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SENATE ARMED SERVICES COMMITTEE

STATEMENT OF

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UNDER SECRETARY OF DEFENSE
ACQUISITION, TECHNOLOGY AND LOGISTICS

AND

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BEFORE

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EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
DEFENSE WIDE RESEARCH AND DEVELOPMENT

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Mr. Chairman and Members of the Subcommittee,

We appreciate the opportunity to appear before you today to discuss leap ahead technologies and transformation technologies.

TECHNOLOGICAL SUPERIORITY FOR NATIONAL SECURITY

The Nation relies on the technological superiority of its armed forces. As a result, the mission of the Defense Science and Technology (S&T) program is to ensure the warfighters today and tomorrow have superior and affordable technology to support their missions, and provide revolutionary war-winning capabilities. To do this we must understand the warfighters' needs. Fundamental to understanding those needs is an understanding of the strategic environment in which the warfighter operates, now and in the future.

The global spread of advanced technology is transforming the military threats faced by the United States. In order to carry out our defense strategy, the U.S. military must be prepared to conduct operations in any environment, including one in which an adversary uses asymmetric means such as nuclear, chemical, or biological weapons; information operations; ballistic missiles; and terrorism. Future adversaries will increasingly rely on unconventional strategies and tactics to offset the superiority of U.S. forces. Our combat forces must be organized, trained, equipped, and managed with multiple missions in mind. We must be conscious of these threats as we foster technology breakthroughs that will lead to new capabilities to cope with that environment.

Our vision for the 21st century is a warfighter who is fast, lean, mobile, and prepared for battle with total battlespace situation awareness and information assurance. Our Defense S&T program is focused on providing technologies enabling the weapons and equipment our combat forces will need to meet our strategic objectives in the future. The dawn of the information age has given rise to new revolutionary capabilities sparked by leap-ahead advances. For example, our nation has led, and maintains a significant advantage in the development of information-based technologies. The Department has been actively pursuing improvements such as precision-guided munitions, the Global Positioning System, and satellite communications for decades. We are now only beginning to understand how significantly these information-based revolutionary capabilities will transform the essential elements of U.S. Forces. To succeed across the full spectrum of operations, the Department will develop innovative new concepts for conducting operations, test them through demonstrations, rigorous experimentation, and rapidly transition the enabling technologies into revolutionary war-winning capabilities.

The strength of the Defense S&T program depends directly on the health of its partners. These partners together provide the environment that supports the needs of the warfighter- from the universities that provide new ideas and knowledge; to Service laboratories that provide stability and ties to the operational forces; to DARPA for its commitment to high-risk, high-payoff programs; to other agencies that allow us to leverage our combined resources; to industry which provides innovation and transition of technology; and to our international allies for joint research programs that address interoperability from the beginning.

This statement summarizes the priorities of our S&T program from a corporate perspective. These priorities include:

?? basic research, which provides the Department long-range research into areas likely to lead to advances in national security
?? technology transition programs that move S&T into the warfighter's hands
?? S&T which focuses the current and anticipated future high-leverage S&T efforts
?? enabling capabilities which benefit a broad-range of emerging weapons and human systems; and
?? the health of the S&T workforce, which is one of our biggest non-technical challenges.

BASIC RESEARCH

New military capability and operational concepts emerge from many different sources. Historically, the Defense S&T program has responded to both the known needs for military capability and enabled the development of totally new operational concepts and capabilities. This has allowed us to keep the technological edge on which our forces have relied. It follows that the way to address future warfighting needs is to invest in broad areas of basic research that have high potential of yielding revolutionary advances as well as pursuing solutions to known operational problems. The basic research program provides support for research in the following twelve areas: physics, chemistry, mathematics, computer science, electronics, materials science, mechanics, terrestrial science, ocean science, atmospheric and space sciences, biological sciences, and cognitive and neural sciences.

Basic research is a long-term investment with emphasis on opportunities for military application far in the future and contributes to our national academic and scientific knowledge base by providing approximately 40 percent of the Federal support for all engineering research in universities. The Department sustains its investment in basic research because of proven, significant, long-term benefits to the military, which in turn enhances our national economic security. Basic research provided the foundation for technological superiority in each of our recent conflicts. Radar made a significant contribution to winning World War II. Stealth, lasers, infrared night vision, and electronics for precision strike played a major role in the Gulf War. Our nation's defense advantage is founded on a wide scope of scientific and engineering knowledge. The Department must continue to invest broadly in defense-relevant scientific fields because it is not possible to predict precisely in which areas the next breakthroughs will occur.

TECHNOLOGY TRANSITION

Rapidly transitioning technology from S&T to an operational capability is crucial. Key mechanisms that have been established to improve the technology transition process include Joint Experiments, which are managed by Joint Forces Command, and Advanced Concept Technology Demonstrations (ACTDs), which are managed within the Office of the Secretary of Defense. These programs help to ensure the transition of innovative concepts and superior technology to the warfighter and acquisition customer faster and less expensively. The Joint Experiments program provides a venue to develop and experimentally test new concepts and technologies for the military. The ACTD program is used to determine the military utility of proven technologies, expedite technology transition, provide a sound basis for acquisition decisions, and to develop the concept of operations that will optimize effectiveness. Using this process, it has proven successful in taking matured technologies into the field in prototype systems. Recent successes included the Predator and Global Hawk unmanned aerial vehicles (UAVs).

Most ACTDs address warfighting needs addressed by the Commanders-in-Chief, hence they have strong representation in the process. The program also has strong ties with DARPA. Of the 84 ACTDs that have been initiated since the program's beginning in 1994, 33 of these were based on technology developed by DARPA. The ACTD program also works closely with the Joint Experiments program, which assists in improving and demonstrating ACTD products. To date, 37 of the ACTDs have produced 59 transitional products, 22 of which have proceeded to full-scale hardware acquisition. Transitional products include software developments that have already been deployed with warfighters. Ten ACTD transitional products, including hyperspectral scanners, unattended ground sensors and the Predator, were made available for Operation Allied Force in Kosovo. Using the aforementioned programs, we have greatly enhanced the mechanism to transition prototypes to the acquisition cycle.

KEY TECHNOLOGY AREAS

Over the past decade, the national security strategic environment has changed dramatically. This change in national security threats, and how we should respond to these changes is currently under review throughout the Department. The DUSD (S&T) and OSD recently led a collaborative effort, involving the key S&T leaders from the services, agencies, and OSD to closely examine the impact of the new security threats on what the Department needs from the S&T community. This process led to the identification of some areas we believe we must focus on in order to be effective in our mission in the future.

The needs have been divided into three categories: hard problems, revolutionary warfighting concepts, and militarily significant research areas. "Hard problems" are those areas where there are particularly significant technical challenges, which, if solved, would counter a significant operational or strategic threat. Examples include modeling the dispersion of chemical and biological warfare agents, and detecting and neutralizing hardened and deeply buried targets. Hard problems identify "technology needs" to overcome some particularly difficult security challenges we currently face.

Revolutionary warfighting concepts allow us to develop dramatically new ways of addressing military problems. These are the technologies that will lead to the next generation capabilities. Just like stealth, global positioning system, and night vision devices provided our forces a decisive advantage during Desert Storm, these revolutionary warfighting concepts could lead to the novel capabilities for military forces in 2015.

Finally, are enabling technologies that will improve broad classes of weapon and human systems. Again, these capabilities can be revolutionary, but are broader based than revolutionary warfighting concepts, and include areas like advanced materials and advanced power.

Hard Problems

In recent years there has been an increasing proliferation of chemical and biological agents available to a wider number of adversaries. Technology developments are needed in **chem bio defense modeling and stand off detection** to provide an operational capability to remotely detect and identify potentially toxic chemical and biological agents and to forecast their dispersion through a defined battlespace. We need to focus on developing capabilities in four major areas: detection of biological and chemical agents and toxic industrial chemicals and materials; diffusion and dispersion modeling for predicting hazards; improved understanding of agent toxicity, and increased comprehension of genetic and chemical compositions.

Increasingly, potential adversaries are using buried facilities to protect their delivery systems, weapons of mass destruction, command and control systems and other military capabilities. This is an asymmetric measure to offset US capabilities in intelligence collection and precision strike. Technology developments in **time critical, standoff, and concealed target defeat** are needed to provide an operational capability to safely identify and strike intended targets. Of specific interest is hardened and deeply buried targets, but the list also includes slowly moving targets (such as mobile missile launchers) and concealed targets (such as tanks hidden under trees). This area can be broken down into the following sub-areas where work needs to be focused: finding and characterizing targets through the use of novel sensing technologies, systems and munitions to defeat these "special" targets, and capabilities to assess damage to targets following strike.

The US is faced with an increasing array of asymmetrical threats as potential adversaries learn of our capabilities and weaknesses. Preparing for and countering these asymmetric threats requires us to understand the mind of the adversary and then to dissuade threatening actions or to counter them. Technology developments are needed in **counters to asymmetrical threats** to provide an operational capability to respond to asymmetric threats by improved use of information operations, computational models and group-dynamics/social science theory to achieve “advantageous” shaping of the security environment. Focused areas where technology development is needed include: dynamic indicator databases, social modeling including group dynamics and decision support, and tools for information visualization.

With the proliferation of weapons of mass destruction and capable delivery systems worldwide, it is becoming increasingly important to defend against potential missile defense deep into an adversary's territory. Technology developments in **cruise and ballistic missile defense** are needed to provide the capability to remotely detect, track, and negate cruise and ballistic missile threats, providing a multi-layered defense and reporting capability. We need to work in the areas of: detecting and tracking strategic and tactical missiles through the use of enhanced sensing systems and novel signal processing techniques, advanced systems and warheads to negate enemy missiles, and providing affordable protection, including radiation hardening, for our defense assets.

As threats have evolved worldwide, we are fighting fewer large-scale battles in open areas and more small-scale conflicts in cities. Hence, we are in need of developing new techniques that are suitable for the complexities of urban areas. Technology developments in **military operations in urban terrain** are needed to provide a capability to locate, surveil, discern, engage, and neutralize threat forces within the close confines of an urban environment. We need to work on: enhanced situational understanding of the urban battlefield; improved training and mission rehearsal capabilities appropriate for the new environment; and faster, safer breaching technologies to allow our forces to move more effectively in urban terrain.

Revolutionary Warfighting Concepts

Technology developments in **network centric warfare** are needed to provide the operational capability to increase combat power by networking sensors, decision makers, and mission executors to achieve a shared awareness, increased speed of command, higher tempo of operations, greater lethality, and a degree of self-synchronization. The technology areas that require capability developments include: robust connectivity and interoperability of network systems; assurance that our information systems are secure against attack; operationally responsive and reliable networks; and tools for information understanding and decision support.

Space operations are becoming increasingly important to military operations. Technology developments aimed at **fuller dominance of space** are needed to provide technologies necessary to capitalize on the space mission and provide the United States dominant access to the military high ground that space provides. Nearly all other operational military concepts are aided by dominant access to space, which allows a decisive advantage in command and control of our own forces, coupled with enhanced reconnaissance of enemy position and intent. The technology areas include: affordable space transportation including advanced propulsion and long-lasting power systems; sensing technologies for enhanced space surveillance; space control, including on-orbit servicing; and protection of our assets in space.

Technology developments in **unmanned systems for land, air, space, sea, and underwater** are needed to provide systems that can execute an expanded range of missions in high-risk environments while keeping the warfighter safe. Autonomous systems range from sophisticated unmanned aerial vehicles - such as the Predator which deployed to Kosovo for reconnaissance missions - to miniaturized, inexpensive autonomous systems which can be deployed and operate together in a "swarm" to provide intelligence at "low risk". Capabilities that need to be developed for future unmanned systems can be divided into the following focus areas: enhanced unmanned system control; miniaturization of components; and integration and collective behavior of multiple autonomous systems.

Militarily Significant Research Areas

Speed-of-light directed-energy weapons -- high energy lasers and high power microwaves -- have the potential to perform a wide variety of military missions, including some that are impossible, or nearly so, for conventional weapons. These include interception of ballistic missiles in boost phase, defeat of high-speed, maneuvering anti-ship and anti-aircraft missiles, and the ultra-precision negation of targets in urban environments with no collateral damage. Technology developments are needed in **directed energy** to revolutionize military operations by exploiting the capabilities of directed energy weapons. Novel S&T to increase efficiency, decrease size and logistics, and improve maintainability of lasers and high powered microwave systems is needed.

A continuing challenge to military operations is to generate, store, use, and project electrical and other forms of power throughout the battlespace. Technology developments in **advanced power** are needed to improve the US capability to focus power and energy, in a logistically supportable way. As these capabilities are developed, we will aid transformation of the force into a more maneuverable force that can precisely project power when and where needed. Our work in this area includes the Navy's development of technologies supporting an electric ship, and the Army's development of electric drive vehicles. Some areas where technology development is needed includes: energy storage and release, including novel battery systems and fuel cells; power generation and distribution; and new and refined applications of power technology.

The future military force will be involved in rapid and dispersed operations requiring individuals to work as a cohesive team, yet be capable of operating independently. The implications of this stressful, dynamic environment must be fully understood in order to improve decision-making processes, the training of decision-makers at all levels, and organizational patterns and procedures. Technology developments in the area of **human dimension and psychological factors** are needed to provide the capability to fully prepare all warfighters and support personnel cognitively and physically to conduct assigned missions and operations. The technology developments needed can be broken down into: training - including simulation based, virtual reality and augmented reality tools; decision making support, cognitive engineering to optimize human-information interfaces, and enhancement of performance under conditions of conflict.

Maneuver and self-protection are two enduring principles of military operations that remain true today. The Department remains committed to the development of smaller, lighter, and stronger materials and components that will enable enhanced maneuverability and self-protection by allowing these lighter and stronger systems. Technology developments in **nanoscience and advanced materials** are needed to provide revolutionary opportunities for the warfighter to develop totally new operational concepts and capabilities, based such developments. In a broad sense, the work in this area can be separated into two areas: nanotechnology, which enables very small mechanical systems; and advanced materials which are designed for specific applications, such as embedded computing, novel composities, and nonlinear, nonisotropic "smart" materials.

ENABLING CAPABILITIES

In addition to work in these areas, the Department continues to invest in longer term enabling capabilities that improve a myriad of systems. In each case, the enabling technology research leverages efforts going on in industry. We now describe three major long-term areas of focused R&D.

Propulsion

Military fuel consumption for aircraft, ships, ground vehicles and facilities makes the DoD the single largest consumer of petroleum in the U.S. Existing and emerging technologies are now available at various stages of maturity that could improve warfighting effectiveness through fuel efficiency. These technologies are applicable to the turbofan/turbojet, turboprop/turboshaft, and expendable engine applications, as well rocket propulsion programs. In addition, the rocket propulsion program addresses technologies to support space launch and orbit transfer propulsion (both liquid and solid), spacecraft propulsion (chemical, electrical, and solar), strategic systems sustainment (post-boost control systems, missile propulsion and life issues), and tactical propulsion (solids and hybrids). A working group has been established to formulate a National Hypersonics Technology Plan to spearhead a much more focused government/industry effort to develop hypersonic technologies, which could enable a whole new range of hypersonic air-breathing engines, weapons, and aircraft. All these propulsion programs are joint efforts with the Services, NASA, industry, and defense agencies.

Software

Software continues to grow in importance in our weapons systems as developments and upgrades increase reliance on software to provide the flexibility to meet existing and future unknown requirements. However, problems attributed to software remain a significant contributor to program cost, schedule and performance shortfalls. To address these problems we established a Directorate for Software Intensive Systems (SIS) that promotes and coordinates software related activities within DoD; we convened a Defense Science Board (DSB) Task Force on Software; and we chartered an SIS Steering Group of senior Service executives chaired by the DUSD(S&T) to articulate a Department software vision and guidance to the SIS Directorate.

The SIS Directorate established a coordinated approach to improving software acquisition in four areas: DoD acquisition policy, collaboration among DoD and Service software experts, education and training of the acquisition workforce, and science and technology transition. The initial actions of the Directorate are focused on responding to the DSB Task Force recommendations. The Directorate has absorbed the Software Program Manager's Network and is integrating its products and activities. We are implementing independent expert reviews throughout DoD to help Program Managers identify and manage software risk, and have completed 24 assessments. We are establishing guidelines for software acquisition management education and training of our workforce. We are sponsoring the Capability Maturity Model integration effort for enterprise wide process improvement. Finally, our Defense Software Collaborators provide a forum for communicating software issues and leveraging our scarce resources to address them. The SIS Directorate is a critical focal point for initiatives that reduce software acquisition risk.

Electronics

While the commercial market can be used to meet many of the electronics needs of the military, the Department has unique needs that are beyond the performance specifications needed for industrial applications. The Department has identified those areas where industry is not investing, but where advancement of technology is of key importance to the Department.

Four major thrust areas have been identified. Advances in **electro optics and infrared** technologies are expected to enable improved countermeasures capabilities, and counter-countermeasures capabilities such as the ability to detect camouflaged targets. Investment in **mixed signal** technologies would lead to enhanced performance and versatility through combinations of electronics, photonics, and micro electro mechanical systems (MEMS) technologies. Advances in **radio frequency** technologies (including vacuum electronics and wide band gap technologies) are expected to enable new communication, detection, and other applications with greater range and the ability to discern small targets. Finally, the goal of investment in **radiation hardened** technologies is to enhance protection of DoD's space systems.

WORKFORCE

A challenge facing the DoD today is that of enhancing and maintaining its S&T workforce. The intellectual capital behind DoD technology is the professional workforce in our 84 laboratories and research and development centers, which includes 28,500 Department scientists and engineers. This workforce is down 42% from 1990 end strength of 43,800. The workforce is also aging - the average age of the laboratory technologist is approximately 45 years and over half of the workforce will be able to retire in the next three years. The S&T workforce has been the subject of multiple Defense Science Board studies and independent analyses over the past decade with a common conclusion that this essential and aging workforce must be sustained and modernized - through creative recruitment and retention options - to provide future warfighting superiority within an aggressive commercial market for these skills.

We are working to implement new authorities recently enacted by Congress, including those that give laboratory directors many of the authorities that commercial lab directors have – such as the ability to hire on the spot when an outstanding candidate is identified and the ability to significantly reward employees who have made critical contributions to important programs, and the ability to offer competitive salaries. There are also efforts to look at providing opportunities for outside scientists and engineers to temporarily work in the DoD labs, and for DoD employees to spend time in industry.

CONCLUSION

Mr. Chairman, we wish to thank the Committee for this opportunity to share with you the priorities of our Defense Science and Technology Program.

In peace, technological superiority is a key element of deterrence. In crisis, it provides a wide spectrum of options to the national command authorities and commanders in chief (CINCs), while providing confidence to our allies. In war, it provides an edge that enhances combat effectiveness, reduces casualties, and minimizes equipment loss. Advancing affordable military technology and ensuring that it undergoes rapid transition to the warfighter are critical national security obligations.

Thank you very much.