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Before the

Subcommittee on Emerging Threats and Capabilities,
Armed Services Committee, U.S. House of Representatives

Department of Defense Fiscal Year 2017 Science and Technology Programs:
Defense Innovation to Create the Future Military Force

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Accelerating the Development of Military Capability through Innovative Defense Research and Development

Introduction

Chairman Wilson, Ranking Member Langevin, and Members of the Subcommittee, I am pleased to have the opportunity to provide testimony on the Department of Defense (DoD) Fiscal Year 2017 Science and Technology (S&T) program and to join my colleagues from across the Services and DARPA to report on the current state of S&T in the Department. Defense S&T enables our nation to sustain the technological advantage that underpins our ability to successfully execute the Department's mission. The DoD S&T program delivers a balanced technology investment, informed by an awareness of global technology trends and critical threat capabilities, and supports the three tenets of the Department's research and engineering strategy**:** to provide technology to mitigate current and anticipated threat capabilities, to affordably enable new or extended capabilities in existing military systems and to create technology surprise through advanced capabilities that significantly expand our capabilities.

Key to our S&T success is our investment in our people – the talented scientists and engineers who perform the complex, state-of-the-art research, development and engineering required to ensure America's future technological superiority in an increasingly competitive global security environment. With their colleagues in academia and industry, our defense S&T workforce is engaged every day in developing the capabilities that our nation's warfighters will need tomorrow.

We are at a pivotal moment in history where the advanced technical capability and capacity that the Nation has relied upon to provide us with unmatched technological superiority on the battlefield (including capabilities in precision weapons, long-range ISR, space systems and stealth) is now being challenged by the military technology investments being made by increasingly capable and assertive powers. Other nations are increasing their investments in advanced capabilities, including anti-access/area-denial capabilities, which are intended to counter US technological strengths and deter the US from projecting power abroad to defend our national interests, maintain international norms, and support our allies and partners.

Our nation has long pursued strategies that leveraged US technological advantage as a force multiplier. We continue to leverage advances in technology and new operational concepts to provide sustained advantage to US forces - shifting the landscape of future national security competition to our advantage by seeking asymmetric opportunities in technological and operational innovation.

Today, our brightest young scientists and engineers are pursuing these technology innovations by leveraging new and emerging capabilities in material science, advanced electronics, computational algorithms, quantum sciences, biology and health sciences, advanced optics, robotics, artificial intelligence, and other disciplines and applying these technologies to create improved military capabilities informed by operational experience and needs.

As any surfer knows, the only way to catch and ride a wave is to paddle out in front of the surge; catching a wave from behind does not work. The same is true with technology. In a fast changing technology environment, the Department must be positioned to understand, shape and exploit technological opportunity to its best advantage for application to military systems. The Department must carefully select those areas where we must invest to lead technology development. We must also identify those areas where we want to partner with academia, industry and our international partners in shaping technology development. By engaging early, DoD can shape the technology environment and drive a focus on speed from lab to field.

Driving Innovation

Our Department-wide focus on technology innovation seeks to identify and invest in unique capabilities to sustain and advance the Department's military superiority for the 21st Century. As Secretary Carter said in his remarks on the budget at the Economic Club of Washington, D.C. on the 2nd of February, we must take a "long view" and "seize opportunities for the future" in order to "sustain our lead in full spectrum war fighting".

In an increasingly competitive and fast moving technology environment, the Department must be open to all sources of competitive technical advantage and must engage with traditional and non-traditional sources of capability both internal and external to the Department.

Today, the Department employs over 39,000 scientists and engineers in 63 Defense laboratories, warfare centers, and engineering centers across 22 states sustaining our ability to support and field military critical technology that often has no commercial equivalent. Our laboratories have produced important innovations in vital defense areas such as electronic warfare, propulsion, and weapons design and maintaining this unique technical expertise is critical for ensuring the Department's ability to prepare for future threats. However, we cannot innovate and bolster our future technological superiority from within the Department alone; our Defense laboratory enterprise touches the broadest range of emerging concepts through a deep engagement with academia, industry, and international partners to keep the DoD smart, knowledgeable, agile, and responsive in the face of new and emerging threats. This includes outreach to a vibrant and growing commercial innovation community that sometimes does not consider applying their emerging technologies to the national security sphere. In Fiscal Year 2015 DoD's research and engineering enterprise established over 2,000 cooperative research and development agreements with private companies or universities and filed over 875 patents.

In fast moving areas, investments made by the commercial entrepreneurial sector are accelerating the development and maturation of technologies with critical relevance to future defense capabilities. Often, small innovative commercial firms lack knowledge about the defense systems, organizations, and problems that could benefit from their products and technology. They are also often unwilling to invest their scarce time and resources in identifying DoD customers for their work and unable to navigate the DoD acquisition system. The Department has begun efforts to address these challenges and recently established the Defense Innovation Unit-Experimental (DIUx) with an initial operating location in Silicon Valley, California. DIUx is experimenting with new approaches to serve as an "point of presence" connecting the Department with non-traditional technology and capability sources by scouting for capabilities relevant to military needs and by matchmaking DoD customers with potential sources of advanced capabilities from innovative commercial entrepreneurs.

Driving Value to the Warfighter through Science and Technology

The Department is committed to sustaining our technological advantage and maintaining our long term technological superiority. Over the last year we have continued to make progress strengthening both our internal capabilities and our connections to external innovation centers. Some representative activities of note from 2015 include:

The Department of Defense played a critical role in supporting the US government and international response to the West African Ebola outbreak to support Ebola planning and response efforts. From the earliest days of the outbreak, DoD S&T personnel worked tirelessly to deliver critical equipment and supplies to the affected West African countries. The Department deployed and sustained Ebola diagnostics laboratories to Liberia and Sierra Leone and provided timely technical subject matter expertise and advice to the Task Force on Ebola Response, the Combatant Commanders, interagency partners, and international partners. The Department also contributed to the development of Ebola-specific detection technologies, developed breakthroughs in medical countermeasures and bio-containment transport systems, and provided knowledge management tools to aid decision-makers. DoD efforts helped curb the spread of Ebola virus in West Africa, saved lives, and contributed to building sustainable bio-surveillance and public health capacity in the region.

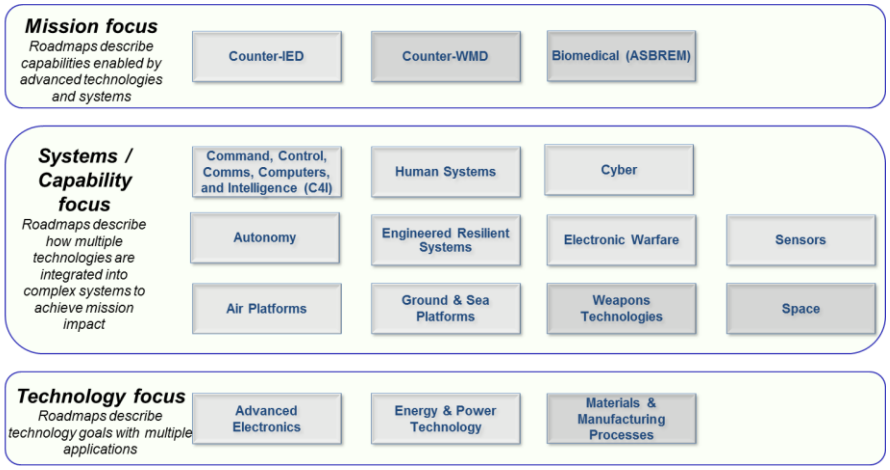
In 2015, the Department continued to focus efforts on developing advanced capabilities to address emerging electronic warfare (EW) challenges, to evaluate these capabilities and to mature them for future operational adoption. One example of these efforts was the successful Vigilant Hammer experimentation campaign. The Vigilant Hammer provided a cost effective, joint opportunity to explore and assess US emerging capabilities to fight in a complex, congested, and agile electromagnetic spectrum. Vigilant Hammer provided the S&T community with unprecedented access to the representative dense signal environment in which US systems will operate in the future.

In May 2015, the Deputy Secretary of Defense hosted the first-ever DoD Lab Day at the Pentagon, which showcased more than 100 Air Force, Army, Navy, Marine Corps, and DoD Medical innovations designed to ensure the future technological superiority of our nation's military. DoD Lab Day increased awareness and understanding of the complexity and diversity of the DoD Lab enterprise and highlighted the contributions that DoD labs made in providing vital support to missions as diverse as global disaster relief, defensive cyber protection, chemical and biological defense' and counter improved explosive devices.

In order to ensure we remain at the forefront of S&T we must also be connected to the global community by continuing to forge relationships with our international partners. The DoD S&T community continues to engage globally with allies and partners and with key academic and technology institutions worldwide. Among our global engagements, we continue to support multilateral S&T cooperation through the NATO alliance and through The Technical Cooperation Program (TTCP) with the United Kingdom, Canada, Australia and New Zealand. The Department continues productive bilateral S&T cooperation, and in the last few weeks have concluded annual reviews of on-going collaborative S&T efforts with a number of partner nations. As an example of the benefits of the cooperation, the US/UK Multi-disciplinary University Initiative (MURI) effort supports projects that are competitively selected with DoD supporting US Academic institutions and the UK Ministry of Defense (MoD) supporting UK researchers who then collaborate in areas of mutual US DoD and UK MoD interest. We have also continued to focus on strengthening US-India defense cooperation. Over the past year, the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) has sponsored five workshops with India covering a wide-range of areas of mutual interest: cognitive sciences; autonomy; directed energy; materials; and munitions (including Counter-improvised explosive devices). Over 30 potential S&T projects from these workshops are currently under consideration for co-development.

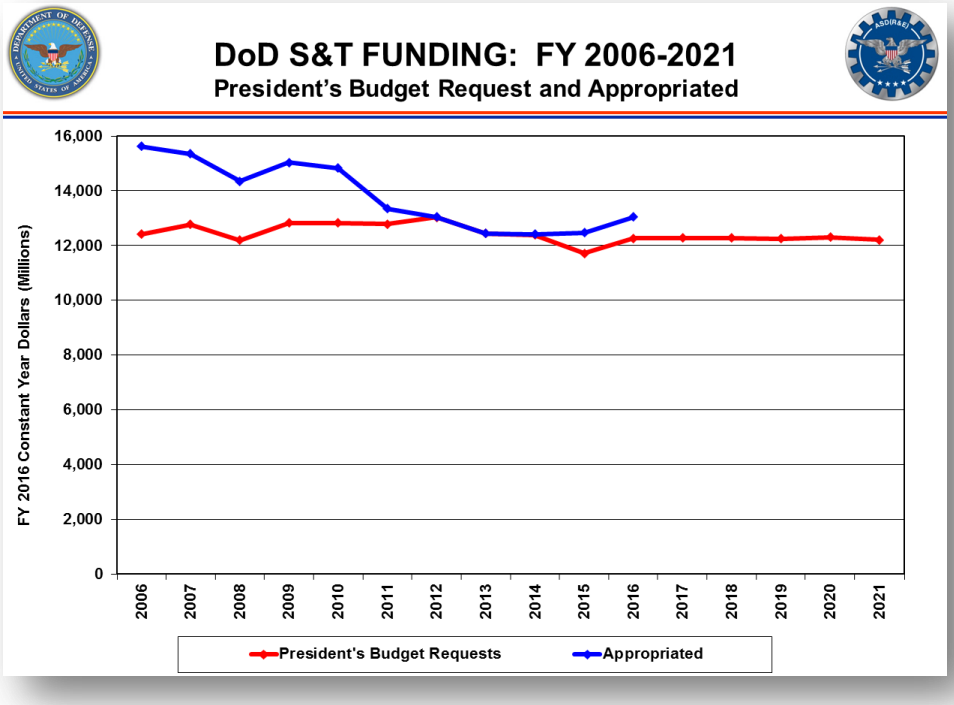
As we execute our plans for the rest of this fiscal year and into Fiscal Year 2017, ASD(R&E) continues to provide oversight of the Department's comprehensive S&T investment portfolio through the Reliance 21 framework. Reliance 21 provides a forum to synchronize, coordinate, and deconflict Service and Agency S&T activities. In the last year, we improved joint planning and coordination of S&T activities among the Department's senior S&T leadership to achieve efficiencies and improve the effectiveness of our support to the Operating force. This collaborative process captures the interests and activities of the entire R&E enterprise and all our partners in a collection of 17 Communities of Interest (COIs). The COIs maintain awareness of their portfolio areas by reviewing and assessing the alignment of current and planned R&E programs, identifying gaps, and helping to prioritize R&E funding efforts to meet the technical challenges of the DoD in their respective portfolio area. Each Reliance 21 COI represents specific cross-domain technology areas with a rotating steering group lead and draws upon subject-matter experts from across the Department working in the relevant technology area.

The Reliance 21 framework, its S&T Executive Committee, and technology area COIs are key mechanisms that support ASD(R&E) integrated oversight of the Department's S&T investments.



Fiscal Year 2017 Budget Submission

The President's Fiscal Year 2017 Budget submission continues to demonstrate strong support for sustaining a robust DoD S&T investment to ensure that the Department is developing the innovative technological capabilities that will inform future capability options and sustain US technological superiority. The chart below depicts DoD funding over the last decade and as proposed in the current budget submission over the Future Year Defense Program.



As evidence of this commitment to a strong DoD S&T capability and capacity, the Fiscal Year 2017 budget request for overall S&T is $12.5 billion; 1.9 percent above the Fiscal Year 2016 budget request and 2.4 percent of the Defense topline ($524 billion). In real terms, the Fiscal Year 2017 S&T budget request is 25 percent higher than the Fiscal Year 2000 budget request of $9.8 billion. The table below details the proposed DoD S&T budget by year and breaks out investment by budget category and by S&T account.

Table 1. FY 2015 - FY 2021 Budget ($ Millions)

Program	FY 2015*	FY 2016**	FY 2017	Δ FY16-17	FY 2018	FY 2019	FY 2020	FY 2021	Total FY17-21
Basic Research (6.1)	2,277.7	2,088.9	2,101.8	12.9	2,228.3	2,268.4	2,302.6	2,329.0	11,230.2
Applied Research (6.2)	4,647.8	4,713.2	4,815.4	102.2	4,961.5	5,048.4	5,136.3	5,221.1	25,182.6
Adv Tech Dev (6.3)	5,326.3	5,464.2	5,583.5	119.3	5,565.8	5,665.1	5,860.0	5,890.9	28,565.4
TOTAL S&T	**12,251.8**	**12,266.3**	**12,500.8**	**234.4**	**12,755.7**	**12,981.8**	**13,298.8**	**13,441.1**	**64,978.1**
Army S&T	2,554.8	2,200.5	2,266.6	66.1	2,321.1	2,371.2	2,425.2	2,475.4	11,859.4
Navy S&T	2,155.3	2,114.4	2,141.1	26.7	2,168.3	2,176.3	2,205.8	2,237.6	10,929.0
Air Force S&T	2,281.7	2,378.4	2,486.0	107.6	2,571.3	2,634.2	2,756.0	2,701.5	13,148.9
Defense-Wide S&T	5,260.0	5,573.1	5,607.1	34.0	5,694.9	5,800.2	5,911.9	6,026.6	29,040.7
TOTAL	**12,251.8**	**12,266.3**	**12,500.8**	**234.4**	**12,755.7**	**12,981.8**	**13,298.8**	**13,441.1**	**64,978.1**

Source (FY2017 -FY2021): CIS 5 January 2016

** FY 2015 Enacted (base), no OCO*

*** FY 2016 President's Budget (base), no OCO*

- The Fiscal Year 2017 S&T budget request includes a $12.9M growth from the Fiscal Year 2016 budget request in Basic Research investment to $2.102B. Much of this investment supports the Department's engagement with academic institutions in the foundational research efforts that drive future innovation.
- The proposed 2017 S&T budget includes a $102.2M growth from the Fiscal Year 2016 budget request in Applied Research investment to $4.815B.
- The proposed 2017 S&T budget includes a$119.3M growth from the Fiscal Year 2016 budget request in Advanced Technology Development investment to $5.584B. Additional investment increases an emphasis on prototyping and experimentation to reduce program risk.

The Department's Fiscal Year 2017 S&T budget request is aligned with DoD priorities that supports increased demonstrations and increased efficiency in our DoD-wide S&T program while preparing the Department for a competitive global security environment.

A Focus on the Future

As the Department looks to the future, significant global challenges are on the horizon that will require renewed emphasis on sustaining US technological superiority. For the last 30 years the US and our allies have been able to count on a set of unique capabilities in combat that no regional adversary could bring to bear: capabilities such as long range precision weapons, airborne ISR for real time targeting, network centric integration of command and control and strike, low observable systems, and integrated use of space assets. These technological capabilities enabled a US strategy of power projection – leveraging a limited forward presence with he ability to respond to provocation with follow-on forces that could be moved to theater and deployed with confidence in an opposed environment. Today, we are seeing a return to a more competitive environment - one where regional actors have studied US strengths and are capable of making the investments required to develop advanced systems designed directly to counter US technological strengths in a power projection environment. This evolution in our competitive technological posture will require the DoD to invest in the technological and operational innovation required to sustain our decisive conventional overmatch against regional adversaries.

As Secretary Carter has said, "Russia and China are our most stressing competitors. They have developed and are continuing to advance military systems that seek to threaten our advantages in specific areas. And in some case, they are developing weapons and ways of wars that seek to achieve their objectives rapidly, before they hope, we can respond."[1] Given our constrained budget resources, we must pursue a technological strategy to ensure our conventional deterrence remains as strong in the future as it is today. Accomplishing this goal is one of the most important strategic tasks facing the Department.

As it has been in the past, technological and operational innovation will be the key to future strategy. Maintaining and extending our competitive, technological, and operational advantages is not a purely quantitative contest with other nations. Rather, the United States must seek asymmetric advantages – particularly those that take advantage of US strengths in military and commercial technological innovation. We must accelerate our approaches to identifying promising technological differentiators, our processes for mapping technological capability to operational advantage, and our methods of moving new capabilities from laboratory to field.

Future capabilities will likely be increasingly joint in nature; leveraging the ability to synchronize simultaneous operations in the space, air, sea, undersea, ground, and cyber domains. Emerging tools based on breakthroughs in computer science, advanced electronics, novel communications and sensors and human-machine interface will enable new operational concepts that will enable faster and better decision making, coordinated operations at range and across the battlespace by manned, unmanned and cyber operations.

[1] Remarks by Secretary Carter on the Budget at the Economic Club of Washington, DC, February 2, 2016

In recent presentations, the Deputy Secretary of Defense has pointed to several areas where he sees significant opportunity for advanced technology to advance differentiating US capabilities:

- Autonomous, Learning Systems – systems capable of manipulating and understanding large volumes data, and/or that have the delegated authority to support or make decisions within delegated limits under operational control , especially in application areas that require faster than human reaction times (e.g., cyber defense; EW attacks; missile defense; and active protective systems);
- Human-Machine Collaboration and Manned-Unmanned Combat Teaming – systems that team humans with machines to exploit the advantages of both for better and faster human decision making;
- Assisted Human Operations –systems that directly support humans to perform better in combat (e.g., wearable electronics and integrates software applications); and
- Advanced Weapon Systems hardened to operate in complex Cyber and Electronic Warfare (EW) Environments – systems that can communicate, coordinate and communicate with each other in mission, in complex threat environments to achieve synergistic effects.

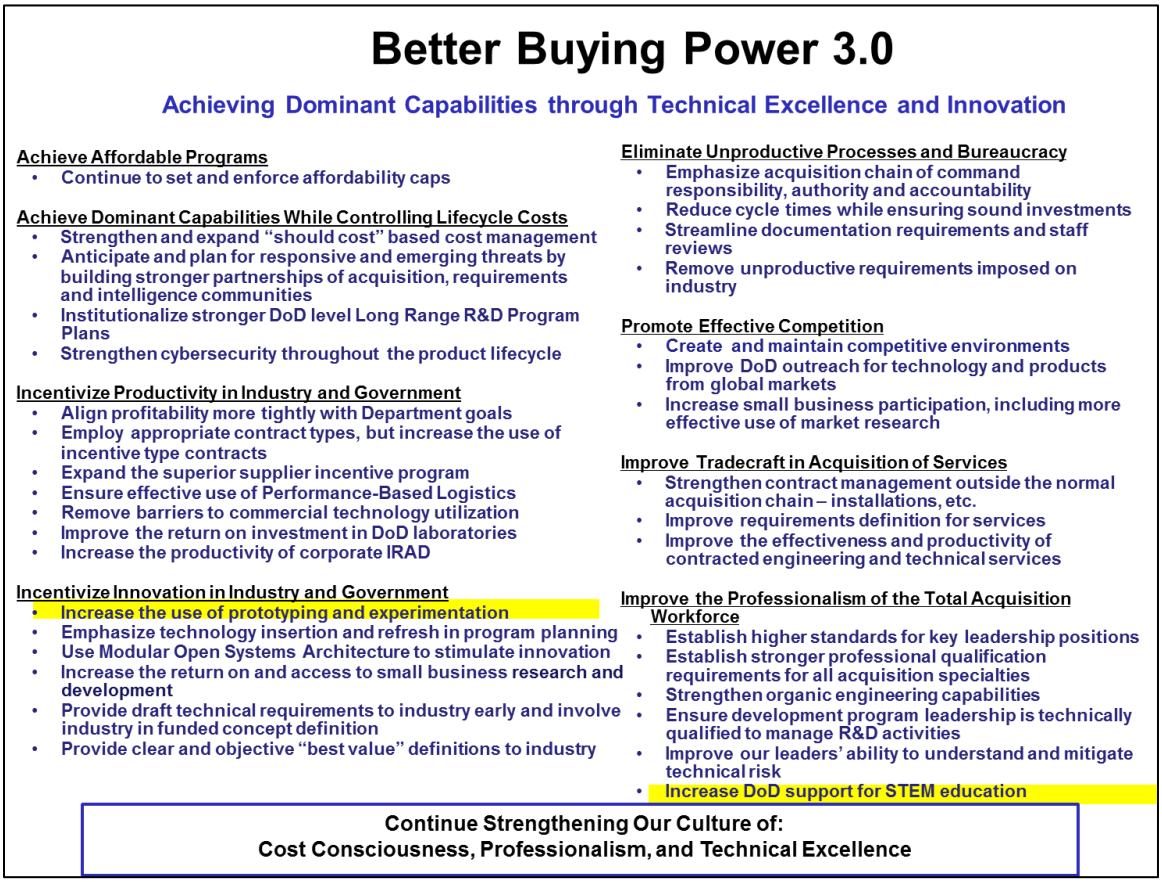
In 2015, the Department conducted a classified long range research and development planning program (LRRDPP) to identify critical technologies and future system concepts that the department should consider to inform material operations for the future force. The Fiscal Year 2017 budget is informed by the LRRDPP study and other analysis efforts and includes more than $3.6 billion in Fiscal Year 2017 and $18 billion over the Future Year Defense Plans to help spur research, development, test, evaluation, and procurement of advanced capabilities that will enable future offset strategies that our military will need to deter and, if necessary, fight and win high-end conflicts in the future. While relatively modest compared to the Department's overall program, these investments will enable the development of leading-edge, primarily asymmetric capabilities and help spur development of new ways of warfighting to counter advanced adversaries.

These investments include new capabilities that can be fielded rapidly through modifying and upgrading existing systems, material concepts that could immediately enter accelerated development, and technology-driven concepts that could have a significant impact on the Joint Force's conventional capabilities over the longer term. They also emphasize the importance of focusing on cost so that we will be able to introduce asymmetric capabilities into the Joint Force at scale.

Our S&T investments ultimately are reflected in the capabilities embedded in material systems that are acquired, fielded, and operated by our fighting forces. For the last six years, the Department has been engaged in a major campaign to improve our acquisition processes. Originally initiated by then Under Secretary for Acquisition, Technology and Logistics Ashton

Carter and continued under current USD(AT&L) Frank Kendall, the Better Buying Power initiatives reduce unnecessary rules and regulations, eliminate unproductive processes, strengthen the acquisition chain of command, and align incentives with performance. The latest iteration of Better Buying Power 3.0 has as its principal focus on "Achieving Dominant Capabilities through Technical Excellence and Innovation." This focus reflects the criticality of the research and engineering components of the acquisition community in sustaining US technological superiority and emphasizes the need to support a strong, effective and productive DoD laboratory enterprise to foster continuous improvement across the research and engineering community.

Two areas emphasized in Better Buying Power 3.0 are 1) the use of prototyping and experimentation to accelerate operational assessment and adoption of key technologies to advance current and future weapons systems and 2) support for a robust DoD STEM engagement to ensure a pool of defense relevant technical talent to support our future force.



We are placing a strategic emphasis on prototyping and experimentation to identify emerging capabilities and unanticipated threats and reduce risk in DoD acquisition efforts. We are using prototyping supplemented by engineering analysis to evaluate new concepts, guide new technology development, and demonstrate new capability. Prototyping may permit the Department to explore the realm of the possible without a commitment to follow-on

procurement. Other benefits of our investments in prototyping include the ability to sustain unique elements of the defense industrial base, stimulate design teams to advance the state of the practice, improve development methods and manufacturing, and promote open standards, and competition throughout the product lifecycle. Our analysis efforts use scenario-based, engineering informed, excursions of emerging technologies and potential operational concepts to inform the requirements, acquisition and warfighter communities.

We also support our forces at the tip of the spear with technology solutions and timely analysis of demonstrations targeted towards critical system solutions. The ASD(R&E) Emerging Capability and Prototyping Directorate is engaged with the Combatant Commanders (COCOMs) and the Service technology and acquisition communities to exploit innovative demonstrations through Joint Capabilities and Technology Demonstrations and other programs that support COCOM concerns and warfighter needs.

Balancing the near- and far-term missions of our military with the rapid rate of technology turnover drives complexity in the engineering, testing, and evaluation of our defense systems. Systems engineering and testing are among the Department's strengths; however, the traditional practices of engineering and tests are challenged not only by the scale and operational tempo of the national security enterprise but by additional factors that include fiscal and budgetary constraints; the evolution and globalization of advanced technology and software; the necessary integration of complementary systems to achieve mission effects; and the responsibility to provide a safe, secure military capability that is ensured to perform as expected. These factors translate into design and performance demands for our engineers and testers in terms of resilience, affordability, interoperability, reliability, safety, and security. We continue to focus on ensuring a robust engineering and test competency and practice across the Department, as this capability remains critical to program success.

Our Research and Engineering enterprise also supports national leadership by engaging with, and shaping the national and international RDT&E environment through our STEM efforts, workforce programs, community outreach, international programs and our support for inter-agency efforts. By teaming with our strategic partners, the Department is taking steps to sustain and strengthen our critical organic workforce capabilities and broaden our partnerships with commercial and defense industry, universities, and federally funded research and development centers to augment our workforce with their talented workforces. As the Nation's largest employer of scientists and engineers, we are concerned with the younger generations falling test scores and global competition for STEM talent. DoD is fully engaged in a national effort to reverse the declining trends in the STEM student population. While focused on defense specific needs, we are partnering with other agencies and local communities, and, most importantly, our own STEM workforce to fully engage students, teachers, and family members with a goal of building a 21st century STEM workforce that will ensure the US remains the world's leader in defense innovation. Two critical STEM efforts are the Departments Science, Mathematics, and Research for Transformation (SMART) Scholarship Program and Military Child program.

SMART is our flagship scholarship-for-service program designed to produce the next generation of Department of Defense laboratory science and technology leaders. The program was identified by the Secretary of Defense as a critical workforce enabler and is included in the DoD's Force of the Future initiative. SMART offers highly competitive scholarships to undergraduate, masters, and doctoral students who have a demonstrated ability and aptitude for excelling in the scientific and engineering fields critical to the Department. Students receiving SMART scholarships commit to a period of employment within the DoD research and engineering community commensurate with the fiscal investment made by the Department in their education. In Fiscal Year 2015, the DoD awarded 207 scholarships adding to the 456 scholars currently in academic pursuit, and hired 167 SMART graduates into the workforce adding to the 485 already serving their commitment. As of December 2015 we had 1,867 SMART applications completed for 150 awards to be made in the 2016-2017 academic year. To date, we have a retention rate of 81% within the DoD beyond their service obligation. This program has been highly successful in attracting the best and brightest to pursue careers in DoD Research and Engineering.

The Department has a critical responsibility to the dependent children of our Soldiers, Sailors, Airmen, and Marines, but military dependents often have a uniquely transitory lifestyle which can challenge our ability to fully meet their educational needs. There are currently 1.2 million military children, with 55 percent between the grades of K-12. As stated in the Joint Explanatory Statement to Accompany the National Defense Authorization Act for Fiscal Year 2015, it is in DoD's interest to promote education programs that benefit both military children and our future national security workforce, both because we have a responsibility to support those who serve and because these students are more likely to go on to serve in national security careers, including military service. To promote STEM education among military dependents, we are partnering with the National Math and Science Initiative in military-connected schools -- building on documented success in improving students' performance in rigorous STEM coursework and associated assessments. Results have been dramatic, with improvements averaging 85 percent increase in Advanced Placement Math and Science scores within the first year of implementation, and 137 percent after three years. Benefits among underrepresented minority and female groups are even higher. In Fiscal Year 2015, we have reached an additional 36 schools with the potential of reaching over 28,000 students and teachers with approximately 9,000 being military children. In Fiscal Year 2016, we are extending our partnership to include the National Science Foundation and are extending the program to include computer science as a core component of the curriculum. An investment in our STEM pipeline ensures our Nation’s technological dominance and develops the innovative brainpower our Nation needs to maintain our security and deter aggression.

Preparing for the Future

The Department’s goal to sustain and advance our nation’s technological superiority for the 21st Century national security environment requires sound research and development

investments. The enhanced use of prototyping, demonstration, and experimentation will help the Department to more rapidly mature and assess the impact these technologies can have on our future force. Our investments protect essential US advantages in design, development, and manufacturing capabilities that would be very difficult to reconstitute if lost replace. These investments deliver the knowledge and tools necessary to preserve our advantage in a future global environment and provide the Department with the ability to make a strategic choice in the future to shape the nature of military competition.

The DoD Research and Engineering community works to create options for how the Department will meet our Nation's future national security needs and serves as an agile innovation engine for the Department. We must continue to focus on speeding the development and application of technology to meet acquisition program needs and must leverage ideas from inside and outside the Department; adapting and shaping them to solve military problems.

Our strength is in our people. We must recruit and retain the best and brightest military and civilian scientists and engineers and harness their innovative spirits to give our military forces the warfighting edge.

Ultimately, our goal must always be to ensure that our Soldiers, Sailors, Airman, and Marines always have the scientific knowledge, the right technology, the advanced systems and tools, the best care and the decisive technology and material edge to succeed when called upon. Our Research and Engineering enterprise measures its success in the security of our Nation and the success of our warfighters.

The Fiscal Year 2017 President's Budget request will enable us to move toward driving a culture of technical innovation across the Department, will help us prepare for an increasingly competitive global National Security environment and will foster a whole-of-department coordinated effort across Army, Navy, Air Force, DARPA, and other DoD research and engineering organizations

Thank you for your support of the Department's science and technology efforts as we work to discover, design and deliver the technological capabilities our warfighters will need to shape the future.