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STATEMENT OF

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BEFORE THE SENATE ARMED SERVICES COMMITTEE

SUBCOMMITTEE ON EMERGING THREATS AND CAPABILITIES

ON ACCELERATING INNOVATION FOR THE WARFIGHTER

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Chairman Kelly, Ranking Member Ernst, and subcommittee members thank you for inviting the Department of Defense to provide testimony for the Senate Armed Services Committee hearing on accelerating innovation for the warfighter. I'm honored and proud to be the Department of Defense's Under Secretary of Defense for Research and Engineering (USD(R&E)) and Chief Technology Officer (CTO). I am pleased and appreciate the opportunity to discuss these important topics. I look forward to this testimony as this is the first time I have been back to the Senate since my confirmation. Thank you for confirming me to this role; it is an honor to be back at the Department of Defense.

On behalf of the Secretary of Defense, the USD(R&E) sets the technology and innovation strategy for the Department of Defense, and oversees the Defense Advanced Research Projects Agency (DARPA), the Missile Defense Agency (MDA), Space Development Agency (SDA) and Defense Innovation Unit (DIU). I am pleased to have the Directors of DARPA and DIU by my side today. The Department's goal is to provide the United States military with an enduring advantage through our technology strategy. The long-term strategy will be laid out in the forthcoming National Defense Science and Technology Strategy, as directed by the Fiscal Year (FY) 2022 National Defense Authorization Act (NDAA). In order to be effective, the Department must recognize both immediate challenges and be prepared to conduct long-term planning and strategies for an increasingly complex environment.

As can be seen by the Russian invasion of Ukraine, technology changes the nature of conflict and battle. Alongside the familiar tanks, ships, and aircraft, there are new hypersonic weapons and unmanned platforms that must be considered now and in future conflicts. Strategic competitors to the United States are rapidly developing state-of-the-art technologies and fielding new emerging threats. Many of these technologies, such as unmanned aerial systems, are

available in the commercial market and are being proliferated worldwide. As the character of war continues to evolve, we must anticipate and be able to defend, fight, and counter any emerging threats and maintain our overmatch.

The Department performs technology horizon scanning to understand where strategic competitors are active and to understand what is state-of-the-art in the commercial sector. This information allows for better-informed decisions and allows the department to assess opportunities that can be harvested from our Nation's commercial and defense innovation ecosystem to accelerate technology adoption, and collaborate with our Allies and Partners to develop interoperable systems.

In order to build an enduring advantage for the United States, we must first build a strong foundation. This includes an expansive basic and advanced research portfolio, state-of-the-art laboratories, diverse set of testing facilities and ranges, and the best and brightest workforce. This foundation is the innovation engine that will allow us to continually develop and produce the breakthrough next-generation technology and provide disruptive capabilities expeditiously to our military. Department efforts to strengthen this foundation also rely on a strong national technological ecosystem and industrial base. Congressional efforts to support long-term U.S. leadership in advanced technologies, in particular the Creating Helpful Incentives for the Production of Semiconductors (CHIPS) for America Act and the broader Bipartisan Innovation Act, are inextricably linked to Department's ability to successfully build enduring United States advantages in applications of technology for national security. Second, we must make informed choices about which critical technologies are important to the Department. To that end, the Department has identified Critical Technology Areas (CTA) that are essential to supporting the

National Defense Strategy and the mission of the joint force to build an enduring full-spectrum advantage for the United States.

## Building a Foundation for Research and Development

The United States' share of international technology innovation (as measured by patents, public and private sector funding, and number of students graduating with technical and scientific degrees) is decreasing, while the Department's need for a strong technical base is becoming increasingly urgent. We must do all that we can to maintain our advantage in science and technology (S&T), especially in an era of strategic competition. The people, processes, and infrastructure that enable the creation of innovative technologies are essential components to a strong foundation.

### Basic Research

The Department's investments in S&T are underpinned by early-stage basic research. Investments in basic research will provide us with the seeds to harvest technology far into the future in ways that we cannot even imagine today. We have demonstrated time and again that basic research yields transformational capabilities for warfighters and often wider commercial use. Many technologies we benefit from today — lasers, the internet, GPS, microelectronics, lithium-ion batteries, and artificial intelligence — all exist thanks to the Department's investments in basic research.

Take for instance our Vannevar Bush Faculty Fellowship (VBFF), the Department's most prestigious single-investigator award, supporting basic research with the potential for transformative impact. Professor Tresa Pollock, one of our 50 active Fellows, is working on making 3D-printed materials more resilient for battlefield use. Dr. Pollock's research team has developed and licensed a 3D-printable, high strength, defect resistant, superalloy that overcomes

the issue of cracking under stress and could prove useful in hypersonics development. Since 2015, 20 percent of VBFF fellows have started new companies creating new job opportunities.

The Department's interest in basic research is not limited to only the STEM fields. The Minerva Research Initiative supports social science research that can improve the Department's basic understanding of the social, cultural, behavioral, and political forces that shape the world. In February, the Department awarded $28.7 million in grants to 17 research projects, covering everything from team cognition for space missions to the social impacts of climate change and how best to combat propaganda distributed by the PRC.

A healthy investment in basic research is one of the Department's best tools against technological surprise. Strong open research collaborations between United States DoD funded researchers and the international science community is one of the best ways to understand the emerging state of the science. Putting barriers in the way of international collaboration does us a grave disservice.

**Applied Research and Advanced Development**

Our Applied Research and Advanced Development is supported by the Department's robust research and innovation ecosystem. R&E works hand in glove with the Service labs, DARPA, Federally Funded Research and Development Centers (FFDRCs), and 14 University Affiliated Research Centers (UARCs) across the country, defense and commercial companies, specializing in fields as varied as nanotechnology, AI and autonomy, electronic warfare, lasers, unmanned platforms, just to name a few. The Department benefits tremendously from strong partnerships across the broad technology ecosystem. The weapons systems and platforms that we have developed from precision strike to UAVs to integrated air and missile defense are highly

sought after worldwide. We must accelerate the development of critical technologies to enable us to operate in a denied environment.

**Laboratory and Test Infrastructure**

The Department's labs and test infrastructure are the proving grounds of our most important discoveries. They are a foundational element in our ability to generate new ideas, test innovative new technologies, and sustain and modernize existing DoD systems. The Department's S&T laboratories engage in activities ranging from basic research to defense system acquisition support, to direct operational support of deployed warfighters. These laboratories are comprised of dozens of facilities across 22 states and employ tens of thousands of scientists and engineers, both civilian and military. The Department's laboratories execute a substantial fraction of the Department's S&T accounts, particularly in RDT&E Budget Activities (BA) 02 (Applied Research) and 03 (Advanced Technology Development), also known as BA 6.2 and BA 6.3.

To develop and test new emerging capabilities rapidly, we must modernize our laboratories and test infrastructures. One of the Department's Innovation Steering Group's primary lines of effort is to assess the state of our laboratories and test infrastructures. While existing systems continue to serve us well in testing legacy hardware, the Department must anticipate and fund new testing and evaluation environments to support emerging technology development.

Funding lab and test infrastructure has been a recurring budget challenge for the Department and thanks are in order to Congress for the support in this area. The relative plateau of Military Construction (MILCON) budgets over the past decade has resulted in degraded facilities and a continual necessity for maintenance and repair work. This raises significant

concerns about the performance, reliability, and long-term viability of the Department's lab and test infrastructure. Following congressional direction, the Department has submitted an infrastructure requirements report coincident with the President's Budget Request since 2017. The Department has taken advantage of funds for infrastructure construction, maintenance, and repair through a variety of sources and authorizations provided by Congress over the last decade, totaling approximately $890 million. The Department looks forward to working with Congress through the development of spend plans for the use of military construction funds and on ways to address the recurring challenges with lab and test infrastructure in the future

**Education, STEM and Talent Programs**

The Department is committed to cultivating the next generation of top-notch researchers, engineers, and innovators. The Department is engaged in a number of programs to promote and foster STEM education from pre-K all the way through to doctoral programs and beyond.

R&E oversees the Science, Mathematics, and Research for Transformation (SMART) Scholarship-for-Service program. In this program, undergraduate or graduate school scholars in select STEM fields receive a full tuition scholarship and internships at DoD laboratories. Upon graduation, scholars return to their respective Department facility and work there for a period equal to the amount of time they received the scholarship. In the past year, 416 SMART Scholarship recipients started work at Department laboratories or facilities.

R&E also oversees the Department's STEM Office, which recently awarded $6 million to Arizona State University (ASU), Boston University (BU), and the University of California, Santa Barbara (UCSB) to develop K-12 biotech programs with teacher support. ASU's online curriculum is supported by their students and is targeted at reaching under-represented minorities and rural areas in Arizona. BU's program for local students includes internships and

opportunities at Boston labs. UCSB is also developing a master's degree biotech program and will pilot with local minority serving community colleges.

While much of the Department's investments in STEM education are academic, the Department is also focused on exciting STEM opportunities outside of the classroom to grow our future pipeline. Since 2009, DoD STEM has sponsored teams in the For Inspiration and Recognition of Science and Technology (FIRST) K-12 robotics competition. This season, Department scientists and engineers are expected to provide more than 300,000 mentorship hours to over a 1,000 teams. The Department also held ten 5-day STEM-focused summer camps with 1,200 junior high students at laboratories, engineering centers, and academic and educational partners. The Army's Educational Outreach Program educates approximately 3,500 students in grades 5 through 12 through its Gains in the Education of Math and Science (GEMS) program. GEMS aims to interest students in STEM who might not otherwise have considered the career path.

Part of building out a talent pipeline for the next generation is ensuring that we are tapping into all of the incredible talent our Nation has to offer. That's why the Department's R&D community has long made concerted efforts to reach out to under-represented communities.

A key part of these efforts is the Department's long-standing relationship with Historically Black Colleges and Universities (HBCUs) and Minority Institutions (MIs). The Department has continued to create and expand partnerships with HBCUs and MIs to stimulate research and innovation leading to the development of technologies critical to national security. Specifically, we recently established two new Centers of Excellence at HBCUs, representing a $15 million investment. West Virginia's Morgan State University, in partnership with Johns

Hopkins and Development Command (DEVCOM) Army Research Lab, established a Center for Advanced Electro-Photonics with 2D Materials. North Carolina A&T, in partnership with Wake Forest, established a Center for Biotechnology that will develop technology for the detection and monitoring of chemical and biological threat agents. These new centers join nine other Department established centers at HBCUs and MIs.

Thank you for the authorities that allow the Department to focus efforts and investment in STEM development at HBCUs and MIs.

**Critical Technologies to support the National Defense Strategy**

The Department's CTAs support the National Defense Strategy and address the needs of the joint force. In February, R&E identified 14 CTAs, grouped into three categories, each of which require a different approach to develop. These three categories are: Seed Areas of Emerging Opportunity (biotechnology, quantum science, Future Generation Wireless Technology (FutureG), and advanced materials), Effective Commercial Adoption Areas (Trusted AI & autonomy, integrated network systems-of-systems, microelectronics, space technology, renewable energy generation and storage, advanced computing and software, human-machine interfaces), and Defense-Specific Technologies (directed energy, hypersonics, integrated sensing and cyber). Early pioneering work in seed areas by our national and international research laboratories and world-renowned academics can revolutionize our capabilities in future conflicts. Effective commercial technology adoption areas can be pulled into the Department to rapidly enhance our capabilities. Defense Specific Technologies are areas where the DoD must take a lead in the R&D to ensure leap-ahead capabilities development.

While this testimony will not address all the CTAs in depth, I'd like to provide some recent updates.

**5G and FutureG**

To date, 5G has awarded more than 65 contracts to include over 100 companies. We are actively experimenting with seven 5G use cases to address key warfighting needs in dynamic spectrum sharing, smart warehouse and logistics, augmented reality for enhanced warfighter training and distributed command and control. The 5G/FutureG Initiative demonstrates the benefits of open 5G systems to create smart warehouses. In May 2021, we prototyped and demonstrated an Open Radio Access Network (Open RAN) in Arlington, Virginia. Immediately afterward it was set up as a testbed in a military warehouse in Albany, Georgia to enable breakthrough warehouses logistics capabilities.

**Biotechnology**

Through our Tri-Service Biotechnology for a Resilient Supply Chain (T-BRSC) program we are exploring the potential to generate high-density, high-performance fuels. Starting this year, T-BRSC will be the largest technologically advanced non-medical biotechnology program for the Department. The capability to create novel energy independence, not derived from fossil fuels, would be revolutionary.

DARPA last year demonstrated a bio-cement helicopter landing pad in 48 hours in Guam. This novel approach, when mature, may result in a significantly smaller logistics footprint and enable rapid use in austere environment.

**Microelectronics**

Seventy percent of the world's microelectronics are manufactured in Asia contributing to supply chain vulnerabilities like those we have seen during the COVID-19 pandemic. In keeping with Section 9903(b) of the FY 2021 NDAA legislation, which directs the Department to establish a National Network for Microelectronics Research and Development (NNMRD) and to

expand the global leadership in microelectronics, we have led a cross functional team that has matured the Microelectronics Commons concept. We are prepared to implement the Commons in three stages. First, create "Lab-to-Fab" testing and prototyping hubs to build a network focused on maturing microelectronics technologies based on the latest research ideas. Second, we want to provide broad access to these prototyping hubs, through augmented academic facilities (i.e., a local semiconductor company or a FFRDC). And finally, we want to increase microelectronics education and training of students at local colleges and universities, creating a talent pipeline for an engineering workforce to bolster the domestic semiconductor economy. We recognize that in order for the Microelectronics Commons to have an impact, it must be closely coupled and connected to interagency R&D, education, and workforce efforts and feed into the whole-of-government microelectronics activities. R&E actively participates in several interagency coordination efforts and DARPA co-chairs the Subcommittee for Microelectronics Leadership under the National Science and Technology Council to ensure the Department's efforts fully leverage both synergistic and complementary efforts from across the federal government.

**Hypersonics**

We are accelerating plans for rapid development and transition of hypersonic weapons to enable fielding of operational prototypes in quantity from land, sea, and air by the mid-2020s. My office is engaging directly with the Joint Staff, Combatant Commands, and Military Services to ensure that the hypersonic technologies the Department is developing are integrally linked to enhancing warfighter needs.

Additionally, we are engaging with academia through the Joint Hypersonics Transition Office (JHTO) that established the University Consortium of Applied Hypersonics (UCAH) in

October 2020. This office is a new way of leveraging university expertise to support the Department's most pressing science and technology hypersonics needs. The JHTO also is developing a pipeline of talented individuals who will make up the hypersonics workforce of the future.

**Working Faster and Increasing Collaboration**

Innovating in a way that will maintain the Department's technical advantage depends on increasing our collaboration across the technology ecosystem and rapidly performing experimentation, testing, and fielding. Commercial technologies are evolving faster than ever before, creating potential new asymmetric threats.

In 2021, through the ISG, the Department created the Rapid Defense Experimentation Reserve (RDER), a continuous campaign of joint iterative experimentation to close joint warfighting capability gaps. We have worked closely with the Joint Staff, Combatant Commanders, the Services, with participation from our Allies and Partners, to formulate a series of joint experimentation in a highly contested environment with the intent to rapidly transition the new capabilities.

The ISG is the principal forum that advises Department leadership and drives DoD-wide strategy, policy, programmatic, cultural, and budgetary change in the areas of science, technology, technology transition, and innovation. This year, OUSD(R&E) announced the first of several sprints with the RDER program.

OUSD(R&E) funds Joint Capability Technology Demonstration (JCTD) programs that intends to meet a single specific capability shortfall defined by a Component Commander since a single Service will not provision funding to solve a joint problem. For example, R&E funded a

National Capital Region's Integrated Air Defense System to extend the detection range of a specific target that met the NORTHCOM's need.

OUSD(R&E) also develops and fund Rapid Prototype Programs which demonstrates a specific capability that's not addressed by a single Service. For example, Southern Cross Integrated Flight Research Experiment (SCIFIRE) is maturing solid rocket motor for an air-breathing hypersonic cruise missile.

OUSD(R&E)'s Advanced Capabilities' Defense Modernization & Prototyping (DM&P) program focuses on funding and transitioning innovative technologies from small businesses and non-traditional performers.

**Collaboration with the Private Sector**

Private sector investment in technology has never been greater than it is today. However, many critical technology areas are not attractive to the private sector due to the expensive costs associated with initial investment. To ensure that the private sector pursues the technologies needed for national defense, the Department is increasing its leadership engagement and collaboration with the private sector. DIU, along with other Innovation Centers across the Department, engage with commercial industry to accelerate innovative solutions to solve military problems.

COVID-19 induced supply chain disruptions over the past few years have laid bare the importance of domestic manufacturing to our national and economic security. Catching up with manufacturing growth abroad, however, will depend on our development of leap ahead technologies like robotics, additive manufacturing, and biotechnology. The Department's

Manufacturing Technology program (ManTech) is working to encourage and support this sort of innovation in the United States manufacturing ecosystem.

ManTech oversees 9 Manufacturing Innovation Institutes (MIIs). These public-private partnerships specialize in exciting fields like photonics or advanced fabrics and work to create workforce education pathways. Lightweight Innovations For Tomorrow (LIFT) has an innovative training and credentialing program that provides a curriculum to active-duty soldiers, enabling them to earn credentials in high demand manufacturing fields. MIIs are transforming how universities and community colleges educate and how companies identify skills needed for industries of the future. These curriculum and workforce programs have helped more than 30,000 learners to date, and we were proud to welcome President Biden to the Advanced Robotics for Manufacturing (ARM) Institute in January.

Despite the Department's enormous contribution to the economy and creation of game changing technologies, it is still a challenge for a small business or startup to work with the DoD. We are committed to doing more to help small businesses and making it easier to work with the DoD and to bridge the valley-of-death.

The Department's Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) programs allow the DoD to support innovative small businesses to develop breakthrough technologies and capabilities that we need.

We have upgraded our SBIR/STTR Innovation Portal, making it easier to engage and participate with the Department. We are engaging with the small business community to understand the challenges that they face and are working to systemically tear down obstacles.

We are also focused on improving how the Department engages with the private sector to ensure that defense needs will be addressed by dual-use technologies. Increasing private sector investments in technology is advantageous for the Department so that we can purchase that technology commercially as it becomes available, supporting both defense and commercial needs. The Department is exploring additional ways to take a more active role in the commercial technology sector to ensure that defense objectives will be addressed.

**Collaboration with Allies and Partners**

Collaboration with Allies and Partners may significantly increase the speed in which we can develop interoperable technologies benefiting both nations. Many existing multilateral and bilateral agreements serve as a platform for increased collaboration, such as The Technical Cooperation Program (TTCP) with our "Five Eyes" Allies (Australia, Canada, New Zealand, United Kingdom, and United States), and the North Atlantic Treaty Organization (NATO) Science and Technology Organization. We are also looking to expand international R&D defense collaboration with other Allies and Partners based on shared defense interests and technology priorities.

The Department supports NATO's efforts to leverage centers of innovation to meet NATO's operational requirements. NATO's Defense Innovation Accelerator for the North Atlantic (DIANA) seeks to accelerate the development of dual-use emerging and disruptive technology through innovation. DIANA's focus on multi-sector participation will highlight innovative entrepreneurs from small start-ups, mid-sized companies and academic institutions that can solve critical defense and security challenges.

The AUKUS (Australia, United Kingdom, United States) defense pact is a new area of opportunity that is already showing success. Last year, President Biden, along with Prime

Minister Morrison and Prime Minster Johnson, announced the creation of an enhanced trilateral security partnership among our three nations. To meet the challenges of the twenty-first century, AUKUS will fortify longstanding bilateral ties while strengthening the security and defense interests in the Indo-Pacific region by evolving advanced capabilities collectively.

Working closely with our Allies and Partners, the Foreign Comparative Testing (FCT) Program enhances our Nation's military's capabilities. FCT is locating, assessing, and fielding mature foreign developed technology products to meet emerging defense requirements. For example, our soldiers utilize a palm-sized unmanned aerial vehicle (UAV) from Norway that enables enhanced battlefield surveillance and reconnaissance, a long-range missile from Israel that's improving standoff lethality and survivability against enemy air defense systems. Our sailors will utilize a mobile coastal defense rocket system from the Republic of Korea, providing a counter swarm capability against maritime attack craft.

**Conclusion**

In order to provide the United States with the long-term capability to develop and rapidly field the most innovative technologies to maintain overmatch, it is essential to have a solid R&D foundation consisting of a broad base of basic and applied research, rapid prototyping capability, continuous joint experimentation and testing, state-of-the-art lab and test infrastructure, rapid ability to transition to fielding, and a highly-talented workforce. The objective of increased collaboration across our technology ecosystem is to accelerate the timeline in which emerging technologies can revolutionize our warfighting capabilities. Implementing these concepts through the National Defense Science and Technology strategy will build a technological enduring advantage for the United States Military. Thank you for the invitation to testify in your committee, and I look forward to the discussion.