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STATEMENT TESTIMONY OF

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Mr. Chairman, Ranking Member Langevin, members of the committee, I am pleased to be here today on behalf of the scientists and engineers in the Department of Defense laboratories, as well as the professional systems engineers and developmental test and evaluation personnel who work to conceive, develop, and mature systems early in the acquisition process. There are over 100,000 scientists and engineers performing these functions. These professionals have worked together, along with our partners in industry, academia, other governmental agencies, and allied partners to develop the capabilities and systems that have provided the unmatched operational advantage employed by the men and women of our Army, Navy, Air Force, and Marines, as well as other deployed US and allied personnel.

I also represent the office of the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)). Within the Office of the Secretary of Defense (OSD), ASD(R&E) is responsible for oversight of Department-wide activity from concept to early acquisition. Our Science and Technology (S&T) portfolio includes Basic Research, Applied Research, and Advanced Technology Development. The Research and Engineering (R&E) portfolio includes these budget activities as well as Advanced Component Development and Prototypes (ACD&P). ACD&P covers the technology transition from laboratory to operational use, and investment for prototyping which includes systems engineering and early developmental test and evaluation. Taken as a whole, these functions define the technical boundaries and possibilities of programs early in the Department's acquisition process.

When we step back and look at the capabilities developed and delivered by the Department of Defense research and engineering programs during the wars in Iraq and Afghanistan, I would contend that the nation has received a good return on investment. I will cite three examples of capabilities developed during the past decade that were developed and fielded from our ASD(R&E) programs.

- Foreign Comparative Test program identified and tested the first Mine Resistant Ambush Protected vehicle systems, vehicles that provide dramatically greater underbody protection for passengers.

- Quick Reaction Fund developed the Persistent Threat Detection System (PTDS) and Persistent Ground Surveillance System (PGSS) both of which are tethered aerostat systems that provide constant surveillance around our forward operating bases.

- Rapid Reaction Fund developed and produced the Jungle Advanced Under Dense Vegetation Imaging Technology (JAUDIT), a laser radar system that can map very high resolution topography and identify objects under canopy. The JAUDIT system transitioned to a major acquisition program of record in the Army; renamed Tactical Operational LIDAR (TACOP). As a next generation improvement to JAUDIT, TACOP is deployed operationally in Afghanistan today.

The Defense Advanced Research Projects Agency (DARPA) and the Services have also developed and fielded a myriad of capabilities for our warfighters. For instance:

- DARPA created and fielded a wide range of highly effective tools including the High Altitude LIDAR Operational Experiment (HALOE), a sensor that delivered three-dimensional views of the battle space to operational and intelligence users, and the Vehicle And Dismount Exploitation Radar (VADER), a radar pod that aided in the tracking of threat vehicles and adversary dismounted personnel.

- The Marine Corps Program Manager for Expeditionary Power deployed the Ground Renewable Expeditionary Energy System (GREENS), a portable hybrid photovoltaic/battery power system that contains stackable 1600-watt solar arrays and rechargeable batteries combined to provide 300 watts of continuous electricity while in remote locations – reducing the need for fuel resupply.

- The Air Force S&T program delivered Blue Devil Block 1, an intelligence, surveillance, and reconnaissance (ISR) asset. Blue Devil began as a response to satisfy multiple Joint Urgent Operational Needs (JUONs) and was delivered to theater in less than 280 days. It is the only ISR asset that integrates both wide and narrow field-of-view high definition day and night sensors. These technologies provide near-real-time information to troops while simultaneously providing forensic information to analysts. The Blue Devil ISR platform has now flown thousands of sorties and saved countless American, coalition, and civilian lives in Afghanistan.

- The Army's Clinical and Rehabilitative Medicine Research Program (CRMRP) made great strides in wound repair and organ/tissue regeneration. To date, ten hand transplants have been performed on six patients. CRMRP currently has burn repair technologies in clinical trials with industry partners to meet military needs.

These examples are only a few of the technologies we provide to the forces deployed in theater. These technologies have given our military unprecedented protection and situational awareness to address the counter-insurgency first we face today. The research and engineering community has performed remarkably to provide new and focused capabilities to our warfighter over the past decade and will continue to provide them into the future.

CHANGES IN SECURITY LANDSCAPE

Over the past decade, the nation and Department have been at war. The Department is now entering a new strategic period and the budget reflects changes in our mission. The strategic situation was well summarized by President Obama in the forward to the Defense Strategy "Sustaining Global Leadership: Priorities for 21st Century Defense." On January 3, 2012, President Obama said in the forward to the strategy:

> *"As we end today's wars and reshape our Armed Forces, we will ensure that our military is agile, flexible, and ready for the full range of contingencies. In particular, we will continue to invest in the capabilities critical to future success, including intelligence, surveillance, and reconnaissance; counterterrorism; countering weapons of mass destruction; operating in anti-access environments; and prevailing in all domains, including cyber."*

On March 15, 2013, Secretary Hagel directed senior leaders to conduct a review to examine the choices that underlie the Department of Defense's strategy, force posture, investments, and institutional management. While Secretary Hagel has directed this review, the "Sustaining Global Leadership" document drove the development of the FY 2014 President's Budget Request just transmitted to Congress. The current budget challenges are forcing a review of the strategy but the S&T investment is crafted to address the still valid strategic challenges.

Secretary Hagel addressed the National Defense University on April 3, 2013. In this address, he highlighted the need to invest in technology during periods of austerity. He said:

> *"As the military grappled with incredible challenges to morale and readiness after Vietnam it also made the transition to an all-volunteer force and protected key investments in technologies like stealth, precision weapons, and platforms like the F-16 and Abrams tank. Even during the 1990s procurement holiday, we invested in satellite guidance and networking systems, as well as remotely piloted aircraft that have been game-changers during the last decade of war. The goal of the senior leadership of this Department today is to learn from the miscalculations and mistakes of the past drawdowns, and make the right decisions that will sustain our military strength, advance our strategic interests, and protect our nation well into the future."*

While the future budget situation is uncertain, the emerging national security challenges are stressing the Department in ways that we have not seen in a number of years. These current challenges need to be dealt with, in spite of a declining budget. I will cite five emerging security challenges that the United States and our allies be prepared to address. They are:

- The instability in Syria, a state with weapons of mass destruction that could fall out of state control;
- The continued development by North Korea of its nuclear weapons and missile programs;
- The emergence of very sophisticated "anti-access, area-denial" capabilities in a number of nations that could prevent the freedom of movement and access of the US and our allies;
- The emergence of sophisticated cyber exploitation and attack; and
- The existence and increase in sophistication of advanced electronic attack capabilities of some of our adversaries.

While there are other emerging security challenges, each of the five challenges listed have strong technical challenges that should be addressed by the entire S&T enterprise.

SCIENCE AND TECHNOLOGY OBJECTIVES

The guidance is clear; the President and the Secretary of Defense depend on the S&T community to make key contributions to the defense of our nation. Those contributions can be summarized in the following three objectives:

1. Mitigate new and emerging capabilities that could degrade U. S. (and allied) capabilities

2. Affordably enable new or extended capabilities in existing military systems

3. Develop technology surprise through science and engineering applications to military problems

Each of these three objectives is important and is listed in order of priority. Collectively, the Services and Defense Agencies work together to address each of these objectives. The first objective is aligned with defense of the homeland. The second objective addressees DoD's need to make every system we own and buy more affordable. The final objective, after we ensure the defense of the homeland and the affordability of our current and future systems, is to develop new concepts and technologies that create technology surprise. Pursuing these objectives form the basis of a new strategy in response to the evolving security situation.

On April 19, 2011, then Secretary of Defense Gates approved seven S&T priority areas. These priorities are still valid, and support our emerging strategy. While each priority has elements for all of these objectives, three of the seven S&T priorities most strongly support mitigating emerging threats—Cyber, Electronic Warfare (EW), and Countering Weapons of Mass Destruction (C-WMD). One of the priorities, Engineered Resilient Systems (ERS), is directly aligned with affordability, and the final three focus on developing technology surprise—Autonomy, Data to Decisions, and Human Systems.

A key element of the S&T Defense enterprise are the Priority Steering Councils (PSCs) which are groups of Senior Executive Service members from each of the Services and Defense Agencies with investments in a technical area who work together to develop an integrated plan for their areas. Each of the seven S&T priorities has a PSC. We will describe the groups in more detail later, but these PSCs are integrating programs in technical areas across the enterprise.

A final element of the emerging strategy is to develop a better integrated R&E program across the entire Department. The job of OSD is to coordinate, integrate, and if possible, optimize the total Department-wide program. The Components do a good job developing Service-unique systems. We want OSD to focus on the technical areas where multiple Components have a substantial investment and provide coordination, integration and if possible, optimization across the Department. These technical areas align with areas no one owns but everyone uses. This includes space, cyber space, the electromagnetic spectrum, communications, and other specialty areas like materials science.

Objective 1: MITIGATION OF EMERGING THREAT

For a number of reasons, we are seeing an increase in the type and complexity of foreign systems and capabilities that could threaten the Department's ability to perform its missions. Examples of the new threats include, but are not limited to, cyber threats, advanced electronic warfare systems, counter-satellite systems, and proliferating short- and medium-range ballistic and cruise missiles. In addition, old threats, such as weapons of mass destruction (WMD), become more acute when tied to extremist terrorist groups. The R&E community must deal with all of these emerging threats. Many of the specific emerging concepts are classified, but we can make some general comments on how the Department is addressing the challenges. We will address several areas.

a) CYBER

The National Cybersecurity Coordinator, Michael Daniel, explained,

"The government's senior-most civilian, military, and intelligence professionals all agree that inadequate cybersecurity within this critical infrastructure poses a grave threat to the security of the United States. Most recently, we have seen an increased interest in targeting public and private critical infrastructure systems by actors who seek to threaten our national and economic security."

In 2011, we established the Cyber PSC to focus the Department's investment. The Cyber team is led by the Technical Director of the Air Force Research Laboratory in Rome, New York with representatives from the Naval Research Laboratory, U.S. Army Communications - Electronics Research, Development and Engineering Center, the National Security Agency, and OASD(R&E). This PSC is attempting to integrate the investments of all three Services, DARPA, and others into an integrated program. Across the Department, we estimate the investment in Cyber related S&T to be roughly $500M in FY 2014.

The PSC has focused Cyber S&T investments into six areas:

- Foundations of Trust - Establishing foundational authentication, confidentiality, identity, attribution, and authorization services that support secure DoD operational use of cyberspace.

- Cyber Resilience - Having the ability to absorb damage and ensure continuity information technology in support of mission operations even in the face of successful and widespread cyber-attacks.

- Cyber Agility - Ensuring that systems can adapt and maneuver very rapidly in their configurations or location. By being a moving target in cyberspace, agile operations make successful attacks from our adversaries much more difficult.

- Assuring Effective Missions – Allowing commanders, decision makers, and operators to evaluate options, tradeoffs, and outcomes to enable the orchestration of cyber elements in support of kinetic and cyber missions.

- Cyber Modeling and Simulation - Developing M&S capabilities that are able to simulate the cyber environment in which the DoD operates and enables a more robust measurement, assessment and validation of cyber technologies.

- Embedded, Mobile, and Tactical - Focusing on unique cyber security challenges of the Department's weapons platforms and systems beyond wired networking and standard computing platforms.

I also want to highlight efforts that we are using to accelerate cyber as a science. The Cyber Measurement Campaign invests to develop new analytical methodologies, models, and experimental data sets to establish metrics to measure a system's state of security. Massachusetts Institute of Technology Lincoln Labs (MIT-LL) is the ASD(R&E) designated study lead for this cross-federally funded research and development center collaborative effort to start the campaign, determine its direction, and perform initial experiments in the areas of resiliency (Phase 1) and moving target technologies (Phase 2). Phase 1 goals were to demonstrate experiments to measure and quantify resiliency with mature research prototypes. Phase 2 is focused on moving target technologies, and will be evaluated during this year's Terminal Fury exercise at United States Pacific Command (USPACOM).

b) SPACE

As with Cyber, the last 5-10 years could be described as an era when the United States space constellation has become more vulnerable. Electronic jammers present challenges for U.S. global positioning, and communications satellites. Both the United States and China have demonstrated missiles against low-earth orbiting satellites. Other threat capabilities have left the U.S. in a position where we must better protect our space capabilities. Again, there are no easy answers to deliver capability, so we need S&T. In FY 2014, the Department plans to invest approximately $550 million in Space S&T. While not all encompassing, our preliminary analysis shows three areas do need attention: precision navigation and timing (PNT), enhanced communications, and space resiliency. The first two are areas where, with S&T, the United States can reduce dependence on our current space architecture; the third area will begin the process of providing a new architecture.

1. Enhancement of Precision Navigation and Timing

The first area of engagement by the Department includes numerous activities to enhance the robustness of PNT. Currently, PNT capabilities are delivered primarily through the Global Positioning System (GPS), a system vital to numerous missions, ranging from conducting precision guided weapon strikes to synchronizing our communications networks. In an anti-access/area (A2/AD) denial scenario, it is reasonable to assume an adversary will seek to degrade or deny our use of GPS. The GPS program of record is pursuing modernization to further

improve the anti-jamming and secure access of the military GPS signals. These vital efforts must continue.

At the same time, the DoD S&T program is providing alternate means to provide PNT for our forces. For example, cross-Service efforts are in progress to develop next generation Inertial Measurement Units to reduce their inherent drift thereby increasing operational time and effectiveness in a GPS-denied environment. Army labs are pursing efforts in relative navigation that will enable a combat team to determine their position even if only one element of a team knows its actual position. DARPA and the Navy are leading efforts to reduce the size of atomic clocks to bring GPS-quality precision timing into smaller systems. Additionally, we've reinvigorated efforts using non-GPS external references like ground/terrain features, RF signals, and stars -- each excelling for certain applications. These near- and far-term efforts are not intended to replace GPS. Instead they will provide robustness in environments where GPS-based capabilities are being degraded or denied either by environmental factors or adversary action.

2. Enhancement of Military Communications

Military operations depend on voice and data communications networks that have robust reliability that exceeds most civil communication infrastructures. Unfortunately, much like PNT, sophisticated adversaries could degrade our space-based communication networks. The S&T community is working to provide other options for secure communications to our operational forces. Robust, cyber-protected and adaptable networks are needed in all domains, as high-priority traffic travels in surface, air and space layers to achieve reliable connectivity.

To better understand assured communications, we have matured or initiated several efforts, including:

- The Battlefield Airborne Communications Network (BACN); is a Rapid Reaction Fund effort that has turned into an enduring podded capability to augment satellite communication, fielded in Afghanistan and headed to Pacific Command.

- The SpiderNet/Spectral Warrior program to enable spectrum awareness by network operators while we continue to assess the resiliency and control of space communications assets aimed at offering increased survivability and effective reactions within A2/AD conditions.

We are conducting a series of reviews with the Services to examine the need for alternative means, such as hosted payloads, new orbits, and layering of communications pathways across air and ground domains. One capability included in the FY 2014 budget is the Asymmetric Broadband Command & Control (ABC2) demonstration, an Iridium-based 'leave-behind' prototype that should assist in portable polar coverage in areas that traditionally experience sporadic and unreliable communications.

3. Enhancement of Space Launch Responsiveness

Finally, our current space architecture is comprised mainly of large satellites that may be vulnerable as some nations have demonstrated the capability to shoot them down. Again the S&T program should provide options. Recent technology developments, such as high resolution, small imaging focal planes, micro-inertial control systems, miniaturized thrusters and software programmable telecommunications, provide opportunities for DoD to employ low-cost, small satellites, ranging in the 10's to 100's of kilograms. When coupled with low cost launch systems this could enable an entirely new space architecture.

We have invested in two Joint Capabilities Technology Demonstrations (JCTDs) to examine these concepts. The Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS) JCTD provides a low cost, quick and predictable launch system for the Combatant Commanders and is capable of responding to urgent requests for augmentation of imagery or communications support. The Kestrel Eye JCTD provides the capability to deploy multiple imaging satellites to provide near-real-time situational awareness to the ground component warfighter. The major benefit of Kestrel Eye is the ability of the satellite to be tasked directly by the lowest echelons of command. This benefit is achievable since the satellite is expected to have a low per-unit cost (<$1.5M) in production. With this low cost, sufficient numbers of satellites could be made and deployed to provide assured access, on-demand to the warfighter. Coupled together, these two JCTDs provide a glimpse of the future of affordable responsive space.

While constellations of small satellites cannot completely replace our need for the main-line Defense and Intelligence spacecraft, our ability to rapidly launch and, if necessary, quickly replenish constellations of small satellites to maintain essential warfighting capabilities could deter potential adversaries.

c) ELECTRONIC WARFARE/ELECTRONIC PROTECTION

The third emergent threat area is electronic warfare (EW) and electronic protection (EP). Simply put, the convergent maturation of multiple technologies has resulted in significantly new EW capabilities. The technologies include:

- Digital electronics
- New microelectronics providing increasing bandwidth, reliability, and agility of sensing systems including radar
- Digital/analog converters
- Photonics

These technologies can, through direct adaptation, provide potential adversaries capabilities that, in some case, could present operational challenges to U.S. forces and systems. Such developments, combined with longer range stand-off weapons and sheer numbers of jammers and decoys, represent a substantially different challenge for our forces, which for decades have routinely enjoyed virtually uncontested dominance in the use of the

electromagnetic spectrum. If left uncontested, this situation could result in circumstances that negate the value of some of our most expensive and sophisticated sensors and weapons.

As with cyber, the Department established the EW PSC, led by the Air Force with senior leaders from all the Services and OSD to guide and focus Departmental investments in EW. The EW PSC has been meeting to aggressively address the threats with a roadmap for coordinated development of EW capabilities. Within ASD(R&E) our Electronic Warfare and Countermeasures Office, in conjunction with the Research, Development and Acquisition (RDA) Task Force, initiated several efforts to regain U.S. dominance of the electromagnetic spectrum.

New emphasis is being placed on research and development to regain U.S. electronic component superiority to mature the next generation of electronic and photonic components with performance exceeding that of commercial-off-the-shelf (COTS) devices and to demonstrate these components in EW systems. To augment a substantial on-going EW S&T investment, the Department launched a pilot effort in FY 2013 to explore technologies that are essential to the superiority of future U.S. EW systems. EW S&T research, at the component and system techniques levels, is vital to the development of new, modern electronic attack and protection technologies for the future. Hand-in-hand with those key developments will be having the advanced testing equipment to facilitate the development of future EW systems.

Test capabilities should adapt to the reality of adversary sensors and weapons systems with advanced electronic components. In FY 2014, the Department has increased investment by $480M over the future year defense program to provide major upgrades of our testing facilities to include advanced radar sensors to represent the digitally reprogrammable systems our potential adversaries are fielding. Not only do we need to test against advanced sensors but also we anticipate enemy weapons systems will be networked with sophisticated command and control functions. Upgrades to our test facilities will provide our advanced platforms with the signal densities from multiple netted sensors that they would expect to encounter in combat. These upgrades are not exclusive to open air ranges, although, that represents a significant investment. We are upgrading laboratory and anechoic chamber capabilities to the point that we will be able to employ electronic attacks and EP in software in the lab with threat representations validated by the intelligence community. As testing progresses through the lab, to the chamber, and finally to open air testing, we will progressively insert hardware in the loop while maintaining consistency in the signal environment.

d) COUNTER WEAPONS OF MASS DESTRUCTION

The final PSC in the emerging threat area, C-WMD, is focused on advancing the Department's ability to locate, secure, monitor, tag, track, interdict, eliminate, and attribute WMD weapons and materials. In FY 2014, the Department plans to invest approximately $87 million in C-WMD. This investment only represents the funding aligned with finding loose fissile material. The Department recently concluded an interagency planning effort to define a robust S&T program to establish the science, technology base, and intellectual capabilities needed to support current and future C-WMD operations. Since 2011, the effort has been narrowly focused on finding and following nuclear materials. However, the products produced by the PSC to identify threat signatures and alternate ways of thinking about C-WMD, have

broad applications across the nuclear, chemical and biological domains. The Defense Threat Reduction Agency (DTRA) is the principal research agency in this domain and has support from all of the Military Departments and several Defense Agencies in performing and supporting relevant foundational research. Because DTRA is also a combatant support command, there is strong connectivity between the technical and operational challenges for this important mission. The DoD S&T program coordinates and collaborates with critical stakeholders, including the National Nuclear Security Agency, the Department of Homeland Security, and the Department of Health and Human Services. We also work closely with international partners in areas of mutual interest.

The S&T support in C-WMD ranges from fundamental research in the physical and biological sciences to more applied research for mitigating the WMD threat. The latter includes technologies for actively countering WMD weapons, sensors and personnel protection for chemical, biological, radiological, and nuclear (CBRN) threats, modeling and simulation of WMD effects, and medical countermeasures against chemical and biological threats. DoD S&T also develops tools for use in reach-back response to chemical, biological, or nuclear hazards. Technically, S&T continues to improve our detection and advanced sensors, both active and passive, and novel combinations of acoustic, radio-frequency, optical, and infrared sensing that may provide definitive detection and characterization and network analysis.

Objective 2: AFFORDABILITY ENABLES NEW OR EXTENDED CAPABILITIES INTO EXISTING MILITARY SYSTEMS

The second objective focuses on affordability, which includes affordability of new systems and their life-cycle upgrades, interoperability between existing platforms, and design and prototyping of new systems. All levels of leadership in the Department clearly understand the need to be thoughtful about each and every dollar we request and to carefully assess and justify the criticality of every item in our budget. As the Department shapes its future plan to reflect fiscal realities, it will continue to focus on efficiency and affordability in everything we do. Acutely aware of budget pressures, a key piece of our strategy is to make the most of our shrinking portfolio with the Better Buying Power Initiative. Our approach has been to maximize our investment dollars by improving design capabilities and making the transition of technologies to acquisition programs more effective and timely.

a) ENGINEERED RESILIENT SYSTEMS

One area where the Department has specifically focused attention on S&T to improve efficiency has been on the design process itself. As stated previously, one of our seven S&T priorities is ERS; an S&T objective that organizes work across the Department focused on rethinking the way we design and develop systems and to explore new concepts, tools, and processes to allow complex design to occur faster, smarter, and more cost-effectively.

The Department's investments in ERS form the bridge between S&T and future engineering and test capabilities that aim to make our warfighting systems more affordable and interoperable. In FY 2014, the Department plans to invest roughly $470 million in ERS. The

S&T investment in ERS is focused on infrastructure, information, design and decision support tools, and knowledge environments that:

- Increase the speed of system development
- Improve effectiveness of fielded systems
- Minimize lifecycle costs

S&T efforts include integrating physics-based models with acquisition, quantifying the effects of architecture changes on system cost and performance, and automating trade-space analyses. ERS will leverage Department investments in human systems and data to decisions (D2D) to improve knowledge management and training during the entire lifecycle. By 2022, the goal of ERS is to achieve:

- A 75% reduction in the time to complete systems by reducing rework;
- A 100-fold increase in the number of parameters and scenarios considered in setting requirements prior to Milestone A;
- Quantified adaptability to changing mission requirements; and
- Integrated producibility and lifecycle concepts across acquisition

The Director of the U.S. Army Engineer Research and Development Center leads the ERS initiative with support from all the Components. The ERS lead monitors existing S&T programs, progress toward ERS goals, and identifies gaps in the S&T portfolio related to ERS.

b) SYSTEMS ENGINEERING INITIATIVES

Within the office of ASD(R&E), DASD(Systems Engineering) and DASD(Developmental Testing and Evaluation) perform additional functions mandated by the Weapon Systems Acquisition Reform Act of 2009. Each of these offices has considerable influence on acquisition success by ensuring that large acquisitions programs are properly planned, include appropriate engineering efforts to map requirements into technical specifications, realize those specifications in product and sufficiently test those products throughout their development. Both of these offices have undertaken significant initiatives to address acquisition affordability by ensuring better technical planning even earlier in the acquisition lifecycle – by engaging programs at the pre-milestone A stage.

The ASD(R&E) Systems Engineering office has led the Department's implementation of development planning, increasing early acquisition program planning and enabling the Department to make more informed early investment decisions based on a better understanding of technical risks and opportunities. DASD(SE) established the Development Planning Working Group (DPWG) in FY 2011, involving key requirements and acquisition stakeholders from across the Military Departments, OSD and the Joint Staff to ensure a common understanding and consistent implementation of development planning across the Department. The DPWG has been effective in developing clear guidance on early phase technical planning, providing sponsors and programs with a roadmap of how to better formulate and execute effective program plans from a program's beginning. With direct support to pre-major defense acquisition program, DASD(SE) has helped establish programs with realistic requirements, shape technical

strategies, and support a robust Analysis of Alternatives (AoA) process that assesses technical risks in areas such as reliability, maintainability, manufacturing, and schedule. DASD(SE) has worked directly with program offices to develop their Systems Engineering Plans, shape the Technology Development (TD) phase technical approach, and review the program's draft requirements, enabling informed requirements trade decisions that balance cost and performance and properly manage technical risks. By engaging programs early through development planning, DASD(SE) has helped to make the Department's senior leadership more informed about early acquisition investment decisions and more effective in planning and executing programs.

c) DEVELOPMENTAL TEST AND EVALUATION INITIATIVES

The DASD(DT&E) office has initiated an effort, entitled "shift left" designed to engage acquisition programs earlier in the life cycle, thereby ensuring a better understanding of program technical risks and opportunities before major milestone decisions. The basic premise of "shift left" is to find and fix problems before entering production. This should save money. There are three key focus areas to the "shift left" concept: earlier mission context, earlier interoperability testing, and earlier cyber security testing. Improved DT&E moves beyond the traditional technical focus to include testing in the mission context to characterize capabilities and limitations. Robust DT&E should also include all of the elements of interoperability and cyber security testing that previously was not tested until late in the acquisition life cycle.

DASD(DT&E) will focus attention on these areas and work with the Program Manager, Chief Developmental Tester, and Lead DT&E Organization to address these issues when they assemble the Test and Evaluation Working Integrated Product Team (WIPT) and write the Test and Evaluation and Master Plan. In the areas of interoperability and cyber security, DASD(DT&E) is working with all stakeholders to insert needed testing early and define the right way to oversee these processes. It is important that we be clear in our intent: our objective is to establish processes to oversee the developmental testing activities that support certification, not oversee the certification process. Simply put, DASD(DT&E) is working hard to improve the Service developmental testing functions.

d) DATA REUSE

The final specific area I would like to highlight is enhancing affordability through data reuse, led by the Defense Technical Information Center (DTIC). DTIC has the responsibility to develop, coordinate, and enable a capability to store, reuse, and apply technical information, data, and knowledge. DTIC has made tremendous strides in the past several years to evolve from a library function to an information exchange function, and in so doing has increased their support of the entire DoD R&E program. In this role, DTIC fosters information exchanges, empowers innovators with greater efficiency, effectiveness, and agility that supports accelerating the delivery of warfighting technology. The FY 2014 budget request for DTIC is $56 million.

DTIC connects scientists, engineers, researchers and warfighters by enabling the R&E community to build on past work, collaborate on current challenges, avoid duplication of effort, accelerate fielding solutions at reduced costs, aid decision makers, and support management of the S&T Enterprise. DTIC registered 6,857 new users and supported 3,771 average monthly

active users in 2012. These new and returning users have increased usage of DTIC collections by 20%.

Bringing together the mix of performers in the lab, operational, and acquisition communities can pose technical and cultural challenges. Colleagues are separated by geographical and organizational structures. DTIC's information sharing efforts extend beyond official reports, to include researcher provided insights, areas for questions and answers, industry capabilities, and communication of DoD strategies and opportunities to industry. DTIC works to break down barriers by providing tools to support organization-to-organization connections and person-to-person interactions. Tools like DoD Techipedia hold an online electronic encyclopedia of knowledge and provide a platform where organizations can share information on challenges and needs. The Acquisition, Technology and Logistics community uses DoD Techipedia to support management of Major Defense Acquisition Programs (MDAPs). Another recently developed tool is called DoD TechSpace, a tool similar to Facebook, which allows teams to connect on work issues, share ideas, and link to experts.

To support our diverse stakeholder community, DTIC ensures appropriate users have easy access to relevant content while protecting sensitive data through information security, cyber security, and intellectual property safeguards. In support of the Better Buying Power initiative, DTIC develops tools to analyze and visualize Independent Research & Development (IR&D) investments for DoD decision makers to strategically invest scarce resources.

Objective 3: DEVELOPMENT OF NEW CAPABILITIES (TECHNOLOGY SURPRISE)

While the Department's S&T program is mitigating emerging threats and striving for greater affordability, completing just these two objectives is not satisfactory by itself. If all we do is react, the Department does not lead change. A critical component in the Department's ability to develop new capabilities is its investment in a wide range of basic research and applied research in new areas that have the potential to transition into major new technologies and capabilities. DARPA lives in this space. Objective 3 tends to be mid- to long-term focus and includes areas like quantum sciences, synthetic biology, engineered nano-materials, and many others.

I will start with the Department's investment in basic research, move through three PSCs that are focused on new capabilities (autonomy, D2D and human systems), discuss a special area, medical science, and then close with a new effort, to be hosted at DTIC, to better provide for technology watch/horizon scanning of emerging technical areas.

a) BASIC RESEARCH

The Department's Basic Research program has a long-standing history of investing in multidisciplinary and transformative research by leading scientists and engineers. The strength of its program is its ability to invest in research areas that have been identified as a priority to the DoD. The FY 2014 President's Request of $2.2 billion with actual real growth compared to

inflation, highlights the importance and strong investment that the DoD places in its basic research program. This investment supports literally hundreds of individual grants.

While the Department invests heavily in traditional basic research areas like chemistry and material sciences, the Department also actively examines and assesses the global scientific landscape to identify emerging scientific research areas that may develop into game-changing technologies in the future. Some of these areas that we are focusing on for the future include:

- Synthetic Biology, where novel products in diverse areas such as bio-fuels, bio-sensors, vaccines, programmable devices, and high-strength materials.

- Quantum Information Science, whose applications might lead to new forms of secure communications, greater precision in the measurement of time and location, and simulation leading to development of new classes of materials.

- Cognitive Neuroscience, where increased understanding of brain function can inform researchers about human learning, decision-making, effective training methods, and the effect of stress, sleep, and post-war trauma on our military personnel.

- Understanding Human and Social Behavior, which can further our understanding of how individuals, groups, and nations work to enhance strategic and tactical decision making, improve immersive training and mission rehearsal, and facilitate cross-cultural coalition building.

- Novel Engineered Materials, such as superconductors, metamaterials, plasmonics and spintronics, which can be designed to provide novel coatings, self-healing properties, energy efficiency, and improved detection and computational capability to existing materials.

- Nanoscience and Nanotechnology, where increased understanding of material properties at the nano-scale can open doors to new classes of electronics and sensors, chemical catalysts, high-strength materials, and energetic properties.

In FY 2014, we are migrating the Historically Black Colleges and Universities and Minority Institution (HBCU/MI) program back to an OSD budget line, and re-categorizing the investment as basic research. The HBCU/MI research and education program strives to build the capacity of HBCU/MI to perform world-class research, as well as to involve students in that research to foster their interest in pursuing careers in science, technology, engineering, and mathematics (STEM) disciplines. As part of our administration of that program, we continually look for ways to increase the participation of HBCU/MI and ensure that we involve these institutions in activities of mutual benefit to them and DoD. Among our efforts during this past year was a very successful workshop where we brought together HBCU researchers from over 30 universities and their technical counterparts in the DoD research offices in a forum that allowed the researchers to talk about their research and understand DoD research priorities. We also seek to ensure that the research and education role of HBCU/MI is recognized as an integral part of the Department's larger research agenda by taking into account HBCU/MI viewpoints

and capabilities as we develop initiatives and address challenges for the longer term. In FY 2014 we plan to increase our HBCU/MI's investment to support the development of Centers of Excellence at HBCU/MI around cutting-edge research areas, such as cyber-security, autonomy, and D2D.

Since its inception in 1992, the DoD HBCU/MI program has funded over 750 research and education grant awards, including awards for investigator-initiated research and awards to acquire equipment and instrumentation. More than 160 HBCU/MIs received these awards, which totaled over $350M. The 150 funded HBCU/MI included 75 percent of the designated HBCUs (76 out of 103) and about 85 percent the Tribal Colleges and Universities (30 out 35), with most of the remaining awards going to Hispanic-Serving Institutions.

b) AUTONOMY

Autonomous technologies enable DoD warfighting systems to function with greater independence from human interaction and with reduced response times in stressed environments. The true value of autonomy is not to provide a direct human replacement, but rather to extend and complement human capability with autonomous systems. The Department's FY 2014 S&T investment in autonomy is approximately $300 million and focuses on developing systems that perform complex military missions in dynamic environments with the right balance of warfighter involvement. Such autonomous systems can extend warfighters reach via unlimited persistent capabilities, offer warfighters more options and flexibility to access hazardous environments, and react at speeds and scales beyond human capability.

To implement autonomous capabilities, the Department has established four technical autonomy focus areas: Human and Agent System Interaction and Collaboration (HASIC); Scalable Teaming of Autonomous Systems (STAS); Machine perception, Reasoning and Intelligence (MRI); and Test, Evaluation, Validation, and Verification (TEVV) and has developed a capability development roadmap for each area.

Additionally, the Department established the Autonomy Research Pilot Initiative (ARPI), an initiative that will facilitate a coordinated S&T program guided by feedback from operational experience and evolving mission requirements. This program engages multiple Department laboratories on an internal, inter-service competition of autonomy-related applied research topics conducted by government scientists and engineers. The ARPI source selections are on-going for the work to be performed in FY 2014-2016.

Through the ARPI, the Department will allocate approximately $15M for up to three consecutive years, totaling up to $45M. Advancement of technologies from investments in the four technical areas will result in autonomous systems that provide more capability to warfighters, lessen the cognitive load on operator/supervisors, and lower overall operational cost. In addition, these investments will facilitate harnessing the potential of autonomous systems and strengthening mission effectiveness while maintaining fiscal responsibility and optimizing interoperability across space, air, ground, and maritime domains.

c) DATA TO DECISIONS

The second area to develop new capabilities is D2D which brings in elements of "big data," data analytics, graph theory, and other emerging concepts in the knowledge domain. The 2012 National Security Strategy states that "for the foreseeable future, the United States will continue to take an active approach to countering [threats] by monitoring the activities of non-state threats worldwide[.]" D2D seeks science and applications to reduce the time and manpower associated with the analysis of large data, leading to actionable data. In FY 2014, the Department plans to invest approximately $535 million in D2D. Investments in this new research priority area provides tools and insight into the widely available data to discover patterns and trends, analyze potential outcomes, and prevent strategic surprise. As a cross-cutting and enabling priority area, the research foundations of mathematics, statistics, and computational methods within D2D area are relevant across many of the missions and business areas within the DoD to include intelligence, operations, logistics, and personnel and readiness.

For intelligence data, challenges persist in analyzing the increasing amount of information resulting from improved sensor performance and the widely available and relevant open source information to support analysis and decision making. With this abundance of data, the need to discover and identify patterns, such as threat signatures, in complex, incomplete, imprecise and potentially contradictory large data sets has become a critical issue in decision-making processes within the DoD. It is beyond the abilities of humans to read and assimilate such large data sets and create comprehensive analytic products that leverage them. Said another way, as the amount of data grows, extracting actionable information, and fusing these results with relevant contextual or situational information to inform effective and timely action becomes progressively more challenging.

Some commercial technologies, such as cloud computing, are maturing and are widely available, but the development and use of data analytics to support DoD missions and business areas requires further research and development to exploit these advancements. Additionally, the unique challenges of the military tactical environment as well as the time and manpower constraints of tactical missions complicates adaptation of this technology as well as the development of data analytics to support mission requirements. On a much broader level, the foundations of D2D research can be used across many mission and business areas within the DoD to use data more effectively to save time and manpower costs.

d) HUMAN SYSTEMS

Human Systems research is focused on maximizing warfighter performance through focused and strategic research investments. The Department's primary focus has been to foster true synchronization between the hardware, software, and human elements of warfighter systems. This synchronization will enable effective and efficient mission performance, training, and warfighter selection, as well as affordable and effective equipment to support and conduct military operations. In FY 2014, the Department plans to invest approximately $270 million in human systems.

The Department's Human Systems research is focused on three research areas: Personnel and Training, Human System Interfaces, and Biology-based Innovation. The research

area of Personnel and Training focuses on improving warfighter training so that they are not using yesterday's technology, methods, and strategies. The training must address evolving mission complexities and dynamics. The Department has made substantial progress in developing tailored training approaches, mission essential competency development, fleet synthetic training, intelligent adaptive training and enhanced cognitive competencies.

The research area of Human Systems Interfaces is addressing the problem that most of the Department's current operating systems are rigidly data-centric vice flexibly information-centric. Research in this area is addressing these challenges with the realization that data quantity will continue to increase nonlinearly. Substantial progress has been made in human interaction with autonomous system and command and control decision making.

In summary, the human sciences provide guidance on how to modify techniques, tactics, and procedures to achieve desired goals without an expensive materiel solution. Human systems research can provide tools for decision makers to evaluate whether non-materiel solutions or modified materiel-solutions can meet desired requirements at lower cost.

e) MEDICAL RESEARCH AND CAPABILITY DEVELOPMENT

A somewhat specialized area of investment in S&T is defense medical research. The Department's research efforts in the biomedical arena reflect the focus on taking care of our people throughout the full spectrum of operations to include prevention of injury and disease both in garrison and on the battlefield, diagnosis and treatment at the point of injury, delivery of world-class medical care both en route to, and within medical treatment facilities and rehabilitation. Over the past decade, we have made remarkable progress in research areas aimed at minimizing bleeding and preventing hemorrhagic shock. The major investments in medical research; however, focus on acquiring a better understanding of the underlying cellular mechanisms and functional impacts associated with traumatic brain injury (TBI), particularly those characterized as mild TBI or concussion. For the battlefield commander, it is important to quickly assess the extent of this injury after a blast or blunt head trauma, in order to get prompt and appropriate medical care for the warfighter. To this end, the Department's investment has led to the development of a high definition fiber tracking method for use with existing magnetic resonance imaging (MRI) scanners to assess brain tracts for damage with much greater sensitivity than ever before. Complementing this new imaging capability is the development of a blood test for TBI to determine if brain cells are physically damaged after a traumatic event. This test is now in pivotal clinical trials for approval by the FDA and if successful, this test is expected to be the first objective diagnostic test for the presence and extent of TBI that may become part of the gold standard by which this condition is diagnosed. With regard to brain functional assessment, the Department's research efforts have led to a novel method for assessment of brain injury that is based on eye tracking metrics. This technology will also benefit the operational community by enabling assessment of performance degradation due to stress and fatigue.

Finally, and quite amazingly, we are now deploying service members back into theater with ruggedized prosthetic legs that can withstand the rigors of the combat environment while dramatically improving agility. These new legs allow the user to move rapidly across uneven

terrain with improved efficiency. The Department is capitalizing on advances in understanding neuromuscular control to allow users to more naturally control prosthetic devices by harnessing nerve signals from the brain and linking them to the device. Although most of the investment in prosthetics has focused on the lower extremities, significant progress has been made in the development of a prosthetic arm that mimics the natural function of the human arm. Future investment will focus on reducing the weight and increasing the degrees of freedom in the motions that can be achieved by these prosthetic arms. Many of the Department's advances in rehabilitation are improving the quality of life of amputees in the civilian population as well.

Important to the development of injury prevention measures, is the knowledge and understanding of the mechanisms and forces involved in creating the injury. To this end, our S&T research program has developed a small, lightweight, multiple axis accelerometer/pressure blast injury gauge that is worn by the warfighter and is capable of storing the pressure and force profile of their exposure. This information, combined with associated medical symptoms, will aid in modifications of future designs of the warfighter's protective gear. These gauges are currently deployed.

f) TECHNOLOGY WATCH/HORIZON SCANNING

In the FY 2014 budget, we have a new low-cost, but high-risk effort to apply advanced data analytics to try to isolate and identify emerging "hot" science and technology areas. This type of approach is fairly well defined in industry for short-term financial prediction. We believe, but no one has proven, that the same non-parametric methods will apply to technology watch/horizon scanning. We will ask for industry bids to offer their software and modified for our purposes, then host the application at DTIC, for all DoD users to be able to access.

This is a high-risk initiative to bring emerging data analytics to bear on identifying significant changes in the global technology landscape. This effort will leverage a range of algorithms and data streams to provide both leadership and program managers more insight into evolving technical capabilities worldwide.

S&T INFRASTRUCTURE AND HUMAN CAPITAL

In order to execute programs that are designed to solve problems, an effective R&E enterprise must plan for and maximize its employment of people, facilities, and planning processes.

1. PEOPLE

Within the R&E functional areas, we have to both shepherd today's workforce, as well as develop the future workforce. Over the past several years, we have seen some initiatives that have increased our flexibility for hiring people – this has helped.

While previous legislation has helped with recruiting new talent, we have also made gains in the acquisition workforce due in part to the hard work of the Acquisition Career Field functional managers, three of whom reside in ASD(R&E) -- Science and Technology, Systems

Engineering, and Test and Evaluation. The Department's responsible officials for each are the Director, Defense Laboratories; the Deputy Assistant Secretary of Defense for Systems Engineering; and the Principal Deputy Assistant Secretary of Defense for Developmental Test and Evaluation. While we have made progress, I am concerned that the current budget and sequestration pressures will make retaining this workforce difficult.

a) SCIENCE AND TECHNOLOGY WORKFORCE

As part of the strategic workforce planning initiative, the Department has completed two assessments of its Scientist and Engineer (S&E) workforce this year – the Science and Technology (S&T) Functional Community assessment and the Technical Workforce of the Science and Technology Reinvention Laboratories (STRLs) assessment. The S&T Functional Community assessment focused on the mission critical occupation of Computer Scientists indicated that there is increasing demand across the Department for highly skilled and highly trained individuals in emerging fields like cyber research, quantum computing, and artificial intelligence. The assessment also found that many of the skills necessary for the Department are best cultivated in-house because of the high degree of specialization needed and multi-disciplinary requirements. The SMART program (Science, Mathematics, and Research for Transformation) was identified as a critical tool for successfully attracting, training, and preparing the future workforce. Using SMART, we have been able to compete for very high-quality talent.

The Technical Workforce of the STRLs assessment examined the more than 37,000 scientists and engineers working in the STRLs. The assessment emphasized the successes of greater flexibilities for STRL directors that legislative changes have produced, particularly Direct Hiring Authority (DHA). DHA, which is available on a limited basis only for individuals with advanced degrees, has reduced the average hiring timeline from nearly 100 days to just under 30 days. This flexibility was identified as critical to hiring the most talented scientists and engineers in an extremely competitive market. Attrition due to retirement has been identified as potentially impacting the ability of the STRLs to maintain the critical skills and competencies necessary to fulfill their mission. The assessment concluded that the ability of STRL directors to be flexible and adaptive in the management of their respective workforces is a key component to maintaining the scientific and technical excellence across the STRLs.

b) SYSTEMS ENGINEERING WORKFORCE

The scope of the DoD engineering enterprise represents a remarkable investment of human capital. The Department, with its Services and Agencies, is one of the largest engineering enterprises in the world, with a non-construction Engineering civilian workforce made up of nearly 76,000 engineers. The DASD(SE) serves as the Department's Functional Leader for the technical subset of the Defense Acquisition Workforce, which includes the Systems Planning, Research, Development and Engineering (SPRDE) (about 39,000 civilian and military) and Production, Quality and Manufacturing (about 9,000 civilian and military) career fields.

Today's DoD weapons, combat systems, and technical activities provide unprecedented capabilities to the Department and presents engineering challenges to the Department's

engineering workforce. The Department has responded to these challenges, growing the SPRDE workforce 3.5% per year from 34,537 at the end of FY 2008 to 39,807 at the end of FY 2012. A strong government technical workforce balances the Department's partnership with industry by providing greater capability for the government to manage complexity and exercise technical judgment required to conceive, manage, invest in and oversee development of advanced weapon systems. In view of the programmed out-year weapons, combat systems and engineering initiatives, this workload, and the Department's need for world class engineering talent, is expected to continue well into the future. This environment will place greater pressure on the Department's ability to meet this continued demand for a multi-disciplined engineering workforce and adequately support increased program requirements.

The Department's engineering community has evolved over time to stay relevant to emerging defense challenges and, while systems engineering has always been an essential function, it becomes even more critical in a fiscally constrained environment. However, 12 percent of the SPRDE workforce is eligible to retire immediately. Many of the potential retirees will be those in senior and key lead SE positions on major defense acquisition programs. This highlights not only the potential loss of experienced SE workforce members, but also increases performance risks in programs and further highlights the need for the Department to continue support to maintain our engineering workforce as a national asset and critical function in support of the warfighter. DoD leadership is committed to further strengthening the systems engineering capability and capacity to assure there is a pipeline of qualified workforce members to serve current and future programs.

c) DEVELOPMENTAL TEST AND EVALUATION WORKFORCE

The DASD(DT&E) is the senior official responsible for the T&E Career Field in the acquisition workforce. DASD(DT&E) has also made significant progress in strengthening the T&E workforce, including revising the core education requirements to advance technical proficiency within the T&E profession, and the annual review to update the Defense Acquisition University T&E curriculum to enhance the T&E workforce's ability to meet tomorrow's challenges.

The current T&E acquisition workforce is 6,838 government and 1,765 military personnel for a total workforce of 8,603. The T&E workforce has increased from 7,420 in 2008 to our current level of 8,603. We continue to monitor impact of the budget pressures on the T&E workforce by providing assessments of the T&E workforce in future DT&E Annual Reports to Congress. The assessment will look at the ability to attract, develop, retain, and reward T&E experience to meet the needs of DoD.

d) SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM)

In addition to taking care of today's workforce, the ASD(R&E) has responsibility for the S&E workforce of tomorrow. The Department depends on over 100,000 S&E as well as other STEM professionals. In 2011, we established the STEM Executive Board which provides strategic leadership to the Department's STEM initiatives. The Board is comprised of Senior Executive Service-level representatives from the Services; USD Personnel and Readiness;

Intelligence; and representatives of key acquisition Components, and provides strategic coordination of DoD's STEM investments. Specifically, the STEM Strategic Plan and Implementation Plan align the Department's investments with DoD STEM workforce requirements and with Administration STEM guidance, including robust, on-going impact assessments.

The future of the Department's STEM workforce depends on a robust education system that provides diverse pathways into STEM to meet the Department's mission. Numerous studies in recent years have called our attention to the need to improve STEM skills of U.S. students, who have fallen behind other nations. Through basic science workshops, increased funding for university research and other dedicated STEM programs, we are trying to stay connected to universities.

Within the ASD(R&E) portfolio, we have the National Defense Education Program (NDEP). This program supports the scholarship-for-service Science, Mathematics, and Research for Transformation (SMART) program, which provides financial support for undergraduate and graduate degrees in 19 STEM fields that are critical to the Department's future. Under SMART, we have attracted over 1,500 top quality researchers. To date over 700 students have completed their degrees and entered the DoD workforce. Of these, 82% remain employed in the DoD beyond their service commitment. We continue to make use of the SMART program to improve our workforce.

2. FACILITIES

As part of a much larger Office of Science and Technology Policy led effort to assess the overall status of infrastructure at our government labs dedicated to national security, the Department is currently conducting an assessment of Defense Laboratory facilities in order to more quantitatively and comprehensively evaluate the current state of DoD Laboratory facilities. The Department is also examining the process of how the Services currently prioritize military construction projects and how Laboratory projects are evaluated in this context. There are general concerns both within and outside the Department that Laboratory facilities are underfunded relative to the non-lab infrastructure in the Services. We are in the process of determining quantitatively if this is true. Without quantitative evidence, it is impossible to develop proper solutions that adequately address any problems.

Through this study, the Department will also be able to quantify the nature and scope of deficiencies at the Laboratories and the potential costs of rectifying them. Anecdotal evidence suggests that Laboratories' sustainment, restoration, and modernization efforts lag those of the rest of the Department, but by how much and to what extent is unclear. The successful uses of the expansion of minor military construction authorities to Laboratories suggest that there are indeed gaps, and the Department is committed to eliminating them. With a more accurate understanding of any gaps and their size, the Department can take the necessary steps to ensure that our Laboratories' facilities remain state-of-the-art and capable of supporting today's mission and future requirements.

In addition to quality laboratories, the Department also needs high-quality test facilities. Planned T&E infrastructure upgrades have been partitioned between System Integration Laboratories (SIL), Installed System Test Facilities (ISTF), and Open Air Ranges (OAR) investment to provide a capability mix that effectively supports technology experimentation and design performance verification testing. This investment benefits S&T through providing more modern and representative test facilities. Planned upgrades are focused in three investment areas. First and foremost, the Department is improving its System Integration Laboratories at Eglin Air Force Base, FL and Naval Air Station Point Mugu, CA to allow programming of flight test mission data files and EW libraries to reflect foreign integrated air defense systems (IADS) threats. As mentioned earlier, the Department is upgrading our next-generation EW emulators to mimic modern IADS and finally, we are upgrading open-air ranges to better iterate live-virtual demonstration exercises.

We are also very interested in enhancing our cyber test facilities. The increasing demand for cyber test, training, and experimentation will challenge our capabilities and capacity of our cyber ranges. We have transitioned the National Cyber Range (NCR) from DARPA to the Test Resource Management Center (TRMC), where we will operationalize its capability to support test and training. The Department will continue investment in this critical infrastructure to increase both capacity and capability for cyber training, testing, and experimentation. Once operational and accredited for the required level of classification, the NCR will have increased capacity, with standard services, more efficient sustainment of capability, and fail-over capability to improve Cyber R&D.

3. DEPARTMENT R&E PLANNING PROCESS

A key strength of DoD's S&T Enterprise is its substantial emphasis on coordinated research planning. The Department's S&T components devote great care and attention to ensuring that DoD's research investments are well planned and coordinated. In these challenging budgetary times, it is important to strengthen these efforts to ensure that we receive the utmost value from our investments in science and technology.

The overarching framework of the Department's S&T joint planning and coordination process is called Reliance 21. We are resurrecting and enhancing Reliance 21, a process with roots that go back several decades, which has undergone continual renewal and refreshment as circumstances evolved. The Reliance 21 framework is led by an S&T Executive Committee (ExCom) that embraces the major Departmental S&T organizations, including the Military Services and DARPA who sit at my side at this hearing today. The S&T ExCom, and the S&T Deputies Committee that serves as its primary operating arm, meet several times per month to coordinate both strategically and at a tactical level to harmonize resources and coherently address emerging challenges. Once every year, the 3-star and 2-star members of the S&T ExCom conduct an intensive multi-day planning exercise of the Department's out-year research investments, to ensure proper attention to potential gap areas, and to minimize unwarranted overlaps. This event is conducted in close coordination with the future requirements specialists of the Joint Staff.

Underpinning the S&T ExCom leadership is an ecosystem of technical groups known as Communities of Interest (CoI) and S&T Priority Steering Councils (PSCs). There are 18 of these groups that span almost all of the cross-cutting areas of science and technology in the Department. Examples of such areas include Advanced Electronics, Sensors & Processing, and Cyber security, among many others. These groups are populated by the Department's subject matter expert leaders drawn from the Services, Defense Agencies, and from OSD. The subject matter experts often have decades of experience in the Defense S&T research enterprise and are an asset in DoD's efforts to generate technology surprise and rapidly convert that surprise into operational capabilities. Fundamentally, the subject matter experts guide and coordinate the portfolios of research investments in each of the CoI and PSC areas. They do this primarily through development of research roadmaps and investment plans. The roadmaps are used extensively to guide long-term budget decisions and to influence near-term investment decisions in each of the Components. The CoIs and PSCs also provide forums for developing younger staff and for maintaining technical awareness of S&T developments both inside and outside DoD. Each year, roughly half of the PSCs and CoIs brief the health, direction, and connectedness of the programs in their portfolio.

In addition to this coordinated approach across the Department, we have taken steps to better leverage Industry's Independent Research & Development (IR&D) for which DoD reimburses industry approximately $4 billion annually. IR&D projects are a critical source of technology innovation for DoD. Under the Better Buying Power initiative, ASD(R&E) was charged to reinvigorate IR&D. The key challenge identified was communication – industry wanted information about Department investment priorities to help them better plan their IR&D projects, and DoD planning was hampered by limited insight into industry IR&D projects. The Defense Innovation Marketplace website (www.defenseinnovationmarketplace.mil) was developed to provide a one-stop-resource for Department priorities so industry could better align their R&D investments. Industry can also securely share IR&D projects with the government, allowing S&T and acquisition program managers to leverage this data to inform future program planning.

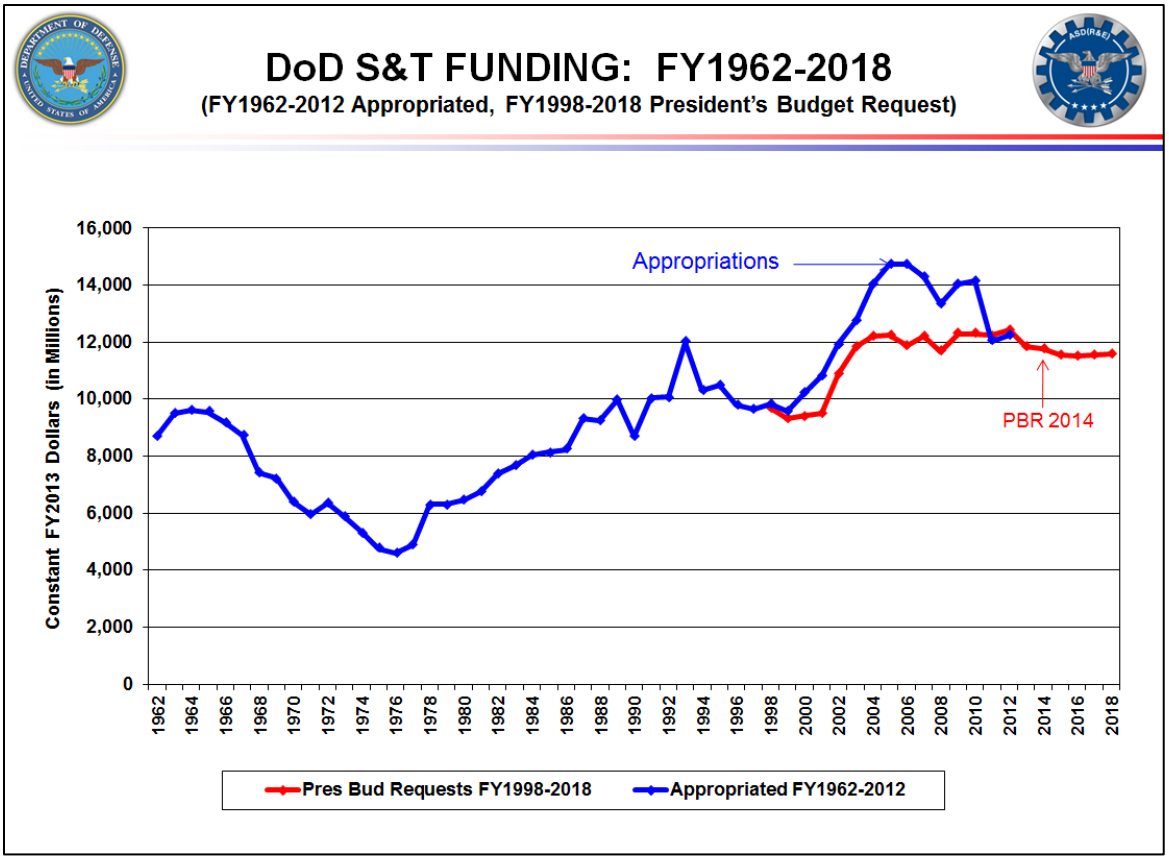
BUDGET PRIORITIES

1. DoD S&T TRENDS

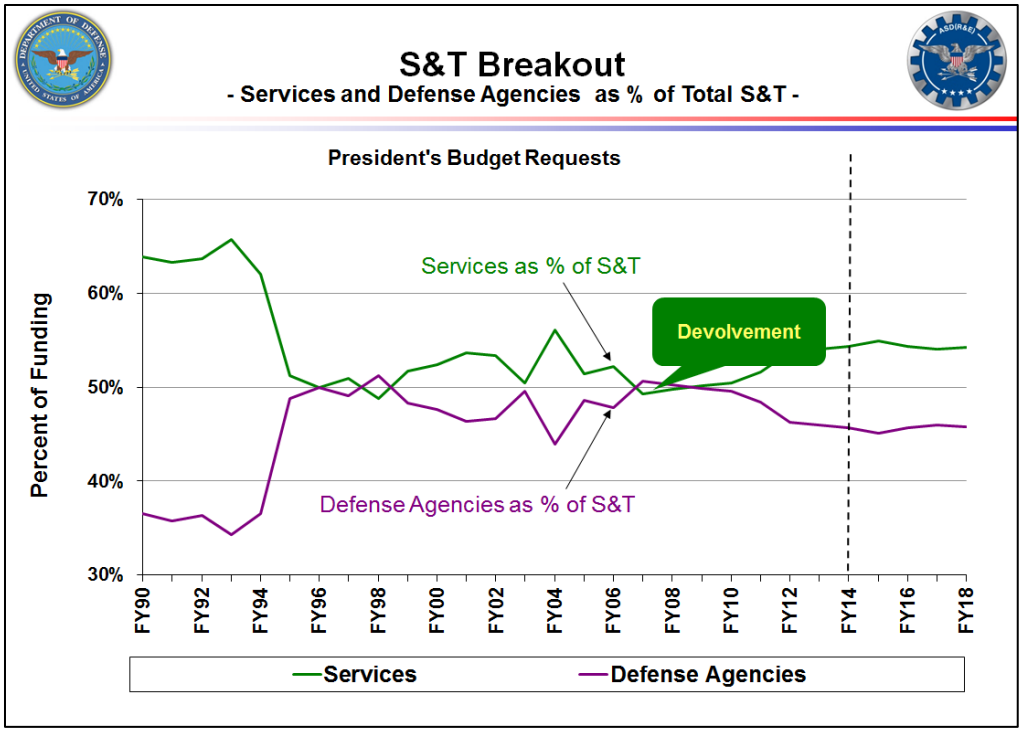
The FY 2014 President's Budget Request (PBR) for S&T is $11.98 billion, which represents a nominal growth from the FY 2013 PBR of $11.86. For R&E, the FY 2014 PBR is $24.04 billion, which is a 2.6% decline from the FY 2013 PBR of $24.27 billion. This is because the budget category of Advanced Component Development and Prototypes declined 4.47%, in real buying power. See table:

($B)	PBR 2013	PBR2014 (FY13 CY $)	% Real Change from 2013 PBR
Basic Research (6.1)	2.117	2.164 (2.128)	.53%
Applied Research (6.2)	4.478	4.627 (4.549)	1.59%
Advanced Technology Development (6.3)	5.266	5.192 (5.105)	-3.06%
DoD S&T	**11.861**	**11.984 (11.782)**	**-.67%**
Advanced Component Development and Prototypes (6.4)	12.409	12.057 (11.854)	-4.47%
DoD R&E	**24.270**	**24.040 (23.636)**	**-2.61%**
DoD Topline Budget	**525.449**	**526.637 (518.854)**	**-1.26%**

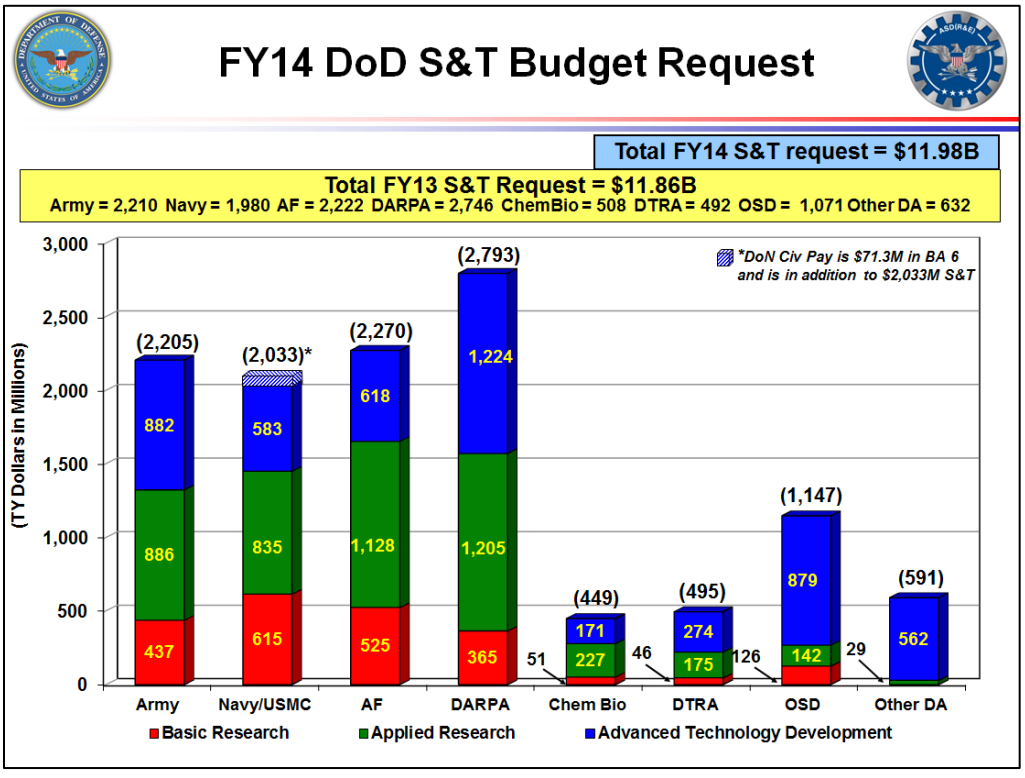
We must continue to balance the investment with all our partners across Acquisition, Technology and Logistics. We also recognize R&E provides lower cost options which become more important during budget austerity. The FY 2014 President's Budget represents a strategic choice made by the Department to preserve, to the greatest extent possible, technology-based options for the future. While we expect continued pressure on the S&T and R&E budgets over the next several years, it is significant to note that there is recognition of the value of preserving future options—a characteristic of R&E. Taking a longer term view, the chart below shows the actual S&T investment in constant year 2013 dollars, since 1962. The budget request for S&T has been largely flat since about 2003. This highlights another key characteristic of a healthy S&T program: long term stability. It is important to not have big fluctuations in R&E funding from year to year so as to maintain a stable workforce.



Another macro trend we see in the DoD S&T budget is highlighted in the next chart. Since the FY 2008 President's Budget Request, we have made a conscious choice to focus more of the investment to the Services, in relation to Defense Agencies and the Office of the Secretary of Defense. We still have an investment of $5.48 billion in the Defense Agencies and the Office of the Secretary of Defense for S&T in FY 2014, but this is down from a figure of $6.09 billion as recently as FY 2010. Much of these funds were with programs that devolved to the Services.



Finally, the chart below displays the S&T investment by major Components. Investment in S&T for the three Services is between $2.0 and $2.2 billion and DARPA remains the single largest investment with $2.8 billion in FY 2014. The other components make up a much smaller piece of the S&T portfolio.



The FY 2014 S&T budget also supports White House priorities in the areas of advanced manufacturing, robotics and autonomous systems, cyber security, hypersonics, and electronic warfare described in earlier sections.

2. ASD(R&E) PORTFOLIO

Shifting focus from the overall DoD S&T to the ASD (R&E) investment portfolio, the FY 2014 S&T budget of $738 million is 5.5 percent higher than FY 2013 budget of $700 million. The FY 2014 budget reflects a significant change in major investments that align to the defense strategy, DoD S&T priorities and OMB priorities described above. These FY 2014 S&T investment changes include:

- Termination of 5 existing programs/program elements to create a new $45 million 6.2 Applied Research for the Advancement of S&T Priorities Program to focus on the 7 S&T priorities, applied research projects, concept explorations, and technology solutions for future military needs. In FY 2014, this new program will support the aforementioned autonomy pilot and acceleration of engineered resilient systems. The remaining funds will be competitively allocated to the other PSCs generated proposals. All funding in this program will be executed by the Components.

- Transfer of responsibility and $16 million in funding for the Historically Black Colleges/Minority Institutes program from Army to OSD consistent with the FY 2012 National Defense Authorization Act including realignment of additional $15 million for Centers of Excellence.

- Realignment of $13.8 million in the Emerging Capabilities Technology Demonstration program to address developmental prototyping.

- Realignment of $60 million from 3 existing programs for the standup of a new Strategic Capabilities Office (SCO) responsible for analyses of emerging threats with emphasis on innovative and architecture-level concepts, intelligence concepts, red teaming, and conducting disruptive technology demonstrations.

- Realignment of $130 million for the Advanced Innovative Technologies Program to accelerate a land-based prototype of an electromagnetic railgun for improved theater missile defense capability. This program is not S&T, but ACD&P.

LEGISLATIVE PROPOSALS

PRIZE AUTHORITY

The Defense Budget Priorities and Choices guidance, issued in January 2012, calls for "cutting-edge capabilities that exploit our technological, joint, and networked advantage." Extending the authority for Prizes for Advanced Technology Achievements, requested by this proposal, will allow the Department to continue the cutting-edge technology prototyping that

results from the prize challenges. Partnerships created under this legislation also strengthen the ties of the Department with industry and universities. Prize competitions are unlikely to replace the traditional acquisition process in the DoD, but for specific technology problems, it is a method that has demonstrated to be tremendously useful for stimulating and incentivizing a broad spectrum of individuals to offer solutions to problems of significant interest to our Nation's Warfighters.

SMART

The Science, Mathematics, and Research for Transformation (SMART) is a Scholarship-for-Service program designed to produce the next generation of DoD S&T Leaders as our current workforce is aging and eligible to retire. The program accomplishes this goal by providing support to undergraduate and graduate students for their educational expenses in exchange for service in our DoD facilities. This program matches the SMART scholars with DoD laboratories and other Defense agencies where mentors transfer their STEM knowledge to the students and introduce them to the DoD culture beginning with internships and culminating in full-time employment at those facilities. The Department is asking for a revision of the SMART legislation that would create three major benefits; (1) increased flexibility to administer the program, (2) reduced stipends to make them more consistent with other Federal scholarship-for service programs, and (3) removal of the restriction that only United States citizens can participate in the program.

SOFTWARE LICENSING

The DoD develops significant quantities of computer software in a variety of areas such as modeling and simulation, training, and command and control. A legislative proposal has been prepared to allow the DoD to protect its software and to facilitate the license process for transfer to commercial firms. In the course of that licensing action, it would be protected from release to the general public in response to a Freedom of Information Act request for up to five years providing the commercial licensing partner adequate time to develop the product, prepare user documentation, and deploy to both military and commercial markets. At the same time the commercial firm’s investment of funds to underwrite these product activities is protected from undue competition. The request is for a 5 year limit on this pilot program. This provides adequate time for DoD to develop data that would justify a future request for extension, modification, or cancellation of this authority.

SUMMARY

I would be remiss if I did not mention the impact of sequestration. At the macro level, the reduction to S&T investment is roughly $1 billion in FY 2013. Since in many cases, the work in S&T is sequential, the work planned for FY 2013 will be deferred to FY 2014--and reduces the work planned in FY 2014 by that same $1 billion. Some of this reduction will be seen at our government labs, but other impacts will be seen in government and universities. For example, we expect the total investment in universities to decline by about $250 million.

In closing, I am proud to say our R&E enterprise is delivering capability and value for the Department and Nation. I would also like to thank Congress for your continued support of the S&T program of the Department of Defense. As we enter a new strategic era, it is important to examine all Department investments. It is just as important to understand the value of investments like R&E that strengthen the overall capabilities of the Department. With your support of the FY 2014 President's Budget request for RDT&E, you will allow our community to continue to deliver future capabilities for the Department.