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on
“The President’s FY 2021 Budget Request for Research & Development”

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Chairwoman Johnson, Ranking Member Lucas, and Members of the Committee, it is a privilege to be here with you today to discuss the President’s Budget for science and technology (S&T) research and development (R&D) in Fiscal Year (FY) 2021.

In his State of the Union Address, President Trump declared that “We are pioneers” who “look at tomorrow and see unlimited frontiers just waiting to be explored.” Hearing these words, I was reminded of the words written in 1945 by Vannevar Bush, President Roosevelt’s *de-facto* science advisor. Dr. Bush wrote: “The pioneer spirit is still vigorous within this nation. Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great.”

Since Dr. Bush, the architect of America’s post-World War II research framework, wrote these words in his treatise, *Science—The Endless Frontier*, America has experienced nearly uninterrupted growth in combined public, private, academic, and nonprofit research and development investment. Our Nation has created educational and training pathways into STEM for hard working, creative, and entrepreneurial Americans from every zip code, and we’ve attracted the best and brightest from every country. We have built the best discovery and innovation engine in history on bedrock American values, such as free inquiry, competition, and inclusion. And as Dr. Bush predicted, the rewards indeed have been great for our Nation and the world.

The Multisector American S&T Enterprise

Seventy five years later, America is the unquestioned global leader in S&T. The foundation of our success is the ability of the Federal government, private sector, academia, and nonprofits to not only make substantial investments in R&D—an estimated total of \$580 billion in 2018¹—but also work in mutually complementary ways to discover, innovate, educate, and train. The Federal government serves as a catalyst for innovation by investing in early stage basic and applied research, particularly in areas where little or no commercial incentive exists. The Federal government also facilitates discovery and innovation by removing barriers, streamlining processes, and avoiding the creation of unnecessary regulatory hurdles.

American academic institutions, which include many of the world’s best research universities, performed an estimated \$74.7 billion in R&D in 2018, including 48 percent of all U.S. basic research.² Between 1996 and 2017, academic R&D led to over 13,000 start-ups (with 6,518 operational as of 2018), more than 200 drugs and vaccines, 420,000 invention disclosures, and 100,000 U.S. patents, contributing \$865 billion to the U.S. gross domestic product (GDP) and an astounding \$1.7 trillion in gross industrial output.³ Additionally, R&D performed at our Nation’s colleges and universities helps prepare the next generation of researchers, technicians, engineers, and millions of other STEM-capable workers who together are building America’s future.

The private sector leverages the discoveries and talent resulting from Federal and academic investments to fuel its own massive R&D capacity. As of 2018, businesses were responsible for funding over two-thirds of U.S. R&D, including nearly 29 percent of all U.S. basic research⁴. The industries that perform the vast majority of private sector R&D, such as the aircraft, pharmaceutical, motor vehicle, IT services, and computer products industries, together account for 11 percent (\$2.3 trillion) of U.S. GDP, employ nearly 10 million workers, and produce many of the innovations transforming our lives.⁵ For example, in October 2019, researchers from Google reportedly demonstrated, for the first time, that a quantum computer could perform a calculation impossible for a standard computer (quantum supremacy). This breakthrough has the potential to accelerate advancements in security, health, and many other areas and was made possible through collaborations with NASA Ames Research Center, Oak Ridge National Laboratory, and international researchers and built on the results of federally-funded research.

Nonprofits funded an estimated \$22.7 billion in R&D in 2018, which represents the third highest level of funding behind the private sector and Federal government and slightly more than the \$21.1 billion funded by colleges and universities themselves. Non-federal government R&D spending contributed another \$4.7 billion to the U.S. total.⁶

¹ National Science Foundation, National Center for Science and Engineering Statistics 2019. National Patterns of R&D Resources: 2017–18 Data Update. NSF 20-307. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsf20307>

² National Science Foundation, National Center for Science and Engineering Statistics 2019. National Patterns of R&D Resources: 2017–18 Data Update. NSF 20-307. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsf20307>

³ https://autm.net/AUTM/media/Surveys-Tools/Documents/AUTM_FY2018_Infographic.pdf

⁴ National Science Foundation, National Center for Science and Engineering Statistics 2019. National Patterns of R&D Resources: 2017–18 Data Update. NSF 20-307. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsf20307>

⁵ National Science Board, National Science Foundation. 2020. Production and Trade of Knowledge- and Technology-Intensive Industries. Science and Engineering Indicators 2020. NSB-2020-5. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsb20205/>

⁶ National Science Foundation, National Center for Science and Engineering Statistics 2019. National Patterns of R&D Resources: 2017–18 Data Update. NSF 20-307. Alexandria, VA. Available at <https://nces.nsf.gov/pubs/nsf20307>

Although America is the global S&T leader, continued leadership is far from guaranteed. Extraordinary opportunities and profound challenges confront our country daily. From defending against threats to American economic and national security, to promoting international R&D collaborations, to ensuring that Americans are prepared to navigate the impact of technology both at home and in the workplace, our global S&T leadership will only become more important in an unpredictable future. This is why the Administration has prioritized substantially increasing the ability of the four sectors of our S&T enterprise to coordinate, collaborate, and partner to leverage resources and share expertise, data, and infrastructure *well beyond* that of the past and present.

The President's FY 2021 Budget

R&D represents the seed corn of innovation, and thus of our economic prosperity, quality of life, and national security. Most of the technologies we enjoy today—from streaming online services to wayfinding apps to medical diagnostics and treatment—trace their roots to R&D. The Trump administration recognizes the actions our Nation takes now in laying a strong foundation for R&D will pave the road ahead, and we are committed to taking the wise and necessary steps to ensure that America remains the world leader in S&T research and education for generations to come. The FY 2021 Budget reflects this commitment by investing \$142.2 billion in Federal R&D. This represents a 6 percent increase compared to the President's FY 2020 Budget and a 20 percent increase from the President's FY 2019 Budget.

The FY 2021 Budget demonstrates responsible leadership by prioritizing areas with the most potential to benefit all Americans, combined with thoughtful reallocations in lower-priority areas. It does this by focusing on the basic and applied research, as well as experimental development, that fuel critical Industries of the Future (IoF)—artificial intelligence (AI), quantum information science (QIS), 5G/advanced communications, biotechnology, and advanced manufacturing. These industries, which rely on basic research discoveries, promise to open new frontiers in sensing and computation, promote health through advances in medical diagnostics, create high-paying jobs and entirely new industries, transform the way Americans communicate and travel, and keep the Nation and its people safe and prosperous.

AI and QIS, in particular, hold enormous potential as they intersect with nearly every field of science, technology, and health and can act as innovation force multipliers. As such, the FY 2021 Budget includes major increases in QIS and non-defense AI R&D as part of a commitment to double Federal investment in these areas by 2022. For example:

- The FY 2021 Budget brings spending for AI R&D and interdisciplinary research institutes at the National Science Foundation (NSF) to more than \$830 million. This represents a more than 70 percent increase over the President's FY 2020 Budget.
- NSF investment in QIS research will double to \$210 million.
- The Department of Energy's (DOE) Office of Science will invest \$125 million in AI research, a \$54 million increase over the FY 2020 Budget.
- DOE Office of Science spending on QIS research will increase to \$237 million, which will boost QIS efforts at the National Laboratories and in academia and industry. The Budget also includes \$25 million to support early stage research for a quantum internet.

- The Budget includes an additional \$100 million for the Department of Agriculture’s Agriculture and Food Research Initiative (AFRI) to support AI, promote advanced manufacturing in the food and agricultural sciences, and continue efforts in robotics and application of big data that are required to advance precision agriculture.
- The Budget provides a \$25M increase for AI focused work at NIST, effectively doubling their current investment.
- The Budget allocates \$50 million for new research at the National Institutes of Health on chronic diseases using AI and related approaches.

The President’s commitment to double AI and QIS R&D by 2022 punctuates a three year effort that include the enactment of bipartisan legislation, the creation of national strategies, and presidential actions and initiatives. For example, under President Trump, the United States launched the U.S. national strategy for AI leadership—the American AI Initiative—by Executive Order, proposed the first-ever AI regulatory guidance for the use of AI in the private sector, and worked with Congress to pass the National Quantum Initiative Act.

The Budget also includes critical investments in education and job training that will equip more Americans with the skills necessary to support and advance AI and QIS. For example, at NSF an additional \$50 million will go toward workforce development in these two areas, with a focus on community colleges, Historically Black Colleges and Universities (HBCUs), and minority serving institutions (MSIs). Also, to bolster the STEM academic pathways aligned with the local business community and improve public-private partnerships, the Budget for the Department of Education requests \$150 million for the Minority Science and Engineering Improvement Program to fund STEM activities led by HBCUs and MSIs located in Opportunity Zones.

Beyond these investments in AI, QIS, and other IotF areas, the President’s FY 2021 Budget directs R&D efforts to achieve sustainable human exploration in deep space, beginning with returning to the lunar surface where we will develop the skills, systems, and operational experience to enable human missions to Mars. The Budget provides robust funding for the National Aeronautics and Space Administration (NASA) programs, including \$3.4 billion for the development of lander systems, over \$700 million to support lunar surface activities, and \$233 million for robotic precursor missions to Mars that would also conduct cutting-edge science.

Research and partnerships in ocean S&T remain an Administration priority. The FY 2021 Budget advances coordinated and systematic ocean mapping and research so that our Nation can start to better understand the vast resources in our oceans. To support these activities, the Budget increases National Oceanic and Atmospheric Administration’s funding by over 10 percent for its participation in the National Oceanographic Partnership Program and increases funding by more than 60 percent for regional data portals that provide public access to maps and information about the ocean environment.

Leveraging the Full Capabilities of America’s S&T Enterprise – Research Environments

The Trump Administration recognizes that continued global leadership requires not only strategic R&D investments, but also that research environments reflect American values. This means research environments that are safe, inclusive, operate with maximum integrity, appropriately

balance openness and international collaboration with security, and make efficient use of taxpayer dollars by not encumbering researchers, agencies, or institutions with unnecessary administrative work. U.S. policies and practices must evolve thoughtfully and appropriately to meet current and future challenges.

That is why nearly ten months ago I launched the National Science and Technology Council (NSTC) Joint Committee on the Research Environment (JCORE). JCORE is taking an integrative, whole-of-government approach to develop policy recommendations on four interrelated topics:

- Strengthening the security of American research enterprise;
- Creating safe and inclusive research environments;
- Reducing administrative burdens on Federally-funded research; and
- Improving rigor and integrity in research.

I will focus on the first two in my testimony.

To maintain our global leadership, America must *balance protecting* its research enterprise while *promoting* the openness that has been and will continue to be critical to our success. America's S&T enterprise attracts, educates, and trains some of the world's most creative, innovative, and determined students and researchers, which has led to significant discoveries and innovations. Many countries recognize our success and are imitating us by building their own innovation capacity by making significant investments in R&D and higher education. For those that share America's values, we celebrate their participation in a global S&T enterprise, as this creates new knowledge and new opportunities for international collaborations and partnerships.

Unfortunately, some countries have sought S&T progress through illicit means, including unapproved transfer or outright theft of American research, ideas, and intellectual capital. In particular, the government of the People's Republic of China (PRC) continues to steal technology and surreptitiously influence research in the United States for their own economic and military gains. Some U.S.-based researchers also have violated longstanding conflict of interest rules by failing to disclose foreign financing, affiliations, companies, and IP – often at the behest of the PRC government. These actions undermine the integrity of our research enterprise not to mention pose risks to our economic and national security. Universities will need to better protect academic and research program integrity, key interests of the United States, by providing full transparency regarding foreign funding, as current law requires, through their semiannual reporting.

The JCORE Subcommittee on Research Security is the primary mechanism for Federal agencies to share and coordinate different policies and practices to strengthen the security of America's research enterprise. The Subcommittee aims to protect America's research enterprise without comprising our values or weakening America's long-standing competitive advantages, such as the open and collaborative nature of our system or our ability to attract the best talent from around the globe. The Research Security Subcommittee brings together over 20 Federal departments and agencies, including R&D funding agencies, the Departments of State and Education, the law enforcement and intelligence communities, and National Security Council staff.

The Subcommittee is focused on four areas:

- Appropriate and effective risk management;
- Consistent, coordinated, and effective outreach to and engagement with academic and research institutions, at home and abroad;
- Developing guidance to Federal agencies; and
- Developing best practices for academic and research institutions.

America's continued S&T leadership depends not only on balancing security and openness but also creating research environments that are safe and inclusive. There have been numerous reports detailing the persistence of harassment and its detrimental consequences. A 2018 National Academies report, *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*, found that 20 to 50 percent of female students and greater than 50 percent of female faculty and staff experienced sexually harassing behavior in academia. This is unacceptable. Harassment can silence or limit career opportunities for both victims and bystanders, resulting in a costly loss of talent, squandered resources, and the erosion of public trust.

To address this issue, the Office of Science and Technology Policy (OSTP) created the JCORE Subcommittee on Safe and Inclusive Research Environments. Sixteen departments and agencies across Government are collaborating to address the conditions that generate harassment and bias within research environments. The Subcommittee is completing a comprehensive inventory of all Federal agencies' policies and practices targeted at addressing harassment *of all forms* in the research environment. Through this policy inventory, the Subcommittee will identify best practices, which will eventually lead to a Coordinated Federal Action Plan. This plan will present a Government-wide approach to addressing harassment in the research environment.

In President Trump, our innovators have a champion in the White House who will fiercely defend their interests and the American research system at the foundation of our success. Through JCORE, we are protecting the Nation's research enterprise, leading globally with our principles and American values, and empowering our citizens to more fully participate in and benefit from innovations in science and technology.

Leveraging the Full Capabilities of America's S&T Enterprise – Partnerships

Federal investments in R&D are critical, but the real power of American S&T enterprise is that it leverages the combined investments, infrastructure, and creative talent of government, industry, academia, and nonprofit organizations in interdependent and mutually complementary ways. Partnerships create the connective tissue between these sectors and serve as force multipliers, enabling partnering organizations to achieve higher returns on investment, reduce unnecessary duplication, create efficiencies, leverage assets, and advance their respective missions. The August 2019 Memorandum on the Administration's FY 2021 R&D Budget Priorities encouraged agencies to "build, strengthen, and expand strategic multisector partnerships," including partnerships that build S&T capacity at institutions seeking to do so, such as R2 ("high research activity") institutions and HBCUs; support research infrastructure; and improve transfer of federally-funded technologies from "lab-to-market."

To advance this goal, the President’s Council of Advisors on Science and Technology (PCAST) is currently exploring ways to engage industry, academia, and the DOE National Labs collaboratively to further national priorities, such as advancing the Industries of the Future and creating a diverse, highly skilled workforce. During the first ever official meeting between PCAST and the National Science Board (NSB) on February 4, 2020, the collective group identified the need to strengthen and leverage multisector partnerships as a key to unlocking the full innovation capacity of our S&T enterprise, and they agreed to work collaboratively on this topic.

Additionally, on February 10, 2020, OSTP established an NSTC Fast Track Action Committee (FTAC) on Partnerships. The FTAC will include representation from across the entire Federal government, not just agencies involved in R&D activities, and has been charged with identifying within 90 days actions that will improve the ability of departments and agencies to partner with each other and non-federal entities on S&T research, development, and education.

Leveraging the Full Capabilities of America’s S&T Enterprise – People

The American people have been and will continue to be our Nation’s greatest resource. The Trump Administration recognizes this and has made building the workforce of the future a central priority. In December 2018, the Administration released a 5-year strategic plan for STEM education, *Charting A Course For Success: America’s Strategy for STEM Education*. The plan identified three goals:

1. Build Strong Foundations for STEM Literacy by ensuring that every American has the opportunity to master basic STEM concepts and to become digitally literate.
2. Increase Diversity, Equity, and Inclusion in STEM and provide all Americans with lifelong access to high-quality STEM education, especially those historically underserved and underrepresented in STEM fields and employment.
3. Prepare the STEM Workforce for the Future—both college-educated STEM practitioners and those working in skilled trades that do not require a four-year degree—by creating authentic learning experiences that encourage and prepare learners to pursue STEM careers.

Federal departments and agencies are continuing to implement the goals of the strategic plan and, in October 2019, OSTP released a report detailing their progress. Although the Federal government plays a key role in STEM, preparing *all* Americans with the knowledge and skills necessary to adapt and thrive in a constantly evolving workforce demands a multisector approach. To engage the private sector, one example includes the President’s National Council for the American Worker, which has asked companies and trade groups throughout the country to sign the *Pledge to America’s Workers*—a commitment to expand programs that educate, train, and reskill workers from high-school age to near-retirement. To date, more than 400 companies and organizations have signed the Pledge to deliver nearly 15 million career and training opportunities to American workers. Likewise, the PCAST Subcommittee on Meeting National Needs for STEM Education and a Diverse, Multi-Sector Workforce is collaborating with the NSB to address this topic. These and other actions will ensure that as S&T transform every aspect of our lives, no American is left behind.

S&T Highlights during the Trump Administration

Each year, America's scientists and engineers make new discoveries and create innovations that justify the confidence placed by the public in the research enterprise for 75 years. Just this past year, numerous Federal agencies joined the Event Horizon Telescope—an international collaboration that captivated the world with the first-ever image of a black hole. Previously thought to be impossible, this achievement demonstrates the type of discovery that strong partnerships can achieve.

Under the Trump Administration, our researchers and medical professionals are making great strides in health. For the first time, we eliminated the DNA of the virus responsible for AIDS from the genomes of living animals. We are now producing reliable and reproducible amounts of Actinium-225, a previously scarce alpha emitter thought to be one of the most potentially effective treatments for metastasized cancers because of its capacity to target malignant cells while leaving healthy tissue unharmed. Through the President's Roadmap to Empower Veterans and End a National Tragedy of Suicide (PREVENTS), researchers are using AI and machine learning technologies to more accurately and swiftly identify veterans at risk of suicide.

This Administration continues to recognize the importance of oceans to the U.S. economy, national security, and environment. We are continuing to implement President Trump's 2018 Executive Order on Ocean Policy to Advance the Economic, Security, and Environmental Interests of the United States. In November 2019, the President signed a Memorandum directing the Ocean Policy Committee to coordinate the development of a national strategy for mapping, exploring, and characterizing the U.S. Exclusive Economic Zone and the shoreline and nearshore of Alaska. New and emerging ocean science and technologies, developed and deployed in partnership with the ocean S&T community, will play a critical role by allowing us to more efficiently explore and understand the ocean at a level of detail and at a geographic scale never before possible. This knowledge will significantly advance the conservation, management, and balanced use of our Nation's oceans to the benefit of all Americans.

We are continuously improving our scientific abilities, such as providing high quality elevation data nationwide by 2025 to find our natural water storage through advanced U.S. Geological Survey maps, and improving natural disaster preparations like we did in October 2019 with the first-ever statewide public testing of earthquake early warning systems. From new applications to combat transnational human smuggling such as the Department of Homeland Security's Igloo Program to the National Institute of Standards and Technology's use of blockchain technology in providing tamper-proof transmission of manufacturing data, our S&T enterprise is protecting America's people and institutions from emerging and intensifying threats.

This past summer, we celebrated our budding research workforce by awarding 314 early-career professionals with the Presidential Early Career Award for Scientists and Engineers (PECASE). In October, I welcomed 215 teachers and 15 mentors to the White House and awarded them with the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST) and the Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM). These leaders in research and STEM are the heirs of the legacy forged by the great American pioneers and trailblazers of yesteryear, and we will continue to recognize their accomplishments.

We will be highlighting these and other achievements in the annual S&T Highlights document now in preparation and scheduled for release in early March.

In conclusion, I believe the Nation's R&D investments, strategies, and policies must reflect and address the urgent opportunities and challenges confronting the Nation and make use of every tool, asset, and competitive advantage at our disposal. Federally-funded R&D remains an essential building block for discovery, innovation, and education. But Federal investment is only one part of a much larger enterprise that unites, inspires, and rallies people and organizations from every sector to a common cause—to improve the health, security, and prosperity of the Nation. There indeed are “unlimited frontiers waiting to be explored” and the President's FY 2021 Budget in concert with the other actions I have summarized ensure that America continues to lead the way.



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As Director of The White House Office of Science and Technology Policy (OSTP), Dr. Kelvin K. Droegemeier serves as President Donald J. Trump's science advisor and leads OSTP in its coordination of science and technology initiatives across the Federal Government. Kelvin's background is in extreme weather, numerical weather prediction, and data assimilation.

Before joining The White House, Kelvin served as Vice President for Research and Regents' Professor of Meteorology at the University of Oklahoma, where he joined the faculty in 1985 as Assistant Professor of Meteorology. In his 33 years at the University of Oklahoma, Kelvin generated more than \$40 million in research funding and authored or co-authored more than 80 refereed articles and 200 conference publications. He also co-founded, directed, and led the National Science Foundation (NSF) Science and Technology Center for Analysis and Prediction of Storms (CAPS) and served as co-founder and Deputy Director of the NSF Engineering Research Center for Collaborative Adaptive Sense of the Atmosphere (CASA).

Kelvin served two six-year terms on the National Science Board, the governing body of the NSF, including the last four years as Vice-Chairman, having been nominated by Presidents George W. Bush and Barack Obama and twice confirmed by the United States Senate. He has also served on and chaired numerous national boards and committees and is a Fellow of the American Meteorological Society and American Association for the Advancement of Science. He was appointed in 2017 as Oklahoma Cabinet Secretary of Science and Technology.

Born in Kansas, Kelvin earned a B.S. in meteorology from the University of Oklahoma and M.S. and Ph.D. degrees in atmospheric science from the University of Illinois at Urbana-Champaign.