NOT FOR PUBLICATION UNTIL RELEASED BY THE COMMITTEE

STATEMENT OF

HONORABLE HEIDI SHYU

UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

BEFORE THE HOUSE ARMED SERVICES COMMITTEE

SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES,

AND INFORMATION SYSTEMS

ON REVIEWING DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY

STRATEGY, POLICY, AND PROGRAMS FOR FISCAL YEAR 2023: ACCELERATING

THE PACE OF INNOVATION

MAY 12, 2022

NOT FOR PUBLICATION UNTIL RELEASED BY THE COMMITTEE

Chairman Langevin, Ranking Member Banks, and subcommittee members, thank you for the invitation to provide testimony for the House Armed Services Committee hearing on "Reviewing Department of Defense Science and Technology Strategy, Policy, and Programs for Fiscal Year 2023: Accelerating the Pace of Innovation". 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 to join my Service research and engineering counterparts as we discuss our shared goals of delivering game changing capabilities to our armed forces and maintain the Department's technical advantage over our adversaries.

On behalf of the Secretary of Defense, the USD(R&E) sets the science, technology, and innovation strategy for the Department, and oversees the Defense Advanced Research Projects Agency (DARPA), the Missile Defense Agency (MDA), Space Development Agency (SDA) and Defense Innovation Unit (DIU). The goal of the Department's technology strategy is to provide the United States military with an enduring technical advantage. 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), with the goal of ensuring the United States military maintains its enduring technical advantage into the future. 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 the U.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, applied, and advanced research portfolio, state-of-the-art laboratories, a diverse set of testing facilities and ranges, and the best and brightest workforce. As the Department's Chief Technology Officer, I am the champion of DoD Science and Technology (S&T), and specifically, basic research investments across the Department, and I am pleased to report that the FY 2023 President's budget request for Research, Development, Test and Evaluation (RDT&E) was an all-time high of $130 billion department-wide, of which $16.5 billion is for S&T, and of that $2.4 billion is dedicated to basic research. Basic Research is the "seed corn" from which future defense technologies will grow. 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 through funding for the Creating Helpful Incentives for the Production of Semiconductors (CHIPS) for America Act through the Bipartisan Innovation Act, are inextricably linked to the 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 the 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 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.

For this reason, this year the Deputy Secretary of Defense established the Innovation Steering Group (ISG), with the USD(R&E) as the lead. 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, and innovation.

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 we cannot 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 (AI) — 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 and created new job opportunities.

The Department's interest in basic research is not limited to only science, technology, education, and Mathematics (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 $29 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 People's Republic of China.

A healthy investment in basic research is one of the Department's best tools against technological surprise. Strong open research collaborations between Department 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 (FFRDCs), and 14 University Affiliated Research Centers, and defense and commercial companies across the country that specialize 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 unmanned aerial vehicles (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 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 laboratory and test infrastructure. One of the ISG's primary lines of effort is to address the state of our laboratory and test infrastructure. In addition to maintaining and improving facilities that test legacy hardware in existing systems, the Department must anticipate and fund new testing and evaluation environments to support emerging technology development. For example, our development of hypersonic technologies presents new demands on our test infrastructure. The Department is thankful for the resounding support from Congress, expressed in the Omnibus Appropriations Act for FY 2022, which made strategic investments in our test ranges through the Test Resource Management Center. This appropriation is enabling new state-of-the-art facilities, reviving legacy over-land flight test corridors, and allowing the continued fielding of systems.

Funding lab and test infrastructure has been a recurring budget challenge for the Department and we are greatly appreciative of Congress' support in this area. The relative plateau of Military Construction 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-Kindergarten 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 full tuition scholarships 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 investment in STEM education is 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 1,000 teams. The Department also held 10 five-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 country 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 its partnerships with HBCU/MIs to stimulate research and innovation leading to the development of technologies critical to national security. Specifically, the Department 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 the Development Command within the Army Research Laboratory, 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 specified 14 CTAs, grouped into three categories:

- 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 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, which contributes 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 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 (e.g., a local semiconductor company or a FFRDC). And finally, we will aim 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 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.

Directed Energy

The High Energy Laser Scaling Initiative (HELSI) is the Department's key program to develop and demonstrate high energy laser technology. The HELSI drives industry development

of systems to be demonstrated in a laboratory, and transfers the technology to the Services for demonstrations in Service-relevant environments. Four industry partners are developing laser capabilities in Phase 1, up to 300 kilowatts (kW), with each industry partners' laser having unique features and approaches that make it suited for a specific Service and mission applications. The first three laser systems will be delivered in 2022. The next phase of the HELSI will focus on scaling laser technologies up to 1000 kW and on reductions in size and weight. This phase will begin at the start of FY23. Because the development of high energy laser technology has historically shown high risk, the HELSI program was established within OSD to consolidate the effort, reduce the risks, and mature the technology. The Department is also exploring pulsed laser and microwave technology to address mission applications like missile defense and hypersonic defense, and we are thankful for congressional support to partner with emerging centers of excellence to pursue these technologies.

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, Services, and our allies and partners to formulate a series of joint experiments in a highly contested environment to accelerate the transition of new capabilities to the warfighter. 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 are intended to meet a single specific capability shortfall defined by a Combatant Commander when no Service will provision funding to solve a joint problem. This is different from the large-scale, multi-Service experimentation occurring at the mission level through RDER. For example, R&E funded the National Capital Region's Integrated Air Defense System JCTD, to extend the detection range of a specific target that met U.S. Northern Command's need. JCTD projects like this could be considered for inclusion in the constellation of technologies and capabilities combined in future RDER experimentation events.

OUSD(R&E) also develops and funds the Rapid Prototype Program which demonstrates a specific capability that is not addressed by a single Service. For example, Southern Cross Integrated Flight Research Experiment is maturing technology concepts for an air-breathing hypersonic cruise missile jointly with Australia.

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

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 high 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. In November, DIU announced the opening of the Chicago DIU office, the newest of defense innovation outposts that operates across the country. The establishment of DIU's Chicago office is part of its broader regional outreach strategy to connect DoD to

companies, labs, military bases, accelerators, academic partners, and investors. This is one clear example where the Department is opening wider doors to collaborate with innovative commercial partners. 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 (ManTech) program is working to encourage and support this sort of innovation in the U.S. manufacturing ecosystem.

ManTech oversees nine 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 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 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 startups 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 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 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 Minister 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 locates, assesses, and fields mature foreign developed technology products to meet emerging defense requirements. For example, our soldiers use a palm-sized UAV from Norway that enables enhanced battlefield surveillance and reconnaissance, and a long-range missile from Israel that improves standoff lethality and survivability against enemy air defense systems. Our sailors will use 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 RDT&E 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.