

**DEPARTMENT OF DEFENSE APPROPRIATIONS  
FOR FISCAL YEAR 2016**

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**WEDNESDAY, APRIL 22, 2015**

U.S. SENATE,  
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,  
*Washington, DC.*

The subcommittee met, pursuant to notice, at 11:33 a.m. in room SD-192, Dirksen Senate Office Building, Hon. Thad Cochran (chairman) presiding.

Present: Senators Cochran, Shelby, Moran, Durbin, and Udall.

**DEPARTMENT OF DEFENSE**

**DEFENSE INNOVATION AND RESEARCH**

**STATEMENT OF HON. FRANK KENDALL, UNDER SECRETARY OF DEFENSE FOR ACQUISITION TECHNOLOGY AND LOGISTICS**

OPENING STATEMENT OF SENATOR THAD COCHRAN

Senator COCHRAN. The Subcommittee on Defense Appropriations will please come to order.

We are today having a hearing on the Defense appropriations request from the administration for fiscal year 2016, the Defense innovation and research request.

We want to welcome our distinguished panel of witnesses and thank you for cooperating with our committee and being here today to discuss the budget request from the administration. We are specifically going to be reviewing the request for fiscal year 2016, as submitted by the administration, and specifically the Defense innovation and research title.

We are pleased to welcome Mr. Frank Kendall, who is Under Secretary of Defense for Acquisition, Technology and Logistics; Mr. Alan Shaffer, Acting Assistant Secretary of Defense (ASD) for Development, Research and Engineering; and Dr. Steven Walker, Deputy Director of Defense Advanced Research Projects Agency, or DARPA.

I want to commend Mr. Shaffer as he concludes his work with the Department of Defense. He will be departing the Department to serve as Director of the North Atlantic Treaty Organization, Science Office located in Paris. That is pretty good going.

We appreciate your 38 years of distinguished service, and we wish you all the best in your future endeavors.

Mr. SHAFFER. Thank you, sir.

## PREPARED STATEMENT

Senator COCHRAN. Today we look forward to learning more about the science and technology investment proposed in the fiscal year 2016 budget. This subcommittee has been a strong advocate of science and technology investments and has helped provide funding to make certain our Nation can maintain its role as the leader in technology and innovation. We want to continue to receive the input of experts at the Department of Defense, as we do our work. We appreciate your joining us today to testify as our committee continues to evaluate the budget request.

Your full statements have been received by the committee and they will be included in the record, printed in the record.

[The statement follows:]

## PREPARED STATEMENT OF SENATOR THAD COCHRAN

Good morning, the subcommittee will come to order. Our hearing today focuses on the fiscal year 2016 budget request for Defense Innovation and Research. We are pleased to welcome: Mr. Frank Kendall, Under Secretary of Defense for Acquisition, Technology and Logistics; Mr. Alan Shaffer, Acting Assistant Secretary of Defense for Development, Research and Engineering; and Dr. Steven Walker, Deputy Director of Defense Advanced Research Projects Agency (DARPA).

I commend Mr. Shaffer, as he concludes his work with the Department of Defense. Mr. Shaffer will be departing from the Department to serve as the Director of the North Atlantic Treaty Organization, Science Office located in Paris. We appreciate his 38 years of distinguished service, and we wish you the best of luck in your future endeavors.

Today, we look forward to learning more about the science and technology investments proposed in the fiscal year 2016 budget. This subcommittee has been a strong advocate of science and technology investments and has helped provide funding to make certain our Nation can maintain its role as the leader in technology and innovation. We want to continue to receive the input of experts at the Department of Defense.

Thank you for joining us today to testify as our committee continues to evaluate the budget request.

Your full statements will be included in the record.

Now I will turn to the Vice Chairman, Senator Durbin, for his opening remarks. Thank you.

Senator COCHRAN. Let me now turn to the vice chairman of the committee, Senator Durbin, for any remarks he may want to make.

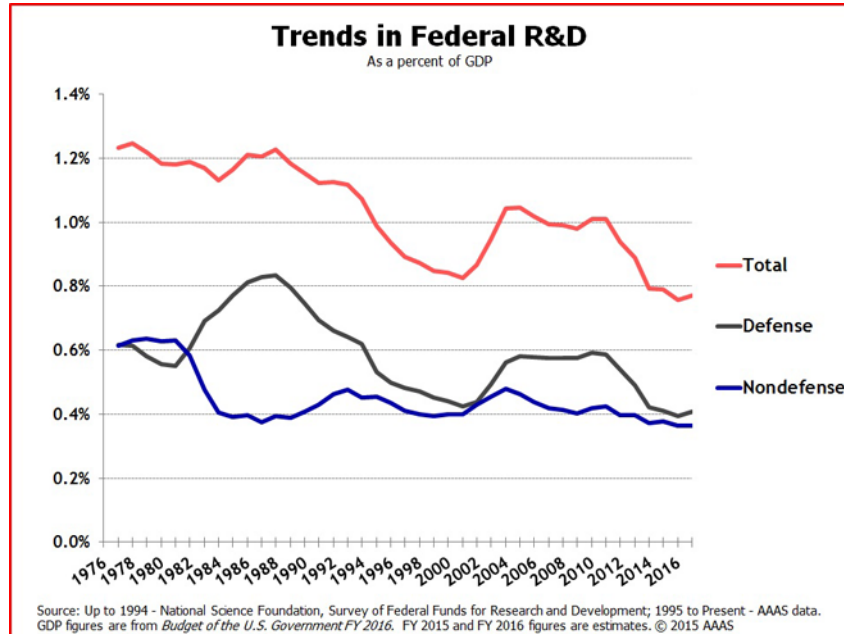
## STATEMENT OF SENATOR RICHARD J. DURBIN

Senator DURBIN. Mr. Chairman, thank you very much.

I want to thank Mr. Kendall, Dr. Walker, and Mr. Shaffer for coming today, and I would also like to echo the comments of the chairman about Mr. Shaffer's service to our country and congratulate him on his new position. Once you are settled in, we are going to come over and visit, of course, and talk about your perspective on NATO (North Atlantic Treaty Organization) and science for a long time to come.

As I stated last year, I am concerned with the state of our Federal investment in research and development (R&D). I would ask my colleagues and those in the audience to take a look at this chart.

[The chart follows:]

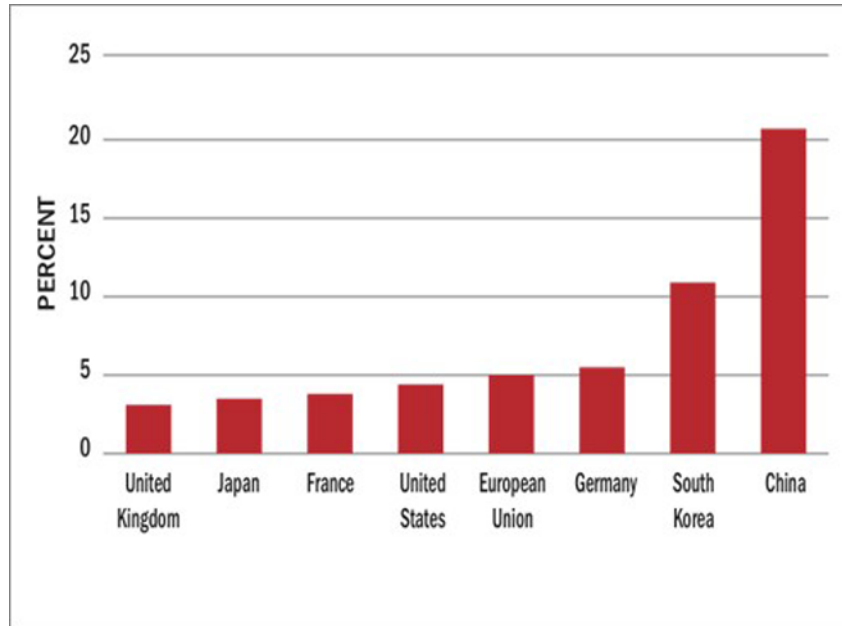


Senator DURBIN. In the 1960s—the chart starts in 1976, but in the 1960s, the United States invested 17 percent of the discretionary budget on research and development. We were putting a man on the moon and doing a lot of things in that era. That number is down to 9 percent, 9 percent of our discretionary budget on R&D.

Between 1960 and 1980, Federal R&D spending as a share of GDP averaged 1.52 percent per year. However, now it averages 0.8 percent per year. This is a steady decline. This led to a cumulative \$1.5 trillion research investment deficit.

And the second chart I will show you how we compare to other nations.

[The chart follows:]



Senator DURBIN. While we are declining in our investment in research, many other nations are surging ahead. Our nearest competitor, China, has increased funding in R&D and is on track to surpass the United States in research and development in a little over 5 years.

Well, I decided to introduce a couple bills to address these deficits directly: the American Cures Act, the American Innovation Act. The Cures Act would increase medical research for NIH (National Institutes of Health), CDC (Centers of Disease Control and Prevention), DOD (Department of Defense), and Department of Veterans Affairs at the rate of GDP (gross domestic product) inflation plus 5 percent. When I went to speak to Dr. Francis Collins at NIH, he said, "Give us 5 percent real growth for 10 straight years and we can make a difference in the lives of people around the world and save more than the money that you will put into medical research." I see my friend, Senator Moran, here from Kansas. He has always been an outspoken supporter of NIH research.

The American Innovation Act complements this and would set science and technology funding at the rate of GDP indexed inflation plus 5 percent for the Department of Energy, the National Science Foundation, NASA (National Aeronautics and Space Administration), and NIST (National Institute of Standards and Technology). Last year, with the support of my colleagues on this subcommittee, we successfully increased basic research across DOD and the services by \$260 million and added \$1.26 billion for DOD medical research.

I tried to demonstrate in this subcommittee that we could do 5 percent real growth as a challenge to the other agencies. This is a great effort, but the challenge continues. Other nations are catch-

ing us. Some are determined to pass us. If we live in the world of budget caps, we will find ourselves mired in a mess.

What former Speaker Newt Gingrich said in the Washington Post this morning is the reality. The cost that we are going to incur for healthcare alone is going to far surpass the cost of research which might avoid some of these terrible outcomes.

I am looking forward to hearing from our panel here on our technology deficits. You have a lot of successes to point to: DARPA's investment in cybersecurity, highlighted on "60 Minutes," DOD's investment in nano-satellites and investments undertaken by DOD's Strategic Capabilities Office. Even though we do not have a packed room here, I think this is one of the most important aspects of this appropriation. I thank you for being here.

Senator COCHRAN. We can now proceed to hear from our panel, and I will call on first Frank Kendall, Under Secretary of Defense for Acquisition, Technology and Logistics.

#### SUMMARY STATEMENT OF HON. FRANK KENDALL

Mr. KENDALL. Thank you, Mr. Chairman.

Chairman Cochran, Ranking Member Durbin, distinguished members of the committee, thank you for the opportunity to discuss some of the measures that the Department of Defense is taking to support and encourage innovation, particularly actions the Department is taking to improve the productivity and performance of our Defense acquisition. Our written testimony has more detail.

I would like to begin by expressing my appreciation for the work this committee has done to support the DOD science and technology program and specifically to preserve basic research, which is the foundation of all of our future capabilities.

The leadership of the Department from Secretary Carter through Deputy Secretary Work, the Chairman and Vice Chairman of the Joint Chiefs, the service leadership, and my colleagues who are with me today, Acting Assistant Secretary Shaffer, Deputy Director for DARPA Dr. Steven Walker, who is sitting in for Director Arati Prabhakar, are all committed to preserving the technological military superiority of the Department.

The Department faces two serious threats in that endeavor. The first is external and the second is internal.

As many of you are aware, I have been expressing my concerns about eroding technological superiority in the modernization programs of potential adversaries for some time. Not too long ago, I briefed Senator Durbin at a highly classified level about the details of some of the foreign modernization programs that concern me. I offer the same opportunity to the other members of the subcommittee.

The short and unclassified version of that briefing is that potential adversaries are aggressively acquiring technologies and weapons specifically designed to defeat the power projection capabilities of the United States. Potential adversaries have studied the American way of projecting power and identified perceived weaknesses, particularly our reliance on small numbers of high-value operational assets.

The foreign systems that concern me include precision ballistic and cruise missiles intended to attack aircraft carriers, airfields,

and other critical assets; advanced electronic warfare systems; air-to-air missiles; and space control systems. The United States cannot afford to be complacent about our technological superiority.

The other threat to our military superiority is one of our own making. It is the threat of sequestration. In this year's budget request, the Department is asking for funding that is well above sequestration levels. We are trying to recover some of the readiness that was lost when sequestration was implemented in 2013. We are also trying to acquire some of the capability we need to remain competitive. We are requesting increases in our investment accounts, research and development and procurement of approximately \$20 billion. Sequestration would force us to prioritize pressing near-term needs at the expense of these investments, preserving capability now but increasing our risk in the future.

Uncertainties about future budgets also make effective planning almost impossible. The uncertainty we face encourages choices to retain forces that we cannot ultimately afford in the hopes of future higher budgets.

The Department is committed to pursuing innovation in all its dimensions. Last fall, Secretary Hagel announced the Defense Innovation Initiative. Secretary Carter has endorsed this broad initiative and will be speaking tomorrow at Stanford about some specific steps the Department will be taking to foster innovation.

My colleagues with me today will discuss what they are doing to strengthen the Department's research and engineering efforts, particularly the science and technology efforts that acting ASD Shaffer oversees and the cutting-edge innovative technology that Director Arati Prabhakar and Steve Walker pursue at DARPA. The name "DARPA" is synonymous with innovation, and one of the joys of my current position is the opportunity to support and work with this fine organization.

My own efforts are focused on the broader DOD acquisition enterprise. Just 2 weeks ago, I announced the final details and implementation guidance for the most recent version of the Department's so-called Better Buying Power initiatives, Better Buying Power 3.0. The series of Better Buying Power versions started in 2010 when Under Secretary Carter and I promulgated what we now call Better Buying Power 1.0. Although there has been more continuity than change in this series of initiatives, the focus has shifted. The most recent version is focused on innovation, technical excellence, and technological superiority.

#### PREPARED STATEMENT

While we will continue all of our core efforts to improve efficiency and productivity throughout defense acquisition, this version of Better Buying Power focuses on the steps we can take to spur innovation and get the greatest value we can from each of our research and development efforts and from sources of innovation outside the Department's traditional sources. These efforts include our science and technology accounts, DARPA's budget, the work of the DOD laboratories, contracted research and development, reimbursable, independent R&D conducted by industry, the Small Business Innovative Research Program, and other efforts.

We urge you to support all of this valuable work, but most of all, we urge you to permanently repeal the threat of sequestration. Removing this specter would do more than any other single act to spur innovation and preserve our military technological superiority.

Thank you, Mr. Chairman.

[The statement follows:]

PREPARED STATEMENT OF HON. FRANK KENDALL

Chairman Cochran, Vice Chairman Durbin and distinguished members of the subcommittee, we appreciate the opportunity to testify today. I am joined here with Mr. Alan Shaffer, Acting Assistant Secretary for Research and Engineering and Dr. Arati Prabhakar, Director of the Defense Advanced Research Projects Agency. Together, with the Research and Engineering enterprise, we work hard every day to advance our Nation's defense technologies. The Department's current and planned innovation initiatives reflect our belief that the future security of the United States and our allies depends upon maintaining our technological superiority. Our superiority directly correlates with a healthy and robust industrial base, stable and adequate budgets, and an effective defense acquisition system. We look forward to the opportunity to discuss the Department's progress in each of these areas, and our roles in supporting the Department of Defense (DOD) Defense Innovation Initiative.

The following written testimony includes a summary of the actions being taken under the Department's Better Buying Power 3.0 set of initiatives, which are focused on innovation and technical excellence, other measures including the Research and Engineering Strategy and an overview of our Research, Development, Test and Evaluation (RDT&E) investments promulgated by the Assistant Secretary for Research and Engineering (ASD(R&E)), and the program being pursued by the Director, Defense Advanced Research Projects Agency (DARPA). All of these efforts are connected parts of a larger whole.

We would like to begin, however, by discussing the reason it is so crucial for our acquisition system to be more productive; that is the clear risk the United States faces today of losing military technological superiority when compared to our Nation's potential adversaries. Controlling cost and increasing efficiency and productivity are always important, and the Department remains focused on improvements in these areas. Our first responsibility, however, is to ensure the United States has, and will continue to have, dominant military capabilities relative to any potential adversary. We are deeply concerned about the adverse trends in U.S. military technological superiority. The recently released Better Buying Power 3.0 set of initiatives is focused on innovation, technical excellence and technological superiority largely because of these concerns. Secretary Carter will be speaking tomorrow about the importance of bringing advanced technology into the Department more effectively, and about some steps we can take to make that happen. However, nothing the Department, or any of us testifying today can do possibly overcome the negative impact of sequestration. Our budget request for fiscal year 2016 includes a significant recovery in procurement and research and development investments. If sequestration is allowed by the Congress to occur in fiscal year 2016, the combined demands of global operations, a readiness deficiency caused by sequestration in fiscal year 2013, the expenses associated with force structure we are still in the process of reducing, and the Congress' refusal to accept recommended sources of savings will all combine to ensure a disproportionate and devastating impact on our modernization accounts.

THE RISK OF LOSING MILITARY TECHNOLOGICAL SUPERIORITY

The U.S. and our allies have long enjoyed a military capability advantage over any potential adversary. The military capabilities of long-range precision strike weapons, stealth, wide area surveillance, and networked forces emerged from what Deputy Secretary Work describes as a "technology offset strategy" that had its origins in the 1970s. This mix of capabilities was originally designed to deal with the overwhelming number of Warsaw Pact mechanized forces. The First Gulf War in 1991 demonstrated the unprecedented impact of these technologies and marked the beginning of a period of unchallenged American military dominance that has lasted a quarter of a century and served us well in several conflicts. We used the same capabilities, with some notable enhancements, in Serbia, Afghanistan, Libya and Iraq. The U.S. has had a good run, but the contest is not one sided, and all military advantages that rely on a technology advantage are temporary. Globalization has leveled the technology field. Potential adversaries have taken good advantage of fast

moving commercial technology, acquired technology through cyber theft and espionage, and carefully studied the American way of war to identify weaknesses and vulnerabilities.

In the First Gulf War, the United States put a new suite of technologies and associated operational concepts on display for the world to observe and study. No nation paid more attention to the results of the First Gulf War than China. The intelligence estimates in the early 1990s suggested that, while China might be a concern in the future because of its accelerating economic growth, it would take 15 to 20 years for China to become a peer competitor. It is now 20 years later and the intelligence estimates were accurate. China has developed and fielded a number of advanced weapons designed to defeat U.S. power projection forces. Many more are in development. These systems include a range of capabilities, but foremost among them are accurate and sophisticated cruise and ballistic missiles designed to attack high value assets, particularly the aircraft carriers and forward bases that we depend on for power projection. These missiles, fielded in large numbers, coupled with advanced electronic warfare (EW) systems, modern air-to-air missiles, extensive counter-space capabilities, improved undersea warfare capabilities, fifth generation fighters, and offensive cyber weapons pose a serious and growing threat to U.S. and allied forces.

To be clear, we do not anticipate or foresee a military conflict with China. That would not be in any one's interest. However, we do not want the United States to be in a situation of inferiority or even parity with respect to military technology and capability. If this came to pass the United States would lose influence, regional rivalries and security dilemmas would compound, and the possibility of a conflict due to a miscalculation would increase.

China is not the only nation of concern. Russia is fielding or developing advanced systems including unmanned air vehicles, highly effective air defense systems, fifth generation fighters, and state-of-the art submarines. Russian doctrine, organization, and equipment while placing greater emphasis on conventional deterrence, continues to feature the possibility of a first strike with nuclear weapons in its doctrine.<sup>1</sup> North Korea is increasing its nuclear and ballistic missile capabilities. Iran is acquiring precision missiles that threaten our forces in the Persian Gulf and our allies and friends in the region. Globally, the United States' technological superiority is being challenged today in ways not seen since the Cold War. As all of this is occurring, the Department lives under the debilitating threat of sequestration.

Taken together, the foreign modernization programs referred to here are clearly designed to counter American power projection forces. They are intended to ensure that the U.S. does not interfere in what Russia calls "the near abroad" and China refers to as inside "the first island chain." Even if our relationships with these states remain peaceful and military confrontation with them never occurs, the capabilities we are concerned about will inevitably proliferate to other states where the likelihood of conflict may be greater.

#### DEPARTMENT OF DEFENSE RESPONSE TO EMERGENT CHALLENGES

The Department is taking several steps to better respond to the emerging challenges—most notably through the Defense Innovation Initiative and the recently released Better Buying Power 3.0. Secretary Carter is also expected to discuss other steps the Department will taking when he speaks at Stanford later this week.

##### *The Defense Innovation Initiative*

In November 2014, Secretary Hagel announced the Defense Innovation Initiative (DII) as an ambitious Department-wide effort to identify and invest in novel ways that sustain and advance the Department's military superiority and improve business operations throughout the Department. An ultimate aim is to help craft "offset strategies" that maximize our strengths and exploit the weaknesses of potential adversaries. The initiative also focuses on attracting, developing and retaining innovative leaders; improving internal business practices; reinvigorating wargaming across the Defense enterprise; developing new operational concepts and investing in leap-ahead technologies. Last fall the Department also announced the next version of the series of USD (AT&L) acquisition improvement initiatives, Better Buying Power 3.0, which is focused on innovation and technical excellence. One shared aspect of DII and BBP 3.0 is the Long Range Research and Development Planning Program (LRRDPP), a focused effort to identify innovative and game changing technologies that can be matured over the next 3 to 5 years.

<sup>1</sup>See 2014 military doctrine, paragraphs 26 and 27.

Through LRRDPP, the Department has reached out to the broadest possible community to identify technologies that can shape future military systems and capabilities. The LRRDPP effort will help the RDT&E community prioritize its investments, identify the S&T investments with the highest potential impact, and prepare the Department for development of new innovative capabilities. To support the LRRDPP effort, the Department released a Request For Information in December 2014 to solicit broad input on five focus areas: Space Technology, Undersea Technology, Air Dominance and Strike Technology, Air and Missile Defense Technology, and general “Other” Technology-Driven Concepts. The LRRDPP will complete this summer in time to inform the fiscal year 2017 budget.

Through the overall DII effort, the Department is investigating new technologies and operational concepts that will provide an enduring military advantage. One goal is to identify weapons and systems in the force today that can be used in more innovative ways. The Department will also look for promising technologies, including commercial technologies that can be accelerated into products. Finally, longer range science and technology investments that will have a high payoff in the future will be identified. The Department is also devising new ways of engaging the commercial sector. To be successful, the Department also has to attract and retain high quality scientists, engineers, and technical managers. This focus on achieving dominant capabilities through technical excellence and innovation is the new emphasis now being implemented in Better Buying Power 3.0.

#### *Better Buying Power 3.0*

The Department’s continuous improvement approach to obtaining better results from the defense acquisition system and in everything the Department obtains by contracting with industry, has been formulated in a series of initiatives originally called “Better Buying Power” by then Under Secretary Carter. The three versions of Better Buying Power to date are more about continuity than change. Efficiency and productivity are at the core of all three versions of Better Buying Power and many core initiatives appear in all three versions—and almost certainly would be in any future version. The evolution from BBP 1.0 to 2.0 to 3.0 is based on the premise that emphasis should shift as initiatives are put in place, experience is accumulated, data is collected and analyzed, and conditions change. Each iteration of BBP is characterized by strong continuity with previous iterations. Areas of continuity include: an emphasis on competition and competitive environments, incentives linking profit to performance, cost consciousness demonstrated by active management including targets for cost reduction, improving the management of contracted services, utilization of small businesses, and strengthening the professionalism of the acquisition workforce. BBP 3.0, which was released in its final version with implementing instructions last week, maintains that approach, with an increased emphasis on achieving dominant capabilities through innovation and technical excellence.

The draft of BBP 3.0 was released in the fall of 2014 when it was distributed for comments from the workforce, industry and other key stakeholders. Feedback was received from industry, think tanks and other institutions and the Department worked with the Congress on legislative portions of the initiatives. BP 3.0 does not reflect everything that the Department will do to increase innovation in industry and government, but it is a significant subset of the actions being taken to enhance innovation and technical excellence in the Department. The USD (AT&L) will utilize the Business Senior Integration Group, originally formed under then Under Secretary Carter, as the management forum to implement the BBP 3.0 initiatives, track them and identify new opportunities to improve acquisition outcomes. The Department’s management approach remains one of continuous improvement, with the focus of this iteration of BBP on innovation and technical excellence.

We have submitted the BBP 3.0 “implementation instructions,” which describes BBP 3.0 in more detail for the record.<sup>2</sup> The following is a brief summary of key components in the Better Buying Power 3.0 Initiatives that will have impact to the Department’s ability to innovate.<sup>3</sup> There are seven major areas of emphasis that have a number of individual initiatives associated with each area. For the purposes of this statement we will highlight examples of efforts focused on innovation and technological superiority.

<sup>2</sup> Frank Kendall, Better Buying Power 3.0: Implementation Guidance, Office of the Under Secretary of Defense, Acquisition, Technology and Logistics, April 9, 2015 [http://www.acq.osd.mil/fo/docs/betterBuyingPower3.0\(9Apr15\).pdf](http://www.acq.osd.mil/fo/docs/betterBuyingPower3.0(9Apr15).pdf).

<sup>3</sup> Frank Kendall, Better Buying Power 3.0 Fact Sheet (9 April 2015) <http://www.acq.osd.mil/fo/docs/BBP3.0FactSheetFINAL.PDF>.

The Department is increasing its emphasis on responsiveness to threat changes through tighter integration of requirements, intelligence, and acquisition. When the Department introduces a system to the field, its capabilities cannot be assumed to remain adequate against advancing threats. The threat is dynamic, and the Department must stay ahead of the threat curve. The Department will increase the use of modular designs, open architectures, and competition to spur innovation and ensure that our designs can accommodate upgrades that keep us ahead of potential adversaries at affordable cost.

BBP 3.0 adds a specific initiative on cybersecurity. Innovation that is stolen before it is fielded, and systems whose capabilities can be negated by cyber-attack offer no advantage to the United States. Cyber security is a pervasive problem for the Department. It is a concern for our programs from inception through retirement. The cyber-security of the industrial base that supports the department, and the ability to protect even unclassified technical information, including design, supply chain, and logistics support systems for our weapons systems, will be addressed more effectively. Everything associated with a weapons system is a potential point of attack. The Department has taken steps to address these concerns, but more action is needed.

The Department intends to make it easier for people to do business with the government. Under BBP 3.0, barriers to doing business with the department will be reduced so that we can engage new, innovative suppliers, especially small businesses. The Department is also working to find ways to transition commercial technology more effectively, so that we can leverage a vibrant, innovative commercial technology sector and get capability into the hands of warfighters more quickly. Outreach to commercial firms has already increased, as demonstrated in the LRRDPP initiative which will inform the fiscal year 2017 process.

BBP 3.0 is also increasing the Department's focus on getting the most out of all of our various research and development investments leading up to actual product development. This includes the science and technology, advanced component, and early prototype investments. The productivity of our in house laboratories, external research efforts funded through contracts and grants, and the Independent Research and Development (IR&D) conducted as a reimbursable expense by private industry are all of concern. Each of these investments will be assessed and evaluated with a goal of getting as much from them as possible.

BBP 3.0 includes several initiatives designed to encourage innovation in industry. One is the direction to provide industry with draft requirements earlier on in the process, allowing industry the opportunity to provide feedback and to make well informed investment decisions. The Department will also contract with industry for early concept definition work to better inform requirements decisions and analyses of alternatives. Finally the Department will expand the process of defining "best value" in monetary terms so that industry will know what the government is willing to pay for enhanced performance. This knowledge will spur innovation by giving industry a solid understanding of the competitive advantage available to firms offering innovative ways of achieving higher performance at acceptable costs.

BBP 3.0 also continues to emphasize professionalism in the acquisition workforce, with a specific focus in this version on technical excellence. A strong engineering and scientific government acquisition workforce is a necessary for effective innovation and management of development programs. Technical risk management is at the core of cutting edge weapon system development programs, and the Department cannot just transfer this responsibility to industry. Well qualified technical managers, normally with relevant engineering backgrounds, should be running our development programs. The Department cannot be an intelligent customer who insists on high levels of performance and knows how to get the most out of industry, without well qualified technical managers. The Department would like to work with the Congress to create greater incentives to recruit, grow, and retain professionals with these capabilities.

In summary, BBP 3.0 does not end the Department's focus on controlling costs, critical thinking and sound professional management. It shifts the emphasis toward the products the Department acquires for our customers: the warfighters who depend on us to give them dominant capabilities on the battlefields of the future. BBP 3.0 continues the effort to strengthen the Department's culture of cost consciousness, professionalism and technical excellence.

#### OTHER INITIATIVES IMPACTING INNOVATION

In the spring of 2014, the Department released the Defense R&E Strategy, which described the technical priorities for the Department. The first R&E priority is to develop capabilities that mitigate existing and emergent threats. This effort includes

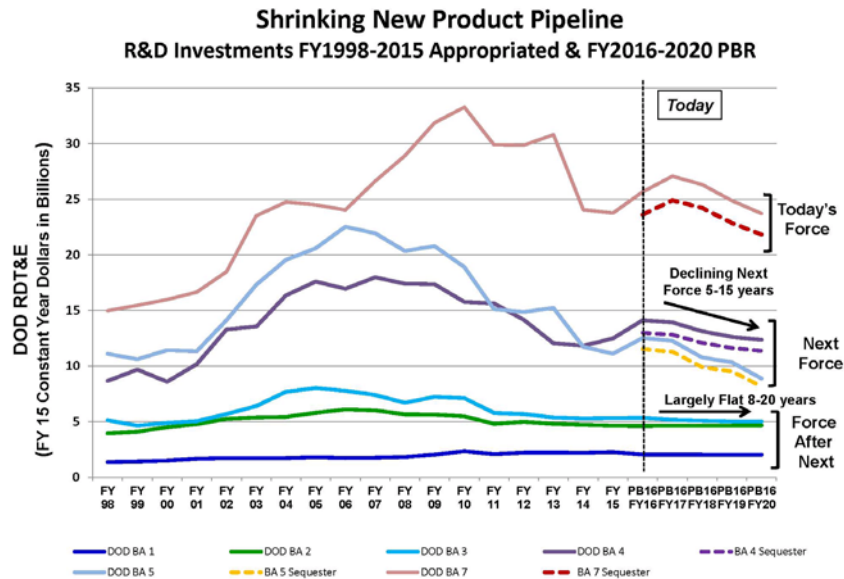
innovation in electronic warfare, missile defense (both cruise and ballistic), cyber, preservation of space capabilities, and countering weapons of mass destruction. The Department is also committed to developing capabilities that build innovation into existing and future systems. This includes expanding the use of prototypes and demonstrations to reduce risk in early acquisition, expanded use of open systems, modeling and simulation, developmental planning, and systems engineering. Lastly, the R&E strategy includes a focus on developing capabilities that deliver technological surprise to potential adversaries. This includes research in subjects such as autonomy, human cognition, quantum sciences, and hypersonic flight.

*Prototyping and Demonstration Efforts*

The Department has increased prototyping where possible within its budget constraints. This will help to preserve key capabilities in our industrial base by keeping our design teams healthy while advancing the state of the art to reduce development lead time and hedge against threat developments. The Department is focusing these efforts to support innovation, mitigate current and near future threats, enhance affordability and develop technological surprise whenever and wherever possible. The President’s fiscal year 2016 budget includes an “Aerospace Innovation Initiative,” a new joint program led by DARPA in partnership with the Navy and Air Force that is intended to develop the technologies and address the risks associated with the air dominance platforms that will follow the F-35. This initiative will culminate with the development of two “X” plane prototypes.

INVESTMENTS

The Department’s fiscal year 2016 budget request for Research, Development, Test, and Evaluation is \$69.8 billion. This includes investments of Science and Technology (S&T) at \$12.3 billion. The chart below shows the evolution of RDT&E budget lines over the past several decades. Briefly, the accounts “Advanced Capabilities Development (6.4), and Engineering, Manufacture and Development (6.5) are the accounts that prepare the next force. These accounts have been in decline over the past decade. In Constant Year (fiscal year 2015) the overall RDT&E appropriations have declined from \$89 billion in fiscal year 2009 to \$64 billion in fiscal year 2015.



The fiscal year 2016 budget request has largely protected S&T, and has also preserved DARPA at \$2.973 billion. The table below shows the investment trends in the last 2 years. While this budget request is sufficient, the investment request for S&T in Constant Year fiscal year 2015 dollars peaked in fiscal year 2012 at \$12.9 billion.

## S&amp;T BUDGET

Table 1.—Defense Budget for Science &amp; Technology; Research &amp; Engineering; and DOD Top Line Budget (Fiscal Year 2015 Appropriated and PBR 2016)

	PBR 2015 (dollars in millions)	Fiscal year 2015 appropriated (dollars in millions)	PBR 2016 (fiscal year 2015 constant year dollars)	Percent real change from fiscal year 2015 appropriated (fiscal year 2015 constant year dollars)
Basic Research (BA 1) .....	2,018	2,278	2,089 (2,049)	- 10.05%
Applied Research (BA 2) .....	4,457	4,648	4,713 (4,622)	- 0.55%
Advanced Technology Development (BA 3) .....	5,040	5,326	5,464 (5,359)	0.61%
DOD S&T .....	11,515	12,252	12,266 (12,030)	- 1.81%
Advanced Component Development and Prototypes (BA 4) .....	12,334	12,491	14,402 (14,125)	13.08%
DOD R&E (BAs 1-4) .....	23,849	24,743	26,668 (26,155)	5.71%
DOD Topline .....	495,600	497,396	534,313 (524,029)	5.35%

Table 2.—Service and Agencies S&amp;T Budgets (Fiscal Year 2015 Appropriated and PBR 2016)

	PBR 2015 (dollars in millions)	Fiscal year 2015 appropriated (dollars in millions)	PBR 2016 (fiscal year 2015 constant year dollars)	Percent real change from fiscal year 2015 appropriated (fiscal year 2015 constant year dollars)
Army .....	2,205	2,555	2,201 (2,159)	- 15.51%
Navy .....	1,992	2,155	2,114 (2,073)	- 3.80%
Air Force .....	2,129	2,282	2,378 (2,332)	2.22%
DARPA .....	2,843	2,845	2,901 (2,845)	0.00%
Missile Defense Agency (MDA) .....	176	195	224 (220)	12.61%
Defense Threat Reduction Agency (DTRA) .....	473	481	485 (476)	- 1.09%
Chem Bio Defense Program (CBDP) .....	407	430	394 (386)	- 10.12%
Other Defense Agencies .....	1,289	1,310	1,569 (1,539)	17.47%
DOD S&T .....	11,515	12,252	12,266 (12,030)	- 1.81%

Within the S&T accounts, roughly 50 percent is spent in DOD laboratories and universities, and roughly half (\$6 billion) is invested in Industrial Contracted R&D (CRAD). Industry also spends roughly \$4-5 billion in reimbursable Independent R&D (IRAD). Among DOD's investments in innovation, DARPA plays a unique role. DARPA's mission is to explore high risk high payoff technologies.

## DEFENSE ADVANCED RESEARCH PROJECTS AGENCY'S STRATEGIC INVESTMENTS

DARPA's strategic priorities can be grouped within four areas, each one focused on developing and ensuring a family of key capabilities. The first priority, rethink complex military systems, includes goals like assuring dominance of the electromagnetic spectrum; improving position, navigation, and timing without GPS; maintaining air superiority in contested environments; and asserting a robust capability in space among others. Second, master the information explosion, aims to derive meaning from big data and build trust into information systems. Third, harness biology as technology, which includes accelerating progress in synthetic biology, outpacing infectious diseases, and mastering new neurotechnologies. Lastly, expand the technological frontier, which includes applying deep mathematics, inventing new chemistries, processes and materials, and harnessing quantum physics effectively.

DARPA also continues to focus on the important work of transitioning its technologies to the Services or to other outlets in support of national security. One of the ways DARPA achieves this goal is through its Open Catalog—a publicly accessible database of published papers, open-source code and other resources generated by DARPA-funded research. Some months ago, for example, DARPA published the open-source code it developed through formal methods that can render complex software systems unhackable for given applications. That code is already being incorporated into a range of devices on the commercial market, including the automotive

industry, changing the economics and incentives for those who might otherwise seek to disrupt critical cyber systems.

Further details on each of these areas are available in the recently released “Breakthrough Technologies for National Security”<sup>4</sup> report. However even through effective collaboration between the Office of the Secretary of Defense, the Services and Agencies, our strategic choices will only go so far without consistent funding.

As such, it is essential to remember three facts about research and development investments. First, our technological superiority is not assured. It takes active investments in both government and industry to keep our critical capabilities superior to those of potential adversaries. We have come to assume technological superiority is a given; it is not. Second, research and development is not a variable cost. The number of items we would like to procure or the size of our force has nothing to do with how much research and development we should fund. It takes as much research and development to buy one production asset as it does to buy 1000s. Despite this fact we have a tendency to cut research and development proportionately to other budget accounts that do represent variable costs. Third, time is not a recoverable asset. It takes a certain amount of time to develop a new weapon system. Once that time is lost it can never be recovered. Today the Department of Defense is being challenged for technological superiority in ways we have not seen for many years. Our ability within the Department to respond to that challenge is severely limited by the current budget situation. While we try to resolve the issue of the future size of the Department, so we can plan effectively and execute our budgets efficiently, we are losing time, a highly perishable asset.

The combined impact of reduced budgets, even without sequestration, on-going combat operations, and our global commitments significantly impact U.S. investment in new technology and weapon systems. The rise of foreign capability, coupled with the overall decline in U.S. research and development investments, is jeopardizing our technological superiority. The Defense Department has to balance among many competing requirements and the President’s Budget will, as it always has, reflect the best balance of force structure, readiness, and modernization available. Our responsibility is to use the available resources as efficiently and effectively as possible to deliver needed capability to our warfighters.

#### CONCLUSION

All of our efforts to increase innovation and improve acquisition outcomes are efforts to swim against the current of inefficiency caused by the threat of sequestration and constant budget uncertainty and turmoil. We must restore balance to the Department, but we cannot do so until our plans and future budgets are better aligned. Until that occurs, modernization investments, particularly research and development, will suffer. This means that development programs will be stretched out inefficiently and that production rates will be well below optimal for many programs. The uncertainty about whether or not sequestration will be imposed makes it impossible to determine where the optimal balance between force structure, readiness and modernization lies. In this environment the tendency is to hang on to assets that the Department may not ultimately be able to afford. We need a certain level of funding to sustain the force that is necessary to execute our national security strategy and we need to remove the threat of sequestration so that our planning can be on a sound basis.

The Department continues to make the health of our industrial base a top priority; at the most senior level, the Deputy’s Management Action Group continues to meet specifically to review industrial base budget implications and the Deputy Secretary and Secretary have taken action to ensure we are doing what we can to protect critical companies that make up this important part of what we consider our “total force structure.” The U.S. is well into the process of losing tens of thousands of engineers and skilled production workers from our industrial base—this community matched with our technical managers is essential to continued technological superiority of the Nation.

Given the Department’s 5-year plan through 2020, we can tell you right now what capabilities the Department will have in 2025. If a weapon system is not in our 5-year plan as a development program today, the Department will not have that capability in meaningful quantities within the next decade. It is possible to move a complex weapon system through development in those additional 5 years from 2021 to 2025, but we are unlikely to be able to also produce and field a useful inventory within that same period of time. Technological superiority is not a tomorrow prob-

<sup>4</sup>DARPA “Breakthrough Technologies for National Security” (25 March 15) <http://www.darpa.mil/WorkArea/DownloadAsset.aspx?id=2147488951>.

lem; it is here today. The Department remains committed to working with the Congress on acquisition improvement, particularly to stimulate innovation, and we are confident that the initiatives being pursued under the Defense Innovation Initiative, Better Buying Power, the R&E Strategy, and DARPA's Strategic Plan will lead to improvements.

Nothing we can do, however, will overcome the harm done through sequestration and the resulting lack of adequate research and development funding. We conclude with three truisms about research and development—the source of all our innovation. First, that technological superiority against competitive adversaries is not assured; it depends on a healthy and continuing pipeline of new product development. Second, that research and development is not a variable cost; foregoing research and development doesn't lower the quantity we will have in our inventory—it eliminates future products entirely. Third, time is not a recoverable asset; the time to develop a new product is not something we can purchase later, and technological superiority, once lost is almost impossible to recover.

Senator COCHRAN. Thank you for your statement.

We will now call on Mr. Alan Shaffer, Acting Assistant Secretary of Defense for Development, Research and Engineering for DOD. Mr. Shaffer.

**STATEMENT OF ALAN SHAFFER, PRINCIPAL DEPUTY ASSISTANT SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING**

Mr. SHAFFER. Thank you, Chairman Cochran, Vice Chairman Durbin, and members of the committee. I am proud to be here once again to represent the 100,000-plus personnel in the Department of Defense research and engineering enterprise, the enterprise that has powered previous innovation cycles that has produced the world's most dominant military. The research and engineering enterprise has been challenged, however, in many ways over the last several years, but the people continue to perform remarkably well.

I also want to thank this committee for the longstanding support of the Department's science and technology (S&T) program. With your help, we have maintained S&T funding at above \$12 billion a year in fiscal year 2015 and ask that you support our fiscal year 2016 budget request of \$12.2 billion. In my office, we have revised the way we plan and execute and S&T program through Reliance 21, an oversight construct that has created communities of interest to bring scientists working in specific technology areas together to jointly plan and execute their Department-wide program in a more effective way.

But to be truly effective, we have to continue to enhance the connection of my S&T community to the broader Department. As mentioned by Secretary Kendall, the current national security environment forces the DOD to examine new ways of operating to enhance our innovation. My office is directly involved in both the Defense Innovation Initiative and a large number of the specific initiatives under Mr. Kendall's Better Buying Power 3.0.

The Defense Innovation Initiative is a new Department-wide effort to identify and invest in novel ways to sustain and advance the Department's military superiority for the 21st century and to improve business operations throughout the Department. The initiative has five major lines of effort, including people, war-gaming, operational concepts, business practices, and a new long-range research and development planning program, an effort to reach out to the broadest possible community to identify technologies that can shape future military systems and capabilities. This effort will help the RDT&E (research, development, testing, and evaluation)

community prioritize its investments, protect the S&T investments with the highest potential impact, and increase the return on our S&T investments. The effort will complete its initial review this summer.

Under Better Buying Power, there are a number of specific initiatives that address the Department's ability to innovate. I will cite a few that are directly aligned with my office. Under Better Buying Power, we are more tightly coupling the acquisition requirements and intelligence community to more dynamically adjust the changes in potential threats.

We are addressing barriers to the adoption of commercial technologies in our systems and capabilities.

We are addressing the productivity of corporate independent research and development.

We are increasing the use of prototypes and experimentation across the Department to burn down technical risk early in a program cycle and understand how systems will operate.

We are emphasizing technology insertion and refresh in our program planning so that we can become much more agile.

We are expanding the use of modular, open systems architecture to stimulate innovation and allow us to become more agile.

We are improving the outreach for technology and products from a global market. As Mr. Durbin showed, technology now is global and R&D has become a global commodity. We have to go out and get the best possible for our forces. We are increasing the participation of small business.

Taken together, these initiatives will enhance our ability to improve the systems and capabilities we design, develop, and field well into the future.

In addition, as mentioned by Mr. Kendall, tomorrow Secretary Carter will be announcing some actions that he is directing to improve our outreach to and the use of some of the fastest growing commercial technologies and talent in the world. Meeting the national security needs for the future requires we have some urgency in implementing this multi-faceted strategy. I am confident that with the continued support of this committee, the professionals who make up the research and engineering enterprise are up to the task.

Senator COCHRAN. Thank you very much.

We will now hear from Dr. Steven Walker, Deputy Director of DARPA.

**STATEMENT OF DR. STEVEN WALKER, DEPUTY DIRECTOR, DEFENSE  
ADVANCED RESEARCH PROJECTS AGENCY**

Dr. WALKER. Thank you. Thank you, Mr. Chairman, Senator Durbin, members of the subcommittee. I appreciate the chance to participate and be here at this hearing today.

DARPA is part of this broader DOD community and we are also part of a bigger national R&D ecosystem. Within these communities, DARPA has a very particular role. That role is to make the early pivotal investments that help develop breakthrough technologies. We do that to change what is possible for the future so we can take big steps forward in national security capability.

I would like to give you just an example of how our work in DOD science and technology makes those advanced military capabilities possible. I want to do that by looking under the hood a little bit at a trio of new radar and jammer systems coming online today.

So today our military services are building a new generation of radio frequency phased arrays to field in the coming years: The air and missile defense radar that will allow the Navy destroyers to handle more threat systems at once; a next gen jammer that will provide more precise jamming at greater ranges; and the space fence radar that will allow us to look at lots of objects in space from the ground. Each one is a big step forward in our military capability.

So let us take a look under the hood at how we have enabled these capabilities to come to fruition.

One thing you will see in each system is many commercial integrated circuits. So these are catalog parts. But you will also find some components you cannot find in any catalog. That is the unique technology that gives each one of these systems its power. And that technology is gallium nitride power amplifiers. These semiconductor components send and receive radio signals at higher power with much greater efficiency than chips that they replace.

So where did the gallium nitride radio frequency technology come from? It actually started as a crazy idea over at one of our sister agencies, the Office of Naval Research, ONR. A creative program manager there in the 1990s had this idea for this new material called gallium nitride. But at the time, he could only build a very small crystal of material. So that is how the journey started.

But with DOD basic research investment in new materials at universities and laboratories, then a big push by DARPA to demonstrate the first practical devices made with gallium nitride was done, followed by ManTech and service laboratory investment and industrial investment to mature the technology, ultimately building a tech base, an industrial base that actually could produce these devices. So that is how we can build the AMDR, next gen jammer, and space fence today. This is just one example of the impact of science and technology and how it helps develop and drive new products for DOD.

Looking forward, if you look at our portfolio at DARPA today, you will see many variations on this theme. Whether it is platforms and weapons so we can prevail in a highly contested battle space or cybersecurity or new fields of research where we see the next seeds of technological surprise, this work that we do along with the rest of the Department's science and technology community is the foundation for our military technological superiority in the future.

So I thank you for your support. The subcommittee's support over the years continues to be essential to what we do at DARPA. And I will be happy to take the questions along with Mr. Kendall and Mr. Shaffer. Thank you.

Senator COCHRAN. Thank you very much.

Mr. Kendall, let me start questioning by asking you about your recent paper, The Challenge to U.S. Technological Superiority. It seems to portray that other nations' advances in technologies are placing some of our security interests at risk. What specific recommendations would you make to the committee and the Senate

to ensure that we are investing in the correct warfare domains to maintain our technology dominance?

Mr. KENDALL. Mr. Chairman, the paper you referenced lays out some of the threat developments, modernization programs that I alluded to in my opening remarks. It basically goes through with the unclassified level some of the very specific types of systems that are being built.

The United States introduced a way of warfare for power projection, particularly conventional warfare, that was unprecedented in its efficiency and effectiveness. That was in the first gulf war in 1991. The prediction going into that fight was that we would have 10,000 or more casualties. In the event, we had less than 300 if I remember correctly.

The reason that we are so dominant on the battlefield was a mix of technologies that included precision weapons, stealth, network forces, and wide-area sensors. That same suite of capabilities, which came out of technology investments of the 1970s primarily, is the set of capabilities we continue to advance and enhance certainly but that we continue to rely on.

Nobody watched more carefully what happened in the gulf war, wrote about it more, or reacted to it more than China and to a lesser extent Russia. It was right after the cold war had ended, of course. So Russia was not much of a threat at that time, and China was relatively poor at that time compared to where they are today. But they have had 25 years since then, roughly, to invest in capabilities that are designed to counter that set of capabilities that we demonstrated so dramatically in the first gulf war. And that is what they have done.

I come in every morning and I get an intel brief when I come in and I tend to focus on technical intelligence because it is what I am concerned about. And I have been looking for 5 years now at the weapon system developments that are taking place, again particularly in China. And it was quite clear to me 5 years ago that they are focused on investments which are designed to defeat our power projection capabilities. And many of those systems have been fielded. There are many more in their pipeline that will be fielded in the next few years, and the quantities, of course, are increasing. So that is the problem we face.

The fundamental things we need to do about that. First of all, we need to invest adequately. And the reason I gave such a strong statement about sequestration and about the importance of preserving our longer term investments is because without resources nothing that we can do at the Department will make us adequately efficient or make up for the loss or lack of resources. That is number one.

We think we have struck a fairly balanced approach to our investments. There is a lot of work ongoing right now to make sure we have got the right focus. We think we are in a reasonably good place but may want to make some adjustments. Secretary Work came in interested in a third offset strategy, as he calls it. It is the next generation, the next suite of capabilities that we would field to go to the next level of performance, if you will, compared to those that I talked about earlier. We are in the process of looking at that. Mr. Shaffer mentioned the long-range R&D planning activ-

ity that is ongoing. That is designed to inform the fiscal year 2017 budget, and we may make some investments based on that. Secretary Carter is very interested in making sure we make the right bets for the future, that the Department makes some conscious decisions about where we need to go. So that is all work in progress.

We think right now with what we have requested we are in a reasonably good place. We do expect to make some adjustments in 2017. What we would ask for more than anything else is adequate funding from the committee, from the Congress to do the things that we need to do.

Senator COCHRAN. Thank you.

#### TECHNOLOGY TRANSITION

Mr. Shaffer, what processes have you observed that enable technology transition from the laboratory to programs of record? Are there any recent examples of the transitioning of such technology?

Mr. SHAFFER. Yes, sir. So I think at the end of the day, technology transition is a contact sport. We have got to have demonstrations and prototypes that the users can then go out and use and see if they can break it, see how they use it, see how the capability can be employed. And we have seen a number of very successful smaller scale prototypes that have been developed and deployed. I will mention a couple that came out of our office because I think they are illustrative of the type of thing that we can do.

About 6 years ago, the Johns Hopkins applied physics laboratory came to one of my program managers with a small-scale laser radar that can be put on a UAV (unmanned aerial vehicle). This system can be used to map the terrain locally in Afghanistan at roughly the 1- to 2-inch resolution level. We put that system into a prototype in a UAV, had the Army go use it in theater, and they ended up finding a lot of caves that they did not know existed where some of the terrorists were hiding. The program was so successful it has transitioned into a program of record in the Army called tactical observing system, or TACOBS, and is being fielded for future Army systems.

There are numerous other of those types of capabilities, but at the end of the day—and we have made a huge push in the Department to increase our level of prototyping and demonstrations, but it is actually building a capability, giving it to the operators so they see how it can be employed, and then going ahead and modifying the final production system. We find that we can go much more quickly through the system that way.

Under Dr. Walker, we found that we needed a longer range air-to-surface ship missile, anti-ship missile. That program, known as LRASM (long range anti-ship missile), came out of a DARPA program. Mr. Kendall went ahead and sent in a transition plan for LRASM, managed jointly by DARPA and the Navy for a couple of years, transitioned to a Navy program of record, and we will actually field some long-range anti-ship missiles in about a 4-year period. Again, that is another success and it came about because it is a contact sport, sir.

#### LONG RANGE ANTI-SHIP MISSILE

Senator COCHRAN. Well, thank you.

I think I will ask Dr. Walker, since your name has been associated with that effort, to see what the long-range capability prospects are for our missile arsenal capabilities.

Dr. WALKER. Yes, sir. Mr. Shaffer mentioned the long-range anti-ship missile. DARPA had three key successful demonstrations of that capability, and that is moving out into a program of record. So that is a very big success.

But I think the things I would like to highlight are two programs that we are actually working with the Air Force on, both in hypersonics. One is a boost-glide system. Basically you boost it with a rocket and glide the system to the target. And the other is a hypersonic air breathing weapons concept where you also boost that concept. You then take over with the air breathing scramjet engine on board, and that also hits its target as well. We are working both of these jointly with the Air Force.

These are hypersonic speed, so at least five times the speed of sound. What that buys you is a strike capability for time-critical targets from long standoff ranges. And so we see these systems—if we can pull that hypersonics technology into a weapon system concept, we see that at the end of these programs the Air Force would be ready to go off into an acquisition program on those systems potentially if we are successful.

That is really the future. If you could combine that capability with any of our platforms, we will have a capability that will provide us an advantage in a contested environment in the future.

Senator COCHRAN. Thank you.

Senator Durbin.

#### CYBERSECURITY

Senator DURBIN. Thanks a lot, Mr. Chairman.

And let me commend to my colleagues here—I did spend an hour with Mr. Kendall talking about breakthroughs in technology on our side and the other side. It is well worth your time. It is an eye-opener in terms of what we are appropriating here.

So we used to live in the world, the John le Carre world, of cloak and dagger spies, and we still hear of them popping up from time to time. But it appears that the real vulnerability now is in cybersecurity and cyber spying. So when we talk about the advances being made by our hard target enemies or others around the world, how much do you attribute to their invasion of our knowledge, theft of our knowledge?

Mr. KENDALL. I have to be careful what I say. But, Senator, cyber espionage, cyber theft is a huge concern. It is a pervasive problem. I think I can tell you that we protect our classified information reasonably well, but we have not done a good job of protecting unclassified information.

About a year ago, we put in place a mechanism in our contracts to require people to protect unclassified technical information to a certain set of standards. They come out of the National Institute of Standards and Technology. That is a first step. And we have got about 200,000 contracts I think now which include that clause, and we are enforcing that so that people do a better job of protecting technical information. We are going to evaluate that over time, and we may have to put some more stringent controls in place.

Getting access to that technology and, if you will, coming into somebody's computer and unloading their drawings and all their information is that you save an enormous amount of time and money in developing your own capability. You take something as benign as, say, the landing gear design for the F-35, which there is no real reason why that would have to be classified. And you can emulate that. You know that there is a successful design there. It saves you an enormous amount of cost and risk getting to a similar design. That is a mundane example, but there are lots of them.

Our ship designs, for example, are basically unclassified, and they have to be handled that way for a variety of reasons. But we need to protect all that information much more effectively.

We are under attack. We are under attack every day, and it is very depressing to see some of the successful attacks that have occurred, again unclassified technical information largely. So we are doing some things there.

We are trying to increase our awareness of cyber threats and the necessity of doing something about them throughout a program's life cycle. It is a program manager's responsibility. It is a lot of people's responsibility to ensure we protect our information in all aspects by which we could be attacked with cyber attack. And it is your supply chain. It is your actual design work at your prime contractor's. It is the features of the logistics system that connect the weapon system to the world of suppliers that we have out there. It is the operational systems on the weapon system. It is everything. And in all those cases, we have to be worried about cyber vulnerabilities and take steps to mitigate them.

So I think there is a growing awareness throughout the Department. Secretary Carter had a meeting on a Saturday just a week or so ago, brought in all the senior people of the Department involved in cyber to talk about just this issue and what our strategy is going to be to address it. We have just published—I am not sure if it is out today or tomorrow, but we have a cyber strategy, for example, that we are going to be publishing. So we are addressing this aggressively. It is not free to have cyber security. It is going to cost us money, but we have to do that. The return is there to protect our information.

#### BASIC RESEARCH

Senator DURBIN. Let me zero in on the budget request this year. The President's fiscal year 2016 budget request for RDT&E is \$69.6 billion, \$6.1 billion over fiscal year 2015 enacted. \$3.5 billion of that requested \$6.1 billion goes into more advanced research like building prototypes and evaluating their potential for mass production. Only \$14 million—\$14 million of that increase—is for science and technology research.

Is there a risk to this approach where we are putting heavy investment in the basic technologies for the battlefield at the expense of neglecting our seed corn, the basic research that should be part of this as well?

Mr. KENDALL. Good question, sir.

One of the things I am proud of this administration for having done is to protect our basic science and technology accounts. If you look back at the last several years, we have maintained, despite all

the budget fluctuations, a fairly steady investment in science and technology. We have made a very minor adjustment, I think, this year in our request there to get back to more historical norms and to rebalance things a little bit. But we have worked very, very hard to protect that. It is about \$10 billion to \$12 billion out of our \$60 billion to \$70 billion of R&D, and that is a very stable part of our budget.

The part of our budget that has been changing a lot has been the two accounts which are our pipeline of new products. It is the prototyping effort and the pre-full-scale development effort and the effort to actually get a product to where you are ready to produce it. Engineering, manufacturing, development it is called. Those two accounts have come down quite substantially.

The other largest account in the portfolio of R&D investments is upgrades to new systems. It is called the 6.7 account. That has grown over time substantially. As we have gone through cuts, everything has come down to some degree except the S&T accounts. But that shows that we are keeping things longer and we are putting money into upgrades instead of into new products in the pipeline. If I compare our new product pipeline to other countries that we are worried about, it is a lot of white space compared to a lot of very dense space. Let me put it that way. So I think if there is a concern, it is not in the S&T part of the budget. It is in the new product pipeline part of the budget, that part of the overall R&D investment.

Senator DURBIN. Thank you.

Senator COCHRAN. The Senator's time has expired.

The Senator from Alabama, Mr. Shelby.

Senator SHELBY. Thank you.

#### ROCKET PROPULSION SYSTEM

Secretary Kendall, a Reuters article from June 13th of last year quoted you discussing the Russian rocket engine replacement, stating—and I will quote—“We have not figured out exactly how to get there yet.” Since then, Congress has appropriated, as you know, \$220 million for the new rocket propulsion system. It is my understanding that 6 months into the year, nothing has been obligated yet.

How does DOD plan to provide for national security launches in light of section 1608 restrictions in the law last year and the lack of a certified alternative launch provider to date? How do we avoid a gap there?

Mr. KENDALL. We are wrestling with that right now, Senator Shelby. It is a real problem for us. Let me start with the basics on this.

What we need is assured access to space. Rocket engines are a part of that, but we do not necessarily go out and buy rocket engines. We buy launch services. We want somebody to get us into space reliably. So that is number one. We want to be sure that when we want to put a satellite up, that we are going to get it up successfully and not drop it in the ocean. So that is number one.

We would like to have more than one way to do that. So we would like to have two sources of space launch in case something

happens with one of them—we have a technical problem or whatever, somebody goes out of business. So that is next on our list.

We would like to have competition. We would like to be able to drive cost down through competition.

So you put those three things first. Then you look at how do rocket engines fit into all of that.

We have got a problem with the lead time to replace the RD-180. I think we are committed to getting off of the Russian source for this. It has been a dependency we have been nervous about for a long time. Recent current events have made that a much more significant concern of ours, obviously. So we would like to get off the RD-180.

The most direct path to do that is to go finance an engine program somewhere and have somebody build an engine that we could then make available to whoever wants to provide space launch services to us. It is hard to do that and make an engine available that could work on anybody's rocket. They tend to be tailored very much to a specific platform. But that is one path we could go down.

The more desirable path for us is to work with the commercial launch providers out there—and there are multiples of them. Some of them are very prominent—to have them provide launch services to us and guarantee that they will provide those launch services that we want and do so in a competitive environment. So what we are looking for is what we call public-private partnerships, business arrangements where we work with the launch providers, provide them whatever is needed to close their business case so that they can assure us that they will be there for us and provide launches we can count on the reliability of a few years down the road. There is a lead time to getting there, and that is where 1608 comes in.

Senator SHELBY. But we do not want to have that gap. Do we? We do not want to create a gap.

Mr. KENDALL. We do not want a gap. Exactly. That is why lead time is important. It is going to take us a few years to either develop a new engine or have launch service providers that are ready for us and qualified. We have gone out and asked industry for their input on this. There was a lot of good input. The next step is another request for information. That will be followed by a request for proposals. We are proceeding with the money that the Congress appropriated to do some risk mitigation on the propulsion side, on the engine side at the same time. So we have that option available as fallback if the public-private partnership arrangement does not work out. But that arrangement I think is the best business deal for the Government. It is the best way for us to get to assured launch services that we can count on a few years down the road.

The biggest problem in 1608 is the gap you mentioned. There is going to be a period of time where we would like to have the option possibly of using RD-180s if necessary. There are much more expensive options available to us, but we prefer not to go that way. So we are trying to manage our way through all this. It is a very, very complicated situation. I would be happy to go through it in much more detail with you. We are doing our best to get to where we need to be as efficiently and effectively as we can.

Senator SHELBY. Let me ask you this. For a launch provider whose engine is barred by section 1608 at the moment, how far in advance of a planned launch would they need to seek and obtain a waiver to 1608? Or we could do it here.

Mr. KENDALL. We are working that with that contractor. Obviously, if the law were changed, it would make things simpler for us, but the law is written in a way which has some pretty specific legal requirements that we have to follow. So we are working our way through that. A waiver exception—nominally, I am told that there is a 5-year lead time from engine purchase to launch. I think that could be shortened. I think it could be shortened to as little as maybe 3 years. There is about a 2-year lead time from when we contract with someone for a launch to when we actually do the launch. So, obviously, if you are going to buy engines, you need to buy them well ahead of the launch schedule. That is part of the problem.

Senator SHELBY. Mr. Chairman, I have a number of questions for the record that I will submit in the interest of time, and I would hope they would respond to them.

Senator COCHRAN. Thank you, Mr. Chairman. I am certain they will.

Senator Udall was here next first, but he has agreed to defer to Senator Moran who has another commitment right now. With your permission, we appreciate that very much.

Senator MORAN. Tom, thank you very much. Mr. Chairman, thank you very much.

Mr. Secretary, gentlemen, thank you for joining us.

#### BETTER BUYING POWER

Secretary Kendall, I would like to take you up on your offer. I would love to hear what Senator Durbin heard and maybe more. So I would welcome that chance.

I think this issue—I served as the ranking Republican on the Labor-H appropriations subcommittee where we spent a lot of effort trying to figure out how to increase the resources available for medical and scientific research on the human side. I am pleased to now be a member of this subcommittee and believe that the benefits that can come from the research that we are talking about today are tremendous. So I would tell the chairman and the ranking member I want to be an ally as we work together to try to figure out how we do more in regard to advancing the safety and security of our country but also creating opportunities for technological and scientific advances within our economy, which is important to our defense as well.

This is, I suppose, a provincial issue to some degree. Wichita, Kansas is the air capital of the world. We manufacture lots of military and general aviation aircraft. Wichita State University in particular is working on an innovation university, trying to tie research and the private sector together for advancements using science and technology.

And finally, Mr. Secretary, I wanted to thank you. I co-chair with Senator Murray the Aerospace Caucus. You were our first guest the day I became a co-chairman, and I became very interested in what you had to say that evening in Better Buying Power.

My question that I would take from the concept of Better Buying Power is, is it still a theoretical concept or are there ways that we are bringing the private sector and actual production, use of technology into the acquisition at the Department of Defense?

Mr. KENDALL. Thank you, Senator Moran.

No. It is a very practical hands-on, as Mr. Shaffer alluded to. The Better Buying Power label originated when Dr. Carter was the Under Secretary for Acquisition, Technology and Logistics. And we have kept the label, which turns out to have been a pretty good decision in my mind I think. But it is really a collection of initiatives that has evolved over time, and they are all designed to give us incremental improvements in the performance of the acquisition system. And by the acquisition system, I mean not just our major programs but everything, all the things we contract out for, all the things that the Department acquires. Services are half of the things that we contract out for—more than that actually financially. It certainly includes our science and technology investments.

In the most recent version, which is focused on innovation and technical excellence, it includes provisions for getting greater access to commercial technologies. It includes provisions for getting greater access to foreign technologies that can be contributing. It basically looks at all the possible sources of technology. It looks at all the different accounts where we spend money on R&D to mature and develop technology and all the overhead charges associated with that so that we can move money from nonproductive things to the things that actually provide technology for our soldiers. So it is all of those things.

There is a 30-to-40-page document that I put out recently with all the actions we are taking in each of these different areas. And what I will be doing over the next 2 years is overseeing the implementation, managing the implementation of all these things. So while it does not name technology specifically, it really is going to get down to the very details of what we do in a lot of different areas.

Senator MORAN. Well, Mr. Secretary, how are you able to get to the point where the industry, the private sector is responding to this program and they are utilizing the opportunities that it provides to change the way they operate, to advance their technological willingness to invest in advancements, in a sense, maybe before the Department of Defense is acquiring something they might be building?

Mr. KENDALL. There are a number of provisions in Better Buying Power designed to incentivize industry. One of them, which I think is very important, is to tell industry how much we are willing to pay for enhanced performance. Normally when we ask for a weapon system proposal, we set a level of threshold performance, which is the minimum that we will accept. And we also set an objective, which is what we would desire. It is higher. Industry almost uniformly will bid to the threshold level and ignore the objective because the threshold level is always cheaper. It is less capable and that goes with cost.

So what we are going to tell industry—we started to do this—is we are going to tell industry how much more we are willing to pay for that higher level of performance. So industry can then

make an informed judgment about whether to invest in technology that will get to that level of performance or not. Without that information, there is really no incentive for industry. And then when we do source selection, we make an adjustment based on the parameters that we set out in the request for proposals.

We are trying to involve industry earlier on in concept definition and requirements formulation so that we have an interaction with industry. We give industry a head start, if you will, to work on how they would satisfy our requirements, and we give industry a chance to interact with us earlier so that we can form our requirements based on their inputs, which can be beneficial competitively to companies that have better ideas. And then we ask industry to do analytical work again to bring in their technologies to help us make some decisions about requirements.

In general, we are trying to align our incentive, our financial incentive structure, with the things that we want. In this case, what we want is innovation, more creative, more capable products that we can get to the warfighter.

When Secretary Carter speaks tomorrow, he will be talking about another thing that is also included in Better Buying Power, which is the outreach and our ability to reach out to nontraditional sources. So he will be talking. He will be on the West Coast, one of the places where commercial technologies are blooming, and he will be addressing some of the things associated with getting access to those technologies.

Senator MORAN. We want to be helpful to this proof of concept. My time is expiring, and I will submit a couple questions for the record about proof of concept to demonstrate that the plan is working and can move to the private sector.

Dr. Walker, one of the things that was said in a March 2015 report by DARPA was future U.S. capabilities require an integrated system of intelligence, surveillance, and reconnaissance, ISR, weapons communication, electronic warfare, cyber, and other advanced technologies. I will submit a question for the record to you and perhaps to the Secretary as well about how we are altering the capabilities to meet those needs.

And, Mr. Chairman, thank you and Senator Udall for your assistance.

Senator COCHRAN. Thank you, Senator.  
The Senator from New Mexico.

#### SEQUESTRATION

Senator UDALL. Thank you, Chairman Cochran.

And, Mr. Shaffer, congratulations and thank you for your service. NATO is a good place to be right now. A lot happening. And so I agree with Senator Durbin. I think we may see you over there.

And thank you to the panel for being here today and meeting with the subcommittee.

As you know, New Mexico plays a very important role in research and development throughout the Department of Defense. At Kirtland Air Force Base, directed energy and the development of new space technologies is a key part of the mission of the Air Force research lab. The Army research lab in New Mexico also plays a key role in assessing the durability of new technologies before they

are deployed, as well as the testing of air defense missile systems at White Sands Missile Range.

White Sands Missile Range is the premier testing range of the Department of Defense, as you all well know. And while its mission is to test many of the technologies developed through R&D, I think we can agree that the future health of White Sands Missile Range is tied to the continued development of new technologies, which give our troops the tools they need to keep their strategic advantage.

And, Mr. Chairman, I pointed out in previous hearings, but I think it is worth pointing out again, White Sands Missile Range is currently dealing with a major multimillion dollar maintenance shortfall, which has been caused by budgeting shortfalls, including sequestration. This shortfall is a possible weak spot in the R&D chain if left unaddressed, and it may take time to rebuild capabilities at White Sands and could negatively impact testing and the progress for all the military branches working on developing missile technologies.

I am hopeful that all of you will help communicate this long-term problem to your counterparts in the Pentagon so that we can help ensure that our testing capabilities are still able to support your research and development priorities. And I see you are nodding. Just reflect that for the record. Thank you.

A question on tech transfer. I believe that technology transfer is one of the most important priorities in New Mexico and the Nation. Tech transfer can help the development of businesses and create new markets for technologies being developed by the Department of Defense.

How will this budget support technology transfer, and would an increase in the applicable budget lines help improve the development of commercial military applications through cooperative research and development agreements?

Mr. KENDALL. Senator Udall, if I could comment on your comment about the ranges. We are concerned about installations in general and test ranges in specific. The Department has been forced, because of budget levels, to take some risk in those areas. It is not just a White Sands problem. It is a larger problem than that. So I appreciate your calling our attention to it.

I will turn to Mr. Shaffer to talk about the tech transfer and contracted R&D, which is one of his areas.

Mr. SHAFFER. Sir, actually we have seen an increase in the last couple of years in cooperative research and development agreements (CRDAs) between private industry and our Government laboratories. We have somewhere in the order of 4,000 individuals CRDAs right now with small companies, and we are looking to do more.

We have seen an increase in applications of small business innovative research. And thank you. The ceiling for that program has gone up. But we have taken management processes to more tightly couple SBIR with our acquisition program managers. Mr. Kendall mentioned Better Buying Power 3.0. Some of the pilots are to actually go ahead and derive requirements from PEO's and program managers to the Small Business Innovative Research program specifically to bring technology across the finish line. We have been

very successful. That is a model that was employed by the Department of the Navy at the Naval Undersea Warfare Center in Newport, Rhode Island for predominantly their submarines, and I do not have the exact number. I remember being shocked by it, but some 70 to 80 percent of the individual components in some of our submarines emerged from the Small Business Innovative Research program.

So thank you. You are increasing the ceiling on that by a tenth of a percent per year, and we are getting good payoff from that.

We are also trying to expand our use of novel contract mechanisms to allow us to reach out to some of these smaller companies. They are called other transaction authorities. The key point with those types of contract arrangements are that we can get money out to the small businesses much more quickly. Our standard process of having a competitive bid and award going out is a very slow and laborious bureaucratic process. So anything we can do to fund some of these companies in advance, we do.

We also have extensive ties to small innovative companies out in Silicon Valley, in Boston, in Austin, Texas from our defense laboratories and are effectively using those capabilities. In fact, we have the Laboratory Scientist of the Quarter Award. We have awarded five of those right now. These are all young, first-rate scientists and all of them are very tightly coupled to academia and small businesses, as well as large businesses, in their field. Mr. Kendall awarded one yesterday to someone working in superconducting quantum devices. Tremendous outreach into industry, and we are taking and bringing that in transition to technology to systems that we field.

Senator UDALL. Thank you very much for that answer, and thank you for your hard work in that area.

I have a couple of other questions, one on the long-range research and development plan and also the CHAMP project, but I will submit those for the record. Thank you very much.

#### ADDITIONAL COMMITTEE QUESTIONS

Senator COCHRAN. Thank you, Senator.

Let me express our deep appreciation to the panel for your attendance today and your good assistance as we begin to look more carefully at a lot of our programs that are being funded because we do not have an unlimited supply of money to appropriate. And you know that. We know that. Having your guidance and professional experiences can be very helpful to this committee as we try to identify what the highest priorities are and be sure that we are putting money where they ought to be in research and development of new capacities to protect our country and our economic interests around the world as well. So we are in your debt, and we are grateful to you for your leadership.

Mr. KENDALL. Thank you, Mr. Chairman.

Senator COCHRAN. Our hearing will be adjourned now, and we ask that any additional written questions be submitted—and the answers thereto—in a reasonable time.

[The following questions were not asked at the hearing, but were submitted to the Department for response subsequent to the hearing:]

## QUESTIONS SUBMITTED TO HON. FRANK KENDALL

## QUESTIONS SUBMITTED BY SENATOR THAD COCHRAN

*Question.* Secretary Kendall, have you considered creating a program for the R&D non-profit community akin to the University Affiliated Research Center (UARC) program? If not, why not?"

*Answer.* I have not considered creating a non-profit community akin to UARC's, primarily because I do not believe it is necessary. We have the flexibility needed to work with not-for-profits. Multiple effective and efficient avenues for procuring technical expertise from non-profit research organizations, regardless of affiliation with a university, are in common use.

I believe creation of a new program for non-profit research organizations would add management burden and, without a specific, essential, and long-term research and development need, would be contrary to the Better Buying Power 3.0 objective of eliminating unproductive processes and bureaucracy.

## TECHNOLOGY DOMAIN AWARENESS

*Question.* In 2014 the National Defense Industrial Association (NDIA) conducted a study on steps that the Department of Defense can take to improve the acquisition system. One of the key findings of NDIA's "Pathway to Transformation" report (pg 62) is to develop Department of Defense Technology Domain Awareness in order to better identify and exploit technology opportunities and threats derived from the commercial and other non-traditional sources. What is the Under Secretary of Defense for Acquisition, Technology, and Logistics' plan to make sure that the DOD Information Analysis Centers' Technology Domain Awareness initiative is appropriately resourced and supported?

*Answer.* The Department of Defense Information Analysis Centers' Technology Domain Awareness (TDA) initiative is currently being conducted as a limited pilot project. In October 2015, once the pilot is completed, I will assess the results and determine whether to continue TDA beyond the initial pilot. If I decide to continue the TDA programs, I note that the model is customer-funded and would not require extensive core funds.

## PROTOTYPING AND DEMONSTRATIONS

*Question.* The Department of Defense is requesting additional funding in the fiscal year 2016 President's Budget for prototyping and demonstrations. This emphasis on prototyping weapons before starting large acquisition programs is a way to decrease the risk of technology not being ready. How do you ensure prototyping does not lead to increasing the time to deliver new capabilities to the warfighter by stretching out technology maturation? Should the U.S. continue to invest in virtual prototyping using the DOD's high performance computing assets?

How do you ensure prototyping does not lead to increasing the time to deliver new capabilities to the Warfighter by stretching out technology maturation?

*Answer.* Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics guidance ensures prototyping does not lead to increasing the time to deliver new capabilities by stretching out technology maturation and risk reduction phase of the acquisition cycle. The Department of Defense (DOD) Directive 5000.02 directs a draft Capability Development Document (CDD) at Milestone A to inform the Technology Maturation and Risk Reduction (TMRR) phase. The draft CDD is a living document driving prototyping and other risk reduction activities. Should the results of prototyping activities suggest that technology maturation required to meet the existing need will "stretch out" the TMRR phase, the sponsor can adjust the requirements in the CDD to reflect the current state of technology, provided the change still meets the warfighting need.

Additionally, DOD Directive 5000.02's increasing emphasis on tailoring the acquisition process encourages program managers to work with the contractor to focus TMRR activities primarily on obtaining key knowledge points (i.e., employing prototyping and analysis to capture key weapon system's behaviors in order to advance the system design and make necessary programmatic decisions). Depending on the knowledge point, full system prototyping may not be needed, reducing the cost and the length of the TMRR phase.

*Question.* Should the U.S. continue to invest in virtual prototyping using the DOD's high performance computing assets?

The U.S. should continue to invest in virtual prototyping using the Department's High Performance Computing (HPC) assets. Virtual prototyping's physics-based high performance computing tools have been proven effective in many industry and

Federal agency applications, reducing “time-to-market” and product development costs. The Department’s HPC tools can virtually prototype military ships, air vehicles, and radio frequency antennas, accurately predicting the performance of these weapons systems. HPC tools help engineers identify design flaws and performance shortfalls and fix them early in the acquisition process, well before live tests are possible and “metal has been cut”.

HPC tools are an integral part of the Department’s Engineered Resilient Systems (ERS) initiative, a concerted Modeling and Simulation effort to leverage HPC throughout the acquisition process. Through ERS, HPC tools are enabling the Department to explore larger solution spaces to address capability needs. These tools have created a virtual common area for an industry/program office/Warfighter sponsor collaboration to identify better performance/cost trades, leading to selection of more efficient and effective solutions that still meet demanding Warfighter requirements.

#### RAILGUN TECHNOLOGY

*Question.* Beyond ship-to-shore bombardment and Integrated Air/Missile Defense (IAMD) missions, what other missions is the electromagnetic rail gun currently being considered to perform? Aside from the Navy, what other services have shown an interest in adopting railgun technologies, and for what mission sets? Is the Navy considering integrating the railgun onto other vessels beyond the DDG-1000? If yes, which class of ships? Is a fixed-based/land-based system being considered for any of the services? How does the DOD intend to preserve competition and innovation within the limited industrial base for rail gun technologies? Are there risks associated with providing railgun weapon system capabilities to our warfighters? Please describe these risks, and identify which risks are the highest or most concerning.

#### MISSIONS, ADDITIONAL SERVICES, FIXED BASING

*Answer.* Beyond the ship-to-shore bombardment (i.e.; Naval Surface Fire Support (NSFS)) and Integrated Air/Missile Defense (IAMD) missions for electromagnetic railgun, Anti-Surface Warfare is also being analyzed. This mission leverages both the strike warheads being developed by the Navy for NSFS and the closed-loop fire control against moving targets being developed by the Strategic Capabilities Office (SCO).

Aside from the Navy, the Army has recently shown interest in the hypervelocity projectiles that enable both offensive and defensive missions simultaneously. For 2 years, SCO and the Navy have been analyzing the mission effectiveness of firing the same projectile being developed for the electromagnetic railgun and Navy 5” powder gun from the Army’s current Paladin, future Extended Range Cannon Artillery (ERCA), as well as future land-based railguns. This year, the Chief of Staff of the Army signed a memorandum partnering the Army with SCO in demonstrating both land-to-land bombardment and IAMD with projectiles, sensors, and fire control that are common with the Navy. The initial focus will be on the over 900 Paladin and ERCA guns, which are expected to achieve 1 km/s and 1.3 km/s muzzle velocities, respectively, equivalent to 9.7MJ and 13.5MJ railguns. This would provide an offense/defense capable system in the near term whose projectile, sensor, and fire control architecture would enable future deployments of land-based railguns at much higher velocities (e.g.; 2km/s at 32MJ). The SCO is funded to prototype and conduct a series of live-fire demonstrations with Navy and Army powder guns in the fiscal year 2018 timeframe and a land-based railgun in the fiscal year 2019 timeframe. Assuming success, transition of these capabilities to Services would occur subsequently. The SCO, Office of Naval Research, Naval Sea Systems Command, and Army have been working with Missile Defense Agency to assess the technology maturation required to transition land-based railguns. In December 2014, MDA provided to Congress, a report on “Missile Defense Applications for Electromagnetic Railgun Technology.” The report identifies the technical achievements and tests required to validate the suitability of the land-based railguns for missile defense applications and enable transition. The SCO expects these tests to be completed in fiscal year 2018.

For sea-based railgun, the Navy has studied several hulls currently in service and is investigating the feasibility of integrating a Railgun onto a DDG1000-class ship. In response to the current National Defense Authorization Act, the Navy has initiated a broader study to examine other Navy hulls. This study is due March 1, 2016.

#### PRESERVING COMPETITION AND THE INDUSTRIAL BASE

All the major components of the system have been developed using competitive means. The Navy competed both the railgun barrel and projectile, which were

awarded separately to BAE in 2014. Prior to this, pulse power was competed and awarded to three vendors (i.e., Raytheon, General Atomics, and BAE). The Navy and SCO are also prototyping the fire-control sensor for railguns and powder guns leveraging existing Department sensors, including ground-based fighter radars. A Request for Information was released with a subsequent Industry Day in 2015, and 11 vendors requested follow-up sessions with the government team. As their submitted papers are evaluated, follow-on efforts may be awarded in fiscal year 2016. Additionally, as a major performance driver across all missions and guns, SCO has released a call for papers this month for an Advanced Projectile to reduce component risk, explore advanced technologies, and broaden the industry base participating in hypervelocity gun initiatives. Award is expected to occur in the first quarter of fiscal year 2016.

Should these prototyping efforts be successful, Milestone B will initiate another full-and-open competition for the electromagnetic railgun system and major sub-systems.

#### RISKS AND CHALLENGES

Fielding electromagnetic railguns does come with unique risks and challenges associated with high voltage and magnetic fields induced by large currents during firings. These high voltages present the potential for electrical shock hazards, which can be mitigated using existing personnel protection, safety procedures, and electrical grounding techniques for naval vessels. The magnetic fields created during railgun firings can be mitigated by creating 15 ft keep-out zones for humans around the gun mount during firings. This distance is consistent with existing weapons and sensor keep-out zones. The impact of the shot blast has also been analyzed and found to be equivalent to the Navy's existing 5" gun. Given this, rigorous safety standards and procedures developed during over the past decade should translate to Warfighter use of electromagnetic guns.

#### EMERGING TECHNOLOGY

*Question.* How important is it for the DOD to have private firms making independent Research and Development (R&D) investments to advance technology? How does the DOD let industry know what its priorities are, and where industry should make those independent investments? What role do you see for industry in advanced R&D? Do you envision industry as a partner or competitor to advanced R&D?

How important is it for the DOD to have private firms making independent Research and Development (R&D) investments to advance technology?

Answer. Industrial independent Research and Development is an important component of technology maturation. Maintaining superior military capabilities for the Department of Defense (DOD) requires some pluralism in the development of advanced technologies to ensure we always have the best technologies for the Warfighter. The Department has a strong science and technology (S&T) program. It has served the Nation well. However, the ability for private firms to perform independent R&D that address either existing military capability gaps from a different perspective or to create new military capabilities not yet defined is an important element to guard against technology surprise on the battlefield, creating technology surprise for our adversaries, and reduce risk and cost to our acquisition programs.

*Question.* How does the DOD let industry know what its priorities are, and where industry should make those independent investments?

Answer. All of our outreach is meant to meet the complementary goals of providing industry an opportunity to exercise independent judgement on investments in promising technologies that will provide competitive advantage, while at the same time pursuing technologies that advance the state of the art in U.S. Military capability. That said, the Department is constantly making improvements in its outreach. For example, to better communicate our needs, the Department launched the Defense Innovation Marketplace (the "Marketplace") website in 2013. The Marketplace is a source of information for industry as to the Department's S&T and R&D priorities and it provides ideas on where industry might consider investing its research and development dollars. For DOD R&D personnel, the Marketplace is the place where they can review the Independent Research and Development (IR&D) projects being performed by government contractors. IR&D conducted by industry is an important source of innovation for both industry and the Department. Additionally, the S&T community hosts Technical Interchange Meetings (TIMs) with industry. The TIMs are focused on specific technology areas and companies are invited to submit their IR&D projects that are responsive to the TIM focus area. All projects are reviewed by subject matter experts and a significant number of projects are se-

lected for in-person briefings by the submitting company to the TIM's government hosts and subject matter experts. Companies participating in these briefings receive substantive feedback on their projects from the DOD subject matter experts at the end of the briefing. To date, the Department has conducted six TIMs, and we plan to increase the number. For general outreach regarding R&D/S&T, the Department uses fora such as the National Defense Industrial Association S&T Conferences, as well as other industry associations and specific briefings to industry regarding hard technical problems.

*Question.* What role do you see for industry in advanced R&D?

*Answer.* While industry's Independent Research and Development is a fundamental pillar of our advanced R&D work, I would like to see industry put more of its own money at risk in advancing the state of the art in R&D. Industry spending on IR&D is a recoverable cost to industry through its negotiated overhead rates. I believe that if industry invested more of its own money in advanced R&D; coupled that with "reimbursable" IR&D, DOD-funded contractor research and development, and the work conducted by our DOD laboratories; we could buy down technology risks in our programs, create new military capabilities, and surprise any adversary.

*Question.* Do you envision industry as a partner or competitor to advanced R&D?

*Answer.* In a world where technological superiority can no longer be assumed, it is imperative that the Department work cooperatively with industry, academia, and our foreign allies and partners to ensure that our Warfighters will be dominant.

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#### QUESTIONS SUBMITTED BY SENATOR RICHARD C. SHELBY

*Question.* I understand that there may be a six-year gap in guaranteed access to space, under the fiscal year 2015 NDAA Section 1608 restrictions. How, then, does DOD plan to carry out its national security launches? Will a legislative fix beyond DOD's current proposal be required?

*Answer.* To support our national security launches, the Department of Defense submitted a legislative proposal requesting a modification of Section 1608 of the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for fiscal year 2015, Public Law 113-291. If enacted, it would allow use of Russian rocket engines that had been contracted for prior to February 1, 2014. If these changes are made and with the addition of a certified New Entrant launch service provider, the Department believes it can minimize impacts to its launches while industry transitions fully to domestically produced propulsion systems.

Legislative proposals beyond the recently submitted fiscal year 2016 proposals are not anticipated at this time.

*Question.* During the hearing, I asked about how DOD plans to provide for national security launches in light of fiscal year 2015 NDAA Section 1608 restrictions and the lack of a certified alternative launch provider to date. Could you please clearly outline DOD's acquisition strategy for a new rocket propulsion system, for which Congress appropriated \$220 million last year?

*Answer.* The Air Force is spending the \$220 million appropriated for engine development to reduce the risk of a new engine; however, a new engine development by itself is not the Department's preferred path. Based on interaction with industry and the Department's experience, we do not believe that a dedicated engine development program is the best approach to developing a launch capability that meets the Department's goal of two commercially viable, domestic launch service providers capable of supporting the entire National Security Space manifest. The Department's preferred approach is to enter into public-private partnerships with commercial launch service providers for reliable launch capability solutions. This approach is more likely to enable at least two launch service providers and maintain our assured access to space while promoting competition to control cost.

The Air Force's strategy is a four step approach to transitioning to domestic propulsion while assuring access to space. Step 1, started last year, is to mature the technology to reduce engine development technical risk. The Air Force has obligated about \$50 million toward this effort and will invest an additional \$45-50 million in the next 6 months. Step 2 is to initiate investment in Rocket Propulsion Systems, in compliance with the fiscal year 2015 National Defense Authorization Act. The Air Force will partner with propulsion system or launch system providers by awarding multiple contracts that co-invest in ongoing domestic propulsion system development efforts. In Step 3, the Air Force will continue the public-private partnership approach by entering into agreements with launch system providers to provide domestically powered launch capabilities. In step 4, the Air Force will compete and award contracts with certified launch providers for launch services for 2018 and beyond.

*Question.* Do you believe that 2019 is a realistic date for development and certification of a replacement rocket engine or should the deadline be extended?

*Answer.* The schedule for availability of a replacement rocket engine depends upon the maturity of the technology that is proposed, including its ability to meet performance requirements, and time needed to conduct testing and certification flights. Based on our knowledge of the conventional domestic defense industrial base suppliers, 2019 is not a realistic date for development and certification of a replacement engine. In addition, the Department must plan for at least 2 additional years from completion of the engine development for the engine to be integrated into a new launch vehicle and then certified to fly National Security Space payloads.

The Department recommends the deadline not only be extended to 2022 but that proposed H.R. 1735 section 1603 language be revised to focus on the availability of launch capability rather than the certification of only a new rocket engine.

*Question.* In executing the acquisition strategy for a Russian rocket engine replacement, how important is the risk reduction<sup>7</sup> phase to those efforts? Do you believe there is value in leveraging NASA's decades of risk reduction and rocket propulsion research development in developing an American rocket engine replacement? If so, to what degree is DOD leveraging the existing expertise of the National Institute for Rocket Propulsion Systems in conducting risk reduction for a U.S.-developed rocket propulsion system?

*Answer.* The risk reduction phase is very important. As the U.S. has very limited experience with oxygen-rich staged combustion (ORSC) engines, developing a domestic ORSC engine, without first having independent American technologies, may present significant technical and schedule risks. The "Risk Reduction" phase will help mitigate these risks by acquiring full-scale combustion experience data and ensuring availability of design and analytical tools to inform future development and designs. Among the propulsion community, combustion instability has been identified as the foremost technical risk to development of an ORSC engine.

The Department is leveraging NASA's and the Air Force's decades of experience in rocket propulsion. In particular, NASA's rocket propulsion test facilities and capabilities are making near-term critical component demonstration possible, thus allowing the burn down of engine development risks using existing NASA and Air Force Research Laboratory (AFRL) hardware.

The Department is leveraging the National Institute for Rocket Propulsion Systems (NIRPS) by working with NASA to fully utilize their expertise and capabilities in mitigating the risks associated with ORSC engine development. For example, the Department is providing funding to NASA's Advanced Booster Engineering Demonstration and Risk Reduction program for the combustion stability demonstration of a 500k-lbf thrust ORSC combustion chamber, integrated with AFRL's Hydrocarbon Boost preburners. This integrated demonstration will be performed in late 2016 or early 2017 at NASA's Stennis Space Center in Mississippi. Additionally, the Department is partnering with NASA, AFRL, academia, all NIRPS partners, and industry for the development of combustion stability tools.

*Question.* Secretary Kendall, earlier this year, you underscored China's military capabilities that are aimed at defeating, and I quote, "the American way of doing power projection...when we fight in an expeditionary manner far from the United States." Given China's reported testing of its hypersonic weapon last year, how important is it that we develop our own hypersonic weapon in order to deter the Chinese threat and maintain our forward power projection? Shouldn't we be keeping pace with China's hypersonic development?

*Answer.* Hypersonic development is a high priority for our Science and Technology (S&T) programs, and we believe our program will allow us to keep pace with any other nation. The Air Force and DARPA are teaming for two hypersonic demonstration programs: the Hypersonic Advanced Weapons concept and the Tactical Boost Glide Demonstration. Additionally, we are continuing development of the Conventional Prompt Global Strike hypersonic program (\$71 million in fiscal year 2015 and \$79 million in fiscal year 2016). The Air Force also has a base S&T development program to address technical risk. The Department has allocated \$321 million in our fiscal year 2016 budget request and nearly \$2 billion across the Future Year Defense Program to mature hypersonics. These efforts not only increase our capabilities to better prepare for any future relevant acquisition, but also to better understand what other nations, for example China, are doing in hypersonics.

*Question.* The Long-Range Anti-Ship Missile (LRASM) completed a successful flight test on February 4th of this year. In describing the flight test, a DARPA press release notes that the LRASM procurement resulted from recent initiatives under DOD's Better Buying Power 3.0. Could you please describe how DOD's new acquisition strategy stimulates rapid prototyping and innovative acquisition, with respect to LRASM?

Answer. The new Department of Defense (DOD) Instruction 5000.02 allows the ability to tailor the acquisition process under the new “Model 4.” When USD(AT&L) established LRASM as the solution to the Navy’s Offensive Anti-Surface Warfare (OASuW) Increment 1 requirement, the program was designated as the pilot for using Model 4 to leverage the success of the DARPA LRASM demonstration to deliver the LRASM as an early operational capability to the Air Force (2018) and the Navy (2019). This rare opportunity to transition a DARPA-Office of Naval Research demonstration program directly to the Warfighter is reflective of Better Buying Power Focus Area 3: Incentivize Productivity in Industry and Government. Specifically, the demonstration program not only improved the return on investment in DOD laboratories by leveraging government science and technology efforts from the demonstration program, but also increased the productivity of Independent Research and Development (IRAD) by utilizing existing Lockheed Martin IRAD efforts.

The LRASM Deployment Office (LDO) was established in February 2014 at DARPA as the jointly manned (DARPA, Navy, and Air Force) organization responsible for implementing the accelerated acquisition approach. The LDO understood that critical thinking was necessary for program success and required a commitment to challenging the norm, both technically and programmatically. The LDO immediately began efforts to continue technical development, capitalizing on the opportunity to tailor the program to remove processes, reviews, and documentation that did not provide a ‘value added’ contribution to providing capability on time, while maintaining compliance with statutory, regulatory and milestone requirements. This initiative is directly related to the Better Buying Power Focus Area 5: Eliminate Unproductive Processes and Bureaucracy.

Furthering the connection to the Better Buying Power initiatives, the LDO is closely aligned with both the Intelligence and the Requirements communities as delineated in Focus Area 1: Achieve Dominant Capabilities While Controlling Lifecycle Costs. Within weeks of program initiation, the program received a Joint Requirements Oversight Council-validated requirements memo and a threat baseline, providing extremely stable requirements to begin technology maturation efforts while the Capability Development Document proceeded through the normal process. Additionally, the LDO has maintained continual coordination with the resource sponsor to make adjustments to the program’s funding profile as the work required was better understood, ensuring stability that would minimize development costs while fielding as rapidly as possible.

The LDO team developed an Acquisition Strategy that tailored the systems engineering process and technical maturation schedule to feed Knowledge Points that would serve as intermediate decision events for specific program needs. The LDO also utilizes a lean governance, direct-report approach with an Executive Steering Board (ESB) with the Assistant Secretary of the Navy for Research, Development, and Acquisition and the DARPA Deputy Director as co-chairs. Monthly ESB meetings are the central core for LRASM senior leadership to quickly affect outcomes and critical decisions.

Additionally, rapidly fielding a warfighting capability requires close management of risk and potential acceptance of risk appropriate to the capability gap. The LDO uses a single integrated master schedule that merges both contractor and government activities and is tightly coupled with the risk process. This information is reviewed at each ESB in order to ensure that the program is closely managed toward fielding the required capability at the time specified by the Warfighter.

Improving the professionalism of the total acquisition workforce is a specific theme of Focus Area 8. The Department is addressing this in two particular ways from different ends of the spectrum: ensure that our current acquisition and science and technology leaders are top in their field and current investments in the workforce will pay dividends in the future. When the LDO was created Under Secretary Kendall personally reviewed resumes to ensure the team leadership possessed the critical traits to execute the accelerated acquisition of an advanced technology program. In order to sustain this level of expertise in the Government and recognition of today’s investments aiding in future endeavors, the LDO has implemented an extensive modeling and simulation effort that will allow the OASuW Inc 1 to field on time yet provide a much needed capability for future systems. LDO team is serving as the system integrator for the modeling and simulation facility that will provide the validation venue for the program, and the LDO team will execute the associated testing. As a result, there will be an enduring capability available for future efforts to leverage along with competent, proficient government expertise in executing this cost-effective, efficient methodology for system performance validation.

In all, this program is on track to fill a critical warfighting capability in under 5 years, compared to an estimated eight-to-ten years for a standard program, and

should serve as an example of how prototypes can successfully transition to fill immediate warfighting requirements.

*Question.* Mr. Shaffer, when you testified before the House Armed Services Committee last month, you underscored the Army's high energy laser-mobile demonstrator as a "low cost capability for counter rockets, artillery and mortars." I understand that DOD's current plans seek to make the high energy laser a program of record in the 2020's. If additional funding were provided in the interim, how might we accelerate the design and development of this leap-ahead technology? Is there an immediate need for this technology?

*Answer.* The Department has a well-funded (~\$300 million in fiscal year 2016) cross-service high-energy laser (HEL) science and technology program. This investment is aimed at demonstrations of the technology and technical risk reduction. The first HEL system is targeted at a laser as a component of the Army's Integrated Fire Protection Capability (IFPC Increment II), for fielding in the mid-2020 decade. In discussion with our scientists, the consensus is that additional funding won't substantially accelerate the capability—basic engineering to mature the technology is funded and moving forward well. Additional funding could allow competing concepts to reduce risk and improve the likelihood of success, but would not substantially accelerate the delivery of the capability.

*Question.* Mr. Shaffer, when you testified before the House Armed Services Committee last month, you affirmed SMDC's Nanosatellite and Kestrel Eye programs as "pushing back the boundaries of disaggregated space." It is my understanding that a launch date for the Nanosatellites has been set for August of this year; and, Kestrel Eye is set to be launched in December of this year. In light of the constrained budget environment we face, how important is sustained funding for these programs in order to achieve their anticipated launch dates?

*Answer.* For the first two launches, funds appropriated for fiscal year 2015 will support the launches. Where sustained funding is required is to support planned subsequent launches later in fiscal year 2016.

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#### QUESTIONS SUBMITTED BY SENATOR ROY BLUNT

*Question.* Secretary Kendall, the subcommittee is aware of the Department of Defense's recent March 13 Memo citing the value and special contracting authorities of the R&D non-profit institutions. While I applaud this as a positive step, what is the Department doing to better utilize the non-profit community's special role, capabilities, and skill sets?"

*Answer.* The Department of Defense (DOD) is well aware of and fully agrees with the need to seek subject matter expertise not resident within the Department to keep pace with global technology developments and evolution. Accordingly, the Department uses existing authorities and several initiatives to obtain these technical sources of non-profit organizations that play a central role in providing this expertise.

The Department has a long history of working closely with federally Funded Research and Development Centers, University Affiliated Research Centers, and other non-profit research institutions that serve as our "trusted agents" on research and development (R&D) issues. My March 13, 2015, memorandum (subject: Utilization of Non-Profit Research Institutions) emphasized that the following avenues of engagement could be specifically applied to non-profit organizations:

- One of the most important ways the Department contracts directly with non-profit institutions is by Title 10, United States Code, Section 2304 (c)(3)(B), implemented through Federal Acquisition Regulation 6.302–3. The statute provides authority to directly contract without the need for "full and open competition" when it is necessary, among other purposes, to award work to a particular source, "to establish or maintain essential engineering, research, or development capability to be provided by an educational or other nonprofit institution or a federally funded research and development center." The direct authority enables significant efficiency gains and is one of the primary ways for the Department to ensure vibrant interaction with non-profit research organizations.
- The Defense Innovation Marketplace (<http://www.defenseinnovationmarketplace.mil/>) is a website that organizes the Department's Science and Technology planning, acquisition, funding, and financial information to guide the focus and interactions with numerous DOD contracts, including non-profit research organizations. The platform provides notification of broad agency announcements, requests for information, and requests for proposals that collectively offer a picture of DOD priorities. The Defense Innovation Marketplace can serve as a baseline for the non-profit research community to identify capability alignment

with DOD requirements. The Marketplace also provides a connection to the Reliance 21 process through which the Department manages the Science and Technology portfolio and research priorities.

—The Defense Acquisition University's Service Acquisition Mall (SAM) provides information regarding the full lifecycle of Research, Development, Testing, and Evaluation efforts and includes support to any Service's (R&D) labs. SAM helps the Department's organizations understand the approaches (e.g., market research) for acquiring R&D services such as Operational Systems Development, Commercialization, and Advisory and Assistance.

Military Services and Defense Agencies engaged in R&D are making use of the Other Transaction Authority provided under Section 845 of the fiscal year 1994 National Defense Authorization Act, Public Law 103–160 (as amended) codified as a note in 10 USC 2371, to facilitate innovation and technology transfer between DOD and industry including companies that qualify as non-traditional defense contractors under the requirements of Section 845. For example, the U.S. Army Medical Research and Materiel Command is soliciting proposals from a Not for Profit 501(c)(3) to form and manage a self-sustaining Medical Technology Enterprise Consortium. The consortium will be comprised of industrial and academic organizations to engage in biomedical research and prototyping, capitalization of private sector technology opportunities, technology transfer, commercialization of Government intellectual property, and follow-on production for the U.S. Army Medical Research Acquisition Activity.

*Question.* Secretary Kendall, how do you envision non-profits playing a role in the new Better Buying Power Initiative, specifically moving innovation to commercialization?"

Answer. I believe that non-profit Research and Development organizations are part of the total Research, Development, Test, and Evaluation support structure of the Department of Defense (DOD), and, as such, can contribute to attain the goals of Better Buying Power (BBP) 3.0. A key element of BBP 3.0 is removing barriers to commercial technology utilization. Non-profit research organizations with commercializable innovations can benefit from this initiative. The Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy, with support from the Director of Defense Procurement and Acquisition Policy and the Assistant Secretary of Defense for Research and Engineering, is developing a handbook of methods and best practices, which we anticipate will be completed by August 2015, that informs DOD managers on effective engagement with commercial technology companies, including non-profit organizations.

Another key element of BBP 3.0 is to incentivize innovation in industry and the Government. Technology insertion and refresh are critical components to keep pace with shortening technology cycle times. For instance, the technology cycle for information technology systems is often as short as 18 months. As part of BBP 3.0, the Service Acquisition Executives and the Acquisition, Technology, and Logistics staff will focus on opportunities for technology insertion and refresh to develop more opportunities for non-profit research organizations to provide the Department with novel technologies

*Question.* Secretary Kendall, what steps are you taking to harness the expertise being developed at non-profits?

Answer. The Department of Defense is already harnessing the expertise being developed at non-profit organizations with a wide breadth of multidisciplinary programs. In fiscal year 2012, the Department awarded approximately \$4.9 billion in contracts to non-profit institutions. Non-profit academic institutions were awarded an additional \$2.5 billion in fiscal year 2012 for basic and applied research studies across the spectrum of science and engineering disciplines. The Department will continue to use the unique expertise non-profit organizations provide, while also leveraging expertise from industry and government laboratories.

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#### QUESTIONS SUBMITTED BY SENATOR DIANNE FEINSTEIN

##### NON-PROFIT RESEARCH AND DEVELOPMENT

*Question.* Non-profit research institutions, like the Stanford Research Institute, have unique capabilities and expertise that can provide great value to the research and development portfolios of the Department of Defense.

Undersecretary Kendall, the Department's recent March 13 Memo cites the value and special contracting authorities of non-profit communities for Research and Development. What specific action is the Department considering to better utilize these communities' special role and capabilities?

Answer. The Department of Defense (DOD) is well aware of and fully agrees with the need to seek subject matter expertise not resident within the Department to keep pace with global technology developments and evolution. Accordingly, the Department uses existing authorities and several initiatives to obtain these technical sources of non-profit organizations that play a central role in providing this expertise.

The Department has a long history of working closely with federally Funded Research and Development Centers, University Affiliated Research Centers, and other non-profit research institutions that serve as our “trusted agents” on research and development (R&D) issues. My March 13, 2015, memorandum (subject: Utilization of Non-Profit Research Institutions) emphasized that the following avenues of engagement could be specifically applied to non-profit organizations:

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*Question.* Undersecretary Kendall, the Research and Development non-profit communities’ specific skill set—moving innovation to commercialization—could play a unique role in the recently released Better Buying Power 3.0 initiative. Does the Department believe that non-profit Research and Development communities can contribute to the goals of the Better Buying Power 3.0 initiative? What specific steps is the Department taking to utilize the non-profit Research and Development communities towards this end?

Answer. I believe that non-profit Research and Development organizations are part of the total Research, Development, Test, and Evaluation support structure of the Department of Defense (DOD), and, as such, can contribute to attain the goals of Better Buying Power (BBP) 3.0. A key element of BBP 3.0 is removing barriers to commercial technology utilization. Non-profit research organizations with commercializable innovations can benefit from this initiative. The Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy, with support from the Director of Defense Procurement and Acquisition Policy and the Assistant Secretary of Defense for Research and Engineering, is developing a handbook of

methods and best practices, which we anticipate will be completed by August 2015, that informs DOD managers on effective engagement with commercial technology companies, including non-profit organizations.

Another key element of BBP 3.0 is to incentivize innovation in industry and the Government. Technology insertion and refresh are critical components to keep pace with shortening technology cycle times. For instance, the technology cycle for information technology systems is often as short as 18 months. As part of BBP 3.0, the Service Acquisition Executives and the Acquisition, Technology, and Logistics staff will focus on opportunities for technology insertion and refresh to develop more opportunities for non-profit research organizations to provide the Department with novel technologies.

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QUESTIONS SUBMITTED BY SENATOR BRIAN SCHATZ

ENERGY INITIATIVES

*Question.* In fiscal year 2013, the Defense Logistics Agency spent more than \$15 billion to procure energy for the Department of Defense, representing almost 5 percent of DOD contract spending for that year. But energy is more than just an issue of cost. The Defense Science Board has noted that moving and protecting fuel during military operations not only adds to the cost of operations, but also “divert[s] and endanger[s] in-theatre force capability.” I know DOD is pursuing a number of initiatives to reduce the amount of fuel it needs and to change the mix of fuels that it uses. Perhaps one area ripe for reform is getting energy efficiency adopted as a key performance parameter for all weapons systems that the Department procures so that we are requiring efforts to reduce the energy footprint of a weapons system given that its energy footprint has direct implications for our warfighters.

Can you please discuss the extent to which energy efficiency is being incorporated into the requirements of acquisition programs? And given the lessons learned about fuel dependency broadly, is there any reason why energy efficiency should not be required as a key performance parameter on all systems?

*Answer.* By statute, energy is considered in all new weapon system acquisitions. Program Managers (PMs) define an Energy Key Performance Parameter (eKPP) to ensure the weapon system characteristic is fully considered across the entire acquisition program cycle. The eKPP serves as the foundation and PMs are tasked to complete Energy Supportability Analysis (ESA) to support the decisionmaking process. The ESA identifies operational energy shortfalls and informs decisions on risk mitigation, such as changes in an eKPP, the Concept of Operations, force structure, and/or procuring additional logistics assets.

The role of ESA in informing the eKPP is a recent development and is maturing. Several programs are using ESA to evaluate program requirements. The Marine Corps is currently conducting an ESA for several land vehicle platforms. In addition, the Air Force is preparing to conduct an ESA on the KC-46 aerial tanker and the F-35 Follow-on Development variant.

While Energy is a KPP, Energy Efficiency should not be made a KPP. Energy efficiency is just one of many important considerations in weapons system acquisition programs, and PMs should be afforded the ability to use their best judgement in balancing KPPs and other considerations to ensure the Warfighter is provided the best capability at the most affordable price.

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QUESTIONS SUBMITTED TO DR. STEVEN WALKER

*Question.* Dr. Walker, when Dr. Prabhakar testified before this Committee last year, she noted how our embedded military systems are vulnerable to cyberattacks and how DARPA is working to counter the cyber threats of today, as well as those of the future. Could you please update the Committee on DARPA’s research to counter cyber threats, just as our military would counter kinetic warfare? How important is sustained funding for DARPA’s cybersecurity efforts?

*Answer.* DARPA’s research to counter cyber threats is intended to provide a diverse set of capabilities as this is not an area where a “silver bullet” will address all of the challenges. The following ongoing DARPA cyber projects are making good progress towards achieving their goals:

- Active Authentication is developing novel ways of validating the identity of the person at the console to ensure only authorized users obtain access to critical resources.
- Active Cyber Defense will enable U.S. cyber defenders to exploit their “home field advantage.”

- Automated Program Analysis for Cybersecurity is developing formal methods based techniques for keeping malicious code out of application marketplaces.
  - Clean-slate design of Resilient Adaptive Secure Hosts is using the immune system as a model to create computing technologies resistant to cyber attack.
  - Cyber Grand Challenge is stimulating the creation of automated cyber-defenses capable of responding to attacks at speeds and scales beyond what is humanly possible.
  - High-Assurance Cyber Military Systems is using a clean-slate, formal methods-based approach to enable semi-automated code synthesis from executable, formal specifications with the goal of making ground and air vehicles hack-proof for specified security properties.
  - Integrated Cyber Analysis System is developing techniques to integrate information technology (IT) system information to provide cyber defenders with enterprise situational awareness.
  - Mining and Understanding Software Enclaves will use huge libraries of open source software to assure correctness of newly developed programs.
  - Mission-oriented Resilient Clouds is developing technologies to detect, diagnose, and respond to attacks in the cloud.
  - Network Defense is developing technologies to detect network attacks by analyzing network summary data across a wide array of networks.
  - Plan X is a foundational cyberwarfare program developing platforms for the Department of Defense to plan for, conduct, and assess cyberwarfare in a manner similar to kinetic warfare.
  - PROgramming Computation on EncryptEd Data is developing techniques for computing with encrypted data without first decrypting it, enhancing its confidentiality.
  - The Rapid Software Development using Binary Components program is developing a system to identify and extract software components for reuse in new applications.
  - SAFER Warfighter Communications is developing technology to enable secure and resilient communications over the Internet, particularly in adversarial situations.
  - Vetting Commodity IT Software and Firmware is developing methods to ensure that commercial software and firmware is free of malware.
- In addition, since last year DARPA has initiated the following new cyber projects:
- Building Resource Adaptive Software Systems will enable us to build software systems that are long-lived, survivable, and robust to changes in physical and logical resources.
  - Cyber Fault-tolerant Attack Recovery will develop diversity-based architectures for protecting systems without requiring changes to their concept of operations.
  - Edge-Directed Cyber Technologies for Reliable Mission Communication will bolster the resilience of communication over wide area networks through new edge capabilities.
  - SafeWare will provide provably-secure protection of sensitive information in software that is vulnerable to capture and dissection.
  - Space/Time Analysis for Cybersecurity will develop new program analysis techniques and tools for identifying vulnerabilities to algorithmic complexity and side channel attacks.
  - Transparent Computing will make currently opaque computing systems transparent by providing high-fidelity visibility into component interactions during system operation.

Sustained funding for DARPA's cybersecurity portfolio is of critical importance. The cyber domain is one where we see our adversaries making tremendous technical strides and acting with increasing boldness. Cyber is likely to be the preferred avenue of attack for all actors, large and small, given the kinetic advantages we currently enjoy.

*Question.* During last year's Defense Innovation hearing, Dr. Prabhakar noted how both DARPA and the Navy were trying to get the Long-Range Anti-Ship Missile to operational capability as quickly as possible. I understand that the Long-Range Anti-Ship Missile is scheduled for fielding in 2018. Could you please discuss the importance of continuing to adequately fund these efforts?

*Answer.* The Warfighter has clearly communicated a need to provide additional Offensive Anti-surface Warfare (OASuW) capability to address emerging threats no later than 2018. This message began with a U.S. Pacific Fleet Urgent Operational Needs Statement released in 2008, and subsequently revalidated in 2014. United States Pacific Command has articulated a developing capability gap that will result in increased risk in the operational environment beginning in that timeframe and increasing thereafter.

The Department is addressing this emerging threat through an incremental approach, beginning with the OASuW Increment 1 program, which will field an early operational capability with the Long-Range Anti-Ship Missile (LRASM) to meet the 2018 need until a follow on capability can be fielded (OASuW Increment 2). LRASM development/fielding is funded to focus on meeting the time-critical requirements, while accepting manageable levels of technical risk, and is utilizing the Department of Defense Instruction 5000.02 Model 4 Accelerated Acquisition process to achieve "speed to the fleet." The program's funding profile was developed to enable fielding at the time required by the Warfighter. Due to the accelerated nature of the program's acquisition strategy, volatility in the funding profile has an intensified impact on the program's ability to meet the early operational requirements, and any reduction in funding will increase risk to fielding the required capability at the specified time.

#### SUBCOMMITTEE RECESS

Senator COCHRAN. We are very grateful for your cooperation, along with that of our distinguished staff member team, which is the best in the Senate.

So until then, the subcommittee stands in recess.

[Whereupon, at 12:29 p.m., Wednesday, April 22, the subcommittee was recessed, to reconvene subject to the call of the Chair.]