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INTRODUCTION

Mr. Chairman, Members of the Subcommittee, and Staff, I very much appreciate the opportunity to provide testimony on the Fiscal Year 2005 Air Force Science and Technology (S&T) Program. The United States Air Force is transforming to a capabilities-focused Expeditionary Air and Space Force. We are doing this through the development of the Concept of Operations for each of the seven major tasks the Air Force must be capable of accomplishing to support our combatant commanders. Our goal is to make the warfighting effects and the capabilities we need to achieve them the drivers for everything we do. This is especially true in our S&T Program. We have taken the effects and capabilities required by the seven Concepts of Operations and mapped them to the Long-Term Challenges and Short-Term Objectives identified in the Congressionally-directed S&T Planning Review completed in February 2002. Not surprisingly, we have a high correlation between our S&T programs and the capabilities required by these Concepts of Operations. This is because the Air Force Research Laboratory (AFRL) closely links the technologies reflected in its S&T Plan to warfighter capability needs.

The United States Air Force is committed to an S&T Program that enables us to achieve our vision of becoming an integrated air and space force capable of rapid and decisive global engagement. By continuing our investment in transformational technologies that support a reduced cycle-time, spiral development acquisition process, the Air Force will retain its dominance of air and space in future conflicts, against both traditional and asymmetrical threats.

Innovation is a vital part of our heritage and is key to ensuring the Air Force will meet the challenges of tomorrow. Transforming our warfighting capabilities towards this end will involve continued innovations in how we train our forces and how we think about employing our forces to defend our nation, as well as continued advances in our technology. We must be prepared to

counter regional instabilities, the worldwide availability of advanced weapons, and other emerging and less predictable acts of terrorism against our nation and allies. We are developing transformational technologies that permit flexible forces to operate far from home, on short notice, and for extended time periods. However, we must also be able to afford transformational innovations once we develop them in order to re-capitalize the Air Force to fulfill our vision. To meet warfighting capability objectives, we invest in the most promising and affordable technologies in order to win decisively, protect our forces, and minimize collateral damage.

S&T BUDGET/SENIOR LEADERSHIP INVOLVEMENT

We continue to be faced with the reality of a fiscally-constrained, but operationally-demanding environment. The high operations tempo the Air Force has sustained in support of peacekeeping operations and conflicts, such as in Afghanistan and Iraq, has placed a great burden on our people and the supporting logistics.

In spite of these rigorous demands, the Air Force is working to increase S&T funding, while maintaining a balanced S&T portfolio. The Air Force Fiscal Year 2005 President's Budget (PB) request for S&T is $1.9 billion — this includes $1392.8 million in "core" S&T efforts, which represents an increase of over $80 million or almost five percent real growth compared to the PB requested amount for similar "core" S&T efforts in Fiscal Year 2004. The most significant change in the S&T PB request results from the integration of programs that were devolved last year from the Office of the Secretary of Defense to the Air Force S&T Program. This includes the University Research Initiative program and the High Energy Laser Joint Technology program.

The Air Force understands the concerns of Congress regarding the level of support for these devolved programs and continues to work hard to ensure these programs support the diverse multiple military objectives inherent in joint programs. Furthermore, the Office of the Secretary of Defense continues to provide policy guidance and oversight for these efforts.

In a separate action last year, the Seismic Research Program for detection of nuclear explosions was transferred back to the Air Force from the Defense Threat Reduction Agency (DTRA). We continue to work with the Office of the Secretary of Defense, the Air Force Tactical Applications Center, and the Army to invest in a seismic research program that addresses operational nuclear explosion monitoring needs. Under the guidance of The Office of the Secretary of Defense-led intergovernmental Steering Committee, the Air Force is funding research to increase the understanding of seismic wave propagation at regional distances of less than 2,000 kilometers.

One area in which the Air Force has increased its investment is in space communications technology with initiation of the transformational communications technology development program. This program will identify, develop, and demonstrate the wideband technologies needed to build a space-based laser communications network that could provide higher data throughput to transform our military satellite communications infrastructure.

Warfighter and senior Air Force leadership involvement in the planning, programming, and prioritizing of Air Force S&T continues to be a priority. For example, the Secretary and Chief of Staff of the Air Force, along with the Air Force Service Acquisition Executive and the Air Force Materiel Command Commander, conduct a full portfolio review of the S&T Program similar to the former S&T Summits. In addition, the Integration Capabilities Review and Risk Assessment process involves several levels of senior Air Force leadership, including the Chief

and all the four stars, and further promotes a greater understanding within the Air Force of the S&T Program and its link to warfighting capabilities. The Capabilities Program Execution Review provides a forum in which the Commander of each Major Command is afforded a focused look at his portfolio and an opportunity to resolve issues at the system/program level and provide insight to the S&T Program. Finally, the Applied Technology Councils (ATCs), which are discussed in greater detail later in this statement, bring together acquisition product centers, logistics centers, major user commands, and laboratory personnel to review and discuss S&T efforts — ATCs foster top-level user involvement in the transition of technology from the laboratory to the system developer to the operational user.

TRANSFORMATION

The Air Force continues to transform from a Cold War to a post-Cold War Air and Space Force. As we do so, we must prepare for new forms of terrorism, attacks on our space assets, attacks on our information networks, cruise and ballistic missile attacks on our forces and territory, and attacks by adversaries armed with chemical, biological, radiological, nuclear, or high explosive (CBRNE) weapons. To address this post-Cold War reality, the Air Force has established a process of transformation by which it will achieve and maintain the "advantage through changes in operational concepts, organization, and/or technologies that significantly improve its warfighting capabilities or ability to meet the demands of a changing security environment." Critical to this transformation is the ability to mature and translate a vision into actual operational capabilities in order to prevail in conflict and avert technological surprise.

When examining the concept of combat transformation, it is important to note several fundamental points. First, transformation is not the result of a one-time improvement or change,

but rather a continuum of sustained and determined efforts. Second, meaningful transformation requires integrating expanding capabilities with those of the other Services and non-military elements of national power. Third, transformation is more than new "gee-whiz" technologies. It includes adapting existing capabilities and using them in new ways, changes to the organizational structure to increase effectiveness, and changes in doctrine and concepts of operations to include training and tactics that determine force deployments. Fourth, transformation should not be achieved at the expense of ongoing operations in support of the Department of Defense strategy of maintaining adequate readiness and infrastructure, conducting critical recapitalization, and attracting quality personnel. To achieve rational transformation there must be a careful balance between these requirements, which all compete for limited resources.

To institutionalize transformational changes, the Air Force will capitalize on three core competencies. One, developing airmen to ensure they receive the education, training, and professional development needed to provide a quality edge second to none. Two, integrating operations to enhance combat capabilities that are pivotal to maximizing the air and space environment. Three, the technology-to-warfighting vision of translating technology into operational capabilities. These three core competencies are the foundation of success and will ensure we remain dominant in air and space operations.

Transformation further translates into Air Force Operational Concepts — more commonly known as Concepts of Operations or CONOPs. Air Force CONOPs provide the long-term roadmaps to get the right capabilities at the right time and place for the joint warfighter. Implementation of these CONOPs require new and sometimes revolutionary changes to existing CONOPs and organizations, and refocusing technology developments. The CONOPs form the

basis of the Air Force investment strategies for technology development, system acquisitions, and support decisions. The Air Expeditionary Task Force is an overarching CONOP that uses the capabilities provided by the following six supporting CONOPs:

- **Global Strike** provides the capability to maintain battlespace access for all required joint/coalition operations
- **Space and Command, Control, Communications, Computers and Intelligence, Surveillance, and Reconnaissance** provides persistent space and air situational awareness and executable decision-making information to the Joint Forces Commander
- **Global Response** provides intelligence and strike systems to attack fleeting or emergent, high-value or high-risk targets by surgically applying power anywhere on the globe within hours
- **Homeland Security** leverages Air Force capabilities with joint and interagency efforts to prevent, protect, and respond to identified threats
- **Nuclear Response** provides the deterrent "umbrella" under which conventional forces operate and, if deterrence fails, avails a rapid scalable response
- **Global Mobility** provides the capability to enable rapid, timely, and effective projection, employment, and sustainment of power in support of global interests

The Air Force goals to achieve transformation include information superiority, air and space superiority, precision engagement, global attack, rapid global mobility, and agile combat support. The Air Force S&T Program has been planned and focused to support the Air Force CONOPs and goals. The Air Force Capabilities Review and Risk Assessment (CRRA) process supports the CONOPs by identifying and analyzing current and future capabilities, capability shortfalls, health risks, and opportunities. Part of the CRRA process is to provide information on

these identified technology gaps and shortfalls to the S&T Program planners to provide direction and focus to the S&T capability planning process. The CRRA process is transformational as it concentrates on desired battlespace effects vice specific air and space platforms.

WORKFORCE

The Air Force scientist and engineer (S&E) workforce is another area where senior Air Force leadership involvement plays a pivotal role. Both Secretary Roche and Gen Jumper are deeply involved in shaping our future S&E workforce. Air Force civilian and military S&Es are highly motivated and productive, but we need to be vigilant in continuing to recruit and retain the best and brightest individuals. The Air Force is unique in that approximately 20 percent of its laboratory S&E government workforce is active duty military. It is from this cadre that we draw the technical competence needed in our military Service leadership to operate an ever more technical force. In addition, this gives us a direct link to the warfighter, which in turn helps us to focus technology development on warfighting capability needs. Some of these military S&Es come directly from operational commands, while others will serve and support combatant commanders in operational commands later in their careers.

The Air Force is committed to shaping its S&E workforce with the vision to enhance excellence and relevance of S&T into the 21st Century and appreciates the support Congress has already provided. This challenge requires the Air Force to maintain a dominant edge in warfighting capabilities and also requires us to provide clear direction and growth for our S&E workforce. However, we, as do others, find it a significant challenge to recruit and retain S&Es. The Air Force has several initiatives, both civilian and military, that address recruitment and retention issues.

Civilian initiatives include the recruitment of college students with critical S&E skills via recruiting incentives, a robust marketing effort, and a co-op central funding program that hires college students while still in school. Central funding for recruiting bonus and retention allowances for journeyman level S&Es also promises to provide much needed assistance with civilian recruitment and retention.

On the military side, we're employing the Airman Education and Commissioning Program and the Technical Degree Sponsorship Program to recruit additional S&Es into the military workforce. We are in the process of examining the impact of bonus programs such as the Critical Skills Retention Bonus on retention and will assess future Air Force requirements for this and similar bonus programs.

The Air Force is committed to its S&Es and published a "Concept of Operations for Scientists and Engineers in the United States Air Force" last year. We also baselined the requirement for the Air Force S&E workforce and, upon analyzing this baseline requirement, found that while our military and civilian authorizations were about right, our actual demographics were seriously short in some key areas. We continue to shift our focus towards retaining the workforce we have and infusing it with the vitality of new S&Es to meet tomorrow's need. During the next seven years, we are investing nearly a third of a billion dollars to support the retention and reshaping of our technological workforce. As we replenish our S&E workforce, we are providing career guidance and mentoring that will enable us to meet our 21st Century challenge. Once the National Security Personnel System is implemented it could also produce positive results in shaping our S&E workforce. Again, we express our thanks to Congress for your continued support.

MAXIMIZING OUR S&T DOLLARS

We will continue to leverage technology to achieve new levels of combat effectiveness. Our strategy is to pursue integrated technology capabilities that support our warfighter's highest priority needs. In addition to transformational technologies, we must also pursue the fundamental enabling technologies that will improve tomorrow's Air Force. As technological superiority is increasingly a perishable commodity, we work hard to optimize our S&T funding, by not only "inventing the future" ourselves, but also by speeding the transition of new technologies to our warfighters.

One way of identifying technologies for rapid transition to the warfighter is through our Applied Technology Councils (ATCs) and the Advanced Technology Demonstrations (ATDs). The councils are composed of two- and three-star generals from AFRL, our logistic centers, our acquisition product centers, and our major user commands who formally prioritize proposed ATD programs. We hold an ATC meeting with each Major Command twice every year and have commissioned 34 ATDs that have transition funding. The ATC process is extremely important in linking the S&T Program to the system developers, the logisticians, and, finally, the operational user. This process facilitates technology transition to operational use and secures user commitment for resources to do systems design and development and fielding of the technology. Currently about fifty percent of our Advanced Technology Development (6.3) budget is committed to ATD programs.

Since deployed technology may remain in use for decades, the Air Force S&T Program not only focuses on enhancing performance, but also on sustaining our fielded warfighter capabilities. Emphasizing affordability from the very beginning through training of our management, and science and engineering staff, as well as through an in-depth review of

technology development efforts, increases our potential to reduce the costs of technology early in the system development process and throughout a product's life cycle.

We maintain an excellent balance of military, civilian, and contractor expertise, which allows us to be very selective about investing in high payoff technological opportunities. We constantly seek opportunities to integrate Air Force planning and leverage our S&T funds by cooperating with other Services, Agencies, the private sector, and international partners. For example, we rely on the Army as the lead Service for defensive chemical-biological technology development. The Air Force also has inter-Agency efforts, such as our program in aging aircraft, which is focused on detection and management of corrosion and fatigue in aging structures. It is closely coordinated with the civilian aging aircraft research programs at the National Aeronautics and Space Administration (NASA) and the Federal Aviation Administration (FAA). Our partnership with the industrial and university research base is very strong. In fact, we outsource over seventy percent of our S&T funding to universities and industry. Finally, the Air Force is involved in international cooperative technology development efforts for S&T, such as the non-destructive inspection, tactical missile propellants, and aircraft battle damage repair efforts conducted with the United Kingdom, Germany, and Italy, among others. Another example of international cooperation is the multi-domain network management program with Australia and Canada. This program is developing the technology concepts and tools for creating and managing secure computer networks with our coalition partners.

LEGACY PROGRAMS

Over the years, the best and most reliable way to judge whether you are investing in the "right" technologies is to look at legacy systems that are in development or operational use and see how the technologies you invested in previously have transitioned into these "products." An

excellent example is the F/A-22. A wealth of technologies that transitioned to the F/A-22 can be traced back to an investment of approximately $900 million in Air Force S&T over the years. These technologies include efforts such as low-observable materials, advanced two-directional thrust vectoring nozzles, new supercruise non-afterburning turbine engines, airframe design, mission integrated transparencies, solid state active transmit and receive radar, thermoplastic composite structures, and fly-by-wire integrated flight controls. In the space arena, examples of technologies that have transitioned into space "products" include radiation-hardened electronics to protect our satellites from the harmful effects of radiation; longer life, lighter weight lithium ion batteries; compact, more efficient solar cells for more effective processing of sunlight into electrical power; composite bus structures that are lighter weight and stronger; hall thrusters for orbit change and orbit maintenance; and enhanced antenna designs that provide for more efficient communications. In addition, a number of information-related technologies have transitioned into operational use including the highly effective information data wall that is currently being used in Afghanistan and Korea, multi-layer communications security being used by several government agencies, and software defined reprogrammable radios for secure communications and adaptable for coalition operations.

Some technologies, such as those being implemented as spiral upgrades to the Battlefield Air Operations (BAO) Kit that is used by Air Force ground controllers who call in air strikes, were rapidly transitioned into use during Operation Iraqi Freedom. The BAO Kit is one of the Secretary of the Air Force's top priorities and continues being developed in several different acquisition spirals as the technology matures. The technology transitioned from S&T into developmental and operational products is extensive and provides the confidence that S&T funding is being wisely invested. The panoramic night vision goggles are another prime

example and provide operators a significantly wider field of view than the “soda straw” view of earlier goggles. Technology transition into operational use is the ultimate metric for assessing the value of our S&T investment.

WORLD CLASS RESEARCH

The quality of our program is assessed by the Air Force Scientific Advisory Board (SAB) through yearly reviews. The SAB conducts an in-depth review of half of the S&T Program each year, covering the entire program over a two-year period. Twelve technical areas have been identified as world-class research during the last cycle of reviews — let me highlight a few of these areas that were identified as world-class.

The Directed Energy Directorate’s Starfire Optical Range at Kirtland Air Force Base, New Mexico, is leading the adaptive optics research for use in large ground-based telescopes to image satellites and propagate laser beams through the atmosphere. This will enable high-quality, ground-based observations of space objects and propagation of laser beams through a turbulent atmosphere. Satellite images using this technology can provide real-time status information that cannot be obtained in any other manner.

Our Propulsion Directorate’s Hypersonics Technology (HyTech) work at Wright-Patterson Air Force Base, Ohio, is acknowledged by the SAB as world class and is the cornerstone of future hypersonic capabilities, such as destroying time-critical targets and responsive access to space. Our HyTech program has continued to advance the state-of-the-art in scramjet engines and completed the first ever ground test demonstration of a scramjet producing positive net thrust begun in 2001. In February 2003, HyTech tested a flight weight scramjet Ground Demonstration Engine operating at Mach 4.5. While the 2001 Performance

Test Engine used copper heat-sink hardware and weighted 1,500 pounds, the 2003 Ground Demonstration Engine used JP-7 fuel to cool the scramjet engine walls and weighed less than 150 pounds. This marked another first for the HyTech program—demonstrating the structural durability of a hydrocarbon fueled, actively cooled scramjet. Testing at Mach 6.5 has been completed. United States industry developed this particular engine in collaboration with Air Force scientists and engineers.

Another SAB-rated world-class research program is the Warfighter Skill Development and Training efforts worked by our Human Effectiveness Directorate at Brooks City-Base, Texas. Specific research areas include Integrated Panoramic Night Vision Goggle (PNVG) and Distributed Mission Training. The Integrated PNVG will improve situational awareness and terrain avoidance at night through its wider field of vision and improved resolution. It will also provide protection from laser target designators, laser rangers, and laser threats through compatibility with existing laser eye protection technologies. Distributed mission training will provide an integrated set of training, simulation, and mission rehearsal technologies that will improve warfighter capabilities and mission readiness by enhancing operator and team performance skills. Technologies will increase operational readiness by providing more effective methods and approaches to train and assess personnel. These technologies will contribute to a more highly trained and flexible cadre of personnel at a reduced cost.

Working closely with operational users and the Human Effectiveness Directorate at Brooks City-Base, AFRL researchers in the Materials and Manufacturing Directorate at Wright-Patterson Air Force Base, Ohio, continue to develop and transition new laser eye protection technologies that provide aircrews with improved eye protection. The world-class multi-disciplinary approach anticipates future threats and needs, and assures that next-generation

hardening technologies will address the agile laser threat. The Laser Eye Protection program is enabling aircrews to conduct day and night air operations without visual jamming or personal injury. The Materials and Manufacturing Directorate also conducts world-class research to improve the affordability, durability, and performance of advanced aerospace metals by integrating modeling and simulation into all aspects of the program. The potential cost savings when qualifying metallic materials for insertion into Air Force weapon systems are significant. Revolutionary work on thermomechanical process modeling and probabilistic micromechanical modeling of failure and durability will change the way materials are developed and implemented in air and space applications.

Our research in Electro-Optical Warfare at Wright-Patterson Air Force Base, Ohio, will allow future laser-based sensor systems to penetrate moderate cloud cover, obscurants, and camouflage. This will provide improved target detection and identification for our weapon systems. "See and Avoid" sensors will ease restrictions on unmanned air vehicle operations in civilian airspace and allow autonomous operation in conjunction with manned aircraft. These technologies may also be applied as low-cost missile warning sensors to affordably protect military and commercial aircraft from surface-to-air missiles. Also, experimental research in infrared countermeasures is developing threat adaptive techniques for robust defeat of current and future infrared weapons and sensors.

Space Weather research at Hanscom Air Force Base, Massachusetts, is another SAB-rated world-class technology development program. We continue to develop a modeling capability that specifies and forecasts space weather from the Sun to the ionosphere. In conjunction with this modeling capability, our Solar Mass Ejection Imager, launched in January

2003, is greatly increasing our ability to forecast solar-induced ionospheric disturbances that adversely impact communications systems and spacecraft.

At Edwards Air Force Base, California, the Propulsion Directorate is working on world-class research in polynitrogen propellants. The goal is to enable high performance monopropellant rocket propulsion systems with revolutionary performance. By improving the specific impulse of the propellant, we will have environmentally benign exhaust and reduced signatures. This could potentially improve storage, manufacturing, and rocket engine size.

COMBATING TERRORISM

While the traditional focus of S&T has been on developing long-term capabilities, the Air Force S&T Program also contributes to the current needs of the nation and our troops deployed in hostile areas. One example of an Air Force project receiving a great deal of attention since 9/11 is the Elastomeric Coating polymer, which the Air Force developed to protect key buildings and installations from close proximity explosions, such as air dropped weapons or truck bombs. This easy-to-apply spray coating provides greater structural integrity of exterior walls and prevents dispersion of debris as well as separation of wall elements. In addition to protecting lightweight shelters, this polymeric coating is currently being applied to the interior of the outer walls of the Pentagon.

Another transformational effort is the Vehicular Mounted Active Denial System (VMADS). The VMADS is being jointly developed with the U.S. Marine Corps and is a defensive millimeter wave system with many potential applications, including perimeter defense. It is a directed energy weapon that emits a non-lethal, non-damaging beam, which heats up the

skin of a potential adversary when in close proximity to the system. The resulting temporary pain causes the person to flee.

Yet another effort of significant interest is something called PING. PING is a standoff, microwave-based interrogation unit that has reliably identified AK-47s, rocket propelled grenades, and suicide bomber apparatus in field demonstrations. PING operates by illuminating potential threats and then categorizing the return reflected off metallic objects found in a crowd of people using a laptop computer and specialized software to determine specific weapon types. Metallic substructures on weapons resonate at unique, natural frequencies that permit automatic identification of concealed weapons. The PING demonstration unit is vehicle-mounted and can be positioned up to 100 meters away to monitor persons or groups of people entering a checkpoint for concealed weapons. The unit can also be remotely operated. This Air Force S&T program has been briefed to the Army and we are optimistic that PING will rapidly transition into operational use.

In the war on terror, Air Force Special Tactics Combat Controllers are changing the very nature of warfare. By performing operations deep in enemy territory, they help determine who the terrorists are, where their weapons are located, and who the innocent civilians are. Then, they precisely control the elements of airpower to defeat the terrorist threat, while taking care to spare innocent civilian casualties and minimize collateral damage. Then, these same Special Tactics Combat Controllers are there to provide instant battle damage assessment. We call these deep engagements, "Battlefield Air Operations (BAO)."

The Air Force is accelerating new technology to these Special Tactics Warriors in the form of significant improvements to their BAO Kit of equipment. As a result of this Air Force enterprise, our Special Tactics Warriors will soon have a digital machine-to-machine capability

that helps to quickly connect the right aircraft, with the right munitions, guided precisely to the right target, at just the right time, to achieve the desired effect. This new automated process helps to reduce the time it takes to target the terrorist threat, while at the same time reducing human error in the targeting process.

Working collaboratively with the Special Tactics Warriors, the Air Force "BAO TIGER TEAM" has also partnered with a national team of industry to field significant enhancements of increased capability, while reducing the weight and size of the individual BAO Kit equipment. They are performing these improvements by developing, prototyping, testing, building, and fielding these BAO Kit improvements in very rapid spirals. These new BAO capabilities will help to save American lives, and the lives of innocent civilians. BAO provides a revolutionary and highly effective way to combat the terrorist threat.

TRANSFORMATIONAL TECHNOLOGIES

There are many other Air Force technology areas that deserve special mention. Let me highlight just a few examples. As mentioned earlier, there's our transformational communications technology development program, whose laser communications technology efforts promise to increase data transfer rates at least ten-fold compared to current radio frequency communications systems. Additionally, laser communications use a narrow beam, which decreases the likelihood of intercept and increases resistance to jamming. While laser communications have a high potential to revolutionize satellite communications, there are technical challenges to overcome such as precision pointing and tracking, weather constraints, and adapting the equipment for use in space. We continue to work on the technology challenges and are implementing the results of our recently concluded study to determine the best

architecture for implementing laser communications technologies to complement and integrate with radio frequency-based systems.

To increase aircraft survivability and operational efficiencies, the Air Force is developing the F/A-22 and F-35 - Joint Strike Fighter, aircraft that can carry and employ weapons from both external and internal weapons bays. To increase the number of weapons the flight vehicle can fit into its internal weapons bays, part of our investment strategy focuses S&T funding on developing and demonstrating smaller precision weapons.

One of the small munitions currently being flight demonstrated at Eglin Air Force Base is the Low Cost Autonomous Attack System (LOCAAS) technology program. The LOCAAS is a 100-pound class powered munition of which the primary target set is moving and relocatable targets. This Advanced Technology Demonstration (ATD) program will demonstrate the effectiveness and military utility of this type of munition for the Lethal Suppression of Enemy Air Defenses (SEAD), Theater Missile Defense (TMD) Attack Operations, and Armor/Interdiction mission areas. LOCAAS will integrate a laser radar precision terminal seeker with autonomous target recognition algorithms, a multi-modal warhead, Global Positioning System (GPS)/Inertial Navigation System (INS) mid-course guidance, and a miniature turbine engine with a fly-out range of 100 miles.

In Fiscal Year 2005, the Air Force will conduct a cooperative program with the Royal Australian Air Force (RAAF) using the small diameter bomb. A test program on the RAAF F-111 aircraft in Australia is scheduled for the first quarter of the Fiscal Year 2005. This will be an important test for both nations – the U.S. is able to test munitions release at supersonic speeds and Australia benefits from the test results. These results could enable maturation of the computational simulation codes for separation of symmetric and asymmetric miniature weapons,

providing for a reduction in the risk and cost of weapons certification efforts for aircraft with internal weapons bays such as the F/A-22, the F-35 - Joint Strike Fighter, and unmanned combat air vehicles.

To continue the trend of miniaturization of space platforms, the Air Force is also conducting the Experimental Spacecraft System (XSS) series to demonstrate increasing levels of microsatellite technology maturity. Following the successful XSS-10 mission in January 2003, we plan to launch the XSS-11 microsatellite in late 2004. XSS-11 will demonstrate fully autonomous operations and provide experience with command and control in proximity operations to another space object over several months. If successful, this could provide the capability to repair, refurbish, and perform maintenance operations from unmanned microsatellites.

One of the most transformational and quickly deployable technologies available today is command, control, and communications technology, also known as information technology. This technology is at the heart of our Moving Target Indicator Exploitation program, which is developing web-enabled automated tools to exploit data from current and future sensor systems such as the Joint Surveillance face Target Attack Radar System, better known as JSTARS. The effort is focused on four technology areas: ground moving target tracking; motion pattern analysis; behavioral pattern analysis; and sensor resource allocation and scheduling, which provide the capability to track moving targets and get the information to the operations center.

BREAKTHROUGH TECHNOLOGIES

In recent years, we have all come to appreciate the success of unmanned vehicles. We hear over and over again the tremendous operational advantages that systems such as Predator

and Global Hawk are bringing to warfighters from all Services. Over the first two decades of the 21st Century, advances in micro unmanned air vehicles will provide significant additional capabilities to our Armed Forces. Micro air vehicles utilize advances in microscale aerodynamics, electronic miniaturization, munitions, and propulsion to package sensory and weapons payloads into highly reliable, on-demand systems. These systems will provide unprecedented levels of situational awareness in the most severe threat environments. Whether we are operating in urban environments, sensing bio-chemical dispersion through the atmosphere, or looking over the next hill, our troops will have the awareness needed to fight and survive. These systems will provide the persistent intelligence, surveillance, and reconnaissance in high threat environments needed by our troops on the ground and our airmen in the air. When called for, swarms of these vehicles will cooperate together to generate both lethal and nonlethal effects.

In the next 50 years, advancements in nanotechnology will provide the greatest change in how man operates since the invention of powered flight itself. Nanotechnology is a science and a series of disciplines that works at the atomic and molecular level to create structures, materials, and devices through improved molecular organization. By working with elements at the level of nanometer scale, we have access to the building blocks of nature. This will fundamentally change the way materials and devices will be produced in the future. The ability to synthesize nanoscale building blocks with precisely controlled size and composition and to then assemble them into larger structures with unique properties and functions will revolutionize segments of the materials and device industry. The benefits that nanostructuring can bring include lighter, stronger, and programmable materials; reductions in life cycle costs through lower failure rates; innovative devices based on new principles and architectures; nanosensors and nanoprocessors;

and use of molecular/cluster manufacturing, which takes advantage of assembly at the nanoscale level for a given purpose.

Another significant breakthrough technology that will change the way we develop systems is our work in biotechnology. Biology has developed unique materials and processes that may be exploited in non-biological systems. Our research is focused on studying the science necessary to incorporate biological components and organisms into Air Force systems. For example, in biomemetics, we research the adaptation of natural biological sensor in reptiles. The natural infrared sensors in reptiles do not need to be cooled. We hope to adapt this biological process to Air Force sensor applications that normally require cryogenic cooling.

TECHNOLOGY TRANSITION

The majority of Air Force S&T is contracted with industry and universities. This promotes relationships between the scientists and engineers conducting the research and lays the foundation for technology transition. Strong connections between the technology supplier and the end user help speed transition of technology to the warfighter. In addition, the various transition programs in which the Air Force participates further cement this foundation. Air Force technology transition efforts include Advanced Technology Demonstration projects, Small Business Innovation Research (SBIR) contracts, and Cooperative Research and Development Agreements (CRADAs) among others.

The Applied Technology Councils discussed earlier were initiated in Fiscal Year 1999 to foster top-level user involvement in the transition of technology from the laboratory to the system developer to the operational user. As noted, these Councils review and approve Air Force Advanced Technology Demonstration projects and ensure that the Major Commands plan

for the transition of successful technology by tying approved Advanced Technology Demonstration projects to planned Major Command Future Years Defense Program funding.

Another Air Force technology transition tool is the SBIR program, which funds early-stage efforts at small technology companies. These programs serve a defense need, but also have the potential for private sector and/or military market commercialization. A similar program, the Small Business Technology Transfer (STTR) program, funds cooperative efforts involving a small business and a research institution (i.e., a university), a federally-funded research and development center, or a non-profit research institution. Finally, a CRADA is an agreement between a government laboratory and a non-federal party under which the laboratory provides personnel, facilities, equipment, or other resources (but not funds) with or without reimbursement and the non-federal party provides funds, people, services, facilities, equipment, or other resources to conduct specific research and development efforts that are consistent with the agency's mission.

These efforts along with many other programs, such as Dual-Use S&T, Independent Research and Development, Mentor-Protégé, Personnel Exchanges, etc., are mutually beneficial to the Air Force and the contractors and universities with whom we collaborate. Technology transition is a key component of the Air Force S&T Program and is vital to our pursuit of national security requirements.

SECTION 253 STUDY

Section 253 of the National Defense Authorization Act for Fiscal Year 2002, Public Law 107-107, directed the Air Force, in cooperation with the National Research Council of the National Academy of Sciences, to carry out a study to determine the effect of S&T program

changes of the past two years. The Air Force Science and Technology Board (AFSTB) of the National Research Council prepared a written report, which the Secretary of the Air Force forwarded to Congress as directed. The findings contained in this report indicated that overall the Air Force has made considerable progress during the past two years in strengthening its S&T Program. The AFSTB noted that great progress has been achieved in increasing the visibility of the S&T portfolio within the Air Force, but challenged us to continue working to stabilize funding levels, strengthen our workforce, and reestablish the "development planning" process. As the report indicated, however, we have already begun many initiatives targeted towards strengthening these areas and will continue to pursue them in the future. In fact, at almost $2 billion, the Fiscal Year 2005 President's Budget request for Air Force S&T is funded at a level to achieve the distinctive capabilities supporting Air Force Core Competencies. In addition, we have also taken steps to strengthen our scientist and engineer workforce through various recruitment and retention initiatives. Finally, the Air Force has shifted from a threat-based approach to a capabilities-based approach to making investment decisions and providing for requirements generation planning. This transformation will be key to our ability to determine what is necessary to support our defense strategy in the years to come. "Development planning" will be a vital and fully integrated part of the Air Force's new Capabilities-Based Planning process.

CONCLUSION

In conclusion, the Air Force is fully committed to providing this nation with the advanced air and space technologies required to meet America's national security interests around the world and to ensure we remain on the cutting edge of system performance, flexibility, and

affordability. The technological advantage we enjoy today is a legacy of decades of investment in S&T. Likewise, our future warfighting capabilities will be substantially determined by today's investment in S&T. As we face the new millennium, our challenge is to advance transformational and enabling technologies for an Air and Space Force as we continue to move aggressively into the realm of space activities. The Air Force S&T Program provides for the discovery, development, demonstration, and timely transition of affordable technologies that keep our Air Force the best in the world. As an integral part of the Department of Defense's S&T team, we look forward to working with Congress to ensure a strong Air Force S&T Program tailored to achieve our vision of a superior Air and Space Force.

Mr. Chairman, thank you again, for the opportunity to present testimony, and thank you for your continuing support of the Air Force S&T Program.