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HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON EMERGING THREATS AND CAPABILITIES
U.S. HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

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SUBJECT: Fiscal Year 2019 Air Force Science and Technology

STATEMENT OF: Mr. Jeffrey Stanley, SES
Deputy Assistant Secretary
(Science, Technology and Engineering)

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INTRODUCTION

Madame Chairwoman, Members of the Subcommittee and Staff, I am pleased to have the opportunity to provide testimony on the Fiscal Year 2019 Air Force (AF) Science and Technology (S&T) Program and our efforts to innovatively and affordably respond to warfighter needs now, while simultaneously creating the force of the future.

To hedge against an uncertain future and ensure technological advantage, the Air Force continues to invest in a broad Science and Technology portfolio and other innovative efforts that will grow into future warfighting capabilities. Within the portfolio, we concentrate on game-changing technologies that can amplify many of the enduring attributes of airpower—speed, range, flexibility, and precision. Examples of Air Force game-changing technologies are: hypersonics, directed energy, autonomous systems and unmanned systems. Historically, the Air Force has maintained investment levels in basic and applied research related to longer-term national security challenges. Over the next several years, the Air Force plans to increase our research investment to maintain national security advantage in the air, space, and cyber domains. Challenges and threats to our national security are evolving rapidly – in some cases, our near-peer competitors are matching or exceeding our nation in gamechanging capabilities. The changes we are making will help ensure our technological advantage over our adversaries for the years to come.

The technologies the Air Force invests in are critically important, but the pace at which the Air Force innovates and responds is just as significant. Global competition has changed the speed at which the world around us operates. As indicated in the National Defense Strategy, "Success no longer goes to the country that develops a new technology first, but rather to the one that better integrates it and adapts its way of fighting." The Air Force Posture Statement reinforces this understanding - it is not the country that innovates the best, but rather innovates and applies technology the fastest who will win the future war. Whether developed by us or leveraging efforts

from across the innovation enterprise such as DARPA, the Strategic Capabilities Office or industry, we must be able to seamlessly integrate new technology into our systems. The rapid pace of change will not relent and the Air Force must ensure it continues to provide the necessary capabilities to dominate the current fight, prepare for the future fight, and always ensure Airmen have the technological advantage over our adversaries.

AIR FORCE FISCAL YEAR 2019 S&T PROGRAM AND ASSOCIATED EFFORTS

As the Air Force budget request highlights, Air Force senior leaders are committed to science and technology and driving innovation across the enterprise. The Air Force Fiscal Year 2019 President's Budget request for S&T is approximately $2.6 billion. This is an increase of $62 million, or a 2.4% increase, from the Fiscal Year 2018 President's Budget request. The Air Force continues to emphasize research in hypersonics, directed energy weapons, autonomy and human machine teaming. The Air Force Fiscal Year 2019 President's Budget request also includes funding in Budget Activity 4 (Advanced Component Development and Prototypes) and in RDT&E Budget Activity 6 (Management Support) to support prototyping and experimentation efforts.

Developmental prototyping and experimentation allow the Air Force to quickly and efficiently explore the art of the possible and assess military utility for the warfighter. An example is the Light Attack Experiment, a live-fly event conducted at Holloman Air Force Base, New Mexico in August 2017 to assess the military utility of various non-developmental, light-attack platforms. This first phase of the experiment allowed the Air Force to assess the potential of these off-the-shelf, light attack aircraft to accomplish various permissive, close air support missions. The Air Force leveraged Other Transaction Authority (OTA) agreements, including industry cost-share agreements, to execute the experiment within *five months of authorization*. The collaborative environment we fostered throughout afforded industry and other stakeholders exceptional insight

into warfighter requirements. The Air Force plans to hold Phase II of the Light Attack Experiment in Fiscal Year 2018 as we develop the acquisition strategy for a potential procurement in the coming years.

GAMECHANGING TECHNOLOGIES

Hypersonics

We are assessing our investments in gamechanging technologies and concepts to ensure our technological advantage tomorrow and give our warfighters a future edge is critical. Although we have a long history in hypersonic research, the United States no longer enjoys preeminence and the Air Force recognizes the urgent need to increase investment in this technology. The Air Force continues to conduct research and development in partnership with the Defense Advanced Research Project Agency (DARPA) and National Aeronautics and Space Administration (NASA) on two S&T flight demonstration programs. The Hypersonic Air-breathing Weapon Concept (HAWC) project aims to develop and demonstrate critical technologies and attributes of an effective and affordable hypersonic cruise missile. The Tactical Boost Glide (TBG) project aims to develop and demonstrate technologies to enable future air-launched, tactical-range hypersonic boost glide systems.

The Air Force views hypersonics as a national issue and is leading a national network to push the boundaries and push to accelerate the possible fielding of this capability through two prototyping efforts. Air Launched Rapid Response Weapon (ARRW) will "push the art-of-the-possible" by leveraging the technical base established by the Air Force and DARPA partnership in hypersonics science and technology. Hypersonic Conventional Strike Capability (HCSW) is using mature technologies that have not yet been integrated to possibly deliver an air-launched delivery system.

Directed Energy

The Air Force S&T investment in directed energy, including high power microwave (HPM) and high energy laser (HEL) technologies, is to the point where distinctive and revolutionary capabilities can be prototyped for several Air Force and joint mission areas. The Air Force developed a Directed Energy Weapon (DEW) Flight Plan and is conducting a series of experiments and prototyping efforts to transition technologies from S&T to operational capability. Initial experimentation applications include forward base defense, aircraft self-protect, and precision strike. Experimentation and prototyping will examine how we operationalize this new class of weapons capability and align it with current capabilities and CONOPS. It will also examine other non-materiel changes, which may need to occur to capitalize on this technology.

Autonomy

Autonomy, artificial intelligence, machine learning and quantum computing have the potential to provide revolutionary enhancements to readiness and lethality as the Air Force prepares for increasingly complex, future operating environments. Advances in these areas provide significant improvements to decision-making speed and mission agility, posing new challenges to the adversary at a pace they cannot match. The Air Force is developing, maturing, and integrating technologies such as manned-unmanned teaming and machine learning decision-aids to enable airmen and intelligent machines to work together.

Building from our successful ground collision avoidance system, autonomy efforts are centered on improved safety, efficiency of operations, multi-system collaboration, and command and control. An example effort is the Actionable Intelligence Discovery and Exploitation (AIDE) tool, which can detect objects, caption intelligence imagery and is working to develop the ability to recommend intelligence, based on the Intelligence, Reconnaissance and Surveillance (ISR) analyst's learned preferences.

In order for the Air Force to continue to operate faster than our adversaries, operationalizing artificial intelligence is necessary; however, it is not without its challenges. First, current weapon systems are not architected to exploit the data being produced. In addition, the data produced is often not mined and tagged, which would enable efficient use. Lastly, machine learning and deep learning techniques associated with artificial intelligence require huge numbers of calculations to be made very quickly, which requires significant processing power. The Air Force is bringing a new focus to these areas and will be conducting an Artificial Intelligence Summit in May 2018 to gather leadership and determine how to effectively operationalize AI into our current Air Force systems.

Unmanned Air Systems

Stealth and precision enabled weapons changed the way the Air Force accomplished many of its missions in the 1980's and 1990's. The advent of Unmanned Air Systems (UAS) introduced a new class of air platforms in the last decade and enable an unrivaled ability to provide ISR on the battlefield. Digital engineering, the ability to design and build systems digitally coupled with advanced manufacturing, will enable a new generation of platforms which will revolutionize our ability to engage the enemy by developing attritable aircraft at a fraction of the cost of other platforms.

Additive and flexible manufacturing efforts from a network of national manufacturing partners are being combined with world-class, in-house Air Force laboratory resources to rapidly design, build, and field near-term limited-life unmanned air platforms as single assets or in 'swarms' of autonomous or manned/unmanned teams. These attritable aircraft can be used to impose high-cost responses from our adversaries and extend mission range. Open system architectures are being used to promote the use of artificial intelligence and also increase our options to rapidly deploy flight packages tailored to specific missions.

ENABLING & RELEVANT TECHNOLOGIES

While the Air Force has identified the above technology areas as gamechangers, there are many other efforts that are foundational to the Science and Technology portfolio.

Basic Research

Air Force basic research collaborates with universities and research centers from around the world and cuts across a broad portfolio of scientific disciplines. The Secretary of the Air Force S&T 2030 initiative is centered on building and reinforcing relationships between the Air Force scientific community and university, government, and industry partners. The Air Force will listen and learn from these relationships through a series of conversations and outreach events. The Air Force basic research portfolio will incorporate what is learned into new research and technology areas. Development of revolutionary capabilities requires broad investment in foundational science to generate new knowledge; Air Force scientists discover potential military utility in new science and research efforts and develop this understanding to change the art-of-the-possible. Gamechanging capabilities begin with foundational, cross-cutting and revolutionary basic research. Investment in Air Force basic research results in revolutionary breakthroughs that will continue to pay dividends in the years and decades to come.

Cyber

The execution of Air Force core missions to deliver airpower relies on the ability to effectively operate in cyberspace. The cyberspace domain is becoming increasingly contested and denied and the Air Force faces risks from malicious insiders, insecure supply chains, and increasingly sophisticated adversaries. Legacy warfighting systems were designed without taking this threat into consideration and are populated with complex systems and Systems of Systems (SOS) that mature independently, stressing the ability to thoroughly test and integrate cyber capabilities.

The Air Force S&T cyber investments include many areas to assure communications across domains and counter global threats to mission performance (spectrum congestion and jamming), increase capacity over longer range air-to-air with military-grade security, and maintain or increase available bandwidth through dynamic spectrum access. The Air Force is enhancing cyber resiliency through an effective mix of redundancy, diversity, and distributed functionality that leverages advances in virtualization and cloud technologies. Efforts such as the Cyber Grand Challenge, executed in collaboration with DARPA, have informed Air Force investments in counter cyber operations such as defensive autonomic response. Air Force S&T efforts in mission assurance are pursuing survivability and freedom of action in contested and denied environments through enhanced cyber situational awareness for air, space, and cyber commanders.

Assured Communications

The renewed emphasis on the Nuclear Command & Control and Communications (NC3) mission has the Air Force conducting a strategic S&T initiative focused on survivable airborne communications that are resilient and responsive in nuclear environments. The initiative will explore technologies in the following areas: waveforms, underutilized frequencies and scintillated environment models to leverage new spectral research intended for satellite communications; enhanced beyond-line-of-sight communications technologies, including wideband HF communications; modeling and simulation to characterize communications performance using high fidelity models for end-to-end NC3 system test and evaluation; and network management and situation awareness required for assured nuclear command and control.

Space

The Air Force confronts a broad spectrum of space challenges that extends from unintentional environmental and physical hazards to intentional threats, some of which might be

constructed to escape easy detection and attribution. The Air Force's S&T investment includes ground-based optical Space Situational Awareness (SSA). The Air Force has two unique 3.5 meter class telescopes to conduct research in characterizing space objects in low earth orbits up to geostationary orbits and to support various customers in providing near real-time data on such space objects. One of the systems is located at the Starfire Optical Range (SOR) on Kirtland Air Force Base, New Mexico and the other is located at the Maui Space Surveillance System (MSSS) on the island of Maui, Hawaii. These sites are complementary SSA sites, technically and geographically situated in different atmospheric conditions, providing critical data to our space warfighters on the health and status of many satellites.

The Air Force SSA S&T program also supports the National Space Defense Center by integrating key astrodynamics, space order of battle and indications and warning tools. The S&T developed Advanced Research Collaborative and Application Development Environment (ARCADE) provides a path for future technologies to affordably reach the NSDC. Other S&T efforts leverage our space environment tools and expertise to enable the rapid attribution of environmental effects on DoD satellites and services – a key step in identifying hostile activities. SSA S&T investments help provide a more complete picture of a space vehicle's operating environment, develop and evaluate operations plans, and exercise improved command and control over space forces to confront tomorrow's challenges in space.

The Air Force seeks to explore and mature a number of space resilience technologies in a relevant environment through on-orbit space experimentation. The ESPA Augmented GEO Laboratory Experiment (EAGLE) project is an AFRL flight experiment that will demonstrate enhanced capabilities in space system anomaly resolution and the capability to supplement ground based space situational awareness assets from a geosynchronous platform. EAGLE is scheduled for a Spring 2018 launch date and will inform future acquisition and operational capabilities. The Air

Force also continues development of the Navigation Technology Satellite-3 (NTS-3), which aims to demonstrate a range of technologies for potential inclusion in future GPS satellites or potential augmentation of GPS, such as hosted Satellite Navigation (SatNav) payloads on other DoD, commercial, or international spacecraft. Launch of NTS-3 is currently projected for 2022 with a planned one-year on-orbit experiment period.

The Air Force is investing in propulsion technologies that will greatly increase the flexibility and resiliency of military satellites. S&T includes: flight programs; advanced electric and chemical propulsion; modeling, simulation, and analysis; and plume phenomenology and signatures. The Air Force has transitioned spacecraft propulsion technologies to most of the nation's National Security Space systems since the 1980s. The latest system to fly Air Force spacecraft propulsion technology (Hall Effect Thrusters) is the Advance Extremely High Frequency (AEHF) satellite. The Air Force has matured Hall Effect Thrusters and is now engaging in research into multimode thrusters in the form of Field Reverse Configuration thrusters. These multimode thrusters are capable of highly efficient, low thrust operations when needed to do station keeping while simultaneously being able to provide high thrust when needed to maneuver quickly, all using a single propellant.

Position, Navigation, and Timing

The Air Force is emphasizing S&T efforts in Position, Navigation and Timing (PNT) to improve the robustness of military Global Positioning System (GPS) receivers, as well as develop non-GPS based alternatives including: exploitation of other satellite navigation constellations, use of new signals of opportunity, and incorporation of additional sensors such as star trackers and terrain viewing optical systems. The Air Force is also partnered with DARPA on inertial and clock size, weight, power, and cost (SWaP-C) advances via a variety of technological approaches and in starting a new very low frequency (VLF) terrestrial beacon based navigation and timing effort.

Ensuring PNT is critical to our nation's security and remains an area of emphasis, especially for the Air Force.

Nanotechnology

Nanoscale structures promise revolutionary advances in a wide range of Air Force and DoD applications and platforms by delivering materials, coatings, devices and sensors with new and novel performance. Air Force investments in this gamechanging technology include ultra-small, customized munitions enabled by the precise control of components at the nanoscale. New designs of energetic material, casing and solid propellant will enable higher energy and smaller weapons, reducing size and weight while delivering the same or greater effect. Nanotechnology enabled multifunctional and adaptive structural materials in development will harden electronics from electromagnetic threats and maintain structural performance during hypersonic conditions. Air Force nanotechnology will underpin many new Air Force capabilities by reducing size and weight and increasing power and strength.

Manufacturing Technologies

The Air Force's Manufacturing Technology program is focused on promoting technologies for an agile, next generation manufacturing industrial base with strategic benefits in efficiency, affordability, and capabilities in Air Force warfighting products. The program strategically aligns key agile manufacturing objectives including: 1) moving manufacturing considerations earlier in the design cycle to reduce acquisition cost and risk; 2) enabling seamless lifecycle management through an integrated digital thread to document and improve process control, optimization, and manufacturing agility; 3) integrating the industrial base enterprise to predict, identify, and react to supply chain issues; and 4) creating the factory of the future with flexible, smart machine cells and assembly processes that are efficient even at low volume production. Mastering the art of designing and manufacturing for attritability—cheap enough to take risk, expensive enough to reuse,

dangerous enough to kill the enemy if ignored—will be key to imposing cost on adversaries while also keeping future Airmen safe in a contested fight.

EXPERIMENTATION AND PROTOTYPING

The Air Force continues to drive toward strategic agility. The Vice Chief of Staff of the Air Force chairs a Capability Development Council (CDC) that recognizes the Air Force's highest priority operational challenges and opportunities and aligns them with strategy, planning, programming, requirements and acquisition activities across the enterprise. The CDC represents our new way of doing business – leveraging innovation, collaboration and teamwork across functional and organizational boundaries to provide balanced, technically sound, decision-quality options to inform senior leadership direction. The CDC directs experimentation campaigns that create an environment where our airmen can take smart risks when exploring innovative ideas and technology.

Experimentation provides the ability to rapidly explore a wide range of innovative materiel and non-materiel solution options - an approach that enables unfettered exploration of alternative concepts. The Air Force has several on-going experimentation campaigns. The Air Force is preparing for Phase II of the Light Attack Experiment. Phase II will experiment with maintenance, data networking and sensors with the two most promising light attack aircraft — the AT-6 Wolverine and the A-29 Super Tucano, and allow us to gather the data needed for a rapid procurement. It will examine logistics and maintenance requirements, weapons and sensor issues, training syllabus validity, networking and future interoperability with partner forces. The Air Force will also experiment with rapidly building and operating an exportable, affordable network to enable aircraft to communicate with joint and multi-national forces, as well as command and control nodes.

This effort to find a lower cost and exportable aircraft for permissive environments is directly in line with the National Defense Strategy and the Air Force is committed to maintaining the momentum gained by the success of Phase I of the experiment.

Prototyping is also a valuable tool for the Air Force. It enables the Air Force to evaluate the design and performance of new concepts and technologies. The Air Force has recognized that engaging operational users intimately involved in need analysis, solution conceptualization, and prototype development enables delivery of a suitable prototype with all the right attributes to satisfy the user need. Furthermore, a rapid spiral development process that incorporates experimentation and prototyping allows the design to evolve quickly based on lessons learned during operations.

In addition to the hypersonics and directed energy prototyping efforts mentioned earlier, the Air Force is also making strides with prototyping. Efforts such include the Low Cost Attritable Aircraft Technology (LCAAT) effort, which will demonstrate manned-unmanned teaming with low-cost unmanned aircraft and the Global Lightning effort, which leverages commercial space internet networks to a global, low-latency, high bandwidth communications network. The benefits of prototyping are paying off, as we accelerate the transition from tech concept to military utility at a pace that is relevant to today's ever changing environment.

SUCCESS STORIES

While we look ahead to what's next, we also celebrate the recent accomplishments and breakthroughs of the Air Force Science and Technology community. The Air Force has seen progress on a broad range of technology fronts. Some of our highlights include:

- *Roll-out Solar Array (ROSA)*: A flight experiment on the International Space Station achieved 100% of its science objectives. The array consists of a 15x15 foot photo-voltaic

wing, which is unfurled by two high-strain composite booms. Developed through a Small Business Innovative Research (SBIR) project collaboration, the array reduces mass by 20% and packaged volume by 75% over rigid panel arrays. ROSA transition of technology to business partners is in progress.

- *Special Tactics Tactical Assault Kit (ST-TAK):* A geospatial application that supported Hurricane Harvey and Hurricane Irma Disaster Response efforts. Air Force personnel collaborated with the Department of Homeland Security and numerous DoD organizations to provide the ST-TAK tool, which enabled information sharing, mapping capabilities and server connectivity for rescue workers via cell phones. ST-TAK enabled better coordination of relief efforts during peacetime disaster response efforts in Texas and Florida.
- *Automatic Ground Collision Avoidance System (Auto-GCAS)* –Auto-GCAS technology prevents loss of aircraft and, more importantly, saves lives. In Spring 2017, the Auto-GCAS system activated during an F-16 training mission; both pilots onboard passed out due to G-force induced loss of consciousness (G-LOC) during a 9G maneuver. Auto-GCAS engaged, steered the aircraft away from nearby high terrain and the aircraft was safely recovered. Since fielding in Sep 2014, Auto-GCAS has saved 6 aircraft and 7 pilots. In Dec 2017, the F-35 Configuration Steering Board approved early implementation of Auto-GCAS on the F-35 for all variants; detailed engineering development will begin in 2018.
- *3-D Printed Turbine Engine Breakthrough:* The Air Force completed successful demonstration of an additively manufactured turbine that can drastically reduce the timeline of the development cycle. The turbine consisted of a super-alloy created using direct metal laser sintering. The part achieved full power in an otherwise stock jet engine. This is the first time that full operating power and speed were achieved using a printed turbine. The approach reduces the time from design to demonstration from two years to months.

WORLD CLASS WORKFORCE

The global competition for technology and the pace of technology development directly translates to the workforce. A world class workforce for the Air Force science, technology and engineering community continues to be our most important requirement. The demand for technical talent is quickly outpacing degree production in the US and competition for talent is at an all-time high. The Air Force recognizes continued technological superiority depends on the technical talent and innovative spirit of our workforce. In order to maintain an agile science, technology, engineering and mathematics (STEM) workforce, two aspects guide investments and collaborative energy this year: attracting and inspiring individuals to Air Force STEM careers and recruiting, retaining and developing the STEM workforce.

Attracting and Inspiring STEM Talent

The Air Force executes a STEM Outreach Program to attract and inspire technical talent to choose an Air Force career. The Air Force is a significant contributor to the Nation's strategy to establish greater economic and military security by educating and inspiring more scientists, engineers and innovators. A STEM trained and STEM literate workforce enables the innovation to make game-changing technologies a reality. The Air Force is leveraging industry and other government agencies, promoting diversity, and measuring results to ensure a successful and effective STEM Outreach Program.

The Air Force executes many STEM programs designed to engage students in STEM events from a young age. One such activity is the *StellarXplorers* competition, which brings teams of high school students together to learn the engineering design process using Analytical Graphics, Inc.'s (AGI) Systems Tool Kit (STK). The competition employs computer simulations for orbit generation and propagation, computer-aided system design, system performance assessment, and budgetary constraints. The program has seen a steady increase in participation as it flourishes into a national

level program. StellarXplorers has grown from 27 teams in 2015 to 180 teams in 2017, including 31 states and 3 overseas locations. In another STEM workforce activity, the Air Force and Navy funded a new Cyber and Electronic Warfare (EW) Reserve Officers' Training Corps (ROTC) effort, which allows cadets to get their security clearances while in school so they can work on real-world research projects for the Air Force and other Services. This effort helps develop the new cadre of Cyber/EW officers for the DoD. The program will grow from 55 initial Air Force, Army and Navy cadets / midshipmen in 2016 to over 200 in 2018. This effort proactively builds a talent pipeline from which the services can pull. Our need for the world's best scientists, technologists, engineers, and mathematicians has never been higher and will continue to increase.

Recruiting, Retaining and Developing the STEM Workforce

The Air Force's ability to recruit, retain and develop the STEM workforce is vital toward building the future Air Force; Congress has been greatly supportive of these efforts. The National Defense Authorization Acts of the past several years have provided additional personnel authorities to the S&T community. Specifically, the addition of direct hire authority for candidates with bachelor degrees has been extremely useful in hiring qualified scientists and engineers in less than half the time of traditional hiring methods. The Air Force continues efforts to fully implement all of the personnel authorities provided specifically to our community by Congress.

The Laboratory Personnel Demonstration Project continues to provide the Air Force Research Laboratory a more responsive and flexible personnel system through direct hire authorities, broad banding, the contribution based pay system, simplified job classification, developmental opportunities, voluntary emeritus corps, among other unique workforce shaping tools. These authorities have enabled the Laboratory to successfully attract and retain high quality scientists and engineers.

LABORATORY INFRASTRUCTURE

S&T infrastructure is an important component to support innovation and force modernization. Thanks to the approval of the Congress, progress is being made on a new Space Vehicles Component Development Lab at the Air Force Research Laboratory Space Vehicles Directorate in Kirtland, NM. The project will break ground Summer 2018, providing the ability for space vehicles component development including four light laboratories, two medium laboratories, and class 1,000 clean rooms required for space vehicle research, development, and experiments. This new facility will consolidate 11 separate S&T infrastructures on Kirtland Air Force Base, New Mexico, increasing the effectiveness and efficiency of work accomplished by the directorate.

In Fiscal Year 2017, Congress approved the construction of an Advanced Munitions Technology Complex on Eglin Air Force Base, Florida. Designs for the facility are now complete and target completion for this project is 2021. This laboratory is integral to support research and development of sub-scale high speed munitions requiring advanced energetics containing nano and conventional materials. This laboratory will fill a need for the Air Force and the entire DoD as it will be capable of handling and using nano explosive powders or advanced energetics that use nano materials, a capability which does not currently exist in the U.S. today.

Not only has S&T infrastructure received Congressional support in the MILCON process, special Congressional authorities provided to the Laboratory Commander to conduct minor infrastructure projects, known as the "Section 219" authority, have enabled rapid improvements to S&T infrastructure. Through this authority, the Air Force is funding multiple capability-enhancing infrastructure projects such as an ultrashort pulse laser laboratory (USPL), which will be the only Air Force Petawatt-class USPL for mid and far infrared lasers, expanding research capabilities and providing our scientists and engineers with an indoor range testing area; a deployable structures

laboratory (DeSEL), which will enable realistic testing of deployable space structures; as well as upgrades to our Missile Assessment Center, a critical laser technology demonstration area.

CONCLUSION

Chairman, Members of the Subcommittee and Staff, thank you again for the opportunity to testify today on the Air Force's expansive S&T program, planned and executed with capability development and strategic agility at the forefront. Your support continues to allow the Air Force to maximize the impact of our robust S&T program (gamechanging, enabling, relevant, and rapid technologies), champion efforts in experimentation and prototyping, and leverage the contributions of our entire world class workforce and infrastructure.