STATEMENT OF

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INTRODUCTION

Chairman Langevin, Ranking Member Stefanik, and Members of this Subcommittee: thank you for the opportunity to come before you today to discuss the Department of Defense (DoD) Science and Technology (S&T) efforts. Maintaining technological superiority is critical to the future security of the United States and its allies – and the foundation for this superiority is a strong S&T enterprise.

When I last appeared before you, I noted that China and Russia were testing and deploying new and unique weapons as they seek to offset the edge in military capabilities the United States and our Allies have enjoyed since the end of the Cold War. That activity continues at an alarming rate, and neither country appears likely to change course. That leaves us, and our Allies with no alternative but to respond with an aggressive program of technology modernization focused on growing, maintaining, and in some cases regaining, our technological edge. I am here today to report on how we are doing that.

THE OUSD R&E ORGANIZATION

Two years ago, when Congress established the office of the Under Secretary of Defense for Research and Engineering, it gave that office a mandate to advance technology and innovation within the Department, and in partnership with the Under Secretary of Defense for Acquisition and Sustainment (A&S) to deliver advanced capabilities for the joint force. To that end, the R&E organization is composed of three major entities: 1) Research and Technology (R&T), which includes oversight of the labs, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), academic research, manufacturing institutes and Small Business Innovation Research (SBIR); 2) Advanced Capabilities (AC), which conducts developmental test and evaluation, accelerates and prototypes more mature technologies to support transition to acquisition; and 3) the Modernization organization, responsible for unifying and advancing the Department's investments and capabilities pertaining to the National Defense Strategy (NDS) modernization priorities. Each entity is headed by a Director for Defense Research and Engineering (DDRE), and collectively they comprise the research, development, engineering, prototyping, test and evaluation responsibility of the Office of the Secretary of Defense (OSD).

Several other offices, defense agencies, and field activities crucial to the national research and development enterprise fall within the R&E organization: the Defense Advanced Research Projects Agency (DARPA), the Defense Innovation Unit (DIU), the Defense Technical Information Center (DTIC), the Missile Defense Agency (MDA), the Space Development Agency (SDA), the Strategic Intelligence Analysis Cell (SIAC), and the Test Resource Management Center (TRMC). Collectively, the FY21 request for these R&E organizations is $16.2 billion.

- DARPA, with a $3.6 billion FY21 budget request, has a 61-year legacy of developing breakthrough technologies and capabilities that both avoid and impose technological surprise. DARPA remains one of this nation's brightest crown jewels. I am honored to be able to assist and support that agency in carrying out its mission.
- DIU, with a $57 million FY21 budget request, seeks out commercial products and solutions for military applications, which come from businesses that do not typically engage with DoD. Working with potential military users across the Services and using an expedited contracting process, DIU ensures the Department's access to the highest technology segments of the U.S. industrial base. This request supports DIU's efforts to add transformative capabilities and transition successful solutions to the warfighter.
- DTIC, with a $62 million FY21 budget request, is responsible for collecting, curating, and disseminating DoD technical information for search and download by DoD, industry, and public users.
- MDA, with a $9.2 billion FY21 budget request, is charged with developing and deploying a layered Missile Defense System to defend the United States, as well as our deployed forces, allies, and friends, from missile attacks in all phases of flight. The request reprioritizes and increases investment in defense of the homeland, increases speed of delivery of new capability to address the evolving threat, and continues delivery of capacity for regional defenses.
- SDA, with a $337 million FY21 budget request, is responsible for driving the department's future threat-driven space architecture and accelerating the development and fielding of the new military space capabilities necessary to ensure our technological and military advantage in space. SDA's initial focus is to develop a low-latency meshed communication network in space to enable beyond-line-of-sight targeting and advanced missile tracking.
- SIAC, with a $23 million FY21 budget request, collaborates with the Joint Staff, the Services, and the Intelligence Community to provide an operational, technical, and threat-based analytic foundation that informs technology strategies and decisions across the R&E enterprise.
- TRMC, with a $691 million FY21 budget request, is responsible for oversight of the Major Range and Test Facility Bases (MRTFB), the core set of DoD Test and Evaluation infrastructure funded, operated, maintained and sustained by the Services and Defense Agencies. TRMC utilizes this enterprise-wide perspective to work with the Services, the Director of Operational T&E, Developmental Test & Evaluation, and other stakeholders to assess the modernization and recapitalization needs of the MRTFB and ensure that these assets fully support developmental test, operational test, and live-fire test requirements of the Department.

We are moving out on the direction you provided in the FY20 National Defense Authorization Act and updating the processes by which we 1) oversee developmental tests and 2) appraise the technical risk in the Department's acquisition programs. This office will continue to exercise oversight of ACAT 1D programs with respect to developmental test plans and will advise the

Service Acquisition Executives and the Services on developmental test practices for all other category programs. Similarly, R&E will perform the independent technical risk assessment (ITRA) for ACAT 1D programs, will approve ITRAs performed by the Services on selected ACAT 1B and 1C programs and will establish procedures and standards for ITRAs that are performed by the Services.

MAKING NEW INVESTMENTS IN MODERNIZATION

We are working hard to drive the Department toward technical dominance in the modernization areas outlined in the 2018 National Defense Strategy (NDS). The FY 2021 budget supports the irreversible implementation of the NDS, which remains our guidepost and drives our decision-making. It continues to strengthen military readiness and bolster the modernization of a more lethal force. The President's Fiscal Year 2021 (FY21) budget puts forth the Department's largest research, development, testing, and evaluation (RDT&E) request in over 70 years, at $106.6 billion, to advance emerging technologies that will expand warfighting advantages over our strategic competitors. Funding for Science and Technology (S&T) is foundational to this, and $14.1 billion is requested for S&T efforts across the Department.

The NDS outlines a clear approach to outpacing our adversaries, through investment in focused modernization priorities: 5G, artificial intelligence, autonomous systems, biotechnology, cybersecurity, directed energy, fully-networked command, control, and communications, hypersonics, microelectronics, quantum science, and space. These technologies overlap, complement, and connect to create a more lethal future force.

5G

Communications networks have become fundamental to how the United States wages war, providing our forces with information to make decisions, communicate decisions to other warfighters, and direct our weapons. Commercial, strategic, and tactical networks now share a common technology base that is increasingly threatened by peer adversaries who are subsidizing their commercial entities in order to gain military, intelligence, and economic advantage. The FY21 budget requests $484 million to advance the Department's efforts in "5G to Next G". Thanks to your support for the FY19 reprogramming request and the FY20 budget, we have been able to move out quickly. This year's request builds on important activities we have initiated this past year to 1) accelerate the military's ability to use and protect these new 5G technologies and applications, 2) provide the capability to operate through contested networks and spectrum wherever we deploy, and 3) innovate to ensure that the U.S. is in the lead for the "Next G" – the next generations of mobile information technology. We have moved forward rapidly, and in collaboration with the Services, we have selected our first set of projects that will be executed at four different military bases. In these projects, we will be assessing 5G-enabled applications for military training, smart warehouses and logistics, and spectrum sharing between 5G and military systems, as well as developing technologies to make these networks more secure and robust.

Artificial Intelligence

The National Defense Strategy predicts that artificial intelligence, or AI, will change the "character of war" in ways not yet even imagined. To maintain U.S. dominance in AI, R&E will continue to invest in cutting-edge AI research and will utilize a systems engineering approach to synchronize efforts to accelerate AI adoption across the Department. DARPA's investment in "AI-Next" technologies - where systems are capable of acquiring new knowledge through generative contextual and explanatory models - is key to maintaining U.S. leadership in AI. DARPA will invest $459 million in FY21 in a variety of future AI technologies, including improving the robustness and reliability of AI systems; enhancing the security and resiliency of machine learning and AI technologies; reducing power, data, and performance inefficiencies; and pioneering the next generation of AI algorithms and applications, such as "explainability" and common sense reasoning. R&E will also focus on moving "AI-Next" to "AI-Now" by partnering with the JAIC and the Services to accelerate and streamline transition from research to use by the warfighter. We will leverage lessons learned from incorporating DARPA's MediFor (Media Forensics) AI software – which detects "Deep Fakes" – into the Joint Common Foundation, an enterprise-wide AI platform under development by JAIC, as well the operational testing of DIU's predictive maintenance prototype to U.S. Army Aviation. We will focus on lowering the barriers to a successful transition, to include bringing a software engineering approach to AI-engineering; improving the connection between test and evaluation with user adoption; and developing infrastructure connections between the Enterprise cloud and edge compute.

Autonomous Systems

Human-machine teaming will significantly transform combat effectiveness by enhancing the freedom and speed of maneuver as well as lethality in contested environments while reducing human casualties and collateral damage. We will continue to focus on advanced autonomy for unmanned attritable aircraft to support manned aircraft operations, persistent operations of unmanned surface and subsurface vehicles under severe sea conditions, and robotic ground vehicles to expand battlefield formation geometry while increasing situational awareness, lethality and survivability. Continued developments will extend these capabilities to include multi-domain, heterogeneous swarms at scale to overwhelm future adversaries by increasing lethality, capacity, and operational tempo. To ensure consistency with the principles recently adopted by the Department for the ethical use of artificial intelligence, we will continue to strengthen the foundation for trust in autonomous systems through rigorous testing. These efforts will develop robust 'test like you fight' test and evaluation methodologies that include realistic environmental and mission variables required to validate intended performance as well as identify and minimize undesirable or unanticipated behaviors.

Biotechnology

Biotechnology has the potential to be a transformative national security technology. For example, biotechnology can enable advanced biomanufacturing that will provide the United States with domestic production of critical supply chain components such as rare earth elements and pharmaceuticals on demand. However, without action by the United States, China will

become the global biotechnology superpower. China has signaled willingness to use this and other emerging technologies against their opposition and adversaries without respect for protocols, conventions, or human rights. The Department is prioritizing partnerships with the commercial sector, and in collaboration with the Services, is focusing biotechnology modernization on three lines of effort: 1) critical capacity and infrastructure, 2) data as a strategic, operational resource, and 3) workforce development, to rapidly field biotechnology-enabled products for the warfighter.

Cyber

For many years our adversaries have engaged in wide-ranging and highly impactful malicious activities in cyberspace, often with near-impunity. Fortunately, through the implementation of the 2018 DoD Cyber Strategy, which embraces a defend-forward and persistent engagement approach, US Cyber Command and the Service Cyber Components are now blunting and disrupting many of our adversaries' malicious cyberspace activities. Through this approach, and by leveraging new capabilities made possible through significant and long-term DoD S&T investments, our cyber forces are now exacting far greater costs on our adversaries. To build on this momentum and ensure increasing dominance, our cyber strategy calls for increased investments to accelerate the development and rapid transition of technologies that provide the basis for 1) vastly enhanced resilience of DoD systems and critical infrastructure 2) substantially increased capacity and unrivaled capabilities for the conduct of cyber and cyber-enabled operations, 3) overmatching skills and expertise within the Cyber Mission Forces, and the Cybersecurity and Cyber S&T workforces. These increased investments will compound the dividends of the now decade-long increased focus, by DARPA and the Services, on the development of innovative and increasingly sophisticated cyber technologies.

Directed Energy

Achieving near-term directed energy technology progress is vital. We must move quickly from the laboratory to the weapons platform, and gain operational experience with these new weapons. Working with the services, we plan to accelerate operational weapon system development and operational experimentation. Through our Laser Scaling Program, we are on the path to building 300 kW high-energy lasers by 2022, increasing to 500-1000 kW capability over the next decade. Through our Rapid Prototyping Fund, the Navy will operationally test new laser and high-power microwave weapon prototypes at sea in 2020 and 2021. Further, we have partnered with the Special Operations Command to accelerate programs for airborne and land-based laser strike weapons and partnered with the Army Futures Command and the Navy to accelerate land- and sea-based laser and high-power microwave weapons for integrated air-and-missile defense, with initial operational capability by FY2022. In anticipation of new and more lethal directed energy weapons transitioning to programs of record, we are upgrading our test and evaluation capabilities with new infrastructure at the test ranges.

Fully Networked Command, Control & Communications (FNC3)

The Department faces two primary challenges with command, control, communications, and networking systems: interoperability and resilience. These longstanding issues are exacerbated

by the absence of synchronization across the Department during previous modernization efforts. The FNC3 strategy contains investment in three areas: 1) a Universal C2 language and architecture, 2) diverse communications links and the software-defined networking techniques necessary to take full advantage of them, and 3) multifunction radio-frequency and optical systems that can perform sensing, communications, navigation, and electronic warfare tasks. This investment approach is being adopted by the Joint Staff, Acquisition and Sustainment, the CIO, and the Services. This represents an important first step to ensuring coordination of these and future investments across the Services, but more work needs to be done. FNC3 is closely tied to other initiatives across the department to include JADC2. FNC3 represents the medium- to long-term vision for JADC2, and is developing technologies that will become an integral part of JADC2 three years into the future and beyond. As such, the testing and demonstration of the FNC3 technologies are included in the JADC2 testing and demonstration battle rhythm.

Hypersonics

The Department continues to accelerate the development and demonstration of prototype hypersonic weapon systems. The $3.2 billion requested for hypersonics in FY21 represents an increase over the FY20 enacted amount of $2.7 billion. One specific example of how the FY21 funding increase will be put to work is the accelerated delivery of an Army Long Range Hypersonic Weapon battery. We are also moving towards flight testing of many of our hypersonic weapon system prototypes in 2020. We intend to conduct approximately 40 flight tests over the next four years, with the goal of delivering new capabilities to our warfighters years earlier than previously planned. Additionally, DARPA is investing aggressively in foundational hypersonics research and related technology development. Two programs within the portfolio are being pursued in close partnership with the Air Force – Tactical Boost Glide (TBG), and Hypersonic Airbreathing Weapon Concept (HAWC) – and are scheduled for flight demonstrations this year.

Microelectronics

The department must have assured access to state of the art microelectronics to effectively deliver innovation and modernization into our military systems without compromise. Historically, the department has relied upon a flawed approach to security that has resulted in an inability to access advanced microelectronics. We are working with our partners in the private sector to remedy this situation, by taking a cue from our colleagues in cybersecurity, who have learned over the past decade that perimeter defense (or “trusted foundries” in this domain) does not work, and who have begun to adopt ‘zero-trust’ security models. The $597 million requested by R&E for microelectronics in FY21 will focus on technologies, frameworks, and policies that will enable a zero-trust, risk-management-based approach to security along the entire life-cycle of microelectronics (to include design, manufacturing, assembly, test, and packaging), informed by data, not perimeters. This work is complemented by a DARPA investment of $318 million in its Electronics Resurgence Initiative (ERI), which aims to create performance advancements in electronics by leveraging circuit specialization, including new materials, architectures, and designs.

Quantum Science

Quantum science takes advantage of fundamental physical properties to devise new technologies whose performance far exceeds what is currently available. We will continue to emphasize atomic clocks and quantum sensors – these quantum technologies provide the most concrete opportunities for continued warfighting advantage. Longer-term, advances in quantum computing and quantum networking may have an impact on our joint warfighting concepts. Still we caution that the hyperbole surrounding these topics may be getting ahead of their military and economic utility. Our research strategy across all quantum technology areas will be guided by scientific rigor and discipline, and our focus will be on the potential military impact that these technologies can provide. For example, in our FY21 budget request, we have included $23 million to advance the development of an enhanced-stability atomic clock, a project initiated at DARPA that will enable GPS-quality time synchronization in a GPS-denied environment, providing a constant connection to sensor networks and encrypted communication channels for our most critical missions. The goal is to reach demonstration-scale by FY 2025 and commercial availability by FY 2027.

Space

The Nation's warfighting capabilities and global commerce are dependent on continued freedom of operation in space. To counter the increased adversarial activity of China and Russia in space, the Department is fundamentally changing how we field critical capabilities. Space modernization is required to outpace adversary development timelines and to negate the incentive to attack our space capabilities. As an example, the Space Development Agency was established to execute rapid prototyping and fielding of systems that will enable a threat-driven architecture. The FY 2021 budget request for research, development, test and evaluation makes a $12.2 billion commitment to the space domain to strengthen our resilience, deterrence, and warfighting options in space.

SPACE DEVELOPMENT AGENCY

The Space Development Agency (SDA) was established in March 2019 to develop and field next-generation space capabilities. SDA is developing capabilities to address a wide range of national security space needs identified in the DoD Space Vision of August 2018. The most urgent of these needs include low-latency tactical communication that will enable beyond-line-of-sight targeting and advanced missile tracking.

SDA will deliver these capabilities by employing a rapid acquisition model, not necessarily developing and fielding all capabilities, but orchestrating those efforts across DoD, filling capability gaps in the integrated architecture. Since its establishment a year ago, SDA has published several requests for information and a Broad Agency Announcement soliciting input for various technical areas. This information will feed SDA's development efforts during the remainder of FY20, including an industry day in Colorado Springs on April 2nd to discuss detailed plans for the first demonstration phase of the transport layer (Tranche Zero), which is the

low-latency meshed network of satellites that will serve as the backbone to deliver critical capabilities to the warfighter. These early demonstrations will provide warfighters with early insights into the capabilities of the new architecture and will inform future development spirals.

In Fiscal Year 2021, SDA plans to demonstrate optical satellite crosslinks and direct downlink and to conduct a flight experiment to collect data in wavebands of interest for detection of advanced missile threats from low Earth orbit (LEO). SDA is leveraging creative partnerships across DoD, including, for example, a recent memorandum of agreement with the Naval Research Laboratory to develop an SDA-specific hardware-in-the-loop testbed and to provide ground system and mission operations support.

SDA plans to field improved defense capabilities every two years, starting in FY22. This rapid development approach ensures that the Department stays ahead of our adversaries' development timelines. As these capabilities are developed and fielded, SDA will remain in lockstep with the warfighter to ensure that the agency remains focused on emerging threats and capabilities that will maintain the United States' military advantage by leveraging the many possibilities the space domain can bring to the fight.

MISSILE DEFENSE AGENCY

The Missile Defense Agency (MDA) cancelled the Redesigned Kill Vehicle (RKV) program in 2019 as a result of its failure to meet the requirements to pass critical design review (CDR), and the subsequent assessment, based on test results, that those contractual requirements could not be met short of a complete redesign. Therefore, MDA is developing a Next Generation Interceptor (NGI), which we believe will improve homeland missile-defense performance and survivability against the assessed threat as part of the Missile Defense System (MDS). In FY 2021, MDA will continue design and development activities for two competitive NGI development contracts, which it intends to award in the fourth quarter of FY 2020.

To deal with the delay imposed by the cancellation of RKV, and as part of a layered homeland defense system, MDA will assess the Aegis Weapon System capability by using an Aegis Standard Missile-3 Block IIA missile to defeat an Intercontinental Ballistic Missile threat-representative target with a demonstration flight test planned for third quarter FY 2020 (FTM-44). MDA will also begin development of an enhanced Terminal High Altitude Area Defense (THAAD) interceptor and will assess its capability to provide greater depth of defense for the homeland. The Aegis SM-3 Block IIA and THAAD are not replacements for the long-range missile defense capability provided by Ground-based Midcourse Defense, but as part of a layered architecture are expected to make a significant contribution to homeland defense.

The Department is investing in technologies and is studying capabilities to defeat offensive hypersonic weapons, the first element of which is to detect and track incoming threats. MDA has delivered a capability for USINDOPACOM under a Joint Emergent Operational Need (JEON) for real-time sensing and display of hypersonic and maneuvering vehicle tracks. This capability is operational now in support of the Missile Warning and Missile Defense missions. In

collaboration with SDA, MDA is pursuing a Hypersonic and Ballistic Tracking Space Sensor (HBTSS). MDA is focusing on risk reduction through competitive prototyping of the payload design and signal chain-processing demonstrations of clutter rejection algorithms.

The Department has demonstrated early capability against advanced maneuvering threats during flight-testing of the SM-6 Sea-Based Terminal defense and will conduct a flight test against a hypersonic threat-representative target in FY 2023. Later this year, MDA will award multiple contracts focused on technology risk reduction for the Regional Glide Phase Weapon System interceptor concept, with the eventual goal of providing greater depth of fire in a layered defense architecture. We are also pursuing advances in joint all-domain and global command and control to support USNORTHCOM in countering very long-range cruise missiles.

With the achievement of the Technical Capability Declaration in FY21, MDA will add the Long Range Discrimination Radar in Alaska into the MDS architecture to provide a persistent capability to defend the United States homeland against IRBMs and ICBMs. With the upcoming test demonstrating the ability of the Patriot missile defense system to intercept a short-range ballistic missile target using THAAD/AN/TPY-2 track and discrimination data (FTP-27), MDA also is continuing to mature an integrated air and missile defense capability in South Korea to support the U.S. Forces Korea JEON.

SHAPING THE WORKFORCE

To stay ahead of our competitors, both economically and militarily, the United States must continue to develop and attract world-class engineers, scientists, and researchers. The Department employs more than 100,000 scientists and engineers, of which nearly half are in the Federal workforce. Despite challenges recruiting and retaining technical talent, the DoD laboratory workforce continues to be exceptional.

Growing Our Pipeline of STEM Talent

In FY 2021, the Department requested $77 million to advance our largest workforce development program, the Science, Mathematics, and Research for Transformation (SMART) Scholarship Program. SMART provides scholarships to United States citizens to pursue bachelors, masters, or doctoral degrees, helping to build the workforce to address the Department's toughest problems. Upon graduation, recipients work in a civilian position in a lab or agency of the Army, Navy, Air Force, or other DoD entity, and have a one-year service requirement for each year of tuition. During 2019, we targeted specific degrees and Ph.D. studies in the Department's modernization priority areas of hypersonics, microelectronics, biotechnology, and artificial intelligence. We are also enhancing our international partnerships through the SMART program. In FY19, we continued our partnership with the United Kingdom (U.K.) to connect SMART scholars with U.K. researchers. We also established a partnership with the von Karman Institute for Fluid Dynamics, where SMART scholars can perform research on hypersonics. Through both of these efforts, the scholars will conduct research with their

overseas peers and gain a better understanding of how the S&T community contributes to the Department's international outreach and collaboration.

Further, to attract and advance an inclusive DoD STEM workforce, the Department is working to increase female and minority involvement in STEM through our STEM Education and Outreach efforts. We are also targeting recruitment for the SMART Scholarship program at Historically Black Colleges and Universities and Minority-Serving Institutions.

Utilizing Hiring Flexibilities

The Department makes use of authorities provided by Congress to enhance recruiting and retention of our science and technology workforce. These authorities give Service laboratories the ability to conduct direct hiring in particular fields, such as cybersecurity, send personnel for continuing education, provide recruitment bonuses, and reward employees with performance-based pay. All of these tools allow the laboratories to recruit and retain top S&T talent and remain competitive with the private sector. For example, AFRL has used the Enhanced Pay Authority to hire subject matter experts in the areas of autonomous systems, data analytics, and communications and networking, directly enhancing their ability to support the Department's modernization priorities. During 2019, the United States Army Space and Missile Defense Command began to implement more fully their personnel demonstration program to take advantage of flexible hiring and other talent management authorities. In addition, the Joint Warfare Analysis Center, the Army Research Institute for the Behavioral and Social Sciences, and the Naval Facilities Engineering Command, Engineering and Expeditionary Warfare Center also began the process to establish new personnel systems that would afford them access to the same flexibilities.

INNOVATION BASE

Maximizing the Impact of Our Federally Funded Research and Development Centers (FFRDCs) and University Affiliated Research Centers (UARCs)

In addition to our Defense Laboratories, the Department's FFRDCs and UARCs are a critical element of our innovation base, providing independent and objective scientific and technical expertise that the Department relies on to create overwhelming technical superiority for the nation. In the last year, we undertook a concerted effort to ensure the Department employs our FFRDCs for maximum strategic impact. Our goal is to make certain the FFRDCs only perform work that cannot be done by the private sector, and that they act as trusted advisors to the government utilizing their unique core competencies and access. Each FFRDC is now prioritizing its research to directly support the National Defense Strategy and the Department's modernization priorities, with a special emphasis on increasing the lethality of the joint force.

In FY19, the FFRDCs and UARCs made numerous contributions to enhance the capabilities of the Joint Force. For example, the Aerospace Corporation FFRDC was an integral part of the Government and contractor team that successfully launched a GPS III on a Falcon 9 rocket. This was the first flight of a competitively awarded National Security Space Launch (NSSL) mission

in nearly 20 years. And Johns Hopkins Applied Physics Laboratory (APL) developed a technically rigorous "space game" that enabled participants to grapple with realistic and technically informed timelines, authorities, questions, and rules of engagement, and the operational implications of pursuing different space architectures. Playing out these scenarios has informed the department's investment decisions.

Overseeing our Academic Partnerships

The capabilities and technologies needed by the future force will be driven through fundamental discoveries made by scientists in our universities and laboratories. For decades, scientists at universities, supported by the DoD, have made ground-breaking discoveries that have led to dramatic commercial and national security advances and significantly improved the lives of citizens here and abroad. DoD's relationship with academia is an incredibly valuable force multiplier for the basic research enterprise. Today's U.S. universities welcome a high percentage of international students, scientists, professors, and industry collaborators, even as our adversaries recruit U.S. and foreign personnel for the benefit of their global dominance. Our strategic imperative is to continue to draw the best high-skilled talent to the U.S. research enterprise. This is an imperative that is not always fully appreciated until we recognize that immigrants have been awarded 38 percent of Nobel Prizes won by Americans in Chemistry, Medicine, and Physics since 2000 and that immigrants or their children founded 45 percent of the 2019 Fortune 500 companies.[1] We want these talented individuals to come here, to stay here, and to choose to work with us no matter where they were born.

Small Business

The DoD SBIR and Small Business Technology Transfer (STTR) programs harness the innovation of domestic small businesses to accelerate the introduction of pioneering technologies into the Department from the small business industrial base and nontraditional suppliers. The Department has made recent improvements to the management of our SBIR and STTR investments. First, the Department has focused the SBIR awards to support the NDS modernization priorities. Second, the Department streamlined the SBIR and STTR programs to be more accessible to small, domestic firms by modernizing the processes by which businesses submit their proposals. For example, we rolled out a new Defense SBIR/STTR Innovation Portal that makes it easier for small businesses to engage with the Department and participate in the SBIR/STTR programs. We are also encouraging innovative contracting initiatives to enable us to reach nontraditional firms and reduce the time it takes for promising SBIR ideas to be put on a contract. DIU continues to harness innovation from startups and other nontraditional vendors via its expedited contracting process, signing 128 contracts to small businesses and adding 66 first-time vendors to DoD. The Department is committed to ensuring these technologies transition

[1] Immigrants and Nobel Prizes: 1901-2017, NFAP Policy Brief, National Foundation for American Policy, 2017. For more background on Nobel Prize winners see https://www.nobelprize.org/. Source: https://nfap.com/wp-content/uploads/2019/10/Immigrants-and-Nobel-Prizes.NFAP-Policy-Brief.October-2019.pdf
Source: https://nfap.com/wp-content/uploads/2019/10/Immigrants-and-Nobel-Prizes.NFAP-Policy-Brief.October-2019.pdf

into commercial markets and military applications, further strengthening the National Security Innovation Base.

THE MANUFACTURING BASE

Manufacturing technology is critical to any of our modernization objectives if we are to deliver capacity in the needed time frame. The DoD Manufacturing Technology program (MANTECH) executes a portfolio of project investments across OSD, the Services and Agencies, focusing on advanced manufacturing technologies and challenges. The MANTECH program also serves as a lead Federal strategic investment partner to eight of the fourteen Manufacturing USA innovation institutes. These institutes promote domain-focused manufacturing ecosystems in areas of value to the DoD, and of emerging importance to the U.S. manufacturing base through pre-competitive technology advancement, community building, and workforce development. They bring together industry, academia, and federal partners to increase U.S. manufacturing competitiveness and promote a robust and sustainable national manufacturing R&D infrastructure.

Through these institutes, we have already begun to accelerate advanced manufacturing technologies through public-private partnerships in areas such as cybersecurity, 5G, photonics, and regenerative medicine. For example, the Manufacturing times Digital (MxD) Institute recently welcomed 5G on its Future Factory Floor to serve as a testbed for demonstrating the opportunities 5G, artificial intelligence, and machine learning bring to manufacturing. AIM Photonics has established a U.S.-based Photonic Integrated Chip (PIC) manufacturing ecosystem, including design, proof of concept, prototyping, validation, and final packaging in advanced node microelectronics and photonic chip fabrication, including a test, assembly, and packaging facility.

Further, as a component of biotechnology modernization, the DoD is pursuing the establishment of the ninth DoD-lead Manufacturing Innovation Institute, specifically focused on bioindustrial manufacturing. This institute will leverage emerging biotechnologies, including modern engineering biology techniques, to develop critical domestic leadership in biomanufacturing. In line with national priorities of biotechnology as an essential industry of the future, this Bioindustrial Manufacturing Innovation Institute will build partnerships across the U.S. bioeconomy and strengthen ties between defense needs and the wealth of knowledge within our industry and academic partners.

In addition, as part of our modernization objectives, the Department is harnessing our Manufacturing Technology (ManTech) Program and cultivating the manufacturing workforce the nation needs for the future. The ManTech program is also addressing the manufacturability of carbon-carbon materials, a critical component necessary to manufacture hypersonic aeroshells at scale. This initiative, the Manufacturing of Carbon-Carbon Composites for Hypersonics Applications (MOC3HA), is working directly with domestic manufacturers of carbon-carbon material to streamline processes, improve quality and reliability at volume and size, reduce cost and cycle time, and increase yield.

Finally, we are convening a DoD-wide Manufacturing Council to coordinate the emerging technology industrial base and human capital investments and strategies and serve as a touchpoint for industry. Through this Council, we will align the funds in the Manufacturing Technology program, Industrial Base Analysis and Sustainment effort, and Defense Production Act Title III authorities to achieve our modernization goals and maintain our technical advantage.

CREATING AND PROMOTING TECHNOLOGY

Modernizing our military requires successful research, technology maturation, prototyping, systems integration, and test capability in order to turn innovative and disruptive technology into fieldable and sustainable military systems. We must ensure access to necessary technical and engineering expertise, tools and facilities, source materials, manufacturing and production, and ability to meet capacity demands. This means access to universities as well as commercial firms that provide emerging technology from all readiness levels.

For each modernization objective, we will assess the potential for the technology to support development timelines in light of adversary progress. Our focus is to understand what is needed to achieve modernization goals, to identify risks and opportunities in each of the priority areas, and to identify capabilities that are common across the priority areas. In accordance with Section 1793 of the John S. McCain NDAA for FY 2019 "Review of and Report on Certain Defense Technologies Critical to the United States Maintaining Superior Military Capabilities," we have conducted initial baseline assessments of the above critical underpinnings for each of our modernization priorities. The initial report was provided to this committee in July of 2019.

TECHNOLOGY PROTECTION

The U.S. military has maintained its technology advantage over the decades by constantly out-innovating its adversaries. This was enabled by our culture of innovation, risk-taking, and access to the top global talent. Today, however, our technological edge is at risk. Competitor nations are acquiring intellectual property and sensitive technologies from our academic research system and industry. They do so through illegal and extralegal means that fall outside the established norms of academic integrity and collaboration.

To address this situation, the Department is taking a balanced approach. For critical technologies and programs, we are applying appropriate protections that prevent technologies from falling into the wrong hands. We are establishing procedures to reinforce the integrity of our research enterprise. We are engaging the broader S&T community and our stakeholders to provide improved threat awareness, inform necessary controls, and develop best practices that can be institutionalized across the DoD S&T enterprise.

One new initiative is the development of Technology Area Protection Plans (TAPPs) for all of our critical technology areas. TAPPs will provide a common understanding of the aspects of

each critical technology area that need to be protected, and a strategy to establish and apply appropriate protection methods. TAPPs ensure that our S&T organizations have information regarding emerging and disruptive research, so that early prevention/safeguarding measures can be applied and transitioned into the Program Protection Plans for programs of record and research and development programs. The TAPPs in development aligns with the 2019 DoD list of critical programs and technologies mandated by Section 1049 of the FY2019 NDAA.

We have taken other steps to protect open research at U.S. institutions. We are working with other federal research funding agencies to develop common standards for identifying and adjudicating conflicts of interest and conflicts of commitment. We are fully engaged with the White House Office of Science and Technology Policy to develop Federal guidance for Research Security and Integrity. In March 2019, we issued instructions to our partners in academia, requiring that key research personnel funded by DoD grants, cooperative agreements, Technology Investment Agreements, and other non-procurement transactions disclose all current and pending projects and funding sources. We are revising research grant and cooperative agreement procedures to exclude research funding for individuals posing an unacceptable risk to national security or who participate in foreign talent recruitment programs. In addition, DoD is encouraging academic institutions, associations, and councils to develop training modules for faculty to explain more clearly the landscape of threats to research integrity.

At the same time, we recognize that the free exchange of ideas and collaboration across research communities is critical to our continued success. To this end, we must preserve the long-standing norms and ethical behaviors that have benefited our research institutions, while at the same time punishing those who disregard the rule of law.

The Department has a variety of tools and resources which can be brought to bear in the face of our competitors' tactics to exploit our technology for their military and economic gain. Protection requires a nuanced approach and a community-wide partnership that includes other government agencies, industry, academia, and allies, to thwart bad behavior without discouraging the participation of the talent that we wish to attract. An uncoordinated, broad-brush approach to technology protection can result in damaging consequences that limit our ability to engage with and benefit from leading-edge research.

So, while we must guard against espionage and the theft of intellectual property, we must also recognize that the United States got to the top of the technology world not by concerning ourselves overmuch with those who sought to steal from us, but rather by nurturing an open, innovative, collaborative culture that set the pace for the world to match if they could. We became the place where brilliant minds wanted to come. We became the place where others wanted to be educated. We became the place where entrepreneurs could thrive. We became the people from whom others wanted to steal. We should worry not that this is so, but instead about becoming overly defensive, insular, and protective and thereby destroying the culture that got us to the top. Others can and will steal from us; there is no perfect defense. But while they will always be able to steal a given idea, they can't steal our culture of innovation. They can't steal who we are. We must always remember that the leaders in any competition are not the people who are looking back to see what others are doing. Winners don't win by blocking others. They

win by running faster. That is what got us where we are. And that is truly the best tool for "technology protection."

CONCLUSION

In the two years since the office of the Under Secretary of Defense for Research and Engineering was established we, in concert with our partners in the Services and you here in Congress, have taken the first important steps in helping the Department of Defense change the way it thinks about developing and deploying the next generation of capabilities to our warfighters, and the processes by which it does so. To be sure, there is still much work to be done, and we look forward to working with you on the long road ahead.

In the final analysis, we have one mission, and that is to ensure the safety and security of the citizens of this great nation. I think we all recognize that we can best accomplish that from the commanding heights of the technological advantage we have traditionally enjoyed. This is R&E's central goal; no higher purpose is necessary, and no lesser purpose will serve.

Thank you for your time, and I look forward to your questions.