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SUBJECT: Fiscal Year 2008 Air Force Science and Technology

STATEMENT OF: Mr. Terry J. Jaggers, SES
Deputy Assistant Secretary
(Science, Technology and Engineering)

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INTRODUCTION

Mr. Chairman, Members of the Subcommittee, and Staff, I am pleased to have the opportunity to provide testimony on the Fiscal Year 2008 Air Force Science and Technology (S&T) Program. As the nation adapts to a new security environment filled with unconventional and non-traditional threats, so the Air Force adapts to fight the global war on terror and proliferation of weapons of mass destruction (WMD). The Air Force continues to rebalance and focus its core S&T competencies to anticipate, find, fix, track, target, engage, and assess anything, anywhere, anytime. The Air Force is aggressively pursuing high payoff technologies focused on countering these new threats today, while modernizing our systems for tomorrow. Air Force leadership recognizes the value of its S&T Program to provide a wide range of technology options to enable us to achieve our vision of becoming an integrated Air, Space, and Cyber Force capable of rapid and decisive global engagement anywhere, anytime.

The Air Force Fiscal Year 2008 President's Budget request for S&T is approximately $1.9 billion, which includes $1.7 billion in "Core" S&T efforts with the remaining funds supporting the devolved efforts – High Energy Laser Joint Technology Office and the University Research Initiative. These investments sustain the strong and balanced foundation of basic and applied research and advanced technology development needed to support future warfighting capabilities. This S&T investment portfolio provides Air Force leadership with opportunities to respond quickly to the threats of today and anticipate those of tomorrow. Continued Air Force leadership support of S&T is exemplified in this year's budget request, which reflects a $66M increase over the Fiscal Year 2007 request. This represents a real growth of 1.6 percent.

FOCUSING INVESTMENTS TO COUNTER UNCONVENTIONAL THREATS

Created in response to the Quadrennial Defense Review, our Air Force technical vision guided many of the counterterrorism and counterproliferation initiatives in this budget request. Born from the Air Force kill chain to find, fix, track, target, engage, and assess the enemy in a traditional theater, we have added "anticipate" to the front of this kill chain to capture the need to develop new technologies that predict our enemy's intentions before they act, and "anything, anywhere, anytime" to the end of the kill chain to focus more research in "24x7" tagging, tracking, and locating of terrorists and WMD in what is now a global theater of war.

Anticipating enemy actions is a difficult challenge. Working with the U.S. Special Operations Command, our Human Effectiveness Directorate has a program underway to apply mathematical techniques from economics, psychology, sociology, and market science to quantitatively assess and optimize the impact of information operations in an effort to anticipate enemy leadership intentions. They are conducting basic research to investigate the role of culture on cognition and behavior, applied research to create cultural research tools, and advanced technology development to demonstrate the decision-aids, models, and simulations required by the warfighter. The research goal of the program is to develop tools, techniques, and methods to enable high-fidelity predictive modeling of individuals, groups, organizations, and societies. Our Sensors and Information Directorates are working on near-term efforts to improve Command and Control, Intelligence, Surveillance, and Reconnaissance closed-loop simulation capabilities to better predict our adversary's actions. Focused on object tracking and identification sensor exploitation, plus multiple sensor dynamic management, cross-queuing and global change detection where input from two images is compared to identify differences, the goal is on predictive tracking of space, air, and ground vehicles with automated high confidence

identification. In the near-term, the Predictive Awareness and Network-centric Analysis for Collaborative Intelligence Assessment effort will transition a work station in Fiscal Year 2008 that will integrate multiple analysis, correlation, and fusion systems into a single operator-focused, multi-intelligence fusion and reasoning system. In Fiscal Year 2011, the Commander's Predictive Environment will provide the added capability to predict adversarial strengths, capabilities, and vulnerabilities in order for us to create high fidelity courses of action to continuously shape the battlefield. In the far-term, efforts funded within our basic research program at the Air Force Office of Scientific Research (AFOSR) are already yielding exciting results in our ability to anticipate threats. AFOSR started funding a University of California San Diego effort in Fiscal Year 2002 to study photoluminescence quenching effects in certain polymers to understand how these effects might be used in integrated nanosensors to strengthen our warfighter's ability to anticipate threats. A by-product of this basic research was a low-cost and robust Improvised Explosive Device (IED) detection sensor, currently being commercially marketed for use in field settings such as security checkpoints, stadiums, and amusement parks. We will continue to leverage our knowledge and competencies across the Air Force Research Laboratory in cognition, cultural, and human behavior modeling, sensors, and information to further our understanding of the challenges associated with anticipating the intentions of terrorists and our adversary's leaders…before they act.

Equally challenging is the ability to prosecute the kill chain against "anything, anywhere, anytime." This requires research in tagging, tracking, and locating terrorists or WMD anywhere on the globe "24x7." One project that could facilitate tracking by Unmanned Aerial Vehicles (UAVs) is called Synthetic Interface Research for UAV Systems, or SIRUS. This research in human effectiveness provides visualization methods for decision-making and trend analysis, intuitive control/mission management, and

seamless switching between UAVs. It is expected to be completed in Fiscal Year 2008. A similar effort – Augmented Reality for Collaborative Decision Support –is also expected to complete in Fiscal Year 2008. It uses three-dimensional synthetic overlays allowing users to insert their own tags to automatically track moving objects. In our basic research program, efforts to exploit terahertz frequency radiation are leading to applications in detecting chemical explosives and biological agents to track the proliferation of these materials. This technology can detect hidden objects underneath cardboard, clothing, plastic, and wood, and has the potential for use in searching the contents of containers or searching for hidden devices under clothing. Continued sensors research is leading to development of a multi-sensor modeling database that will provide automatic target recognition and combat identification enhancements to improve Blue Force tracking, as well as the capability to enable future covert targeting and tracking by Fiscal Year 2011. One significant research project begun in Fiscal Year 2006 that will continue in Fiscal Year 2008, identifies distinguishing patterns of behavior characteristics that comprise behavior signatures to enable us to track individuals by their unique behavioral fingerprints, thus aiding in the anticipation of enemy actions. In addition, the Air Force S&T budget request continues to support development of a human measurement and signatures intelligence system for human tracking, targeting, and identification that was started last year. This project will culminate with a demonstration in Fiscal Year 2013 aimed at helping track terrorists remotely, in any terrain, without any direct contact with the individual.

We are also very excited about our research in biotaggants as a transformational technology to counter proliferation and acts of terrorism. Biotaggants attach either a passive identifying material (or taggant) to a biological warfare agent that can then be read by line-of-sight spectroscopy or an active taggant that is activated by radio frequency

energy so it can be read through walls. The use of these new biotaggants will revolutionize our ability to track WMD around the globe. In response to warfighter needs, our Sensors Directorate rapidly developed the Angel Fire electro-optical staring array. Planned to deploy in April 2007, Angel Fire is an airborne wide-area (city-sized), image gathering, persistent electro-optical sensor array that distributes real-time imagery straight to the warfighter. Angel Fire will allow the warfighter to zoom in and observe more closely any area within the collected image cone, as well as allowing playback of significant events, essentially providing a "Google Earth, TIVO-like" capability to monitor areas of interest. Providing a similar capability using radar sensors with an all-weather/nighttime capability, the Goals, Objectives, Technical Challenges, and Approaches-based (GOTChA-based) Synthetic Aperture Radar sensor algorithm development will continue in an effort to provide "24x7" all-weather capabilities to track and identify moving targets by Fiscal Year 2015.

GAME CHANGERS FOR THE NEW SECURITY ENVIRONMENT

The Information Age presents many new threats and requires a new theory towards warfare. Network Centric Warfare, which involves human and organizational behavior, as well as the connectivity of capabilities to achieve effects, provides a new way of thinking – a new mental model. The Air Force is investing in technologies to ensure individuals and systems are linked, or networked, so the right information is delivered to the right person at the right time in the right format. For example, Interim Capability for Airborne Networking, an airborne networking technology recently transitioned to the Joint Surveillance Target Attack Radar System (JSTARS), is being used in current operations as chat rooms between JSTARS and our Joint and coalition warfighters on the ground. The Information Age also has the Air Force embarking on technologies for a new warfighting

medium – the cyber domain. Due to the low entry costs for cyber adversaries, the cyber arena is dynamic with rapid prototyping and fielding of new cyber threats. On September 6, 2006, the Secretary and Chief of Staff of the Air Force directed the establishment of a new operational command for cyberspace. The cyber technologies we are developing within our Information Technology Directorate will provide this new command with similar capabilities as those developed for conventional Air Force employment, such as strike or reconnaissance systems. Technologies being developed will assist in the new command's Network Warfare and include cyber platforms with the mission of destroying incoming worms or viruses, thus bolstering our information assurance capabilities. An example of this is the Lab's Defensive Cybercraft, which essentially acts as a defensive Intelligence, Surveillance, and Reconnaissance (ISR) asset. Additionally, we continue to research game changing technologies that locate and track terrorists in cyberspace. While the Information Age opens up Pandora's Box for unconventional cyber threats, we continue investment in traditional cyber technologies to provide Command and Control, Electronic Warfare, and ISR capabilities.

The Air Force is currently pursuing game changing research to strengthen our nation's aerospace power. One involves reducing the Department of Defense's (DoD's) dependence on foreign oil. As DoD's leading consumer of jet fuel, the Air Force burned 3.2 billion gallons of jet fuel last year or 57 percent of DoD's total consumption. We are currently leading the evaluation of alternative fuels and engine technologies that may lead to greater fuel efficiency and significantly reduce our dependence on oil. The Air Force is supporting development of a synthetic fuel, based on a domestic source, to ensure a stable energy supply regardless of political uncertainties in oil-producing countries or supply disruptions spurred by natural disasters, such as Hurricane Katrina. Our goal is to have 50 percent of our aviation fuel coming from alternative fuel sources by Fiscal Year

2016. As a result, we are currently working to certify Fischer-Tropsch (F-T) fuel for military aviation use. The Air Force recently performed flight tests on a B-52 using a blend of JP-8 and a synthetic fuel derived from natural gas using this Fischer-Tropsch process. By working together, the military and civil market will expand the demand for synthetic jet fuel and make it more economical to produce. The Air Force is also looking at ways to increase aircraft fuel efficiency, including advanced computational fluid dynamics tools to improve aircraft design optimization and reduce drag, and various efforts exploring lighter aircraft structures. In addition, the Highly Efficient Embedded Turbine Engine (HEETE) program is developing fuel efficient engine technologies that support future ISR, tankers, mobility, and unmanned combat air vehicle extreme endurance and range requirements with embedded engines buried behind serpentine inlets and exhausts. Estimated benefits of utilizing these technologies, relative to state-of-the-art Calendar Year 2000 engines, include a 25 percent improvement in fuel efficiency. Another program promoting engine efficiency is the Adaptive Versatile Engine Technology (ADVENT) program. ADVENT is a variable-bypass ratio turbofan engine technology concept that allows efficient engine operation at both subsonic and supersonic speeds. It provides supercruise thrust without after-burner, all using a fixed inlet and/or fixed exhaust configuration. Estimated benefits of this engine, relative to a state-of-the-art Mach 2.5 engine, include a 50 percent increase in engine thrust/weight, with 25 percent subsonic and 35 percent supersonic reductions in specific fuel consumption. Another game changer being explored for lighter aircraft structures involves advancements in composite structures. These advancements are planned to shorten the development time for the next generation cargo aircraft, as well as improve strength, weight, and mission utility over current legacy aircraft. Within our Air Vehicles Directorate, we are challenging the current paradigm of extensive system development time and expense, and we are pushing

the envelope to produce and flight-demonstrate a prototype, sub-scale cargo aircraft in less than two years.

Finally, directed energy is also seen as a game changing technology and includes multiple technologies, both near- and far-term, that will allow several new Air Force applications and missions. Among these technologies are various solid state lasers permitting high energy lasers in small-/medium-sized platforms for offensive and defensive applications, advanced optics to allow high resolution space object imaging and the long-range transmission of laser beams at various power levels, and high power microwave devices and antennas for non-lethal covert electronic attack. The Air Force is currently developing and demonstrating the enabling component technologies required for an airborne non-lethal directed energy weapon. This is a follow-on to the highly successful Active Denial System Advanced Concept Technology Demonstration. We are developing a test capability to enable final validation of a full-power source for this airborne application and efforts will continue to refine existing beam control/antenna concepts to meet airborne requirements to include addressing issues related to propagation and air breakdown. Supporting technologies such as new materials for power and millimeter wave sources; and multi-megawatt, lightweight power generation for these potential directed energy devices are also being developed. Development and transition of these exciting directed energy technologies will continue to provide our warfighters with the best capabilities to defeat the enemy in this new era of irregular warfare.

At the same time, we are focused on combating traditional threats with developments such as improved interoperability between manned and unmanned vehicles; responsive, tactically significant space capabilities; and durable, hardened materials and electronics. The Day/Night EO/IR [Electro-Optical/Infrared] Tracker Countermeasures (DETCM) effort provides aircraft the capability to detect and/or counter passive EO/IR

tracking systems increasingly used by surface-to-air missiles. DETCM would employ laser scanning to detect these threats and incorporate an improved laser-based Closed-Loop Infrared Countermeasures (CLIRCM) technique to defeat the tracking function of the surface-to-air missiles. Successful implementation will significantly enhance aircraft survivability and battlespace awareness. In our Munitions Directorate, we also have efforts in Focused Lethality Munitions (FLM). Conventional bombs pose risks for civilian casualties and infrastructure damage in urban environments. FLMs would allow a highly localized lethal footprint to support military operations in urban terrain. This Secretary of the Air Force high interest item would give the Air Force more flexibility in engaging and prosecuting targets where collateral damage is to be minimized. Additionally, with the increasing numbers of UAVs of all sizes operating in the same air space as manned aircraft, it is imperative that all these aircraft operate safely and without impeding each other. To address this issue, the Air Force is currently developing advanced flight control automation and adaptive algorithms for UAVs; improved aircraft design that will result in less drag, better engine performance, and reduced fuel consumption; photonic sensing and flight controls; and joint air space management and deconfliction software.

We recognize that other nations are developing capabilities that threaten our space assets. Since space dominance has provided an asymmetric advantage to the United States, we are developing technologies to detect these threats, understand the capabilities and intentions of those threats, and protect our space systems from them. One example is the Experimental Satellite System-11, or XSS-11 – a highly mobile, proximity operations effort. XSS-11 is the first fully autonomous microsatellite designed for orbital navigation and inspection around another resident space object. Our microsatellite activities have led to new satellite acquisition concepts, leveraging small satellites to deliver essential capability to the warfighter earlier. The Tactical Satellite-2 (TacSat-2) successfully

launched on December 16, 2006, and future TacSats will add pioneering capabilities, linking the ultimate high-ground closer to the tactical warfighter, and offering solutions to disruptive and catastrophic space threats. Other efforts, such as Airborne Active Denial; protective materials for platforms, sensors, and humans against directed energy weapons; and bio-inspired materials are also being investigated to address emerging disruptive threats as well. An example is the Battlefield Laser Detection System, or BLADES, which allows real-time detection and characterization of battlefield laser threats, including rangefinders, designators, guidance, and blinder threats.

One last area that I'd like to highlight is nanotechnology. Our nanotechnology research involves understanding and controlling matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications. The ability to build things atom-by-atom and molecule-by-molecule will provide for new classes of structural and electronic materials. Nanotechnology will enable Air Force systems to be lighter, stronger, smarter, cheaper, cleaner, and more precise. For example, in nanoelectronics, basic research seeks to understand the techniques needed to control growth of self-assembled quantum structures, connections to the structures, and combinations of both, which will lead to development of quantum computing systems and nanosensor detector systems capable of collecting, processing, imaging, and communicating massive amounts of data with minimal size, weight, and power consumption. In our Materials and Manufacturing Directorate we are developing nano-enabled materials – engineering materials at the nanoscale – that will enable new or dramatically improved functionality for electronic, magnetic, photonic, and structural materials. Our researchers have developed and tested innovative coatings that prevent aircraft corrosion, which will likely decrease life cycle costs, reduce maintenance, and increase readiness by limiting equipment down time.

AIR FORCE S&T GUIDING PRINCIPLES

In 2005, I established five guiding principles for the Air Force S&T Program. Committed to maintaining world-class in-house military and civilian intellectual capital, our number one guiding principle is to value our people. This commitment is reflected in the use of the various flexibilities afforded the Air Force under the Laboratory Personnel Demonstration program or Lab Demo. Additionally, the Scientist and Engineer (S&E) Career Field Management team is developing new leadership development tools and initiatives to vector S&Es into exciting career paths. This team also managed to preserve all Fiscal Year 2007 S&E advance academic degree quotas during a major downsizing activity within the Air Force. In addition, the Air Force considers its involvement in the National Defense Science and Engineering Graduate Scholarship and the National Defense Education Programs (Science Mathematics and Research for Transformation program follow-on) critical towards building our nation's intellectual capital and supporting the growth of future Air Force technical leaders.

Our second guiding principle is to ensure a balanced portfolio between near-, mid-, and far-term S&T investments. As a goal, no less than 15 percent will be allocated to our core 6.1, basic research efforts to ensure we bring to bear the most innovative thoughts to push technology in areas to which we haven't even defined the problem or concept of operation. Alternatively, as a goal, no less than 30 percent of the portfolio will be allocated to 6.3, advanced technology development efforts to increase technology transition successes and real-time support to the warfighter.

Our third guiding principle is to focus our S&T investments, allowing us to demonstrate and deliver technologies that directly meet stated warfighter capability objectives. To ensure a harder link to our capabilities-based planning process, we

continue to build on our new planning framework called Focused Long-Term Challenges, or FLTCs. In their infancy last year, the Air Force has baselined eight FLTCs. While guided by our Air Force technical vision for this budget, these eight FLTCs will serve as the framework to guide most of our 6.2, about 40 percent of our 6.1, and roughly 80 percent of our 6.3 investments on mid- and far-term S&T demonstrations to directly satisfy the needs of the Combatant Commanders and their Components.

Honoring commitments is our fourth guiding principle. We are committed to leveraging and synergizing our S&T investment through our Memoranda of Agreement and similar commitments with our sister Services and Defense Agency partners. Our commitment to the Office of the Secretary of Defense's new Reliance 21 process provides an improved avenue for the Services and Defense Agencies to benefit from each other's S&T investments. In addition, our commitment to collaborations such as the Versatile, Affordable Advanced Turbine Engine (VAATE) program provides innovative cost-share relationships with industry and other agencies such as the Department of Energy. VAATE activities are expected to provide 15 to 25 percent improvement in turbine engine fuel efficiency that not only benefits DoD, but the commercial sector as well. Whether our commitments are with others in the Air Force, our sister Services and Agencies, the Office of the Secretary of Defense, industry, the North Atlantic Treaty Organization, or Congress, you have my word that we will deliver on our commitments.

Last, but not least of our guiding principles is to find new and improved ways of transitioning technology. The Applied Technology Councils, or ATCs, foster top-level user involvement in the transition of technology from the laboratory to the system developer to the operational user. Commissioned by the ATCs, Advanced Technology Demonstrations (ATDs) provide a formal transition path for fielding technology. Integrated Product Teams are now required for each ATD and team members include

users, program offices, and functional organizations, such as Logistics and Test and Evaluation, among others. While the ATD process represents transitions centered on our planning and programming process, we have codified a new method in the laboratory to rapidly prototype and deliver capability to warfighters in a matter of months versus years. This new core process at the Air Force Research Laboratory rallies cross-functional expertise and an innovation center to meet immediate problems in theater. For example, we have conducted work this past year to develop a technology solution to counter helicopter brownout/dust-out conditions (no/low visibility approach for helicopters). Our solution, the Photographic Landing Augmentation System for Helicopters (PhLASH), was recently installed on an MH-53 helicopter and conducted a successful initial flight on February 17, 2007. In the past 25 years, Air Force Special Operations have lost 20 aircraft and 60 lives to mishaps with no/low visibility as a factor. We believe the PhLASH capability will significantly improve the safety of our troops.

In addition, our efforts in the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) and the Manufacturing Technology (ManTech) programs are further examples of programs where we are seeking to improve technology transition. We have made good progress in the SBIR Commercialization Pilot Program and expect significant improvements in the transition of technology, products, and services developed under SBIR. The Air Force appreciates the opportunity provided by Congressional direction authorizing the SBIR Commercialization Pilot Program and we are well on our way to making this program a huge success. The ManTech program recently established a Manufacturing Readiness Level (MRL) "center of excellence" capability that focuses on identifying, tracking, and mitigating manufacturing risks across the acquisition cycle. Coupling these efforts with a focus on more disciplined Systems Engineering in the pre-acquisition planning phases is strengthening the Air Force transition

process, resulting in acquisition programs with the latest technology and more mature technical planning and credibility.

CONCLUSION

The initiatives that I've described will not be without their challenges. Air Force S&T is in a time of great change as we reshape our S&E workforce, retool our processes under the Secretary's Air Force Smart Operations 21 initiative, understand the S&T required as we incorporate cyber defense into the Air Force mission, and move towards a capability-based planning construct using focused long-term challenges. Despite the challenges facing us in Air Force S&T, we are embolden to tackle these head-on as we prosecute the global war on terror and counterproliferation, as attested to by our Air Force Technical Vision. Our Fiscal Year 2008 budget builds on past S&T successes, a future technical vision with a clear focus on the new security environment, and reflects my five guiding principles. Today's Air Force leaders have shown their commitment in supporting an Air Force S&T Program that has served the Air Force well for over sixty years and has positioned itself to meet the challenges of our new security environment. This commitment is clearly shown through the Air Force Fiscal Year 2008 President's Budget request, which consists of over $1.7 billion in "Core" S&T efforts and represents real growth of 1.6 percent.

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.