, and cyberphysical systems, such as by developing sustainable and energy-efficient manufacturing materials and supporting disaster-resilient infrastructure. EL facilitates the development of standards, test methods and reference for innovative technologies including robotics, additive manufacturing,

[6] "Cybersecurity Framework." NIST. April 16, 2018.
[7] "National Cybersecurity Center of Excellence." NIST. Accessed February 18, 2020.
[8] "Privacy Framework." NIST. January 2020.
[9] "NIST Releases Draft Plan for Federal Engagement in AI Standards Development." NIST. July 2, 2019.
[10] "National Institute of Standards and Technology - Fiscal Year 2021 Budget Submission to Congress." Department of Commerce. February 2020.
[11] "An Assessment of the Communications Technology Laboratory at the National Institute of Standards and Technology." The National Academies of Sciences, Engineering, and Medicine. 2019.

smart manufacturing, and biopharmaceuticals. The President's budget request would cut efforts related to physical infrastructure and resiliency by $16.4 million, a 28 percent decrease.[12]

NIST USER FACILITIES

NIST has two user facilities, the NIST Center for Neutron Research (NCNR) and the Center for Nanoscale Science and Technology (CNST). These facilities provide more than 5,700 researchers each year with access to advanced scientific tools.

The NCNR is a neutron scattering facility, where users can use neutrons to probe all kinds of different materials. NCNR contributes to several domains, including engineering, materials development, polymer dynamics, chemical technology, medicine, and physics. However, the NCNR reactor is 50 years old and a 2018 report by the National Academies of Sciences, Engineering and Medicine called on NIST to develop a plan to ensure continued access to a neutron scattering facility by its wide community of users. The budget in FY 2021 is approximately $54 million. The Administration has proposed reducing the budget for NCNR by 9 percent, halting modernization plans for the aging reactor, ceasing operation of two neutron scattering instruments, and reducing reactor maintenance.[13]

The CNST provides users with tools needed to create and characterize nanoscale structures, devices, and materials. The CNST is part of PML and promotes collaboration in nanotechnology both across NIST's laboratories and among researchers nationwide.

INDUSTRIES TECHNOLOGY SERVICES

The Industrial Technology Services Account includes NIST's extramural programs: Manufacturing USA and the Hollings Manufacturing Extension Partnership (MEP).

Manufacturing USA is a network of manufacturing innovation institutes coordinated through NIST that serve as partnerships between companies, academia, and entrepreneurs to develop and deploy manufacturing technologies. NIST currently operates a Manufacturing USA institute in Delaware called the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). The FY 2021 budget request proposes to cease funding for NIIMBL, providing $25 million, a 60 percent funding increase, to competitively award a second institute and continue support of the program's coordinating office.

The MEP program is a federal-state-industry partnership that consists of centers located across the country that work with local manufacturing communities to strengthen the U.S. domestic manufacturing base. The Centers also provide small and medium sized businesses with technical assistance and guidance on cybersecurity. MEP has proven to be a successful model for federal-state partnerships with significant payoff in economic growth and job creation across our Nation.

[12] "National Institute of Standards and Technology - Fiscal Year 2021 Budget Submission to Congress." Department of Commerce. February 2020.
[13] "President's FY 2021 Budget Request to Congress for the National Institute of Standards and Technology." NIST. February 2020.

According to NIST, for every dollar of Federal investment, the MEP National Network generates roughly $29 in new sales growth for manufacturers and $31 in new client investment.[14] The Administration is proposing, for the third year in a row, a complete elimination of MEP.

CONSTRUCTION OF RESEARCH FACILITIES

Many of NIST's facilities are aging or outdated. Based on Department of Commerce standards, roughly 60 percent of NIST's facilities are in poor to critical condition.[15] This decaying infrastructure has taken a toll on NIST's overall mission, limiting staffs' ability to pursue their research, reducing the accuracy and effectiveness of standards, and harming staff morale. Some facilities have leaking roofs and poor ventilation systems, which makes them inoperable for certain experiments. Routine requests for maintenance are often deferred for extended periods of time. There are over $700 million in deferred maintenance projects. In one startling example, one of NIST's campuses had a leaky pipe system that lost 50,000 to 70,000 gallons of water per day in steam that blocked a road for almost a year.

It is projected that NIST needs $200 million in sustained annual funding to both modernize its older buildings and address its maintenance backlog and capital projects. Unfortunately, the President's recent budget proposal would cut NIST's construction budget by $77 million, or 66 percent. The request covers some basic maintenance of NIST facilities. In lieu of direct funding, the budget proposes legislation, *the Federal Capital Revolving Fund Act of 2021*, which would fund large-dollar, federally owned, civilian real property capital projects using special rules.[16]

TECHNOLOGY TRANSFER

NIST has a unique role in the promotion, tracking, and coordination of Federal efforts in technology transfer. These efforts include convening the Interagency Working Group for Technology Transfer to coordinate Federal efforts, and the Lab-to-Market initiative to increase the economic impact of federally funded R&D by accelerating the transfer of new technologies from the laboratory to the commercial marketplace.[17]

In April 2019, NIST released *Return on Investment Initiative for Unleashing American Innovation*, a green paper that outlined a number of steps the Federal government could take to enhance technology transfer.[18] While NIST has worked to develop a legislative proposal that would implement the recommendations outlined in the green paper, the Administration has not yet released any such proposal. In addition, the FY 2021 budget request proposes to cut NIST's Lab 2 Market Initiative, which facilitates technology transfer across the Federal government, by $3.5 million.

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[14] "New MEP Center Will Serve the Needs of Alaska's Small and Medium-sized Manufacturers." NIST. March 2019.
[15] "National Institute of Standards and Technology - Fiscal Year 2021 Budget Submission to Congress." Department of Commerce. February 2020.
[16] The Federal Capitol Revolving Fund Act of 2021. 116th Cong. (2020).
[17] "Lab to Market "L2M." NIST. Accessed February 18, 2020.
[18] "Unleashing American Innovation: NIST Special Publication 1234." NIST. April 2019.

Chairwoman STEVENS. This hearing will come to order. Without objection, the Chair is authorized to declare recess at any time.

Good morning, and welcome to the hearing of the Subcommittee on Research and Technology to explore the major areas of research at the National Institute of Standards and Technology (NIST). We are delighted to have Dr. Walter Copan here today, and we look forward to learning more about how Congress can help this agency in its mission to advance U.S. competitiveness. Thank you again, Dr. Copan, for joining us today, and we're most looking forward also to your testimony.

As many of you know, I am a big fan of NIST. This agency plays a key role in promoting U.S. innovation and competitiveness by advancing measurement science, standards, and technology. Many of you have also heard of NIST's essential work in important industries of the future like artificial intelligence (AI), quantum computing, and the bioeconomy and its notable work to improve cybersecurity across the Nation. We are all indebted to NIST for their great work in these areas.

However, the agency has played an essential role over the last century in dozens of activities that are sometimes less-attention grabbing but also just as important. NIST's reference materials, technical standards, measurement and calibration services, and technical guidance help validate the safety and function of most of the objects around us, most of the objects around us, in both our homes and our businesses.

One of the many important functions of NIST is managing the Hollings Manufacturing Extension Partnership or MEP program, which is a Federal-State-industry partnership that works with local manufacturing communities to strengthen U.S. manufacturing. The Michigan Manufacturing Technology Center, an MEP Center located in my district in Plymouth, Michigan, run by the tremendous Mike Coast, has helped its small and medium manufacturing clients create and retain nearly 11,000 jobs. This center is a national leader in helping manufacturers establish cybersecurity programs, which are critical for manufacturers to protect both their operations and the devices they produce.

Another valuable manufacturing program managed by NIST is the Manufacturing USA program that we were able to reauthorize in December. And I am pleased that NIST is ready to support a new institute in Fiscal Year 2021. It is because of the great work that goes on at NIST that—and here's where we get to the tough part—we're disappointed by the President's destructive budget request, which proposes over a 30 percent cut to NIST's programs. So, this budget would entirely eliminate the MEP program—I can't even believe I'm saying these words—and cutoff funding for the Manufacturing USA NIIMBL institute in Delaware, NIIMBL, the National Institute for Innovation in Manufacturing Biopharmaceuticals.

This budget is demoralizing to the dedicated public servants at NIST. It is harmful to our security, our health, and our environment, as many of the proposed cuts target these essential mission areas. And it is going to be crippling to U.S. competitiveness, as the Administration is putting on the line billions of dollars in economic

growth for U.S. companies to "save," quote/unquote, $316 million in a spreadsheet.

But today, I don't want to dwell on a proposal that we know Congress is going to reject. This is what our role is here today. Today, I would like this Committee to focus on improving NIST and getting the agency the tools it needs to do better to do its job. For example, NIST has aging buildings on its campuses in Maryland and Colorado and faces a substantial backlog in construction and maintenance. We should discuss how to fix these issues so the scientists and engineers who work at NIST have modern and safe laboratories and equipment to do their important work.

In April 2019, NIST released a green paper about how to enhance return on investment for Federal science agencies by increasing technology transfer. This is such a great report by the way, and so we look forward to hearing NIST's other recommendations on how to enhance these efforts.

I couldn't think of a better partner in today's hearing than my colleague Dr. Jim Baird. I want to thank Dr. Copan again for being here.

[The statement of Chairwoman Stevens follows:]

Good morning and welcome to this hearing of the Subcommittee on Research and Technology to explore the major areas of research at the National Institute of Standards and Technology. We look forward to learning more about how Congress can help the agency in its mission to advance U.S. competitiveness. A special welcome to our distinguished witness, the Honorable Dr. Walter Copan, for joining us here today. I'm looking forward to hearing your testimony.

As many of you may know, I am a big fan of NIST. This small agency plays a key role in promoting U.S. innovation and competitiveness by advancing measurement science, standards, and technology.

Many of you may have heard of NIST's essential work in important industries of the future, like artificial intelligence, quantum computing, and the bioeconomy, or its notable work to improve cybersecurity across the nation.

However, the agency has played an essential role over the last century in dozens of activities that are less-attention grabbing but just as important. NIST's reference materials, technical standards, measurement and calibration services, and technical guidance help validate the safety and function of most of the objects around us, in both our homes and businesses.

One of the many important functions of NIST is managing the Hollings Manufacturing Extension Partnership or MEP program, which is a federal-state-industry partnership that works with local manufacturing communities to strengthen U.S. manufacturing.

The Michigan Manufacturing Technology Center, an MEP center in my district, has helped its small and medium manufacturing clients create and retain nearly 11,000 jobs. The Center is a national leader in helping manufacturers establish cybersecurity programs, which are critical for manufacturers to protect both their operations and the devices they produce.

Another valuable manufacturing program managed by NIST is the Manufacturing USA program that we were able to reauthorize in December. I am pleased that NIST is ready to support a new institute in FY 2021.

It is because of the great work that goes on at NIST that I am deeply disappointed by the President's destructive budget request, which proposes over a 30 percent cut to NIST's programs.

The budget would entirely eliminate the MEP program and cut off funding for the Manufacturing USA NIIMBL institute in Delaware.

This budget is demoralizing to the dedicated public servants at NIST. It is harmful to our security, our health, and our environment, as many of the proposed cuts target these essential mission areas. And it is crippling to U.S. competitiveness, as the Administration is putting on the line billions of dollars in economic growth for U.S. companies to "save" $316 million in a spread sheet.

But today, I do not want to dwell on a proposal that is my hope this Congress will reject. Today, I would like this Committee to focus on improving NIST and getting the agency the tools that it needs to better do its job.

For example, NIST has aging buildings on its campuses in Maryland and Colorado and faces a substantial backlog in construction and maintenance. We should discuss how to fix these issues so the scientists and engineers that work at NIST have modern and safe laboratories and equipment to do their important work.

Furthermore, in April 2019, NIST released a green paper about how to enhance return on investment for federal science agencies by increasing technology transfer. I look forward to hearing about these and other recommendations to enhance NIST's work.

I want to again thank Dr. Copan for being here today to discuss NIST's role and in what areas Congress can help NIST build on its incredible work.

Chairwoman STEVENS. And at this time the Chair would like to recognize Mr. Baird for an opening statement.

Mr. BAIRD. Well, good morning, Chairwoman Stevens. And I appreciate the opportunity to be here with you. I do appreciate you convening today's hearing and let us examine some of these major research activities that you mentioned that are supported by the National Institute of Standards and Technology, better known as NIST, in order to inform this Committee's reauthorization of the institute.

I would also like to thank Dr. Copan for making the time and being here with us this morning, so thank you. I'm looking forward to hearing your testimony.

Since 1901, NIST has been at the forefront of setting the standards for weights and measures for the United States and for the world really because of the quality of the product, so almost every Federal agency and U.S. industry sector uses the standards. They use the measurements and the certification services that NIST labs provide.

As these new technologies develop and evolve, then NIST provides the services that are extremely critical for the growth and development of those industries. NIST plays a key role in the development of the industries of the future, including artificial intelligence, 5G networks, quantum computing, and advanced manufacturing. In the last year, NIST has been a key contributor to developing a national strategy for AI, participating in interagency coordination and building the foundation for trustworthy AI systems. As global competition grows, it is essential that the United States invest in the research and development (R&D) programs that focus on these critical technologies.

I was pleased to see that the President's budget request prioritizes investments in these key areas, including nearly doubling NIST's investments in AI. These investments will launch discoveries and advances that will significantly affect America's economy in the coming decades. I look forward to hearing more about them today.

I am proud to have recently introduced H.R. 6145, the *Industries of the Future Act*. And I've joined with Representative Foster, Ranking Member Lucas, and Chairwoman Stevens on that bill. H.R. 6145 would require the executive branch, including NIST, to develop a plan to double the baseline investments in industries of the future by 2022. It would also require a plan to increase civilian spending on future industries to $10 billion by fiscal year 2025.

Our country needs to make the necessary investments in industries like AI, quantum, advanced manufacturing so our workers can continue to lead in the jobs of the future. In January, I cosponsored H.R. 5685, the *Securing American Leadership in Science and*

Technology Act, which provides a long-term strategy for investment in basic research to combat threats to American competitiveness. H.R. 5685 authorizes a doubling of the fundamental research activities supported through NIST's labs over the next 10 years to drive the next generation of technological breakthroughs. It provides NIST with the mechanisms to address its crippling facilities maintenance backlog and provides funding for the infrastructure needed to conduct cutting-edge science.

Lastly, it capitalizes on the great work that NIST did in developing a Return on Investment Green Paper that the Chairlady referred to and provides some technology transfer reform in order to enhance our Nation's return on investment of federally funded research.

It is my hope that this Committee moves forward in considering a reauthorization of NIST, and it will take some time to consider the proposals included in H.R. 5685 and H.R. 6145. This Committee has a long history of supporting NIST's work, and I believe there are many provisions that can have bipartisan support within this Committee.

I again would like to thank you, Dr. Copan, for being here this morning, and I yield back the balance of my time.

[The statement of Mr. Baird follows:]

Good morning Chairwoman Stevens. Thank you for convening today's hearing to examine the major research activities being supported by the National Institute of Standards and Technology (NIST) in order to inform this Committee's reauthorization of the Institute.

I would also like to thank Director Copan for being here this morning. I am looking forward to hearing your testimony.

Since 1901, NIST has been at the forefront of setting the standards of weight and measures for the United States, and the world. Almost every federal agency and U.S. industry sector uses the standards, measurements, and certification services that NIST labs provide. This work is fundamental to our economy and national security.

As new technologies develop and evolve, NIST's services are critical. NIST plays a key role in the development of the industries of the future, including Artificial Intelligence, 5-G networks, quantum computing, and advanced manufacturing. In the last year, NIST has been a key contributor in developing a national strategy for AI, participating in interagency coordination and building the foundation for trustworthy AI systems. As global competition grows, it is essential that the U.S. invest in the research and development programs that focus on these critical technologies.

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turn on Investment Green Paper and provides some technology transfer reform in order to enhance our nation's return on investment of federally funded research.

It is my hope that as this Committee moves forward in considering a reauthorization of NIST, it will take some time to consider the proposals included in both H.R. 5685 and H.R. 6145. This Committee has a long history of supporting NIST's work and I believe there are many provisions that can have bipartisan support within this Committee.

I again would like to thank you, Dr. Copan, for being here this morning and I yield back the balance of my time.

Chairwoman STEVENS. The Chair now recognizes the Chairwoman of the Full Committee on Science, Space, and Technology, Chairwoman Johnson, for an opening statement.

Chairwoman JOHNSON. Thank you very much, Chairwoman Stevens and Ranking Member Baird, for holding this morning's hearing to inform our reauthorization of the National Institute of Standards and Technology, and I want to welcome and thank Dr. Copan for his testimony.

We recognize it can be challenging for the heads of our Nation's great science agencies to come before Congress to defend indefensible budgets. The purpose of this hearing is not to dissect the Administration's myopic and harmful budget request for NIST. Rather, it is to highlight the critical work of NIST to advance our Nation's economic competitiveness, national security, and wellbeing.

The National Institute of Standards and Technology plays a critical role across so many aspects of our economy and society. Many of the efforts that this budget seeks to reduce or eliminate are activities that our constituents have never heard of but that are essential nonetheless. This includes everything from improving the reliability of forensic evidence used to prosecute dangerous criminals, to ensuring our healthcare providers have accurate information about our DNA (deoxyribonucleic acid) when giving us life-and-death medical advice, to protecting factory floor workers from malfunctioning equipment. NIST's support for research and standards for disaster resilience also helps protect communities across the Nation.

Through its Urban Dome program, the agency is developing methods to reliably measure greenhouse gas emissions so we can develop smart climate mitigation strategies. I am sure many of you have heard of NIST's work in artificial intelligence and cybersecurity. NIST also does important work to develop digital identity management systems, protect voting machines, enable the deployment of smart electricity grids, and secure our manufacturing supply chains.

One of the important programs that I want to highlight is NIST's work operating the National Advanced Spectrum and Communications Test Network, or NASCTN. For the last few years, this Committee has been conducting oversight of FCC (Federal Communications Commission) plans for the 24 gigahertz band that could degrade the accuracy of weather forecasting. The dispute between NOAA (National Oceanic and Atmospheric Administration), NASA (National Aeronautics and Space Administration) and the FCC is largely due to disagreement over the methodologies of competing studies. It is my belief that NIST, with its reputation for neutrality and scientific rigor, could use NASCTN to help other government agencies better understand spectrum interference.

Finally, I echo the comments of my colleagues that NIST cannot be expected to carry out any of this work in decades-old facilities, some of which are unsafe, none of which are worthy of the world-class scientists who populate them. It speaks to their dedication to the mission of NIST that these scientists remain at the agency instead of moving to modern labs and higher salaries in industry.

I want to express my gratitude to all of NIST's employees and Dr. Copan, whose leadership has helped to prop up the agency morale through challenging times.

As this Committee considers a reauthorization for NIST, we must ensure that the understandable excitement around industries of the future does not overshadow all of the other important work going on at NIST and the critical facilities that enable that work.

In closing, I want to thank you, Dr. Copan, once again, and I look forward to the discussion. Thank you.

[The statement of Chairwoman Johnson follows:]

Thank you Chairwoman Stevens and Ranking Member Baird for holding this morning's hearing to inform our reauthorization of the National Institute of Standards and Technology. I want to welcome and thank Dr. Copan for his testimony. We recognize that it can be challenging for the heads of our nation's great science agencies to come before Congress to defend indefensible budgets. The purpose of this hearing is not to dissect the Administration's myopic and harmful budget request for NIST. Rather, it is to highlight the critical work of NIST to advance our nation's economic competitiveness, national security, and wellbeing.

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Chairwoman STEVENS. And at this time I now recognize Ranking Member Lucas for an opening statement.

Mr. LUCAS. Thank you, Chairwoman Stevens and Ranking Member Baird, for holding today's hearing on reauthorizing the National Institute of Standards and Technology, or NIST as we all know it. American businesses and consumers depend on the work done by NIST, and I appreciate that Dr. Copan is here today to give us a greater insight into that.

NIST is unusual in that it doesn't have the same name recognition of bigger government agencies, and yet its work touches the lives of every American, every day. Standardized, accurate, trustworthy weights and measurements are critical to everything from medical tests to accurate GPS (Global Positioning System) directions and from auto manufacturing to cybersecurity. They impact roughly half of the U.S. GNP (gross national product). Essentially, NIST's work is the foundation on which U.S. competitiveness grows.

NIST's core measurement science programs aid American businesses in overcoming technical obstacles, fulfilling an essential role that companies cannot do themselves. For example, they provide calibrations and standards for industry broadly from oil and gas to agriculture, aerospace, medicine. That's why this Committee has a long history of bipartisan support for NIST. And it's why I'm hopeful that we can work together on legislation that will give NIST the resources it needs to support our continued economic growth.

For America to compete globally, we not only need to do effective and be efficient in our current industries, we also need to lead the way to emerging technologies and industries of the future. China has made it an explicit goal to surpass the United States and become the world leader in critical technologies like quantum information science, artificial intelligence, advanced manufacturing. By investing in our STEM (science, technology, engineering, and math) workforce, world-class facilities, and the research needed to develop state-of-the-art technologies, we'll secure our R&D and drive progress. NIST is critical to U.S. leadership in AI, quantum technologies, and other emerging technologies.

In January I introduced the *Securing American Leadership in Science and Technology Act* to address the challenges to American competitiveness. It will double funding for basic research over the next 10 years, which includes doubling funding for NIST labs. It provides infrastructure updates and prioritizes research in industries of the future.

As critical technologies are developing for global deployment, it is critical that the United States and its allies continue to shape standards that underpin the technologies themselves and the future international governance of these technologies for generations to come. NIST plays an important role in this arena by developing and disseminating the standards that allow technology to work seamlessly and businesses to operate smoothly. My legislation also takes steps to improve how NIST engages in international standards development.

As the reauthorization of NIST is considered by this Committee, I hope we can work together to address these issues. And I want to again thank Chairwoman Stevens and Ranking Member Baird for holding today's hearing.

And thank you, Dr. Copan, for your leadership of NIST and for your testimony today. And with that, I yield back the balance of my time, Madam Chair.

[The statement of Mr. Lucas follows:]

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And thank you Dr. Copan for your leadership of NIST and for your testimony today. I yield back the balance of my time.

Chairwoman STEVENS. Thank you. If there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

And at this time I'd like to introduce our witness. Dr. Walter Copan is the Under Secretary of Commerce for Standards and Technology and the Director of the National Institute of Standards and Technology, NIST, arguably, the coolest job in the beltway, positions he has held since 2017 by the way. So, as NIST Director, Dr. Copan provides high-level oversight and direction for the agency.

Prior to joining NIST, Dr. Copan founded and served in leadership positions for several innovation and technology transfer organizations and companies. Dr. Copan was formerly a managing Director of Technology Commercialization and partnerships at the Department of Energy's (DOE) Brookhaven National Laboratory and Principal Licensing Executive for Technology Transfer at

DOE's National Renewable Energy Laboratory. Dr. Copan earned dual B.S./B.A. degrees in chemistry and music, and his Ph.D. is in physical chemistry, all from Case Western Reserve University.

Dr. Copan, you will have 5 minutes for your spoken testimony. Your written testimony will be included in the record for this hearing. And when you've completed your spoken testimony, we will begin questions. And, as you know, each member will have 5 minutes for questions. Thank you.

TESTIMONY OF THE HONORABLE WALTER G. COPAN, UNDER SECRETARY OF COMMERCE FOR STANDARDS AND TECHNOLOGY, AND DIRECTOR, NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY

Dr. COPAN. Chairwoman Stevens and Ranking Member Lucas, and Members of the Subcommittee, I am so grateful to have this opportunity to be with you to testify today on the programs, priorities, and the goals of NIST.

NIST targets our research programs toward emerging technologies that will have the greatest impact in advancing innovation and the competitive position of the United States. To continue to be a bedrock of innovation, NIST must reinforce its core competencies and grow new capabilities year over year.

The Administration has identified quantum information science, artificial intelligence, advance communications including 5G, advanced manufacturing, and the bioeconomy as domains that have potential to transform U.S. industry. These areas present NIST new challenges and opportunities to develop new measurement capabilities, technologies, tools, and standards to secure and protect the Nation's economic and national security. Today, I look forward to highlighting NIST's plans and accomplishments in each of these critical technology domains.

NIST is a recognized world leader in the field of quantum science and technology, as was recognized in the National Quantum Initiative. The expertise of NIST scientists and the unique capabilities of our facilities are leveraged closely with partners in academia through NIST's network of joint institutes in Colorado and Maryland. Last year, NIST established the Quantum Economic Development Consortium, the QEDC, in partnership with SRI International. QEDC brings together industry to expand U.S. leadership in quantum R&D and the emerging quantum industry in computing, communications, and sensing, an important goal for NIST to develop the foundation for confidence and trust in artificial intelligence toward new research outcomes and an expanded commercial marketplace.

Today, NIST's efforts in artificial intelligence are focused along three primary thrust areas: first, addressing the fundamental questions about the use of AI to ensure that it's trustworthy and explainable. Secondly, NIST is broadly engaging in using AI across its research portfolios in areas including biometrics, imaging, advanced materials discovery, smart manufacturing, and the design and characterization of engineered biological systems. Finally, we're working with industry, government, and academia to establish governing principles, standards, tools, and best practices for the design, construction, and use of artificial intelligence systems.

NIST programs in advance communications support reliable, secure, high-speed wireless and wireline communications critical to U.S. economic competitiveness, safety, and security. NIST measurement science research and support for the development of standards accelerates the deployment of next-generation communications technologies, including 5G. NIST is committed to solving the measurement and deployment challenges of this fast-moving field to help the United States achieve and maintain global leadership in these areas and to help U.S. industry establish manufacturing capabilities needed for domestic market supply.

Our broad portfolio of activities in advance communications includes the National Advanced Spectrum and Communications Test Network, NASCTN, as mentioned by Committee Chairwoman Johnson, and also the Public Safety Research program, the PSCR (Public Safety Communications Research Division) program that's supported by spectrum auction funds.

NIST measurement research in manufacturing processes, robotics, and advanced materials provides the foundation that helps the Nation's manufacturers to invent, innovate, and create new processes, products, and services more rapidly and more efficiently than our global competitors. The NIST laboratory programs invest heavily in support of advanced manufacturing, and Manufacturing USA helps U.S. industry to develop and implement new technologies, making them more competitive in the global economy. To support the U.S. bioeconomy, NIST is building next-generation measurement science capabilities and engineering biology laboratories to accelerate biotech innovation.

Along with basic R&D, NIST facilitates the translation of technologies to scale through global standardization through technology transfer and industry partnerships. The Manufacturing USA institutes and participants benefit directly from this work.

We have launched the NIST Living Measurements Systems Foundry to advanced U.S. synthetic and engineering biology efforts. The Genome in a Bottle Consortium, Gene Editing Consortium, and support for the regenerative medicine industry are examples of our important collaborative work.

So, again, thank you for the opportunity to highlight these critical technologies and the role that NIST is playing to enhance U.S. innovation and economic competitiveness. I'm happy to answer any questions the Committee may have.

And, as I close my comments right on time I'd like to invite this Committee to celebrate the 120th anniversary of the National Bureau of Standards and the National Institute of Standards and Technology next year, from March 3, 1901. As many of you know, the foundation of NIST goes back to the foundation of America and article I of our U.S. Constitution. And we're achieving a great milestone for this important, storied institute. Thank you for your support. Thank you.

[The statement of Dr. Copan follows:]

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Testimony of

The Honorable Dr. Walter Copan

Under Secretary of Commerce for Standards and Technology
and Director of the National Institute of Standards and
Technology

Before the

Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives

Reauthorization of the
National Institute of Standards and Technology

March 11, 2020

Introduction
Madam Chairwoman Stevens, Ranking Member Baird, and members of the Subcommittee, thank you for the opportunity to testify today before the Subcommittee on Research and Technology on the programs, priorities and goals of the National Institute of Standards and Technology (NIST) for the nation. NIST's core mission is to promote U.S. innovation and industrial competitiveness. We constantly target our research programs towards the emerging technologies that will have the greatest impact in advancing the competitive position of the United States.

Preparing for the Future
To continue to be a bedrock of innovation, NIST must continue to reinforce its core competencies and grow new capabilities over the next decade. In planning for the capabilities that NIST will need to best support the nation over the next 10-15 years, we have examined a number of societal trends and potential emerging technological disruptions that could impact the competitiveness of the U.S. What systems will emerge that will require expanded cybersecurity and privacy capabilities? What technologies are likely to change the way cryptography works? What novel products will U.S. manufacturers make, and what new technologies must they use to be competitive? What technological advances will NIST be able to capitalize on to transform and enhance its mission delivery? These questions have shaped NIST's planning and programmatic investments for the future.

NIST worked with stakeholders across government, industry, and academia to find opportunities for greatest impact. The Industries of the Future (specifically Quantum Information Science, Artificial Intelligence, 5G, Advanced Manufacturing, and Biotechnology) were all identified as technological domains that have the potential to transform U.S. manufacturing, communications, health care, transportation, and beyond. These areas will also present NIST new challenges and opportunities to develop new measurement capabilities and other methods to secure and protect the Nation's economic and national security.

NIST and The Industries of the Future
Today, I look forward to highlighting NIST's plans and accomplishments in each of the critical technology domains:

Quantum Information Science
Advances in quantum technologies, including quantum information science, have the potential to transform and revolutionize computing, medicine, manufacturing, artificial intelligence, communications, national defense, and more. Capturing these economic and national security opportunities will require continued sustained investment and improved technology transfer efficiency to ensure U.S. leadership, especially given that other nations have stepped up their quantum-focused programs and investments as well. NIST plays a central role in this critical race for quantum leadership.

NIST is a recognized world leader in the field of quantum science and technology, including four Nobel Prizes awarded to NIST scientists for their discoveries in this field. NIST has been a strong contributor in the National Quantum Initiative. Our expertise in quantum draws directly from our mission to make the most precise and accurate physical measurements possible. Over the last quarter century, NIST has shaped an entire generation of quantum science. A significant

portion of today's quantum scientists have trained in NIST laboratories. NIST's research to develop a measurement infrastructure has enabled quantum information science to advance to where we are today. Consider just a few recent NIST achievements:

- development of a quantum logic clock;
- demonstration of near quantum-limited amplification of weak signals;
- creation of new measurement and error protocols for characterizing quantum many-body systems; and
- pioneering work in quantum simulation.

This past summer—for the first time in history—NIST scientists teleported a computer circuit instruction between two separated ions. This foundational work opens the door to quantum computer programs that can carry out tasks in future large-scale quantum networks.

The expertise of NIST scientists and the unique capabilities of our facilities are leveraged closely with partners in academia through NIST's network of joint institutes -- with JILA, our joint institute at the University of Colorado Boulder, as well as the Joint Quantum Institute (JQI) and the Joint Center for Quantum Information and Computer Science (QuICS) with the University of Maryland. These institutes have driven numerous breakthroughs in fundamental quantum research and have helped trained the next generation of researchers in this emerging field. Together these capabilities make NIST a true hub of quantum-based innovation.

As the U.S. research enterprise works to realize the potential breakthroughs of quantum information science, opportunities for new quantum technologies are emerging that take advantage of the unusual rules that govern the behavior of the fundamental components of matter. NIST is developing robust quantum engineering capabilities for researchers to rapidly create, test, and validate the performance of quantum technology platforms. Building on our expertise in quantum science, nanoscale fabrication, and semiconductor characterization, NIST is focused on creating these measurement capabilities to serve as the building blocks and the basis of standards for future quantum technologies that the U.S. requires to achieve and to lead the world in "quantum supremacy."

Building out this quantum engineering infrastructure will require close partnership and collaboration with industry. To further these efforts, last year NIST established the Quantum Economic Development Consortium (QEDC) in partnership with SRI International, headquartered in Menlo Park, CA. The QEDC brings together players from across industry with the goal to expand U.S. leadership in global quantum R&D and the emerging quantum industry in computing, communications, and sensing.

With funding from both the government and private-sector member organizations, the QEDC will:

- determine workforce needs essential to the development of quantum technologies;
- provide efficient public-private sector coordination;
- identify technology solutions for filling gaps in research or infrastructure;
- highlight use cases and grand challenges to accelerate development efforts; and

- foster access to intellectual property, efficient supply chains, technology forecasting, quantum literacy and workforce development.

Looking forward, over the coming years NIST will focus a portion of its quantum research portfolio on the grand challenge of quantum networking. Serving as the basis for secure and highly efficient quantum information transmission that links together multiple quantum devices and sensors, quantum networks will be a key element in the long-term evolution of quantum technologies.

Artificial Intelligence
Artificial Intelligence (AI) has long been a strategic priority for NIST, also representing a toolkit to remarkably enhance productivity across all areas of our research and development, as well as toward advanced manufacturing applications. An important goal for NIST is to develop the foundation for confidence and trust in AI that results in new research outcomes and an expanded commercial marketplace. International investment in AI is also exploding, and companies, governments and policy makers around the globe are seeking answers that can provide greater confidence in AI technologies. NIST's study and deployment of AI methods, tools, and standards can provide the basis for confidence and trust that is essential for adoption of these technologies.

NIST has made significant contributions to the fields of machine learning (ML) and AI over the years. For example, the MNIST database, a dataset of handwritten digits, is among the most widely used standardized datasets in the U.S. and around the world for training and testing AI systems. NIST scientists worked with the Defense Advanced Research Projects Agency to develop and deploy smartphone-based systems that enabled U.S. marines to seamlessly converse with native Pashto speaking Afghans. These technology developments have also facilitated rapid commercialization of phone-based voice translation systems such as Microsoft Bing and Google Translate.

Today, NIST's efforts in AI are focused along three primary areas of effort:

First, NIST is addressing fundamental questions about the use of AI. NIST has launched an effort to convene the community around key concepts of trustworthy AI, seeking to develop ways to measure, define, and characterize concepts around the accuracy, reliability, privacy, robustness, and explainability of AI systems. Some examples of NIST work in this space include:

- In November, the NIST National Cybersecurity Center of Excellence (NCCoE) issued a draft NIST Internal Report, "A Taxonomy and Terminology of Adversarial Machine Learning."
- In December, NIST issued a report on the performance of face recognition software tools in identifying people of varied sex, age and racial backgrounds: "Face Recognition Vendor Test (FRVT) Part 3: Demographic Effects" (NISTIR 8280). Such data is intended to provide valuable insights to policymakers, developers and end users about the limitations and appropriate uses of currently available AI tools.
- NIST and its NCCoE are planning to launch a testbed to evaluate AI vulnerabilities.

- NIST intends to release a set of draft "Principles of Explainable AI" for public comment.
- NIST is organizing a workshop to convene stakeholders to explore issues of bias in machine-learning based face and speech recognition algorithms.

Secondly, NIST is heavily engaged in using AI across its research portfolio in a host of areas including biometrics, advanced materials discovery, smart manufacturing systems, and the design and characterization of engineered biological systems as just a few examples. Additionally, the outputs of NIST research in general, especially in the terms of well-characterized data sets, as well as our work in advanced microelectronic systems, will help advance the field of AI. These tools will enable researchers to better train and understand AI systems, including the design and manufacture of next-generation hardware required to reliably and safely run AI systems. Some recent examples of NIST effort in this space include:

- NIST researchers are working on ways to utilize AI to automate vulnerability assessments for digital infrastructure and to produce vulnerability ratings using the industry-standard Common Vulnerability Scoring System.
- In advanced materials discovery, NIST has created a high-fidelity database, Joint Automated Repository for Various Integrated Simulations, density functional theory (JARVIS-DFT), with more than 30,000 materials and 500,000 properties to be used as training data that will help accelerate the development of new materials.
- In wireless spectrum analysis, NIST is creating a curated radio frequency (RF) signal database to aid in the development of machine learning models for signal detection and classification. These datasets, which include radar signals similar to those planned for the 3.5 GHz band and include noise and interference, can be used to train and evaluate AI detectors to enable federal-commercial spectrum sharing.
- In manufacturing, NIST is applying AI in its study of agility performance of robotic systems in manufacturing environments so that robots can "learn" behaviors to operate effectively in today's factories. Recently, NIST launched our fourth annual Agile Robotics for Industrial Automation Competition, offering cash prizes to the teams whose robots perform the best in a simulated environment.

Finally, standards engagement is a key element of NIST's mission, and we are deeply involved in multiple standards development bodies around the world. We are working with industry, government, and academia to establish governing principles and develop standards and identify best practices for the design, construction, and use of AI systems. It is vitally important for the U.S. to have a strong, persuasive, and consistent voice with the relevant standards organizations around the world.

- In August 2019, NIST released the report "U.S. Leadership in AI: A Plan for Federal Engagement in Developing Technical Standards and Related Tools" in response to the Executive Order (EO) 13859 directing NIST to issue a plan for federal engagement in the development of technical standards and related tools in support of reliable, robust, and trustworthy systems that use AI technologies. The plan identifies nine areas of focus for AI standards and urges that the federal government commit to deeper, consistent, long-term engagement in AI standards development.

- Twelve NIST experts are currently involved in the joint International Standards Organization (ISO) / International Electrotechnical Committee (IEC) Joint Technical Committee JTC 1, Subcommittee (SC) 42 on Artificial Intelligence, and NIST is the convener for the Big Data work effort in SC 42. NIST works with many companies (including Google, Intel, Microsoft, and Oracle), other federal agencies, and academia to develop U.S. consensus positions on the U.S. Technical Advisory Group for SC 42, supported by the International Committee for Information Technology Standards.
- NIST staff are participating in over a dozen other AI standards activities in various standards development organizations, including the American Society for Mechanical Engineers (ASME), the Institute of Electrical and Electronics Engineers (IEEE), and ISO/IEC. These activities cover topics such as computational modeling for advanced manufacturing, ontologies for robotics and automation, personal data privacy, and algorithmic bias.

NIST's capabilities, ranging from fundamental research to the delivery of the technical foundations of emerging technologies, make it a valuable asset in establishing and maintaining U.S. leadership in AI technologies.

5G and Advanced Communication

Advanced communications are enabling dramatic changes in how consumers, manufacturers, governments and others provide and consume information, transact business, provide and use essential services, and shop, among other tasks. Gartner, a leading research an analytics company forecasted that there will be over 20 billion connected devices by 2020, and other forecasts have projected continued growth with numbers ranging from 60 to75 billion connected devices by 2025. This insatiable societal demand for connectivity will require significant advancements in communication technologies.

The Administration's multifaceted 5G efforts are being led by Director Larry Kudlow of the National Economic Council, and within that framework, NIST is playing a vital role. NIST's programs in advanced communications support secure, reliable, high-speed wireless, and wireline communications critical to U.S. economic competitiveness, safety, and security. NIST measurement science research and support for the development of standards accelerates the deployment of next-generation communication technologies that promise to be faster and more reliable, including fifth-generation wireless networks. These technologies will support self-driving cars, internet of things (IoT) applications, drones, and future AI systems. NIST is committed to solving the measurement and deployment challenges of this fast-moving field to help the U.S. achieve and maintain global leadership in these areas, and also to help U.S. industry establish manufacturing capabilities needed for domestic market supply. The NIST portfolio of activities focused on advanced communications includes:

- the National Advanced Spectrum and Communications Test Network (NASCTN), which is a national network of federal, academic and commercial test facilities that provides the testing, modeling and analyses needed to develop and deploy spectrum-sharing facilities;
- the Public Safety Communications Research (PSCR) program, which is leading the development of standards and performing the associated research, development and

testing to provide the public safety community access to a dedicated, nationwide LTE broadband network (FirstNet);
- developing and improving the measurement tools and technologies to improve spectrum utilization, and novel spectrum sharing techniques to address the current spectrum crunch; and
- providing the measurements and data needed for the development of the next generation of wireless communications systems and improved optical communications technologies.

Some examples of how NIST is driving strengthened national capabilities in the areas of 5G and other advanced communications technologies include:

- Industry consortia, like the 5G Millimeter-Wave Channel Model Alliance. This is a NIST-sponsored international research consortium working to advance breakthrough measurement, calibration and channel modeling approaches for millimeter and submillimeter wave frequencies. Effective use of this wavelength spectrum represents a key enabler for applications related to IoT, virtual reality, autonomous vehicles, and ubiquitous small cell connectivity, a key element of 5G deployment. Launched in 2015 the Alliance has since grown to include nearly 80 organizations.
- NIST experts are participating in 5G standards development activities in multiple fora including IEEE and the Third Generation Partnership Project (3GPP) where they are working on issues of security and radio access.
- Unique NIST facilities like the Large Antenna Positioning System. This facility provides measurement capabilities to pioneer new antenna measurement methods for future 5G wireless communications systems. These systems will operate at higher frequencies and offer more than 100 times the data-carrying capacity of today's cellphones, while connecting billions of mobile broadband users in complex, crowded signal environments. However, their higher frequency signals are more easily distorted and more likely to be affected by physical barriers such as walls or buildings. The unique measurement capabilities developed by NIST will be important in helping industry develop technical solutions such as steerable beam antenna arrays and performance optimizations through artificial intelligence.
- NIST continues to make a significant impact in driving forward innovation in public safety communications technologies. Through PSCR, NIST has engaged numerous groups from both the private and public sectors to address technology challenges faced by the public safety community. These efforts have helped drive advances in everything from the development of security standards for 5G devices and reliable mission critical voice technologies to enabling first responders to take advantage of new performance and safety enhancing technologies like haptics. A key example of the output of this work was on display at the 2019 Boston Marathon. The SiFi router developed by Spectronn, as a result of funding and participation in the NIST Public Safety Innovation Accelerator Program, provided public safety with critical communication and computing capabilities without access to the internet, enabling first responders to always have a backup line of communication and computing if their local network failed either partially or completely.

Advanced Manufacturing

A strong U.S. manufacturing sector is essential to our economic security and national security. As the Trump Administration's National Security Strategy[1] states, "Support for a vibrant domestic manufacturing sector, a solid defense industrial base, and resilient supply chains is a national priority." American manufacturers contributed $2.18 trillion to the U.S. economy in 2016. Manufacturing plays an outsized role in our economy because of its high economic multiplier effect: U.S. manufacturing supports trillions of dollars of production in other parts of the economy by purchasing from and selling to over 80 other industries.

A partner to the U.S. manufacturing sector for more than a century, NIST has a proven track record in delivering useful tools and technical assistance that both existing manufacturers and aspiring start-ups value. NIST's measurement research in manufacturing processes and advanced materials provides a foundation that helps the nation's manufacturers to invent, innovate and create new products and services more rapidly and more efficiently than their competitors around the world. Through targeted research across a broad portfolio of technologies impacting manufacturing from advanced materials to smart manufacturing systems, NIST helps ensure that the U.S. remains a competitive force in advanced manufacturing to ensure our economic and national security. Our partnerships with large and small manufacturers, federal agencies, and academic institutions help us anticipate and meet the needs of rapidly evolving manufacturing industries.

The NIST laboratory programs in support of advanced manufacturing, ranging from work on materials design and discovery to the use of collaborative robots in factories, to biomanufacturing and standards for data exchange and processing information. Examples of some of NIST's work include:

- NIST develops standards and test methods to help industry take advantage of the latest manufacturing robotics technologies. This work includes technical standards for exoskeletons that can dramatically improve the performance of workers on manufacturing floors, warfighters, and the mobility-impaired.
- NIST partners with the pharmaceutical industry to develop widely available reference materials and measurement methods. For example, NIST's monoclonal antibody reference material provides a benchmark for companies to ensure quality measurements of their biological drugs and to spur biopharmaceutical innovations.
- NIST supports large-scale manufacturing needs by developing laser-based measurement techniques to ensure large objects such as aircraft wings are the right size for proper assembly and function.
- NIST is developing approaches to overcoming technical barriers to the adoption of additive manufacturing (also known as 3D printing), such as surface quality, part accuracy, material properties, real-time monitoring, and process modeling.

In addition to the output of NIST's research programs, NIST's extramural programs, which include Manufacturing USA help U.S. industry develop and implement new technology, develop robust supply chains, and refine their systems for efficiency and effectiveness, all while making them more competitive in the global economy.

[1] National Security Strategy published December 2017 https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf.

- Manufacturing USA is a network of 14 manufacturing innovation institutes located across the country where companies, universities, community colleges, and entrepreneurs develop new manufacturing technologies with broad applications. The primary goal of the network, which is planned to expand to 17 institutes over the next year, is to ensure that American innovations and inventions currently going offshore for production in competitor nations are scaled up from lab experiments to products and processes that can be used by U.S. manufacturers. Manufacturing USA institutes collectively represent two-thirds of Fortune 50 U.S. manufacturers, over 500 small manufacturers, and eight of the 10 top-ranked research and engineering universities. Nonfederal funding matches federal funding at a 2 to 1 ratio, exceeding the original 1 to 1 goal and demonstrating the value of the network to industry, academia, and the states. Manufacturing USA education and workforce training programs have reached nearly 200,000 individuals and include programs focused on training veterans in advanced manufacturing skills.

As a whole, this suite of programs and investments across our laboratory research and extramural programs is an essential set of resources for the Nation's advanced manufacturing enterprise.

Biotechnology
In August 2019, the President named the bioeconomy as one of the three R&D priorities for FY2021 under the main priority of American Heath & Bioeconomic Innovation.

A key factor in unleashing the full potential of the bioeconomy will be the ability to harness the power of complex biological systems (primarily cells) in a predictable and safe way for the manufacture of advanced therapeutics, sustainable fuels, chemical feedstocks, and advanced materials. Remarkable progress has been made in this field throughout the last decade, particularly with respect to genome read, write, and edit technologies, but there is still a widely recognized need for measurements and standards to enable better predictive engineering, and to support reliable and safe translation of engineered biological systems into products and other use cases.

To support the U.S. bioeconomy, NIST is building next-generation measurement science (biometrology) capabilities and engineering biology laboratories for accelerating responsible biotechnology innovations. Along with supporting basic technology research and development, NIST helps facilitate the translation of technologies to scale through global standardization efforts and partnerships with industry. As metrology is central and essential to all engineering biology research, NIST also plays a significant role in convening stakeholders to discuss challenges and solutions as the field moves forward. NIST plays a key role in developing techniques, standards and reference materials used as benchmarks for manufacturing process control and product quality assurance, in order to facilitate commerce for the bioeconomy. The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), the Manufacturing USA institute sponsored by NIST with the University of Delaware, and its participants benefit directly from this work. Recent highlights of NIST work in this field include:

- The launch of the NIST Living Measurement Systems Foundry to advance U.S. synthetic and engineering biology efforts. The foundry enables the engineering of cells for reliable and safe use in dynamic and unpredictable environments for applications such as living

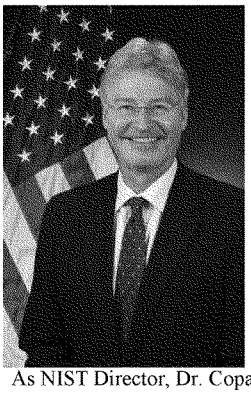
therapeutics, environmental sensing, and structured materials fabrication. An automated facility for high throughput testing and measuring of engineering microbes, the foundry provides a mechanism for partnership with other organizations developing measurement approaches.

- The production of world-leading measurements, standards, technologies, and data needed to drive advances in biosciences and biotechnology.
    - The NIST Genome in a Bottle Consortium brings together over 100 industry and academic partners to develop reference standards, methods, and data to enable the translation of whole human genome sequencing to clinical practice. NIST human genome reference standards have helped the Food and Drug Administration approval of diagnostics, provided confidence to enable rapid response of global health issues, accelerated the development of next-gen measurement capabilities, and provided high confidence data underpinning global biological research related to sequencing.
    - The NIST Gene Editing Consortium brings together 32 leading industry, academic, and government partners to identify pre-competitive standards and measurements to meet the needs of the gene-editing field. NIST leads the Measurement Working Group of this consortium and our researchers are actively developing new capabilities for assessing genome editing outcomes based on the inputs of this group. Working with its partners, NIST recently released a list of lexicons as a unified standard set of terms and definitions serving the needs of the genome editing community. This will provide critical support to various scientific and policy discussions.
    - NIST is assisting the growing regenerative medicine industry to meet their measurement assurance and other challenges. NIST has been working with companies and other federal agencies to develop measurement assurance strategies for quantitative measurement of living systems needed for translation and commercialization of advanced therapies, including cell therapy, gene therapy, and tissue engineered products.
    - NIST is developing key microbiome measurements needed to accelerate the availability of microbiome diagnostics and to enable manufacturing of microbiome therapeutics. Researchers are also developing measurements and standards for pathogen detection in biodefense and infectious disease diagnostics.

With continued support NIST can continue to provide the necessary measurement and standards capabilities and infrastructure that will be required to unlock the full potential of the U.S. bioeconomy.

Summary

With NIST's dedicated technical staff, one-of-a-kind facilities, and non-regulatory role, we are well positioned to have an outsized impact in each of these critical areas that promise significant benefit to the U.S. economy, our quality of life, and national security. With the continued support of this Committee, NIST will continue to thrive in its important mission to promote U.S. innovation and industrial competitiveness. Thank you and I would be happy to answer any questions the Committee Members may have.



Walter G. Copan

Under Secretary of Commerce for Standards and Technology and NIST Director

EDUCATION

B.S./B.A. degrees in chemistry and music from Case Western Reserve University, 1975
Ph.D. in physical chemistry from Case Western Reserve University, 1982

Dr. Walter G. Copan was confirmed by Congress as Under Secretary of Commerce for Standards and Technology and NIST Director on October 5, 2017.

As NIST Director, Dr. Copan provides high-level oversight and direction for NIST.

He has had a distinguished and diverse career as a science and technology executive in large and small corporations, U.S. government, nonprofit and other public-sector settings.

Dr. Copan formerly served as president and CEO of the IP Engineering Group Corporation, providing services in intellectual property strategy, technology commercialization and innovation. Until June 2017, he was founding CEO and chairman of Impact Engineered Wood Corporation, an advanced materials technology company. He also is a founding board member of Rocky Mountain Innovation Partners, where he led technology transfer programs and innovation services on behalf of the U.S. Air Force Academy, U.S. federal labs and academic institutions and helped foster entrepreneurial businesses in the Rocky Mountain West. He also served with the National Advisory Council to the Federal Laboratory Consortium for more than 5 years, providing industry inputs to advance the U.S. economic impacts of the federal laboratory system.

From 2010–2013, Dr. Copan served as managing director of Technology Commercialization and Partnerships at DOE's Brookhaven National Laboratory (BNL). Among his accomplishments were leading the creation and implementation of the new DOE technology transfer mechanism, "Agreement for Commercializing Technology" (ACT), to facilitate collaborations between the federal labs and U.S. corporations. He led the "Startup America" initiative on behalf of DOE for entrepreneurial business creation, and he initiated the DOE's new Small Business Innovation Research – Technology Transfer (SBIR-TT) program, which built upon the experiences of NIST. He served as founding partner and board member of the "Accelerate Long Island" alliance for innovation, economic development and early stage investment.

From 2005–2010, Dr. Copan was executive vice president and chief technology officer at Clean Diesel Technologies, Inc., an international technology development and licensing firm. He spearheaded the company's transformation, growth and listing on NASDAQ (CDTI), as well as the company's subsequent merger. Prior to joining CDTI, Dr. Copan served at the DOE's National Renewable Energy Laboratory (NREL) as Principal Licensing Executive, Technology Transfer. There, he led organizational changes that strengthened relationships with industry and

the investment community and led to the more productive commercialization of energy-related technologies.

After earning dual B.S./B.A. degrees in chemistry and music from Case Western Reserve University in 1975, Dr. Copan began his career in chemicals and materials research at the Lubrizol Corporation (now part of the Berkshire Hathaway Group). He earned a Ph.D. in physical chemistry from Case Western in 1982, and subsequently held leadership positions at Lubrizol in research and development, strategy, business unit management, venture capital, and mergers, acquisitions and strategic alliances in the U.S. and abroad. As managing director, Technology Transfer and Licensing, from 1999–2003, he was responsible for Lubrizol's corporate venturing and open innovation, technology strategy, business development, intellectual assets and the technology licensing business.

Chairwoman STEVENS. Well, at this point we're going to begin our first round of questions, and the Chair is going to recognize herself for 5 minutes and start by saying invitation accepted, to the chagrin of my team that likes to review those things and maybe to the chagrin of the future, but we're delighted to hear about that milestone and always eager to celebrate with our colleagues over at NIST and see what's happening.

I think one of the most significant things about the agency that you run, Dr. Copan, is how much you do with how little, particularly as we get into sub-departments who, you know, maybe have $6 million for different standards programs, if it's election security or cybersecurity, I mean, you can run the gamut. And there are strategic partnerships, there's collaboration throughout industry, and there's this real commitment to almost setting the pace, right?

And particularly as you had touched on and with your vast background in technology transfer, the Lab-to-Market initiative that NIST runs, which, again, is an initiative set forward to conduct tech transfer initiatives throughout the Federal Government, we recognize there's been some proposed cuts but was wondering if you could give us a little bit of an update on the program, talk about the budget considerations and anything else that you might want to share on the Lab-to-Market initiative.

Dr. COPAN. Thank you so much for that question and for your comments. The Lab-to-Market program and the Return on Investment initiative is a top priority for the Administration. It's recognized also as a CAP goal nationally, a Cross Agency Priority, to ensure that the United States, as it invests in science and technology, can create the greatest value for the American people, and for the American economy as a result.

We are excited to be advancing a legislative package with the Department of Commerce, the Administration, and external stakeholders to address the issues around the *Stevenson-Wydler Act* and the *Bayh-Dole Act*, which are 40 years old this year. And important modernization to streamline U.S. innovation is called for in the green paper findings that were referred earlier in this hearing.

The kind of reforms that are important, which we anticipate also working with the Committee in the reauthorization language for NIST, includes addressing regulatory impediments and implementing administrative improvements to enhance the agility of the Federal laboratory system in engaging with industry, the ability also to have broader rights in intellectual property protections, including software copyright, which is so important for the U.S. innovation economy in our digital age.

Finding ways of increasing engagement with the private sector, more flexible tools for partnership, building a more entrepreneurial R&D workforce, we know that so much job creation in this country and globally is created by the entrepreneurs, of which I am a member of that cadre, providing more innovative tools and services to make technologies easier to find, to reduce the administrative burden on our universities and our Federal institutes through modernizing information technology (IT) tools and systems such as iEdison, which NIST has committed to work on a transition from the National Institutes of Health to reduce the administrative burden and improve the productivity of that tool's use. And lastly, to

continue to benchmark globally to ensure that we're measuring the impacts of our Federal science and technology investment on the U.S. economy. There are many more things that I can cover that relate to the Return on Investment initiative, as well as the other implications to the NIST budget.

Chairwoman STEVENS. Yes. And does the OMB (Office of Management and Budget) plan to release guidance based on the green paper on Return on Investment? Are we waiting for them to give us some guidance?

Dr. COPAN. We are in the midst now of advancing the draft legislative proposal that this Committee will be considering, together with the sister Committee in the Senate, and we look forward to providing updates as soon as that's available.

Chairwoman STEVENS. OK. And the green paper was also giving NIST a singular authority to propagate the rules under *Stevenson-Wydler*. So, would this change enable NIST to accomplish more for the Federal R&D enterprise? Is that——

Dr. COPAN. Yes. It's been recognized actually by all of the Federal interagency the importance of having a coordinated approach, and the view that is shared across the interagency, including the Lab-to-Market Subcommittee of the National Science and Technology Council is that the role that NIST plays is one that's valued. It's a teambuilding approach across the Federal sector, which is appreciated, and it allows us to achieve greater harmonization in technology transfer tools, practices, approaches, and sharing and implementing best practices across the Federal interagency.

Chairwoman STEVENS. We're all about efficiency. And with that, my time is up, and I will go to Dr. Baird for 5 minutes of questioning.

Mr. BAIRD. Thank you, Madam Chair.

Dr. Copan, you mentioned in August of 2019 that the President named bioeconomy as an R&D priority for 2021. Could you elaborate on what work NIST is doing and engaged in to support that U.S. bioeconomy?

Dr. COPAN. Indeed. Thank you so much. The bioeconomy is absolutely central to the work that NIST does. It is the central theme of our materials measurements laboratory that supports underlying technologies and measurements for precision medicine, for medical imaging to accelerate our understanding in synthetic biology and genomics. NIST is also building next-generation measurement science capabilities and engineering biology laboratories to accelerate responsible biotech innovations.

We mentioned earlier on—and Chairwoman Johnson actually mentioned some of the work that NIST is doing that relates to forensics and DNA testing—in providing a foundation of trust in the analysis of DNA for a wide range of purposes, including to support our justice system in this Nation.

NIST is also the sponsoring agency for the National Institute for Innovation in Manufacturing Biopharmaceuticals, or NIIMBL, with the University of Delaware. It's an institute that is seen as wildly successful and it has broad support from industry and from academia, as well as the community of donors that cares deeply about the future of the bioeconomy.

And of course, as we know, NIIMBL is one of the 14 institutes within the Manufacturing USA network that's such an important part of this Nation's efforts in advanced manufacturing, including the translation of technologies from the laboratory into the bioeconomy marketplace.

Mr. BAIRD. Thank you. Over 1/4 of Indiana's total gross State product, $102 billion a year, comes from manufacturing. Could you tell us what NIST is doing to help these small and medium manufacturers like those found in my home State to adopt and implement these new technologies such as smart manufacturing systems?

Dr. COPAN. Thank you so much, Ranking Member Baird. The work of the Manufacturing Extension Partnership, the work of the Manufacturing USA institutes, and indeed the coordination between those advanced manufacturing programs focuses on the needs of U.S. small- and medium-sized manufacturers, focuses on the support for the entrepreneurs of America that drive so much translation of new technologies from the laboratory into the commercial marketplace, including in Indiana.

It's so important that we look at the provision of new technologies through these types of programs and systems to enable industry, our small- and medium-size manufacturers to have access to techniques such as digital manufacturing, additive manufacturing, and focus on the quality of the products that come from the additive manufacturing enterprise.

We're in the era of the digital economy, and certainly digital manufacturing is absolutely essential to what's sometimes been called industry 4.0 as we look at the intersection between robotics and artificial intelligence with the manufacturing sector. The Manufacturing Extension Partnership and NIST directly work closely with our Nation's small manufacturers, including in Indiana, to provide them access to these tools, capabilities, and shared services.

And the other element that's so important is to provide security, cybersecurity to the small manufacturers of this Nation because we know that the probability of failure of those small enterprises if they are the victim of a cyber attack is very, very high indeed, as statistics show us.

Mr. BAIRD. So, thank you. I've got about 29 seconds, and I don't know whether you want to make a comment about advanced manufacturing. Maybe I just share with you that I'm impressed, as I tour the facilities in my district, of the capabilities in the manufacturing. And I guess I'll just say thank you and I yield back.

Dr. COPAN. Thank you.

Chairwoman STEVENS. Thank you. At this time we'll recognize Chairwoman Johnson for 5 minutes of questions.

Chairwoman JOHNSON. Thank you very much.

Doctor, in 2019 NOAA, NASA, and the Navy all claimed that the FCC's plan for the 24 gigahertz band could degrade the accuracy of weather forecasting. The FCC denied these claims. Part of the reason for this was disagreement over methodologies of completing—competing studies that showed these results.

NIST has a communication technology lab and operates the National Advanced Spectrum and Communication Testing Network. Is

it correct that NASCTN did not do any studies about spectrum emissions in the 24 gigahertz band? Or how could NIST's spectrum studies have helped to resolve some of these interagency disagreements?

Dr. COPAN. Thank you so much for that question, Chairwoman Johnson. NASCTN as we know it, the National Advanced Spectrum and Communications Test Network, is a national resource to address questions such as the one that's been posed by our Federal partners in regard to the 24 gigahertz band. NIST has met with colleagues at NASA, colleagues at our sister agency NOAA, with the Department of Defense, and with other stakeholders to work toward outlining a definitive test program that could be conducted at NASCTN.

The value that an independent test facility such as that provides is unbiased analysis using a test methodology that's broadly agreed and communicated to the entire public of practice that cares about these types of issues to ensure that the work is done in the light of day, that it's open, it's transparent, the results that are expected are highlighted and made broadly available to the community.

So, we look forward to the work with the sister agencies and also with the input of the FCC as we look to the future of intelligent data to guide spectrum allocation decisions.

Chairwoman JOHNSON. Thank you. I noticed that the President's fiscal year 2021 budget request called for the doubling of funding for artificial intelligence research at NIST. What are NIST's plans for this additional funding?

Dr. COPAN. As I've said I believe before this Committee in the past, NIST can always do more with more.

Chairwoman JOHNSON. Yes.

Dr. COPAN. And it's actually wonderful that NIST has such a deep experience in the applications of artificial intelligence. It is broadly applied across all of our laboratories to improve the productivity of what we do.

One very simple example is we used to have postdoctoral fellows and graduate students and principal investigators aligning by hand the laser tables that we use for the next-generation atomic clock research. That is now done by artificial intelligence and machine learning protocols. It saves our researchers time and allows them to focus on the big questions.

Artificial intelligence is clearly a strategic priority for us at NIST. There's much work to be done in developing tools to provide insights into artificial intelligence programs, as we've done also with facial recognition technology in which this Committee has had great interest. It's provided insight into statistical bias that comes from training sets and data sets that are used to establish artificial intelligence protocols.

There's important work to be done in standardization so that the United States can lead the world in the application of artificial intelligence in a trustworthy and ethical manner. And we are at the early stages of the world focusing on the power of AI and also needing to understand its limitations and biases.

Our goal is to ensure that we'll continue our fundamental research into AI systems, understand the performance of algorithms, providing testbeds for things that relate to the industrial Internet

of Things, to autonomous vehicles and how they perform with advanced sensor systems on the roads of America in the future.

We are going to continue to apply AI to our research programs to increase productivity of our labs, and to translate them, those learnings, for U.S. industry to continue to lead the world as we seek to capture the value of industrial productivity from artificial intelligence.

Chairwoman JOHNSON. Thank you very much. I yield back.

Chairwoman STEVENS. And now we recognize Mr. Lucas for 5 minutes.

Mr. LUCAS. Thank you, Madam Chair, and I appreciate the opportunity to visit with Dr. Copan.

Before I ask my one question, though, I have to note there's been lots of discussion about the President's budget. And when I enthusiastically see the Majority's budget, I know a lot of these issues will be addressed whenever it's available. Whenever it's available.

That said, let's focus for a moment on an issue that I am very concerned about, Doctor, and that's the moves China is making in the 5G wireless technology, particularly in trying to dominate the global market. How do you think the United States stands on 5G, and what do we need to do not just to compete but to lead in that area?

Dr. COPAN. Thank you so much, Ranking Member Lucas. That's a very, very important question. And we have entered in the United States, as we know, a hypercompetitive environment with China. As a lead in activities related to standardization, we see that in some ways the standardization process has been weaponized where the free market economy that is represented by the United States, a private-sector-led process that's coordinated by our sister organization the American National Standards Institute, ANSI, which brings together many of the key players in the private sector, are looking now at more effective coordination within the United States, looking to incentivize also the engagement by U.S. industry in the standards process. We know that these are long-term investments that are made by U.S. industry, as well as by the Federal sector led by and coordinated by NIST.

We know that there are important rules for the standardization process, and we have seen that at times other players have bent or indeed broken the rules of fair play in standards. The United States needs to continue to utilize the standardization process to lead in the future. That includes more effective coordination, the use of tools so that standardization processes can be accelerated, and that greater information-sharing amongst these standards players can lead to more effective consensus development around the standards that would benefit the United States and its private-sector players, as well as others in the global economy.

We want the best technologies in the world to win, and we want the United States to continue to be the leader in not only delivering those technologies but securing the intellectual properties behind them and translating those into market value.

The work that NIST is doing also involves a coordination across the Federal interagency. We have been called upon by this Committee and by others to continue our work to step forward to provide greater coordination, greater training, and to work collabo-

ratively across the entire Federal interagency to ensure that the United States leads in standards for the future.

We've already spoken briefly about artificial intelligence standards and the importance for the future, and NIST has responded to the President's executive order on maintaining American leadership in AI through the standards process. I believe that that's a very powerful document that NIST has developed in collaboration with participants from the private sector and across the Federal Government, as well as with academia. That same process also focuses on the United States being able to sit at the table in the United States and globally with the global standards development organizations to ensure that U.S. industry, U.S. Government, U.S. stakeholders are present at the standards negotiating tables around the world.

Mr. LUCAS. Thank you, Dr. Copan. And, surprisingly, Madam Chair, I'll yield back a little time.

Chairwoman STEVENS. And now we'll recognize Congressman Lipinski for 5 minutes of questioning.

Mr. LIPINSKI. Thank you, Madam Chair.

Dr. Copan, I was proud to have passed the *American Manufacturing and Competitiveness Act* in 2014 as part of a broader manufacturing legislation package requiring publication of a strategy for American leadership in advanced manufacturing. And I was excited to see the first strategy published in October of 2018. And I note that you are the Co-Chair of the Committee on Technology that worked on that strategy, and I sincerely thank you for your efforts. I have to admit I had some concerns about what it was going to—what was going to wind up being in there, but you did an excellent job in putting this together.

As my colleagues are well aware, I have long been interested in programs to encourage research coordination and facilitate tech transfer, so it's no surprise that I was particularly interested in the recommendations within the report, the report section entitled "Encourage Ecosystems of Manufacturing Innovation." In response to these recommendations, I recently introduced H.R. 5978, the *MADE HERE Act*. This bill aims to create new regional manufacturing innovation clusters by bringing together educational institutions, private-sector companies, labor organizations, and government-funded entities such as the Manufacturing Institutes and Manufacturing Extension Partnerships.

Through the three-phase funding model, the program would place an emphasis on entrepreneurial training and business plan formation to meet regional need. So, this is all very much in keeping with the recommendations of the report.

So, Dr. Copan, can you please describe the value of regional entrepreneurial manufacturing cluster programs like the one that I described?

Dr. COPAN. Thank you so much, Congressman Lipinski, and thank you for your great support for America's manufacturers.

We know that entrepreneurship drives value, and we are in an era of networks where bringing together the key players in the ecosystem is critical to establishing new or strengthening existing industry-driven consortia such as the Manufacturing USA institutes and their connections broadly with entrepreneurs, accessing also

the capabilities of the Manufacturing Extension Partnership, which supports small- to medium-size enterprise, as well as the Nation's entrepreneurs.

There are high-priority challenges that need to be addressed to grow advanced manufacturing across the United States. The United States needs to continue to lead the world in advanced manufacturing, including the applications in the digital economy and the bioeconomy. The value in technology-based ecosystems facilitate interactions between manufacturers, leverage Federal funding much more broadly, much more efficiently, and promote cross-sector collaboration. These activities also create new important connections for the value of America's supply chain and for the resilience of the supply chain.

That's an area that the NIST Manufacturing Extension Partnership has focused on greatly. In particular, as we look at the threat of the coronavirus, COVID–19, of which we are all aware. The resilience models for U.S. industry and U.S. small companies as well is something that's top of mind, and the resilience focus of NIST and the Manufacturing Extension Partnerships can utilize these ecosystems across our Nation to ensure that our supply chain and our advanced manufacturing programs remain strong and lead the world.

Mr. LIPINSKI. Thank you. And I would appreciate—this is something that—the *MADE HERE Act* is something you could take a look at and perhaps the—help to build some support for this, and hopefully the Administration could really embrace this because it really is in keeping with the strategy that was—that you had put together.

Dr. COPAN. Yes.

Mr. LIPINSKI. Do you have any other thoughts to share about other recommendations of the—of that strategy that we should consider as we prepare for the NIST reauthorization?

Dr. COPAN. Thanks so much for that question. I am very familiar with the *MADE HERE Act*, and I'm delighted that NIST has been engaged in providing feedback. The Nation's strategic plan for advanced manufacturing provides us with an important roadmap. There are important elements for the future of building out a manufacturing workforce for America that is supported by the Manufacturing USA institutes, and we are collaborating much more broadly now across the Federal interagency to ensure that we focus on the workforce needs of the future. I look forward to working with you and with Members of this Committee to ensure that the legislation that's needed for the future and the robustness of U.S. manufacturing that will build upon the national advanced manufacturing strategy and the great work of the interagency program is continued.

Mr. LIPINSKI. Thank you for your work, and I appreciate our work together and look forward to continuing to work with you.

Dr. COPAN. Thank you.

Mr. LIPINSKI. I yield back.

Chairwoman STEVENS. All right. Congressman Balderson, 5 minutes of questioning.

Mr. BALDERSON. Thank you very much, Madam Chair Stevens. Dr. Copan, good to see you, sir.

I was proud to be an original cosponsor of Chairwoman Stevens' bill, the *American Manufacturing Leadership Act*, which passed the House in July of last year. This bill would strengthen our Nation's largest investment in advanced manufacturing, the Manufacturing USA program. I am pleased to see that in the President's budget request the Manufacturing USA program was given a 60 percent funding increase. Could you speak to what new opportunities NIST could pursue with this increased funding for the Manufacturing USA program? And what could this increased funding level mean for small and midsize manufacturers?

Dr. COPAN. Thank you so much, Congressman Balderson. The advanced manufacturing focus of the budget proposal for 2021 is really authorizing NIST to begin the competition for a new advanced manufacturing institute. We are excited about that potential. We're also excited about the new model that NIST has in the reauthorization of the Manufacturing USA program because it provides us much greater flexibility in how we bring new centers and new partnerships together as part of the broader initiative for U.S. advanced manufacturing and Manufacturing USA.

We would look specifically to begin in this fiscal year the competition process, which we anticipate to be a year-long journey to bring an open competition together that the best possible opportunity for a new U.S. manufacturing cluster can be established.

We know that this is a highly competitive process, but competition is a great thing because it brings together new collaborators, new partners, and looking at the most important problems for U.S. manufacturing to be addressed. So, it's really looking to continue NIST's great work in coordinating of the interagency process, the National Science and Technology Council's Advanced Manufacturing Subcommittee, which NIST co-chairs. And we're looking forward to that broad engagement in the process, the continuation and the increase of funding that allows us to do even more for America in the future.

Mr. BALDERSON. Thank you for that answer. My follow-up question would be—and you spoke a little bit about the competition, but given the rise of the international competition in the field of advanced manufacturing, what could it mean for the United States if another country were to gain dominance in these techniques?

Dr. COPAN. We know that the rest of the world is watching what we do and in many cases are emulating what we do in the United States. Having recently visited in Brazil for the Joint Commission on Science and Technology cooperation between the United States and Brazil, it's very clear that there's been close collaborative efforts between the economies of the United States and Brazil in imagining what the advanced manufacturing systems of our respective nations will look like. We'll continue to benchmark globally to ensure that the United States continues to have the information that we need to build the advanced manufacturing infrastructure of the future.

Very clearly, we're pleased at the opportunity to increase funding in these areas, but we know that there are commitments that have been made, for example, by China as part of their Made in China 2025 program that calls for the buildout of 40 advanced manufacturing institutes. And this in itself provides us an opportunity to

see what China is doing. They have in many cases duplicated the types of institutes that we have in the United States, including the same names for the institutes. And it's been something that we are keeping our finger on the pulse.

We do know that our sustained investment for this Nation, as well as utilizing American creativity to ensure that we're addressing the greatest opportunities of the industries of the future, recognizing that, as we make, we learn.

We know also that measurement science is absolutely essential to the future of manufacturing and also that standardization is essential for the adoption of the new products that come from our advanced manufacturing programs across the Nation.

Mr. BALDERSON. Thank you very much. Madam Chair, I yield back.

Chairwoman STEVENS. Thank you. I tell everyone back home when we got this *American Manufacturing Leadership Act*, Congressman from Ohio, Congresswoman for Michigan, it's the only time Michigan and Ohio have ever come together to win anything, but we do it for manufacturing. And that's where our region in the Midwest shines. And, you know, certainly delighted to see that, the Administration agrees with the investments and we want to continue to support NIST in that process as well. So, thank you for those thoughtful comments, Dr. Copan.

And now we're going to recognize Congressman Cohen for 5 minutes of questioning.

Mr. COHEN. Thank you. I appreciate it, Madam Chairman.

Dr. Copan, thank you for your testimony. In light of all the news around Clearview AI and its secretive facial recognition system, I wanted to discuss NIST's important work in accuracy benchmarking for facial recognition technology through its Face Recognition Vendor Test program. As the debacle around Clearview AI shows us, this technology poses significant societal risks, and understanding their accuracy is paramount.

In its most recent test last December, NIST found vast differences between the accuracy of algorithms with the top 17 performing algorithms being nearly perfect across demographics while the bottom-performing algorithms showed significant false-negative and false-positive rates.

Doctor, what accounts for the significant differences in accuracy between the top-performing face recognition algorithms and the lowest-performing algorithms?

Dr. COPAN. Thank you so much for that question, Congressman Cohen. NIST is excited to provide the insights into the direct performance of facial recognition and other artificial intelligence programs, including the performance validation and the performance testing in an unbiased way as NIST does.

Congress appreciates the work, I know, from the discussions that we've had in this Committee and elsewhere by the clear testing protocols that NIST utilizes. So often, the building of algorithms is enhanced or we see detriment based on the selection of the training sets. NIST provides the validation testing. And we don't give the answers to the test. That is, we don't allow the artificial intelligence producers to actually game the tests by providing them the tools to validate them. We do that on an independent basis. And

it's a very important relationship of trust that NIST has with the community of practice in AI.

It's important to provide ongoing reports to policymakers to understand the strengths and the weaknesses of various systems, but it's also very important feedback to industry so that they can develop algorithms and training sets that are much more robust in the future, tools that can utilize cloud-based solutions for artificial intelligence to take advantage of massively parallel computing.

And so we look forward to continue to provide unbiased insights into the performance of facial recognition technologies and are delighted to partner with Congress, as well as with industry to provide these insights.

Mr. COHEN. Well, I'm not sure if I understood exactly what accounted for the differences in the low-and the higher-rated algorithms.

Dr. COPAN. Yes.

Mr. COHEN. Did I miss that or did you miss it?

Dr. COPAN. Well, the performance is really based on the algorithms themselves, as well as the training sets that are utilized to establish the algorithms. Sometimes, the performance is enhanced by the actual computing architecture that's used, a cloud-based solution, for example. And so it really comes down to the—we're not the ones who actually tell people how to fix their problems, but we are there to advise when it comes to the design of their algorithms and their tools. But we can certainly provide insights into what's working well and what's not.

Mr. COHEN. Well, is the problem—so you're saying the problem is in the standards that they use, it's not in the inability to accurately assess people based on their personal or similarly related characteristics?

Dr. COPAN. Yes. It really is a combination of the actual sort of mathematical model, the algorithm tool that's utilized, the training set that allows the initial performance to be established by the vendor, and then ultimately it's affected by the toolset of technology, including cloud-based solutions, that can give greater computing power to the decisionmaking.

Mr. COHEN. So, do you think scientifically they can get it right and not have low-performing algorithms? It's just a matter of them getting it right?

Dr. COPAN. Indeed. It's a matter of time. This is a field that's emerging. Tools are being improved all the time. And now that the problems are more apparent to the developers, NIST will continue to provide testing and feedback so that industry can refine its tools, its systems for better performance in the future.

Mr. COHEN. I yield back the balance of my time.

Chairwoman STEVENS. The Chair now recognizes Congressman Gonzalez for 5 minutes of questioning.

Mr. GONZALEZ. Thank you, Chairwoman Stevens and Ranking Member Baird. I also want to thank Dr. Copan. Thanks for coming back and for your testimony.

As you know, last August NIST released a plan for prioritizing Federal agency engagement in the development of standards for AI. A few of my colleagues and I wrote a letter to you in December urging NIST to work collaboratively with industry and stakeholders in

developing useful frameworks. In your response you mentioned NIST was considering follow-on workshops to bring together the government, industry, and academia. Just a quick status update, how are things progressing on the front? What next steps are imminent?

Dr. COPAN. Yes. Thanks very much. And, as you know, NIST works collaboratively with industry and across the Federal sector, with academia as well to convene the stakeholder community. We've held actually a series of programs and workshops very recently. NIST was also at the RSA conference in California that allowed the community of practice to talk about the development of tools and systems for the future. We look forward to continue to hold programs and workshops and also providing the testing tools as well on an increasingly focused basis. We know that this is something that NIST is called upon to do from the executive order, and also having a broad range of tools for the broad range of applications. We've spoken at some length now about facial recognition technologies but biometrics more broadly.

Mr. GONZALEZ. Yes.

Dr. COPAN. Our utilization of systems for positive identification and so many applications also in the biological laboratory and also our ability to utilize protocols such as machine learning to quickly identify deepfakes, which are becoming an increasing concern for our Nation, as we also look to the election process coming ahead.

Mr. GONZALEZ. Yes. Thank you. And we look forward to following your progress on that.

Dr. COPAN. Thanks.

Mr. GONZALEZ. Another thing that you've mentioned is the notion of international standards and participating in international standard-setting organizations. I think that's critical. The book *Tools and Weapons* by Brad Smith that came out recently I think frames technology well, right?

Dr. COPAN. Yes.

Mr. GONZALEZ. It's not good or bad. It's how do we apply it.

Dr. COPAN. Right.

Mr. GONZALEZ. And, as I look at the technologies of the future and the incredible powerful technologies of the future, I think we all know that it's incumbent that Western values, Western democratic values ultimately dictate the standards for that future.

That being said, how have we progressed within the international community? What steps do we need to take, and how important is it that we are the dominant player economically or technologically in being able to set those standards or influence the dialog?

Dr. COPAN. Yes. Thank you so much, Congressman Gonzalez. It's an exciting time, as we know. Standards drive commerce and global trade. It's important for the United States to be at the leadership table. I'm delighted that the principles for artificial intelligence, for example, that were communicated through the Office of Science and Technology Policy. NIST has been a contributor in the development of the OECD (Organization for Economic Cooperation and Development) guidelines for the appropriate use of artificial intelligence.

It's important for the United States to understand the competitive dynamic globally in which we work. It requires us to organize more efficiently, recognizing that we are still a private-sector-led standards process and that we respect the role of the private sector. But it's important for the government—in this case, the role of NIST is being called out time and again, that we need to stand up even more strongly as a close partner to industry at the standards tables. And I'm delighted to say that NIST is involved in standards organizations globally, each of the key ones. Nearly 1,500 standards committees has representation from NIST and support from NIST. It represents a major investment by our community, and we recognize that that's something we need to continue to step up to to assure American leadership globally.

Mr. GONZALEZ. Great. And we look forward to continuing to support your work in that endeavor, critically important. And with that, I yield back.

Chairwoman STEVENS. At this time Congressman Foster, 5 minutes of questions.

Mr. FOSTER. Thank you, Chairwoman Stevens, Ranking Member Baird, and Dr. Copan for joining us today.

Dr. Copan, I'd like to start by thanking NIST for its tremendous work on digital identity and to encourage you to expand this effort both nationally and internationally. The issue of digital identity and the need to reliably authenticate yourself online is becoming increasingly critical as more and more of our lives are lived online from how we purchase goods to how we communicate with our loved ones or how we get our news. And fraudulent activity in these areas from identity theft to inauthentic bots on social media to fraudulent transactions online can only be prevented by providing citizens who wish one with a means of privately and securely authenticating their identities as a specific human being.

And the secure digital ID will also be crucial to the implementation of digital dollars, which is something that I think our country is going to have to get into to answer the Chinese competitive threat from digital Chinese currency.

And, as you know, NIST published the digital identity guidelines in 2017. These guidelines provide technical requirements for Federal agencies implementing digital identity services. These guidelines cover identity proofing, authentication of users interacting with government IT systems over open networks. They define technical requirements each of the areas of identity proofing, registration, authenticators, management processes, authentication protocols, federation, and related assertions. You know, this is really high-quality work, and I want to thank you for it.

Dr. COPAN. Thank you.

Mr. FOSTER. In addition, in 2015 NIST founded the Trusted Identities Group, TIG, which aims to convene, facilitate, and catalyze a private-sector-led implementation approach to advance trusted digital identity solutions built upon four guiding principles, which I thought were well-thought-out and also to enable government adoption of these by continually involving a risk-based guidance and to encourage adoption of innovative technologies in the market.

The four principles are that identity solutions should be, first, privacy-enhancing and voluntary; secondly, secure and resilient;

third, interoperable—and this is where standards are crucial—and fourth, cost-effective and easy to use.

Now, my office is working on legislation to direct NIST to create standards for online authentication. And can you talk about how your digital identity guidelines might help you in that project?

Dr. COPAN. Thank you so much, Congressman Foster. We are very proud of the work indeed that NIST has done. You refer to also NIST's special publication 800–63, which has been updated. There's new information actually available online from NIST that provides new insights and addresses frequently asked questions on digital identity.

To the point that you've made, digital identities are such an important component of our modern lives, and it turns out that they're complicated by the fact that we are multiple personalities online if you will. People have multiple identities when it comes to their email, to their online banking, to how they interact with social media. And these identities are so important to be preserved. Sometimes, it requires a surrendering of certain information to access services. And so we are very pleased at the foundational work that NIST has done regarding digital identities.

The entire federation process as well that allows the conveyance of authentication across network systems is absolutely essential to get right. NIST looks forward to working with you and with this Committee as you seek to strengthen the protection of Americans' digital identities.

And also as we look to the future, NIST's work in blockchain, for example, as we look to the future of cryptocurrencies and other——

Mr. FOSTER. I very much enjoyed attending your—one of your blockchain-related summits.

Dr. COPAN. Yes. Yes.

Mr. FOSTER. And——

Dr. COPAN. Thanks so much for your support.

Mr. FOSTER. Also, I'd really like to encourage you to continue to work on this internationally as well. I mean, you know, just, for example, at the upcoming G7—I guess G6 now—Summit there's going to be significant discussion——

Dr. COPAN. Yes.

Mr. FOSTER [continuing]. Of central bank digital currencies, and having an international digital ID will be, you know, at the very heart of that discussion.

Dr. COPAN. Yes.

Mr. FOSTER. And then in my last 9 seconds—maybe I'll ask you a question for the record having to do with the strategic vision for the neutron science enterprise at NIST.

Dr. COPAN. Very good. I will—I'll look forward to addressing any questions for the record and, if time permits in the testimonies today, to be able to come back to both of those topics. Thank you so much.

Mr. FOSTER. Thank you. I yield back.

Chairwoman STEVENS. Thank you. And, Mr. Tonko, Congressman Tonko, recognizing you for 5 minutes of questions.

Mr. TONKO. Thank you, Madam Chair. And welcome, Dr. Copan.

As some may or may not know, today is International Plumbing Day. For decades, NIST led research efforts to inform the basis for

U.S. plumbing structure, design, and construction standards. These efforts were ended in the 1970s and, as a result, today's plumbing standards do not fully account for technological advances that could enable us to meet our daily water needs while conserving resources and reducing utility bills. That is why I joined Representative Cartwright in cosponsoring the *NIST Plumbing Research Act* to reinvigorate these efforts.

So, Dr. Copan, given NIST's history and its role in similar efforts related to energy efficiency and building codes, do you see a role for NIST in plumbing research? And what is standing in the way of NIST doing this important work?

Dr. COPAN. Yes, thank you so much, Congressman Tonko. I really appreciate your support and your interest in this important topic.

Yes, plumbing is one of those things that is not seen as a glamour industry, but it's something that we rely upon for the quality of water that's delivered. And we know that with the low-flow appliances and devices that we need to take a fresh look at plumbing systems for the future.

NIST has actually been meeting with the leadership of the industries, with the industry associations, as well as those who look at future building codes and standards that incorporate guidelines for plumbing systems. We have a plumbing tower that has been essentially mothballed at NIST. It's something that was very useful for the development of the previous set of guidelines.

We've also been sharing with the plumbing and the built environment community some of the modern work that NIST has been doing as well in how we analyze flow. Some of the new techniques for microfluidics characterization and the work of our physical measurements, as well as our engineering laboratories is very focused on the ability to translate in the future some of these new technologies to help us understand and to do the work that's so necessary for the future of the plumbing industry.

As mentioned earlier on, the appropriations that NIST receives, we will look forward to applying that appropriately to the important problems of the future, and we look forward to working with this Committee and appreciate your leadership in the legislation for the future of plumbing safety, for water quality in this Nation, and also to support the export markets of America's plumbing industry. We've seen by the work that NIST, ANSI has been involved in in global markets that has actually helped the U.S. export business for plumbing. And we look forward to that collaborative work that would open up the door to new markets for the American plumbing manufacturers.

Mr. TONKO. Great. We think it's important to do, especially with this innovation economy.

More and more Americans are living in crowded urban and suburban communities. Some communities are leveraging public- and private-sector dollars to invest in technologies to address challenges such as reducing traffic congestion, increasing efficiency of services, and fostering economic growth. I'm impressed by the terrific examples of smart cities in my district such as the city of Schenectady, a terrific example of what we can achieve when we use technology and data to better serve our communities.

However, for many communities the risk of investment in smart technologies is still too great. There is still much work to be done to achieve greater implementation of smart city solutions. The Federal Government can play a role in addressing some of these risks, including barriers to interoperability and data-sharing among the different public and private stakeholders and between communities that are looking to develop smart city plans.

NIST launched its Global City Teams Challenge in 2014 as an effort to encourage collaboration in standards in the development of smart city technologies. What is the status, sir, of that initiative?

Dr. COPAN. NIST is proud of the work that it's done in the Global Cities Challenge and smart communities directly. We have been doing some I think very important work also as part of our advanced communications efforts, the public safety communications program, which links together work in smart cities with intelligent new technologies that allow the creation of cost-effective solutions for industry and also for communities such as we've seen at the Boston Marathon.

The challenge that was there was to deploy a low-cost solution that provide access to digital identification and so many elements of public safety. And so we look forward to working with you and also with this Committee toward the future of the smart cities program in the Nation and around the world.

Mr. TONKO. Well, thank you. And I just hope that NIST will continue to contribute to the development of standards for smart and connected communities.

And with that, Madam Chair, I yield back.

Chairwoman STEVENS. OK. Well, I——

Dr. COPAN. Thank you so much.

Chairwoman STEVENS. The Chair doesn't think she's ever heard anyone talk so eloquently about plumbing in her life, so hats off to the Congressman and the Under Secretary.

Before we bring this to a close, we are going to briefly open up for one more question on behalf of the Chair and the Ranking Member that we had for you, Dr. Copan, which is that the budget request made pretty clear that there are maintenance needs of facilities on both NIST campuses. And many of the agency's buildings were built in the 1950s and 1960s and are experiencing some of the similar deterioration, as the Nation's other major infrastructure is as well. And so NIST has a deferred maintenance backlog of over $700 million.

And, Dr. Copan, I was just—we were just wondering if you could speak a little bit about how this significant construction and maintenance backlog impacts both the science and standards development at NIST, as well as NIST's ability to attract top scientists.

Dr. COPAN. Thanks very much for that very important question. And indeed the condition of NIST facilities are challenging. Over 55 percent of NIST's facilities are considered in poor to critical condition per Department of Commerce standards. And so it does provide some significant challenges for us. The latest number that I had is that the deferred maintenance backlog is over $775 million.

It's always much more attractive to build something new than to maintain what one has. The infrastructure, including plumbing, is very, very important, but the kind of plumbing that we really care

about is our IT infrastructure and the ability of our systems to have controlled climate. Temperature control is vital for many of the experiments that NIST metrology laboratories carry out.

It's a testament to the resilience and the committed-ness of the NIST people that they can work in sometimes challenging outdated environments. And, once again, when you make a visit to NIST Boulder or NIST Gaithersburg, whether it's at our 120th anniversary or at any time, you'll see the good, the bad, and the embarrassingly bad.

And—but we have wonderful people who care about the mission of NIST. They are true public servants. They're scientists. They're Nobel Prize winners who are working in these conditions. And people want to come to work to NIST. We are delighted at the commitment of our NIST people, the very strong collaboration that we have with the academic sector, with the industrial sector, but it becomes an increased challenge for us.

As you know, there have been some creative solutions proposed, the development, for example, of a Federal capital revolving fund has been one of the proposals that's been made. But having some certainty for the future in our ability to plan, we have 20-year plans for the NIST facilities that have been prepared, communicated, and this Committee has also received information about those plans. We look forward to sharing more with you about those.

We're also looking creatively at the combination of maintenance with lease options as well for some of our facilities so that we can move more rapidly to have people cycle out of laboratories, begin the rebuilding, renovation process. It's one of my top priorities as the NIST Director to have our NIST people work in 21st-century facilities that we can be proud of and that enable the important work of NIST for the Nation.

Chairwoman STEVENS. Thank you, Dr. Copan. Thank you for that additional question.

And before we bring the hearing to a close, we want to thank you again. I think it's clear you have a committee of NIST enthusiasts and people who are appreciative and attracted to your work and your leadership. Today's robust dialog covered the gamut, but it also speaks I think to the power and the impact of NIST.

So, on behalf of all of us, you know, we're, one, so proud of you and so proud of the team and the dedicated scientists and the people who have devoted their careers to making this world a better place through proven expertise and love of standards and measurement and good technology.

So, the record is going to remain open for 2 weeks for any additional statements from Members and for additional questions that the Committee may have of you, Dr. Copan.

And with that, Dr. Copan, you are excused, and the hearing is adjourned.

Dr. COPAN. Thank you so much.

[Whereupon, at 11:43 a.m., the Subcommittee was adjourned.]

Appendix

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by the Honorable Walter G. Copan

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"Reauthorization of the National Institute of Standards and Technology"

Questions for the Record to:
The Honorable Walter G. Copan
Under Secretary of Commerce for Standards and Technology
Director, National Institute of Standards and Technology
Submitted by Chairwoman Haley Stevens

1. In February, POLITICO reported that the U.S. blacklisting of Huawei could impact U.S. engagement in international standards setting for 5G. U.S. companies, afraid of running afoul of export laws, are unable to work with the Chinese telecommunications company, even in these international consensus settings. Are these concerns valid? How have actions taken against Huawei impacted U.S. participation in 5G standards setting? What role can NIST, or the Department of Commerce more broadly, play in both helping companies to participate in international 5G standards while still sanctioning the Chinese company?

NIST response:

Maintaining American competitiveness in the global 5G market demands that U.S. companies participate actively, and hold leadership positions, in 5G standards-setting at all levels of domestic and international standards development. Impediments to U.S. participation in 5G standards, real or perceived, could unintentionally advantage Entity List companies at the expense of U.S. companies. As part of a Department of Commerce-wide effort, the National Institute of Standards and Technology (NIST) is working with the Department's bureaus and particularly the Bureau of Industry and Security (BIS) to assist in providing clarity to stakeholders impacted by the Entity List. When approached by impacted stakeholders, NIST has helped those stakeholders connect with BIS officials.

U.S HOUSE OF REPRESENTATIVES
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"Reauthorization f the National Institute of Standards and Technology"

Questions for the Record to:
The Honorable Walter G. Copan
Under Secretary of Commerce for Standards and Technology
Director, National Institute of Standards and Technology
Submitted by Congressman Steve Cohen

1. The United States has failed to invest in the development of domestic recycling markets, and today, the nation only recycles 9 percent of its plastic waste, a fraction of the hundreds of millions of pounds of plastic produced globally. The Federal Government can play an important role in supporting research and development and facilitating standards, tools, and technologies needed across the different stages of the plastics production and recycling lifecycle to minimize plastic waste. NIST is currently doing some of this important work in collaboration with university and industry partners, including through an external grant to Troy University in Alabama. Please elaborate on the status of this research and how NIST can continue to collaborate with academia and industry on this environmental and human health crisis.

NIST response:

In the past three years, NIST has begun research and development toward making the plastic circular economy a reality. NIST's efforts include:

1. Researching effective methods for the deliberate and responsible production, collection, and recycling of plastic materials;
2. Developing an understanding of recycling on a regional level;
3. Serving as a consensus-building body;
4. Studying the impact of plastics in the environment; and
5. Collaborating with multiple agencies, such as NSF, NOAA, EPA, and DOE including serving on merit review panels.

NIST is collaborating with Troy University in Alabama and Pittsburg State University in Kansas. The universities have received a combined total of approximately $10,000,000 in cooperative agreements focused on research and workforce development, primarily at the undergraduate level.

As part of its efforts, NIST is examining the effects of the manufacturing phase of plastic on the eventual recycling of the material as well as understanding the latent economic value of the materials. To meet the second goal, NIST is preparing to gather highly specific regional information on recycling rates. The data will be shared and evaluated with collaborators including the Environmental Protection Agency, non-profit organizations, industry, and local governments.

NIST is also developing plans to convene a series of workshops in which industry, academics, government, and non-profit organizations will discuss and develop a roadmap to develop a suitable plastic product recycling-based circular economy via sorting and other approaches, with a balanced processing ecosystem for multiple pathways back into the supply chain (including fuels and mechanical and chemical recycling routes) and the domestic manufacturing infrastructure to do so at scale.

Finally, NIST has developed programs to evaluate the impact of plastics on the environment. These programs include a wide range of industry sectors and expertise. These programs are focused on determination of exposure and minimizing risks. Nanoplastics in the environment are also being investigated in order to develop a better understanding of fate and transport as it affects human health. NIST is in the process of bringing together internal experts, as well as collaborating with external stakeholders including other agencies, industry, and non-profit organizations, to build a program focused on marine plastic and the effects of microparticles and nanoparticles on living organisms and the environment.

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"Reauthorization of the National Institute of Standards and Technology"

Questions for the Record to:
The Honorable Walter G. Copan
Under Secretary of Commerce for Standards and Technology
Director, National Institute of Standards and Technology
Submitted by Congressman Bill Foster

1. **What digital identity standards does NIST maintain?**

NIST response:

As a part of its Identity and Access Management Program, NIST has developed and maintains the following:

- Federal Information Processing Standard (FIPS) 201-2, Personal Identity Verification (PIV) of Federal Employees and Contractors
- SP 800-76-2, Biometric Specifications for Personal Identity Verification
- SP 800-157, Guidelines for Derived Personal Identity Verification (PIV) Credentials
- SP 800-63-3, Digital Identity Guidelines
- SP 800-63A, Digital Identity Guidelines: Enrollment and Identity Proofing
- SP 800-63B, Digital Identity Guidelines: Authentication and Lifecycle Management
- SP 800-63C, Digital Identity Guidelines: Federation and Assertions

All of these materials can be accessed from the NIST Computer Security Resource Center website https://csrc.nist.gov/. Although they are not consensus standards, they are developed with significant public input. NIST also leads in the development of national and international identity and access management standards and produces example solutions that bring together the identity management and cybersecurity requirements needed to address specific business cybersecurity challenges through NIST's National Cybersecurity Center of Excellence.

2. **What can Congress do to help NIST develop guidelines and standards for digital identity and authentication standards and to encourage collaboration with other federal agencies and private industry partners? Would reauthorizing the Trusted Identities Group help in the effort of collaboration?**

NIST response:

NIST appreciates the support Congress has provided for its work. In order to help NIST develop guidelines and standards for digital identity and authentication, and to encourage collaboration with other federal agencies and private industry partners, these efforts need to continue to be resourced at an appropriate level. NIST also appreciates Congress's

longstanding support for its cybersecurity and privacy program, including NIST's Identity and Access Management Program. This program is conducted in close partnership with other federal agencies and with private industry partners, including through NIST's National Cybersecurity Center of Excellence. Furthermore, Congress can raise awareness about the importance of sound approaches for digital identity and authentication as articulated in the NIST FIPS 201-2, SP 800-76-2, SP 800-157, and the SP 800-63 series, and support the adoption and use of robust digital identity and authentication schemes and approaches. The Trusted Identities Group currently has the authorization it needs to successfully build partnerships to advance digital identity.

3. **What is the current status and future of the NIST Center for Neutron Research, and more specifically the 50-year-old reactor?**

NIST response:

The NIST Center for Neutron Research continues to serve the U.S. technological community. Each year, NIST serves approximately 2,000 research participants from government, industry, and academia from all areas of the country through the facility. In the most recent year, this activity resulted in 343 technical publications. The reactor is currently licensed by the Nuclear Regulatory Commission to operate until 2029. An expansion of the Center is included in the NIST Master Plan, and options for updating the reactor are being considered.

4. **Can you please provide a list of your construction and maintenance backlog that impact both the science and standards development at NIST, as well as NIST's ability to attract top scientists? Out of these projects, can any be accelerated with additional funding?**

NIST response:

As of September 30, 2019, NIST estimated a backlog of $774.4 million in deferred maintenance, an increase of $98.6 million from the $675.8 million reported in the Agency Financial Report at the end of FY 2018. The $98.6 million increase is due to:

- $85.3 million of newly identified deficiencies
- ($29.3) million of backlog deficiency reductions
- $42.6 million increase due to 5% inflation correction factor applied to the estimates

Of the $85.3 million of newly identified deficiencies, there are:

- $40.0 million of new Information Technology (IT) infrastructure deficiencies
- $15.0 million of new site utilities infrastructure deficiencies
- $7.0 million of new hazardous materials abatement deficiencies
- $6.5 million of new mechanical deficiencies
- $5.3 million of new life-safety deficiencies
- $3.4 million of new architectural deficiencies
- $3.3 million of new electrical deficiencies
- $2.6 million of new roofing deficiencies
- $1.9 million of general site deficiencies
- $0.3 million of safety deficiencies

NIST maintains a ranked list of the top five Capital Projects needed at its Gaithersburg and Boulder campuses that impact both the science and standards development as well as NIST's ability to attract top scientists. Currently, they are:

Gaithersburg:

1) New Research Building 228
2) Building 101 Renovation (HQ Building)
3) Building 221 Renovation (Research)
4) Gate F Shipping and Receiving Facility for Security (New Construction Security)
5) Building 220 Renovation (Research)

Boulder:

1) B1 Renovation: Wing 5 (Research)
2) Building 2 Replacement (Research, New Construction/demo existing Bldg. 2)
3) Building 3 Addition (Research, New Construction)
4) Building 24 Renovation
5) New Childcare Center

To meet the needs for modernizing facilities and for operating and maintaining current facilities, the Administration has proposed the Federal Capital Revolving Fund as a way to fund large capital projects. The 2021 budget request proposes: (1) to create a Federal Capital Revolving Fund (FCRF) to fund large-dollar, Federally-owned, civilian real property capital projects; and (2) provide specific budget enforcement rules for the FCRF that would allow it to function, in effect, like State and local government capital budgets. The FCRF will be housed in the General Services Administration (GSA). This proposal incorporates principles that are central to the success of capital budgeting at the State and local level -- a limit on total funding for capital investment, annual decisions on the allocation of funding for capital projects, and spreading the acquisition cost over 15 years in the discretionary operating budgets of agencies that purchase the assets. The 2021 Budget proposes to use the FCRF concept to fund the renovation of NIST's Building 1 in Boulder, Colorado, estimated at $294.0 million including furniture, fixtures and equipment.

5. **Can you please provide specific plans for how NIST is planning on addressing this backlog?**

NIST response:

NIST recently completed a 5-year cycle of facility inspections in February 2020. All updated data will be ready in 2020, which will result in updated deferred maintenance values. NIST is using the U.S. Army Corps of Engineers' BUILDER database developed by the Engineer Research and Development Center as an asset management tool to assist in maintaining sustainable building and infrastructure investment. This activity captures the inventory and identifies components and significant life cycle attributes to predict Condition Index measures for the buildings on the NIST campuses in Gaithersburg and Boulder. Inspections will be performed to verify inventory condition based on criticality, condition, and rate of deterioration, as well as remaining maintenance and service life cycle. The resulting metrics will better enable NIST's Office of Facilities and Property

Management to focus on the most critical components, performing both condition and functionality assessments, while providing a comprehensive picture of overall assets and their key components, so work can be planned, programmed, and budgeted efficiently.

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