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MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

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SUBJECT: FY 2020 Administration Research and Development Budget Priorities

The United States is a nation of thinkers, inventors, and entrepreneurs. Empowered by free-market capitalism and driven by bold ideas, Americans created an ecosystem of innovation that is the envy of the world, advancing science and technology and making the Nation prosperous and strong. America brought the miracle of electric light to people's homes, placed millennia of knowledge in people's pockets, and put men on the Moon and brought them safely back to Earth.

Building on a foundation of Federal research and development (R&D) investments, America will also be the nation that leads in today's emerging technologies, from artificial intelligence (AI) and quantum computing, to biotechnology, advanced wireless communications, and space commercialization.

Federal R&D dollars focused primarily on basic and early-stage applied research, paired with targeted deregulation, and investment in science, technology, engineering, and mathematics (STEM) education and workforce development, will strengthen the Nation's innovation base and position the United States for unparalleled job growth, continued prosperity, and national security.

This memorandum highlights the Administration's R&D priorities and provides guidance to agencies as they formulate their Fiscal Year 2020 budget submissions. This memorandum also details priority practices to effectively leverage R&D resources, including R&D workforce and infrastructure.

## **R&D Priority Areas**

### **Security of the American People**

In the National Security Strategy, the President calls for leadership in research, technology, invention, and innovation to “ensure we will be able to fight and win the wars of the future.” As adversaries leverage emerging technologies to threaten the nation, it is imperative that we invest in R&D to maintain military superiority and keep the American people safe. This requires prioritized investment in AI, autonomous systems, hypersonics, a modernized nuclear deterrent, and advanced microelectronics, computing, and cyber capabilities. Advanced cyber capabilities at scale require investment in new computing and technology paradigms, including adaptive and automated defensive measures.

Agencies should also invest in R&D to improve the security and resilience of the Nation and its critical infrastructure from natural hazards, physical threats, cyber-attacks, and emerging threats from autonomous systems and biological agents. In order to develop stronger air, land, and maritime border defenses, agencies should invest in technologies for border surveillance and capabilities to detect and interdict illegal activity, including the smuggling of contraband or other illicit materials. Agencies should enhance decision-making before, during, and after natural disasters by investing in geospatial decision support tools and innovative approaches to improve weather prediction.

### **American Leadership in Artificial Intelligence, Quantum Information Sciences, and Strategic Computing**

Continued leadership in AI, quantum information science (QIS), and strategic computing is critically important to our national security and economic competitiveness. Advances in these areas promise opportunities for major scientific breakthroughs and are quickly transforming American life and industry. Agencies should invest in fundamental and applied AI research, including machine learning, autonomous systems, and applications at the human-technology frontier. Agencies should prioritize QIS R&D, which will build the technical and scientific base necessary to explore the next generation of QIS theory, devices, and applications. Agencies should prioritize investment in research and infrastructure to maintain U.S. leadership in strategic computing, from edge devices to high-performance computing, that accelerates delivery of low-power, high performance devices; supports a national high-performance computing ecosystem; and explores novel pathways to advance computing in a post-Moore’s Law era.

### **American Connectivity and Autonomy**

Advanced communications networks, including 5G wireless networks and beyond, will be critical to an increasingly connected society. Agencies should support the development and deployment of these networks, including by prioritizing R&D to manage spectrum, secure networks, and increase access to high-speed internet. Connected systems, including autonomous and unmanned systems such as drones and self-driving cars, rely heavily on robust and secure connectivity to provide novel, low-cost capabilities across a broad range of commercial sectors, including transportation. Additional R&D is needed to safely and efficiently integrate autonomous driving systems and unmanned aircraft systems (UAS), including urban air mobility aircraft, onto our roadways and into the national airspace. Specifically, agencies should prioritize R&D to lower barriers to the deployment of autonomous vehicles and to develop operating standards and a traffic management system for UAS.

## **American Manufacturing**

The next generation of manufacturing technologies will help keep jobs in America, ensure products are made in America, and strengthen our national manufacturing industrial base. Priority technology areas for agency investment include smart and digital manufacturing, and advanced industrial robotics, especially systems enabled by the industrial internet of things (IoT), machine learning, and AI. Agencies should also invest in the development of advanced materials and the associated processing technologies, including high performance materials, critical materials, and additive manufacturing. Agencies should invest in R&D of methods for low-cost distributed manufacturing and continuous manufacturing, including investments in bio-based manufacturing to ensure domestic access to needed medicines. In order for the United States to maintain leadership in semiconductor design and fabrication, including assured access to advanced microelectronics, agencies should work in collaboration, and, when appropriate, in partnership, with industry to develop new design tools, materials, devices, interconnect solutions, and architectures needed for future computing and storage paradigms.

## **American Space Exploration & Commercialization**

Research and innovation in space have a direct impact on Earth, generating advancements in our basic understanding of the universe and our own planet, and inspiring the next generation of scientists and engineers. Research investments should be focused on ensuring American leadership in space for long-duration spaceflight, in-space manufacturing, in-situ resource utilization, long-term cryogenic fuel storage and management, and advanced space-related power and propulsion capabilities. Agencies should prioritize demonstrations and flight tests to ensure an industrial base for commercial activity in space and on celestial bodies. One area of potential scientific and commercial importance is microgravity-related research that has the potential for near-term breakthroughs in biopharmaceuticals and materials science. Finally, agencies should seek opportunities to work with advanced materials, additive manufacturing, optical communications, and machine learning—capabilities that have broad potential applications in space and on Earth.

## **American Energy Dominance**

Fueling America's greatness requires access to domestic sources of clean, affordable, and reliable energy. Unleashing these abundant energy resources will require investment in next-generation energy technologies to efficiently convert them into useful energy services (e.g., light, heat, mobility, power, etc.). Agencies should invest in early-stage, innovative technologies that show promise in harnessing American energy resources safely and efficiently. Federally funded energy R&D should continue to reflect an increased reliance on the private sector to fund later-stage research, development, and commercialization of energy technologies. Agencies should invest in user facilities that can improve collaboration with industry and academia and achieve advancements across the full spectrum of discovery, from incremental improvements to game-changing breakthroughs.

## **American Medical Innovation**

Billions of people around the world benefit from American medical breakthroughs. Agencies should prioritize basic medical research, particularly for personalized medicine, areas underserved by industry, disease prevention and health promotion, and the translation of these biomedical discoveries into life-saving diagnostics, treatments, and cures. Agencies should work together to

ensure health data security, interoperability, accessibility, and portability—including data generated through emerging medical technologies. Federally funded R&D should continue to support efforts to combat the opioid crisis, contain infectious diseases, and confront other public health threats. Agencies should prioritize R&D efforts that will lead to more efficient and effective healthcare for veterans, with a particular focus on mental health and suicide prevention. Agencies should also invest to enhance the independence, safety, well-being, and health of aging adults and those with disabilities.

### **American Agriculture**

American agriculture is the most productive in the world, largely due to a long history of R&D investments that yielded vast improvements in crop efficiency, nutrition, resilience, and variety. Agencies should prioritize R&D that enables advanced and precision agriculture and aquaculture technologies, including the use of embedded sensors, data analytics, and machine learning techniques to minimize agricultural inputs and maximize the quantity and quality of agricultural products. Agencies should prioritize investments in pre-competitive research regarding the safety of microorganisms, plants, and animals developed using gene editing, in order to greater leverage biotechnology products for agriculture.

### **R&D Priority Practices**

#### **Educating and Training a Workforce for the 21<sup>st</sup> Century Economy**

An American workforce capable of succeeding in the 21<sup>st</sup> century economy will require adaptability to the increasingly technical nature of work across all employment sectors and ongoing technical training. Experiential learning, such as apprenticeships, internships, job-shadows, and other employer-educator partnerships will help ensure the alignment of curriculum with workplace demands. Agencies should prioritize initiatives that reskill Americans for the jobs of today and the future. Education in science, technology, engineering, and mathematics (STEM), including computer science, will be foundational to preparing America's future workforce, and should be integrated into instruction through application to real world challenges. Agencies should work to ensure the STEM workforce includes all Americans, including those from urban and rural areas as well as underrepresented groups.

#### **Managing and Modernizing R&D Infrastructure**

State-of-the-art Federal science and technology infrastructure is critical to the continued success of our Nation. Maintaining these assets requires on-going investments to ensure the Nation has the most up-to-date capabilities managed in the most efficient manner. Agencies should prioritize infrastructure investments that enable shared resources and improve capabilities across a range of disciplines. Innovative management approaches that enable a broad set of users, outside of government as well as within, should also be prioritized. Long-term stewardship of scientific infrastructure also necessitates that agencies decommission or divest out-of-date or obsolete facilities quickly and efficiently.

#### **Maximizing Interagency Coordination and Cross-Disciplinary Collaboration**

Coordinated interagency initiatives play an important role in achieving national R&D priorities. The National Science and Technology Council (NSTC) is the primary means to coordinate high

priority science and technology initiatives across the Federal government, and agencies should leverage the NSTC to coordinate and plan their R&D programs. Additionally, agencies should support cross-disciplinary teams and novel programs that allow experts from a variety of disciplines to converge on shared challenges, combining their strengths to uncover new and innovative solutions to difficult problems.

### **Transferring Technology from Laboratory to Marketplace**

Federally funded R&D can lead to transformative products and services that solve problems from the boardroom to the classroom. Agencies should continue to focus on the basic and early-stage applied research that provides the fundamental building blocks of new technological advances, and expand efforts that empower the private sector to accelerate the transfer of research discoveries from the laboratory to the marketplace. Agency budget proposals should prioritize and highlight lab-to-market initiatives, such as efforts to identify more efficient regulatory and administrative approaches to technology transfer, enhancements to small business innovation programs, entrepreneurial workforce development initiatives, and other programs that improve the transition of federally funded technologies from discovery to practical use.

### **Partnering with Industry and Academia**

The U.S. R&D enterprise requires a strong foundation of academic, industry, and government collaboration. Agencies should engage in public-private collaborations to help align basic research with future private sector needs, establish testbeds and datasets reflective of real-world conditions, transfer techniques and technologies across sectors, and more quickly diffuse basic research results to the private sector. Agencies should consider methods to reduce regulatory and administrative barriers and align incentives to engage with non-Federal actors, including through personnel exchanges and acquisition reform. Innovative partnership models involving other agencies, state and local governments, the private sector, academia, and international parties can help maximize utilization of Federal facilities and lead to sharing the costs of new R&D facilities. Agencies should seek to rapidly field innovative technologies from the private sector, where possible, that are easily adaptable to Federal needs, rather than reinventing solutions in parallel.