NOT FOR PUBLICATION UNTIL RELEASED BY
HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON INTELLIGENCE AND
EMERGING THREATS AND CAPABILITIES
U.S. HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS
AND CAPABILITIES

U.S. HOUSE OF REPRESENTATIVES

HEARING DATE/TIME: March 11, 2020, 2:00 P.M.

SUBJECT: Fiscal Year 2021 Air Force Science and Technology Strategy, Policy, and Programs

STATEMENT OF: Dr. William B. Roper, Jr.
Assistant Secretary of the Air Force for Acquisition, Technology and Logistics

NOT FOR PUBLICATION UNTIL RELEASED BY
HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES
U.S. HOUSE OF REPRESENTATIVES

Strategic Environment and Addressing the National Defense Strategy

Chairman Langevin, Ranking Member Stefanik, and distinguished Members of the subcommittee, thank you for the opportunity to provide testimony on the Fiscal Year 2021 Department of the Air Force Science and Technology (S&T) Program and our continued efforts to respond to the warfighter faster, while simultaneously developing the future force.

As the nature and sources of conflict have become more diverse and less predictable, our nation continues to face a complex set of current and future security challenges, including the resurgence of great power competition from China and Russia. The rapid proliferation of global technology means the speed at which we change must increase. It is clear that supremacy in the air and space domains—a given for any U.S. military operation since the end of the Cold War—can no longer be presumed without deliberate investments in leap-ahead technology. Consequently, the National Defense Strategy shifts our priority, including those for S&T, to high-end warfighting.

The Department of the Air Force has fully embraced Secretary of Defense Esper's goal of irreversible momentum toward National Defense Strategy implementation. The Department of the Air Force must be ready to compete, deter, and win in this rapidly changing and increasingly complex security environment; defend the homeland; provide a safe, secure, and effective nuclear deterrent; be able to defeat a powerful conventional enemy while we deter opportunistic aggression in another theater; and continue to disrupt violent extremists.

These missions require that the Department of the Air Force develop innovative technologies more rapidly, and integrate new technologies, both Defense and commercial, onto military systems with unmatched agility. Competing across the entire technology ecosystem is a new challenge for the Department—especially with 80 percent of our nation's R&D now commercial—but it is one on which we have made much progress.

As the Department of the Air Force budget request highlights, we are committed to sustaining

our S&T portfolio and driving innovation across the enterprise. The Department of the Air Force Fiscal Year 2021 (FY21) President's Budget request for S&T is $2.8 billion. Our investment in S&T for FY21 grew by $7.0 million over the FY20 President's Budget request. In addition to S&T funding, the Department of the Air Force FY21 budget request includes approximately $1.3 billion in prototyping and experimentation funding focused on getting technology into the hands of warfighters to determine military utility and inform requirements for future force capabilities. Additionally, we have seen a threefold return on investment increase in our Small Business Innovative Research (SBIR) and Small Business Technology Transition Research (STTR) accounts since implementing what we now call our "Air Force Ventures" process in 2018.

In the FY21 PB, the Department of the Air Force restructured our S&T Program Element structure to increase agility. Today, technology associated with future warfighting must be more integrated across disciplines, providing integrated capabilities vice stand-alone solutions. Twenty-seven Program Elements (PEs) have been merged into 19, including realigning existing projects from the current 13 Budget Activity (BA) 6.3 Advanced Technology Development PEs into five new capability-focused BA 6.3 PEs. We also created a new BA 6.2 Applied Research PE to serve as an incubator for transformational S&T efforts. In only two months, we went from 236 new applied research concepts to 7 we are exploring at max speed. PE consolidation gives our S&T enterprise greater ability both to adapt to change and work across disciplines. We ask for Congress to support this initiative, which we are looking to continue in the future.

As part of implementing the NDS, our S&T portfolio also now includes larger initiatives, called Vanguard Programs, meant to accelerate the transition of war-winning capabilities into programs of record. The Vanguard Programs focus on five strategic thrusts meant to dominate time, space, and complexity across all operating domains:

- **Global Persistent Awareness** – continuous and timely knowledge of our adversaries through the operating environment;
- **Resilient Information Sharing** – assured and resilient communications and precise position, navigation, and timing across all Joint Force assets;
- **Rapid, Effective Decision-Making** – use of automation and artificial intelligence to accelerate battlespace knowledge and decision-making faster than our adversary;
- **Complexity, Unpredictability, and Mass** – overwhelming adversaries with complexity, unpredictability, and numbers; and
- **Speed and Reach of Disruption and Lethality** – exploiting new methods to rapidly attack, disrupt and neutralize dynamic and mobile targets with speed and global reach.

Vanguards

This new Vanguard initiative, designed to accelerate technology from the Air Force Research Laboratory into programs of record, is modeled after the rapid-prototyping process used by the Strategic Capabilities Office. Specific Vanguard efforts are approved by the Department of the Air Force Capability Development Council, co-chaired by the Under Secretary of the Air Force and the Vice Chief of Staff of the Air Force, signifying an enterprise commitment for each effort. Warfighters, future force designers, technologists, and program managers ensure technical feasibility, operational utility, and a solid business case to work through the complexities of implementation and facilitate transition into acquisition and fielding. S&T funds will be dedicated to complete the S&T components of each Vanguard effort. To accelerate Vanguard transitions, Program Executive Officers (PEOs) are designated upfront to develop and execute an acquisition strategy in collaboration with the Technology Executive Officer (TEO). Upon successful prototyping and experimentation, the Department of the Air Force will transition the technology into an operational capability. We recently approved the first three Vanguards: Navigation Technology Satellite 3 (NTS-3), Skyborg, and Golden

Horde.

NTS-3 is the first Satellite Navigation (SATNAV) space experiment in 40 years. The program will develop advanced techniques to provide military, civil, and commercial users with a more resilient SATNAV capability. If successful, these techniques will transition to future generations of the Global Positioning System (GPS) satellites and receivers. Launch of NTS-3 is currently projected for 2023 with a planned one-year, on-orbit experimentation program.

Skyborg integrates Artificial Intelligence (AI) with autonomous Unmanned Air Vehicles (UAVs) to enable manned-unmanned teaming. AI technologies, ranging from simple algorithms to fully autonomous flight controls, will be worked in partnership with our AI Accelerator at the Massachusetts Institute of Technology. If successful, Skyborg will transition AI-enabled low-cost attritable aircraft technology (LCAAT) via the NGAD program, or a new program of record. The first LCAAT, the XQ-58A Valkyrie, has already demonstrated high subsonic speeds at operationally relevant altitudes and payload capacities. Its next flight in April 2020 will connect the F-22 and F-35 via the gatewayONE radio link as part of the next Advanced Battle Management System (ABMS) demonstration.

Golden Horde will demonstrate collaborative, semi-autonomous networked weapons that share data, interact, and execute coordinated actions to defeat targets. Golden Horde will leverage onboard radios and algorithms to share data between weapons as well as manned platforms. Flight testing with existing weapons will begin this year, and, if successful, those weapons programs will transition Golden Horde upgrades into their respective programs of record.

Global Persistent Awareness and Resilient Information Sharing

Quantum, Advanced Communications, 5G, and Microelectronics

The Department of the Air Force continues to invest in quantum information science in three specific areas: quantum timing and quantum sensing (e.g., sensors and clocks used for navigation, detection, and force orchestration), quantum communications (e.g., advanced, secure, tamper-evident communications and networking enabled by fundamental quantum effects), and quantum computing (e.g., storage devices, specialized circuits, and algorithms operating on data maintained in superposition). While quantum technologies may have longer development timeframes, their impacts are expected to be far-reaching, allowing local GPS-like accuracy, new scales of computation, and new detection modes that obsolesce current ones. We can ill afford to fall behind.

Consequently, we are increasing our outreach to industry and academia to ensure our scientists and engineers remain on the cutting edge of quantum science. For a second year, the Department of the Air Force co-sponsored the Quantum for Business (Q2B) event, where industry leaders gather to hear the latest announcements, explore partnership opportunities, and collaborate on practical applications of quantum science. In May 2019, we formed a partnership with IBM to establish AFRL as an IBM Q Network Hub, which provides the Department of the Air Force and its collaborators access to IBM's commercial quantum computing systems to explore practical applications important to our two Services. The IBM Q Network has established Quantum Hubs across the world to increase access to quantum systems and advanced research, which is critical to accelerate learning, skills development, and implementation of quantum computing. This year we are stepping forward with a two-day Quantum Collider event, offering $50 million to small businesses to boost the quantum ecosystem by pairing them with university expertise in quantum fields.

5G is an important communications technology being deployed world-wide with heavy commercial investment. 5G provides critical underlying infrastructure for the "Internet of Things" (IoT), where all devices will be connected to a global network. This will be especially important as we work to maintain warfighting dominance through Joint All-Domain Command and Control

(JADC2) powered by the Advanced Battle Management System (ABMS), which builds the digital infrastructure for the Joint Force's IoT. We are exploring ways to exploit 5G in this endeavor and are working with industry to install on three Air Force bases. We would be happy to share more information about these efforts in a classified setting.

Reliance on foreign microelectronics jeopardizes our ability to modernize our military systems in the future. The problem is three-fold: low market share; an expansive range of needs, from boutique and legacy components to state-of-the-art technologies; and a lack of domestic trusted foundries to manufacture trusted microelectronics. In FY20, we are executing over $300 million to modernize microelectronic design and provide Department of Defense access to the commercial microelectronics supply chain. In FY21, we will leverage the latest digital engineering capabilities to develop a cloud-based microelectronics infrastructure that provides traceability and provenance across the entire microelectronics lifecycle.

Cyber and Big Data Analytics

Every day, we encounter sophisticated and persistent adversaries in cyberspace. The Department of the Air Force's cyber S&T investment is integral to assuring communications across physical and security domains, protecting our legacy and future avionics systems, countering global threats to mission performance, and expanding available bandwidth through dynamic spectrum access. We are enhancing cyberspace resiliency through an effective mix of redundancy, diversity, and distributed functionality that leverages advances in virtualization and cloud technologies.

The Department of the Air Force is focused on securing our weapons systems. We must be vigilant in our cyber hygiene as we are sharing a global hardware supply chain and harnessing more rapid software development best practices. This past year, the Air Force Research Laboratory sponsored an "attack the base" challenge at the DEFCON Security Conference, an annual event which brings together over 30,000 of the world's best security researchers, hackers,

and industry incubators to advance the cyber resiliency of many industries. We identified DEFCON as an ideal open environment to harness the best-of-breed in the security research community. The top prize awarded for our "attack the base" challenge was an internship where time is split between the embedded security industry and the Department of the Air Force. Use of this out-of-the-box approach provided access to the best cybersecurity candidates by leveraging competitive technical challenges. This year, we will be returning to DEFCON to bridge the security and space communities by holding a research challenge to penetrate a satellite (i.e., "hack-a-sat") and its ground and radio frequency components. The challenge will not only enhance our space system and infrastructure resiliency, it will contribute to the development of relationships with top cybersecurity professionals and build awareness about space cybersecurity as more companies—and more of our economy—depend on it.

We are also leveraging Big Data technology to provide analytic capabilities across multiple modes of intelligence, including virtualization, distributed computing, and machine learning to achieve operational agility through superior decision speed. Our S&T portfolio is investing in prototype development of an expandable cloud processing analytic capability that combines Signals Intelligence, Moving Target Indicator radar, and other data sources. This infrastructure provides the necessary tools for data scientists to engage with large-scale military data sets, so we are excited to see what doors this opens in the future.

Space and Fully Networked C3

Our adversaries have recognized the advantages we gain from operating in space and are developing capabilities to deny us this advantage in case of crisis or war. Consequently, our space S&T portfolio is broad in scope, spanning basic research published in world-renowned scientific journals, to conducting operations on satellites assembled by our government workforce, to classified activities. Our space S&T portfolio invests in five specific disciplines: space environment;

nuclear deterrence operations; space domain awareness; communication, position, navigation and timing; and intelligence, surveillance, and reconnaissance, including missile warning.

We continue to explore and mature a number of space resiliency technologies through on-orbit space experimentation. In June 2019, we launched the Demonstration & Science Experiment (DSX). In July, it successfully deployed two booms at 80 meters to become the largest unmanned structure ever in space. The DSX satellite is now performing a series of basic research experiments, including investigating the physics of radiation belt remediation techniques.

In another effort called "Global Lightning", AFRL researchers are experimenting with communication pathways that leverage the emerging commercial space internet. Our approach is to be an early adopter and influencer of this commercial technology. In December of last year, we conducted a test in which a SpaceX communications terminal onboard an Air Force Special Operations Command AC-130 was used to communicate target coordinates from Advanced Battle Management System (ABMS) sensors through the Starlink commercial space internet constellation to Army forces. This April, during our next ABMS experiment, we will test communications through the Starlink constellation with a KC-135. This effort will continue to build the connective backbone for ABMS in four-month iterative cycles as we build out the military's IoT.

Rapid, Effective Decision-Making and Complexity, Unpredictability, and Mass

Autonomy and Artificial Intelligence

The Department of the Air Force is committed to operationalizing Artificial Intelligence (AI) to move inside the adversary decision cycle. To address near-term operational challenges, we initiated an AI accelerator at the Massachusetts Institute of Technology staffed by Airmen from the operational community. The Department of the Air Force looks to connect with the world's best

scientists and engineers to field practical AI solutions for real-world national security challenges. We are excited about future possibilities our partnership with MIT will enable as world-leading principle investigators are now engaged on technical problems in Vanguard programs, as well as at our Kessel Run software development center-of-excellence.

Last year, Air Force researchers successfully integrated AI into DoD Intelligence Analysis for the Air Force Distributed Common Ground System (DCGS). “FuelAI” is a cutting-edge, AI-enabled, and government-owned Full Motion Video (FMV) crowdsource labeling application that enables the tagging, characterizing, and analysis of a large amount of data at unprecedented speeds. The datasets produced at Air Force DCGS sites enable researchers to train AI algorithms for specific national defense missions. Additionally, AFRL created and deployed the Deep Learning Video Pipeline (DLVP) in conjunction with industry partners. DLVP is a government-owned S&T framework to insert artificial intelligence algorithms into FMV intelligence operations, rapidly. Through FuelAI and DLVP, we have established a higher standard of trust for human-machine partnerships by embedding data labeling directly into our intelligence processes.

Artificial Intelligence applications, such as FuelAI, will be most effective in the future fight if the computing can be done at the tactical edge. In September 2019, we completed a demonstration moving us closer to providing this capability to the warfighter by leveraging Agile Condor, a high-performance computing architecture which can be mounted on various platforms that will be used to demonstrate artificial intelligence and machine learning technologies. The team built upon the Agile Condor’s embedded High Performance Computing open system and neuromorphic computing technologies to deliver on-board advanced computing with superior processing capabilities.

AI and advanced autonomy introduce new opportunities for unmanned air platforms. The Department of the Air Force continues to demonstrate the Low Cost Attritable Aircraft, the XQ-58A Valkyrie. The Valkyrie completed three flights this past year, flying at high subsonic speeds and

operationally relevant altitudes. The XQ-58A Valkyrie is the first instantiation of a class of attritable aircraft, which opens the door to new manned-unmanned concepts being explored in the Skyborg program. This year, we will assess the military utility of various LCAAT through an experimentation campaign focused on reliability, maintainability, sustainment, and life cycle cost. We appreciate the support of Congress on these effort, including the additional $100 million it appropriated in the FY20 Defense Appropriations Bill.

Disruption and Lethality

Hypersonics

An operational hypersonic air-launched weapon enables the U.S. to put high-value, time-sensitive targets at risk in contested environments. We remain committed to developing an operational hypersonic strike weapon capability by the end of FY22. We have pursued two rapid prototyping efforts to achieve this objective: the Air-Launched Rapid Response Weapon (ARRW), which is based on our joint Air Force/DARPA Tactical Boost Glide S&T demonstrator; and the Hypersonic Conventional Strike Weapon (HCSW), which is based on the Conventional Prompt Strike program.

Over the past year, ARRW successfully fired a new solid rocket motor, completed warhead design verification, and completed several captive carry flights of the Instrumented Measurement Vehicle. These activities have reduced risk, and ARRW is on track to deliver capability in FY22. HCSW also had many successes, including transition of Conventional Prompt Strike technology from the laboratory to industry. The HCSW team pioneered significant advancements, including maturing component technologies that may be used by other Department of Defense hypersonic programs, and was also on track to deliver capability in FY22. The Air Force down-selected to a single concept a year earlier than originally planned, with ARRW being selected as the higher-capacity weapon.

We will take HCSW through Critical Design Review later this month to document its design should it be needed in the design of future solutions. The Section 804 Rapid Prototyping Authorities

granted by Congress accelerated both programs by four-to-five years, allowing this early down-select to be done with greater confidence.

In addition to boost-glide weapons, we are also accelerating our development of hypersonic cruise missiles in partnership with DARPA. The Hypersonic Air-breathing Weapon Concept (HAWC) is maturing and integrating critical technologies for an effective air-launched, scramjet-powered hypersonic cruise missile. First flight will be later this year. To accelerate our ability to prototype such demonstrators, our S&T portfolio includes wide-reaching investments in propulsion technology, advanced materials, manufacturing technology, sensors and algorithms, and aero-structures.

Directed Energy

Directed Energy Weapons (DEWs) offer transformational capabilities to defeat massed attacks effectively, affordably, and rapidly. Disruption and lethality at light speed will have broad impacts on how future wars will be fought and won.

As part of the Department of the Air Force's Directed Energy Experimentation Campaign, we are conducting the first-ever extensive overseas field evaluation consisting of five counter-unmanned aerial systems—three high energy laser systems and two high power microwave systems. In addition, five to six additional systems are in procurement and will ship within 18 months. We are putting DEWs for base protection in the hands of the warfighter to get feedback on training, maintenance, operations and logistics to inform requirements for a future program of record. The Self-protect High-Energy Laser Demonstrator (SHiELD), a podded aircraft-protect laser demonstrator, has validated its lethality models and tracking algorithms by using the ground-based Demonstrator Laser Weapon System to shoot down missiles at White Sands Missile Range. We also continue to partner with the Navy on the High-power Joint Electromagnetic Non-Kinetic Strike (HiJENKS) effort, which is an initiative to integrate a counter-electronic payload on an airborne platform.

Biotechnology

The National Defense Strategy highlights the role of rapid advancements in biotechnologies for national security. Biotechnology tools and technologies are revolutionizing virtually every industrial sector and presents opportunities for defense innovation in a number of domains, including specialty materials manufacturing, novel sensors, warfighter performance optimization, and security. Using synthetic biology, we are developing approaches to secure the supply chain in critical materials for aerospace systems, protect our Airmen from directed energy, and exploit vulnerabilities for directed energy weapons.

For example, our basic research partnership with Australia has resulted in an ultraprecise ultrasound sensor on a silicon chip. The technology is so sensitive that it can hear the miniscule random forces from surrounding air molecules. We will soon have the ability to listen to the sound emitted by living bacteria and cells. In the health and performance area of research, we are focused on advances in cognitive sciences for developing optimized and resilient human-machine teams. Integrated Cockpit Sensing integrates bio-physical sensors with a common data storage platform to provide standalone pilot alerting capabilities. The sensors enhance pilot decision-making and provide in-flight data needed to perform root-cause analysis of physiological events. Integrated Cockpit Sensing will improve operational readiness by preventing mishaps and aircraft groundings, and enable increased pilot awareness during flight.

Accelerating Commercial Technology to the Warfighter

With over 80 percent of our nation's research and development (R&D) now commercial—and our Defense Industrial Base continuing to shrink through mergers and acquisitions—transforming the way we work with commercial tech companies is imperative. In 2018, we began energizing our Small Business Innovative Research/Small Business Technology Transfer Program (SBIR/STTR) to lower barriers for commercial tech companies, speed contracts, and bring private investment into the

Defense market. In 2019 alone, we awarded over 1,000 contracts worth $240 million to 700 companies, with over half new to the government; conducted 15 “Pitch Days” that awarded $77 million in same-day contracts; and induced over $400 million of private investment matching for companies receiving Department of the Air Force awards. Our research laboratories were integral to this success, providing technical expertise to help evaluate commercial technology opportunities and risks.

Given the threefold return on investment increase we have experienced since 2018, we will formally launch this new “Air Force Ventures” process at scale so that tech companies can depend on us as an early innovation partner of choice.

Working with tech startups is only part of how we are working with the commercial technology ecosystem. We recently launched Agility Prime, a non-traditional program run in partnership between our PEO for Mobility and AFRL, seeking to operationalize commercial electric vertical takeoff and landing (eVTOL) vehicles (i.e., “flying cars”) for military missions, and accelerate the emerging commercial eVTOL market in the United States. The Department of the Air Force has unique testing and safety resources—and revenue-generating military use cases—to help mitigate current commercial market and regulatory risks. Agility Prime will use these resources, vice significant R&D funding, to attract investors, build confidence, and hopefully expedite commercialization, all while providing warfighters revolutionary flexibility for numerous missions. We recently released an Innovative Capabilities Opening that establishes the rapid contracting mechanism to explore and potentially field transformative vertical flight aircraft within three years, and the program will host a challenge series this year to select vehicles, certify safety and airworthiness, procure systems for the most promising missions, and reach operational capability by FY23.

Expanding our R&D enterprise from creator to catalyst is key for accelerating dual-use

technology and countering the advantages of state-sponsored industrial bases. We appreciate the support of Congress on this effort, including the additional $25 million it appropriated in the FY20 Defense Bill.

Supporting Innovation – People, Infrastructure, and Authorities

Our S&T Strategy recognizes that technological superiority depends on the talent and innovative spirit of our workforce. Competition for highly-qualified, technical talent will continue to intensify. We appreciate Congress' support of our ability to recruit, retain, and develop the Air Force science, technology, engineering, and mathematics (STEM) workforce. The National Defense Authorization Acts of the past several years have provided additional personnel authorities to the S&T community. In order to stay competitive, we used direct-hire authorities to gain over 300 personnel from academia and industry in 2019. The authorities allow us to attract the right talent for the right positions in the least amount of time, which is vital to our competitiveness. We will continue to use this critical authority for years to come.

The competition for the right talent drives us to focus on our processes and policies to recruit, hire, and retain top talent—our people are our foundation. The Air Force Research Laboratory is implementing a workforce pilot using executive headhunter recruitment firms for hard-to-fill senior leader positions, resulting in large and diverse candidate pools. In October 2019, we used the enhanced pay authority (EPA) to hire a Data Analytics advisor and more EPA positions are in-the-works for Communications and Networking, Modeling Simulation and Analysis, and Microelectronics. Maintaining our technology advantage also requires hiring technology leaders at industry-comparable speeds. The Air Force Research Laboratory is focused on internal processes to expedite hiring timelines, provide better data to supervisors on their hiring decisions, and generate more dialogue between supervisors and employees. We appreciate the authorities Congress has given us to compete for talent and will implement them to the maximum extent possible.

The STEM K-12 Outreach Program, managed by the Air Force Research Laboratory, is also an important component to building the workforce of the future. STEM K-12 Outreach allows us to attract students to possible Department of the Air Force careers. Making it easy for students to envision a future where they can intern, receive a paid STEM scholarship, and then be hired to design future capabilities our nation needs is of utmost importance to compete for talent.

Laboratory Infrastructure

Science and technology-focused infrastructure is an important innovation multiplier. Last year, we broke ground on two Department of the Air Force laboratory MILCON projects: the Advanced Munitions Technology Complex (AMTC), a $75 million research facility on Eglin AFB; and the Space Vehicles Component Development Laboratory (SVCDL), a $13 million research facility on Kirtland AFB. Technologies developed at the AMTC will reduce the size of munitions without sacrificing weapon effects. Lighter munitions allow current and next generation aircraft to carry greater numbers of weapons, increasing mission effectiveness. The AMTC is scheduled for completion in 2021. The Space Control Laboratory (SVCDL) will consolidate efforts being conducted at six different facilities on Kirtland AFB and will advance research in space domain awareness, command and control of space systems, and survivability of space assets. The SCL is also scheduled for completion in 2021.

We continuously assess laboratory infrastructure to determine how to support technology needs. Our recently conducted five-year facility plan identified 533 future infrastructure projects. We look forward to working with Congress to ensure our facilities continue to meet the needs of future warfighters.

Conclusion

The Department of the Air Force's S&T Portfolio is shaped to deliver capabilities that are lethal, resilient, and cost-imposing for our adversaries. While the technologies we invest in are critically

important, the pace at which we must innovate and respond is even more significant. Whatever the next game-changing technology is, we must create or catalyze it faster than our adversaries or risk ceding the dominant tech advantage in air, space, and cyberspace that our nation has relied upon for decades.