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Subcommittee on Emerging Threats and Capabilities

COMMITTEE ON
ARMED SERVICES

UNITED STATES SENATE

HEARING TO RECEIVE TESTIMONY ON THE STRATEGY AND IMPLEMENTATION OF THE DEPARTMENT OF DEFENSE'S TECHNOLOGY OFFSETS INITIATIVE IN REVIEW OF THE DEFENSE AUTHORIZATION REQUEST FOR FISCAL YEAR 2017 AND THE FUTURE YEARS DEFENSE PROGRAM

Tuesday, April 12, 2016

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U.S. Senate
Subcommittee on Emerging Threats and Capabilities
Committee on Armed Services
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:36 p.m. in Room SR-222, Russell Senate Office Building, Hon. Deb Fischer, chairman of the subcommittee, presiding.

Members Present: Senators Fischer [presiding], Cotton, Tillis, Nelson, Manchin, Kaine, and Heinrich.

OPENING STATEMENT OF HON. DEB FISCHER, U.S. SENATOR FROM NEBRASKA

Senator Fischer: Good afternoon. The Subcommittee on Emerging Threats and Capabilities meets today to receive testimony on the Department of Defense's third offset strategy.

In 2014, Under Secretary Kendall provided this subcommittee with a classified briefing on U.S. technological superiority. And in November of that year, then-Secretary of Defense Hagel announced the start of what he referred to as, quote, "a game-changing third offset strategy," end quote.

Since this announcement, many senior leaders in the Department of Defense, including Secretary and Deputy Secretary, have spoken at length about our military's eroding technological edge and the significance of the third offset strategy. However, these discussions tend to broadly focus on abstract ideas and the general importance of innovation. The purpose of today's hearing is to explore the concrete details beneath the notional concepts.

I look forward to hearing from our witnesses today about what activities make up the third offset strategy and the extent to which it represents a change from past practice.

Appearing before the subcommittee today, we have Dr.

Roper, Director of the Strategic Capabilities Office; Dr. Prabhakar, Director of the Defense Advanced Research Projects Agency, or DARPA; and Secretary Stephen Welby, the Assistant Secretary of Defense for Research and Engineering.

I'd like to welcome and thank you all for being here today.

And I would turn to my Ranking Member for any opening comments he would like to make.

STATEMENT OF HON. BILL NELSON, U.S. SENATOR FROM FLORIDA

Senator Nelson: Madam Chairman, thank you.

I simply am a big fan of what these folks do. I think we need to support the President's request, and then double it.

[Laughter.]

Senator Nelson: That's my opening statement.

Senator Fischer: Thank you, Senator Nelson.

And we will now turn to our witnesses. Your full statements will be made part of the record, and I would ask that you provide us with some brief opening comments, after which we will proceed to 7-minute rounds in our questioning.

Secretary Welby.

STATEMENT OF HON. STEPHEN P. WELBY, ASSISTANT SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

Mr. Welby: Chairman Fischer, Ranking Member Nelson, members of the committee, Senator Heinrich, thank you. And I'm pleased to have the opportunity to provide testimony on the technological underpinnings of the Department of Defense's third offset strategy. And I join my colleagues from DARPA and the Strategic Capabilities Office in doing so.

In my role as Assistant Secretary of Defense for Research and Engineering, I serve as the Chief Technology Officer for the Department of Defense, and I'm responsible for the Department's strategies and supporting plans to develop and leverage technology needed to support continued U.S. technological superiority.

For the last 30 years, the U.S. and our allies have had -- been able to count on a set of unique capabilities in combat that no regional adversary could bring to bear. We're now at a pivotal moment in history, where the advanced technical capability and capacity that the Nation has relied upon on the battlefield is now being challenged by military technology investments being made by increasingly capable and assertive powers. As Secretary Carter said during his budget rollout testimony, Russia and China are our most stressing competitors. They have developed and continue to

advance military systems that threaten our advantages in specific areas. And, in some cases, they're developing new weapons and ways of war that seek to achieve their objectives rapidly before they hope we can respond.

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

Merriam-Webster defines an "offset" as something that serves to counterbalance or compensate for something else. An offset strategy is an approach to military competition that seeks to provide an asymmetric advantage to the United States rather than competing head-to-head or tank-for-tank or plane-for-plane in an area where a potential adversary may also possess potential strength. Instead, an offset strategy seeks to shift the axis of competition through the introduction of new operational concepts and technologies towards one in which the U.S. has a significant and sustainable advantage.

The U.S. was successful in pursuing two distinct offset strategies during the Cold War:

The first of these offset strategies occurred in the

1950s, when President Eisenhower sought to overcome the Warsaw Pact's numerical advantage by leveraging U.S. nuclear superiority to introduce battlefield nuclear weapons, which shifted the axis of competition from competing on conventional force numbers to competing in an area where the U.S. had an advantage.

A second offset strategy occurred in the 1980s, with the recognition that the Soviet Union had achieved nuclear power -- the United States. The second offset strategy sought to create an enduring advantage by pursuing a brand new approach to joint operations, leveraging the combined effects of near-zero-miss distance weapons, realtime targeting, and joint battle networks to create a new era of conventional precision engagement.

This combined suite of technologies gave the U.S. a fundamental advantage that we have sustained for the last 30 years, capabilities that provided the U.S. and its allies with an asymmetrical advantage in every fight. Today, we see the emergence of increasing technological symmetry, and that's why the Department is discussing the need for a new offset strategy.

Today, the third offset strategy is not a document that you can go find in a drawer somewhere in the Pentagon. Instead, it -- the term really describes the broad nature of capabilities that the Department expects to realize over the

coming years by pursuing developments in advanced technologies, by conducting experimentation with prototype systems, through increased emphasis on war-gaming to help us understand new concepts, and by emphasizing the need to innovate across the entire DOD enterprise.

In the fiscal 2017 defense budget request, Secretary Carter identified more than $3.6 billion of investment in FY-2017 and 18 billion in specific investment over the Future Year Defense Plan, focused on spurring research, development, and procurement of advanced capabilities that our military will need to fight and win in high-end conflicts in the future. These investments and others directly support and enable a third offset strategy.

The investments in the fiscal 2017 defense budget request include new capabilities that can be fielded rapidly through modifying and upgrading existing systems -- and we'll be happy to talk about some of those here today; material concepts that could enter accelerated development; and, again, something I'd like to talk about, our technology-driven concepts that could have a significant impact on the joint force over a longer term. They -- the investments also emphasized the critical importance of focusing on the cost of weapon systems so that -- to be able to introduce these kind of disruptive capabilities into the joint force at real scale.

Deputy Secretary of Defense Work has emphasized, in his remarks, the importance of advanced software-enabled capabilities for a third offset. Emerging capabilities in advanced algorithms and software intelligence offer a significant potential advantage to a joint force, enabling systems to process large quantities of data at a high speed to identify emergent patterns and trends, speeding decision making and enabling faster-than-human reaction time in new and emerging areas of conflicts, such as cyber and electronic warfare, and supporting new models of manned-unmanned combat teaming; and finally, permitting new weapons concepts that can operate in critically challenging cyber and electronic warfare-constrained environments.

The Department's goal to sustain and advance our Nation's technological superiority for the 21st century national security environment requires a sound research-and-development investment strategy. The DOD's research and engineering community works to create options for the Department and serves as a novel and agile innovation engine for the Department. The core science and technology efforts of ASDR&E, the service laboratories of DARPA and SCO are focused on creating long-range opportunities for the Department's future material options.

As DOD develops the third offset strategy, the Department's research and engineering enterprise is well

prepared to develop, shape, and create technology options to inform future operational concepts. Our goal must always be to ensure that our soldiers, sailors, airmen, and marines always have the scientific knowledge, the decisive technology, the advanced systems and tools, and the materiel edge to succeed when called upon. Our research and engineering enterprise measures its success in the security of the Nation and the success of our warfighters.

Let me close by thanking the committee for its strong interest in and support of the Department's research and engineering efforts as we work to discover, design, and deliver the technology capabilities our warfighters will need in the future.

Thank you.

[The prepared statement of Mr. Welby follows:]

Senator Fischer: Thank you very much.

Dr. Prabhakar, please.

STATEMENT OF ARATI PRABHAKAR, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Dr. Prabhakar: Thank you. Chairwoman Fischer and Senator Nelson, members of the subcommittee, it's a great pleasure to be here with my colleagues today.

DARPA is part of the Defense Department, and we also work with defense companies and commercial companies, with universities and labs of all sorts, so we are very much part of a very large ecosystem. Within that ecosystem, DARPA has one particular mission, and that is to make the pivotal early investments in breakthrough technologies for national security. We do this work to change what's possible so that the Department can revolutionize our military capabilities.

Now, today's hearing is about the third offset strategy, and I want to just spend a little bit of time to tell you what it means for DARPA.

You know, DARPA's work is always -- has always focused ono technologies to offset our adversaries' capabilities, so the third offset strategy hasn't significantly changed the way we start our programs, which range from radically new military systems to artificial intelligence to biological technologies. What is starting to shift, I think, in a very productive way is the kind of pull that we're getting from the Department to transition those technologies. And I'll contrast what's going on today to the environment we were in

5 or 10 years ago. If you look in that period of time, most of DARPA's significant transition successes were direct to theater. We were tracking insurgents' pickup trucks from the air. We were helping to analyze data so that we could help commanders in the field understand the effectiveness of stability operations. And we're very proud of the contributions that we were able to make in that environment. But, in that period of -- and in a really intense focus, of course, on the ground war on counterinsurgency -- in that period of time, we found that there was a very limited appetite in the Department to move ahead with the kinds of technologies that are going to be necessary to deter and defeat a very sophisticated nation-state adversary. And that's what I think has really shifted today.

So, today, when you look at what's happening across the Department, fresh thinking in many ways across the Department, including, of course, the third offset strategy. What that means today for DARPA is that many more of our transitions are working directly with the services in partnerships where we're exploring and experimenting and demonstrating what our technologies can do to counter, again, a very sophisticated adversary, a very capable opponent.

Just to give you one simple example, last week we had the great pleasure of christening a new ship. It's called

the Sea Hunter. This ship will be the first -- the world's first ship that's able to leave the pier to navigate thousands of miles across open seas without a single sailor onboard. And what that means is that it'll be able to do some maritime missions for a tiny fraction of today's operating costs, which is good, but, even beyond that, this is the kind of new capability -- this kind of unmanned ship now allows us to invent whole new ways to exercise influence across the vastness of the oceans. And that's exactly what we're now doing with the Navy, a series of experiments that we're launching on -- launching into with them. And that's a partnership that I deeply value in this particular project with the Navy. It's a partnership I don't take for granted, however, because, when we started that program, originally called the Active Program, many years ago now at DARPA, starting in the early part of this decade, at that time we were going it alone, for a couple of reasons. Obviously, because, at that time, the technology was very new and unproven, but also partly because the Navy's priority at that time, as was the whole Department's -- their focus was on the battle at hand.

And today, very much in contrast to that, the Sea Hunter Project is actually only one of a growing set of partnerships that we have, transition relationships that we're building with the services. And those cover every

kind of operational domain. I mentioned maritime, but also work in the air, space, and ground domains, also work to control the electromagnetic spectrum in cyber, and in the information domain. And at DARPA, we see these partnerships as absolutely essential if we're going to get these DARPA technologies from wild new idea to robust operational capability.

Let me just conclude this afternoon by touching on two pillars of your support that make it possible for DARPA to do this work:

One is, of course, the budget. And your support in -- of the budget over the last few years has been vital in the relative stability that we've enjoyed. And I'll ask you again for your full support of the President's budget request.

The second is people. And I want to give a special thanks to this committee for, first, creating and then many -- over many years, supporting a special hiring authority, the 1101 hiring authority. This is one of the big reasons that DARPA is able to move fast and to hire exceptional people.

So, those are the two elements: great people and the trust that you place in us. This is why DARPA is able to create breakthrough technologies for national security.

Thank you. And I'll look forward to your questions.

[The prepared statement of Dr. Prabhakar follows:]

Senator Fischer: Thank you.

Dr. Roper.

STATEMENT OF WILLIAM B. ROPER, JR., DIRECTOR, STRATEGIC CAPABILITIES OFFICE

Dr. Roper: Chairman Fischer, Ranking Member Nelson, and members of the committee, thank you for your interest in the third offset. Thank you for your interest in the Department's return to great-power competition. Thank you for your interest in the Strategic Capabilities Office, or SCO. It's an honor to be here with colleagues from the research-and-development arm of the Department who are striving to maintain our technology edge against a world of threats.

As mentioned earlier, these threats now span a space from nonstate terrorism all the way up through great-power competition. And the third offset is really trying to return a greater focus of our Department's effort, including the budget, to those highly sophisticated adversaries. In 2012, the SCO was created by Secretary Carter as one piece of this broader strategy; specifically, a near-term piece that is focused on trying to regain advantage. So, I would like to discuss the way that we frame immediate challenges, our process for prototyping solutions, and how we're working to do these prototypes in a partnership with the services. This will be the focus of my remarks today.

Though daunting in many respects, we interpret our immediate challenges via a fairly simple analogy, but an

instructive one, that the U.S. military is akin to a football team that has run a very successful playbook, but for a bit too long. As in football, where opponents watch film to try to find weaknesses to exploit them, 20 years of operations in the Middle East have given great powers a lot of valuable game film to roll right into their weapons development. So, SCO's response to this is to do what football teams do. Great teams often find themselves overanalyzed and exploited, but they don't throw away their playbooks. They use this vulnerability and turn it into opportunity by creating trick plays. They start running in their pass formations, passing in their run formations. They reimagine their strengths rather than playing to their opponents. And like fashion, we can rejuvenate our military playbook if we can reimagine its strengths: ships, aircraft, submarines, things we're familiar with. If we start using them in unforeseen and unexpected ways, we can hope to buy back some of the competitive edge that we're losing to great powers. SCO was created to do precisely this.

Though our strategy often has advantages of lower cost and rapidity, its core tenet, which is our need to change, is anchored in our greatest advantage of all: experienced operators who can do the unparalleled with today's systems and can rapidly master any unconventional tactic we throw at

them. This strategy also will provide healthy connective tissue between our past and future efforts; the past, by keeping taxpayer investments for as viable -- viable for as long as possible; and the future, by trying to buy time for these future technologies, future systems, the leap-aheads, to field. Because of this, we were tapped to be a near-term component of the broader offset strategy, and our goal is a simple one: to try to enhance our current deterrence, backed by an arsenal of surprises, using systems that we have today.

Our process for achieving this is, itself, innovative, because it flows in reverse from the normal one, from operational needs to systems -- actually, from systems to operational needs, rather than vice versa. Living within the constraints of existing hardware and software focuses ideas early on. It encourages cost domain thinking, and necessitates close partnerships with the services to pull off these high-risk prototypes. In 3 and a half years of practice, we've done 23 capabilities, working with the services. Six of them will transition by the end of this year. And none have failed to transition, thus far.

These projects, which are really our versions of trick plays, take on one of three forms: repurposing a system for a new mission it wasn't designed to do; integrating systems into a team that can perform the function together, but not

separately; and including or incorporating enabling commercial technology. I'm sure we'll cover some examples today, but let me highlight three of them:

Unconventional weapons. Standard Missile 6 was originally designed to defend our ships. We've partnered with the Navy to give it an offensive antiship role. You can also do unconventional defense. Army howitzers, Navy projectiles, Air Force radars weren't designed to be a defensive system, but we're partnering to Frankenstein these into a low-cost supersonic missile defense shield.

Could also do unconventional teams, or kill chains. Stealth fighters were originally designed to use their organic weapons. We're partnering with the Air Force to team them with large standoff arsenal planes so that they don't have to go land and resupply during a fight.

Our third i-program is taking this even further, connecting disparate sensors and shooters from across the joint force.

The rest and best of our details necessarily remain classified, but I hope these few examples give you a sense of how broad the applications could be. We should really let no facet of future conflict be predictable or be as it seems.

As one of the bellwethers for the return to great-power competition, I'm pleased say that SCO is making significant

progress in making current systems count towards a future that's shaped by us, and not for us. I really appreciate your interest in this topic, appreciate this hearing today. I look forward to any questions you might have.

[The prepared statement of Dr. Roper follows:]

Senator Fischer: Thank you very much.

And again, welcome to all of you. I think this is going to be a fascinating hearing.

Secretary Welby, if I could begin, a factsheet that was provided by the OSD states that realizing the third offset strategy will require the right combination of bottom-up innovation and experimentation to push the technical and operational envelope and senior-leader top-down direction to initiate major programmatic, operational, and organizational change. So, I'd like to ask you about that last part. What the major programmatic, operational, and organization changes are being made as part of that offset strategy or -- basically, what's the Department proposing to do differently in this budget request with regards to the offset strategy?

Mr. Welby: Chairman, the -- if I -- if you look to the investments that are in the '17 budget, there are some very significant muscle movements that you can see in that budget. I'll point to a couple of key technology areas first: a major reinvestment in hypersonic capabilities, an increase in the number of systems that we're carrying to the range in the hypersonics weapon regime by 50 percent, an increase in the investment in our ranges to increase our hypersonic capabilities, and investments in our laboratories in industry to take those systems from being technology demonstrators to being no-kidding weapons that we could

actually think about deploying with our force.

In the undersea arena, you see a significant reinvestment in unmanned undersea vehicles as an augment to our manned undersea force as a significant force multiplier, as a key experimental asset for the future of the Navy. You can see within that budget significant investments looking at a variety of novel weapons concepts that might have significant application to the future force.

And, over the last year, you've seen the Department really open its aperture to all sources of potential innovation, to include engaging the defense industrial base, in terms of ensuring transparency on their IRAD investments so we can work forward -- march forward together collectively against these kind of challenges, understanding what they're investing in, understanding what we're investing in. And you've seen the Department engaging the innovative commercial sector through outreach efforts like -- EWACS on the West Coast and the Secretary's continuous engagement with the commercial sector, trying to find ways to bring both people and ideas back into -- reinvigorate our activities.

We are reemphasizing the importance of the DOD laboratories to this initiative. The laboratories in the individual services and our engagement with partner laboratories in DOE, as well as innovation engines that can

help drive the future of the Department. And we are emphasizing the need for speed from laboratory to fleet. The recognition that there's enormous innovation that has continued within the laboratories even while the Department may have reduced its focus on fielding that capability, but that store of novel ideas needs to be taken to the test ranges and experimented with.

Finally, I want to point to the focus on prototyping and experimentation. When you look to the second offset that occurred in the '80s, the ideas for that -- for those technologies emerged in the mid-'70s. And in '79 and '80, the Department conducted a series of major experiments on the western ranges, where we put together precision weapons, long-range ISR platforms, the first flights of what became Joint STARS, the first systems of what became the Army ATACAMS, early flights of Apache Longbow, and many other capabilities. And across the range, in the classified portfolio at that time, we were flying the F-117 and experimenting with the emergence of real stealth capabilities. That incredible innovative energy that occurred at the operational level, not simply doing laboratory experiments, but putting it into the hands of operators and letting them understand how they might fight those capabilities, is what enabled the set of capabilities that in the '80s, as the Reagan defense buildup, we didn't

buy the same things; we bought an entire new generation of capabilities. But, we didn't buy it blind. We bought it with the knowledge that came from those exercises. The Department is now preparing for another series of investments in prototyping and experimentation. We want to get our ranges busy again. We want to get new systems out on those ranges. Whether we procure them all, or not, we want to learn from those systems and inform what we need in the future. And so --

Senator Fischer: Right.

Mr. Welby: -- making the Department smart for its future choices.

Senator Fischer: And in the budget's 3.6 billion, funding specifically related to the offset strategy, can you provide the committee with a breakdown of this funding? Will you get that information to us, please, by programs?

Mr. Welby: I'd be happy to provide you detail. Some of those remain classified.

Senator Fischer: You've mentioned a lot of them, but can you get us the detail, by program, for that --

Mr. Welby: I'd be happy to do that.

Senator Fischer: -- for that spending? Thank you.

[The information referred to follows:]

[SUBCOMMITTEE INSERT]

Senator Fischer: Also, we're going to have a change of administration in January, and what sort of things do you want to have accomplished by that time to demonstrate that this effort is on the right path?

Mr. Welby: I'm sure that any transition team that -- for any administration to come is going to face the same set of challenges that we face today. The pull here is the recognition of the need to address U.S. strengths in a future competitive national security environment. That's an external pull. This is not -- while this is Dr. Carter's initiative, it's the Deputy's initiative, while I'm trying to drive this, it's not driven by personality; it's driven by the Nation's need to refresh our technology --

Senator Fischer: Right. And how -- and what are you going to point to that you've accomplished? I think you have a lot of support on this committee. We understand the importance of where we're headed with technology in order to change warfighting so that we continue to defend this country. So, how are we going to make sure this moves forward?

Mr. Welby: We're not going to stop for the next 9 months of running to make sure that the next administration has a running start to these problems. We've completed, recently, the Long-Range Research and Development Planning Program, an 18-month study that looked at details and laid

out a series of opportunities for the Nation, going forward. All that material, we're trying to harness across the laboratory complex today to make sure we're ready for what comes next. And so, I think that we -- that this budget and the initiatives we have ongoing prepare for that future in an important way and lay ground for the next administration.

Senator Fischer: Okay. Thank you very much.

Senator Nelson.

Senator Nelson: Thank you, Madam Chairman.

Mr. Secretary, thank you for your public service.

Dr. Prabhakar and Dr. Roper, given the fact that I've already spent a great deal of time with both of you, asking a lot of questions, and given the fact that our enemies' spies are listening to what you say today, I really don't want to ask you any questions in an open session. And I would invite the members of this subcommittee to get in a classified setting to figure out some of the gee-whiz stuff that these folks are doing. But, since it's an open setting, I'm just going to leave it to you. Say whatever you'd like. And that's all I'm going to say.

Dr. Prabhakar: Well, it's hard to resist an invitation like that. Thank you very much, Senator Nelson.

You know, I think, absolutely, the details of the programs that we think can be very impactful here do need to remain classified. And, of course, we're happy to provide

classified briefing to any of you who would like to come do that. We'd be very pleased to do it.

I actually think the most interesting aspect of what we're all working on in the third offset strategy and these technologies -- really, the question, as a technologist, that I see is -- in a world in which we no longer get to have all the toys and nobody else gets to have any technology capability -- that was an unusual period, after the second World War, when we had that enormous technological advantage over the rest of the world -- that's not the world anymore, and we all know that technology, wherever it originates, it flows. We know that many other countries now have amazing engineers and scientists and laboratory facilities. And, by the way, all of that is really good for the world. It's actually -- it's elevated living standards. It's connected us in new ways. So, most of that is good news.

The challenge, of course, that this is all about is the fact that we still have to come up with a technological edge for national security, despite a more and more level playing field of initial technologies. And I actually think the success here is going to come from something that's a deeply American way of approaching the problem. And I -- you know, a lot of what we do at DARPA is about this idea that we're going to -- we're willing to take risk to reach for high

payoff, and we are willing to try things that might fail. But, in combining these commercial technologies, accessing leading-edge commercial technology and then combining it with places where we do have an edge and where we can protect the technology, at least for some period of time, if we can learn to do that and move faster than anyone else around the planet, I'm actually quite confident that we are still going to be able to win in this competition.

Dr. Roper: Senator Nelson, I think it's an important point that you raise, is that a lot of the technology edges that we're going to develop are developing, and will be moving to testing very soon, are surprises. They're things that are intended to deal us back into the game. They're intended to project power in different ways that we haven't before. And there's going to be a very difficult calculus that we're starting to begin as part of the third offset effort, which is, Is it a surprise that we want to tuck behind our locked doors and save to be able to win a war? We have to be able to so that. That's our job, as the Department. But, if we were to put every surprise that we develop behind the door, we would be biasing our portfolio towards a go-to-war posture, as opposed to a deterrent posture.

So, one of the challenges we're going to have is, we're back into a deterrent mode, as the Department. But, as

opposed to the Cold War, it's not a monopolar deterrent posture. We've got to do it in a bipolar way. Must be able to think about China and Russia while we continue to focus on the Middle East, continue to focus on North Korea.

So, there's no easy math for deciding whether or not to show a capability, or not. We've started putting some of our capabilities public now from Strategic Capabilities Office. We have had almost no public face for 3 and a half years. As you were able to see yesterday, quite a lot of our portfolio is behind the door, and deeply so. But, if we put everything there, we'll be doing the country a disservice, in the long run.

Senator Nelson: Thanks.

Thanks, Madam Chair. That's it.

Senator Fischer: Thank you.

Senator Tillis.

Senator Tillis: Thank you, Madam Chair.

Thank you all for being here. And I look forward to future briefings in a classified setting. I appreciate the work that you all have done.

I'm going to go to the more, maybe, boring side of the equation, and it has to do with actually getting good ideas fielded and in use. So, that gets to procurement, acquisition, specification, partnering with the private sector, where it's appropriate. Can you give me some idea

of where you all think we are and where we need to focus, perhaps even as a matter of public policy changes to remove constraints and try and compress idea-to-fielding timelines over what we have today?

We'll start with the Secretary.

Mr. Welby: Senator, I -- we're emphasizing, in every engagement, speed. In -- as we enter a more competitive future, where we're all drawing off a globally accessible technology base, we're going to need to close our acquisition OODA loop, if you will, faster than our adversaries. We have to turn quickly. We need to think about time to market, like folks do in the commercial sector. And we've been engaging our laboratories in a discussion about how quickly we can move ideas from our tech base to the field. There's no way to rush discovery. I mean, science takes the time it takes. But, we ought to be thinking, even as we're exploring new areas, about that application and how we can prime the pump for that application.

On the acquisition side, we've been challenging ourselves to be able to move faster, especially at that cutting edge of new technologies. We've been looking for ways to be able to engage new partners in timelines that might be measured in weeks, rather than months and often a year, to contract. Especially since we're dealing with

fast-moving technology areas, people aren't willing to wait for a year for the Department to get involved. It -- there's no return on that. They'd rather focus on commercial-sector engagements.

And so, we've been exploring new means to much more rapidly get -- bring folks on to contract, to use competitive vehicles in commercial acquisition, and to think about new ways to bring technology into platforms and systems, leveraging modular architecture approaches, for or persistent architecture approaches for example, be able to plug-and-play technologies into our existing systems to speed the upgrade cycle.

So, I think that, through the S&T initiatives, through the formal acquisition initiatives, the Department's better buying power, 3.0 activities, which have a large focus on modularity and tech insertion, I think that we are trying to move much faster as we go forward.

I think, in the future, we won't see 30-year development programs in anything. And adversaries will have countermeasures prepared for a decade before we field something, if that's the case. And so, we need to up our game, in terms of speed.

And I don't know if anybody else has anything you want to add.

Dr. Prabhakar: I would just add, first of all, that,

in the work that we do at DARPA, of course, we live in the science and technology part of the portfolio. And so, I want to be very clear that our task in developing technologies is not as onerous as procuring systems that our warfighters, you know, need to be confident in and they can trust under extreme circumstances.

Having said that, we've had the opportunity, over the last many decades now at DARPA, to experiment with some novel procurement mechanisms that your committee invented and authorized over numbers of years. One example is other transactions authority. That's an example of a capability that we and others in the Department have. We've used it to great effect, essentially to do business with companies on commercial terms. It -- we comply with the law, but we are able, under other transactions authority, to set aside the Federal acquisition regulations along -- and part of that, of course, means that we -- we're not forcing companies to do government accounting systems and to have that burden. So, especially for commercial companies, it's a particularly good way to be able to move faster, and sometimes it just enables them to be willing to do business with us in the first place.

So, I think there are some practices like that, that I think we've been able to pilot that we hope can be expanded.

Senator Tillis: Dr. Roper?

Dr. Roper: Senator, I think, you know, our piece within SCO is really trying to complete the circle on the acquisition process. So, we currently flow from an operational need to a future system that we field. And, as Secretary Welby pointed out, there are lots of efforts underway to try to speed that cycle up. But, wherever we can find ways to take things that have come out of that pipeline and bring them back to the beginning, solve additional operational needs, whether they're within that service or outside of it, then we're producing lower-cost options that will allow that service to build budgets, where there's more innovation in them.

The biggest issue that service programmers bring up to me is that they want to innovate. And I can attest, from the programs we do with them, there is incredible innovation potential in the services. It's resident in every partnership we build with them. When they build a budget, if their readiness, the fight-tonight capability, is put at risk, the first thing that has to go is the innovation side of it. So, wherever we can buy them flexibility and breathing room to keep that innovation in play, we're doing a good thing, not just for them, but for the country. So, we've got to make stuff that our taxpayers have already invested in do more and stay viable longer if we're going to free up funds to go for the big-win technology leap-aheads.

Senator Tillis: Yeah. And I think your point about turning defensive weapons into -- transforming them into offensive capabilities, and vice versa, is very good. The -- because I'm assuming that the time to field that capability is far less than an all-new platform, and that's why it's important that we squeeze everything we can.

In my remaining time -- you touched on something, Dr. Roper, that I was going to ask. And I know that Secretary Carter has announced a program engaging -- trying to expand our engagement with Silicon Valley in partnering with some of the major tech firms. But, in my experience -- I'm from North Carolina, and down in and around Fort Bragg, there's a lot of small businesses that come from people who have battlefield experience. They're coming out, they're perfecting things that have extraordinary potential, more often than not because they had to put the first iteration together with duct tape and Super Glue, they had to use commercially available products.

To what extent does your area of focus focus on sometimes -- you know, sometimes you need $100 saddle because you've got $100 horse. But, sometimes you've got a $10-horse problem you want solve, which is what I've seen a lot of these folks doing down here. And it seems like every once in a while, DOD wants to put $100 saddle even on a $10 horse. So, how are we getting some of that applied small-

business feedback into the mix as a key part of the innovation loop?

Mr. Welby: Maybe two quick responses.

First is that I'm frustrated that a lot of the discussion around engaging the innovation ecosystem has used Silicon Valley as the term of art, but, quite frankly, there is remarkable work going on from Boston to Austin to Silicon Valley, Research Triangle -- I've gotten right back to that one --

[Laughter.]

Mr. Welby: But -- and I'll touch everybody in the room -- but, look, it's -- and I think that there's really interesting things going on in the small-business side. The Direct to Phase II piece, for example, on our civil work, is now -- we've now identified new mechanisms by which we can reach out and touch small businesses, not just at the hey-do-a-study-for-us scale, but the no-kidding-rapidly-moving-to-a-prototype-so-we-can-try-it -- to get at those folks who have near-immediate solutions and put them into test and evaluation.

I -- as the Secretary has pointed out, the Department needs to focus on porosity, our openness to ideas, wherever they come. We need to take the blinders off and not just to be -- look to the defense industrial base as the only source. It's an important source, but it's not the only

source of ideas. And we're trying to reach out anywhere we can.

Senator Fischer: Thank you, Senator Tillis.

Senator Heinrich.

Senator Heinrich: Secretary Welby, this committee, last year, showed really strong bipartisan support for directed energy weapon systems in the NDAA, and we asked that the Department look at that as part of the third offset approach. How much of the 100 million provided by Congress last year within this effort has gone towards directed energy?

Mr. Welby: Thank you, Senator. We have not -- the language in the report last year for the offset technology initiative requested that we go out and survey the services, looking for competitive ideas, survey the COCOMs, looking for ideas. We have completed that. I have -- we have a stack of proposals that we're going through now, and we're allocating resources against them, expect to be able to provide the details of what we fund from that list here in the next week or two. I am certain that, in that stack of proposals, there will be directed energy. They are at -- they are near the top of the list of things we want to do. I'm expecting that, of the list of things, order of 20 percent would be focused on directed energy. But, we're still trying to finalize both the list and ensuring we've

got the right budgets for those projects. We want to make sure that the things we do fund with that activity are robust and are not underfunded.

Senator Heinrich: I agree wholeheartedly with that approach. And just to sort of follow up on that, I'm curious about -- it seems to me that this technology -- directed energy, in particular -- could be one of those places where we really do provide an offset. It's -- doesn't have a peer-relatable equivalent in other military spaces. And I actually introduced legislation this morning with Senator Inhofe to look at granting rapid acquisition authorities for directed-energy weapon systems. And I'm curious -- and this could be for any of you, actually -- in your opinions, is this an area where the Department is moving fast enough to transition the technology, or are we sort of stuck in an endless R&D loop, where it's always easier to chase the perfect instead of field what is quite applicable today?

Mr. Welby: Senator, I participated in the Directed Energy Professional Society Symposium at the Pentagon today. We have over --

Senator Heinrich: Good timing.

Mr. Welby: -- we have 20 folks sitting in the courtyard of the Pentagon today, demonstrating next-generation laser capabilities and high-power microwave

capabilities. As you know, I've spent a good portion of my career working in this space. And I remain convinced that we are now at the point where we're moving out of the labs and into application space with those kind of systems. I saw some remarkable technology on display today. And we're encouraging folks to think about how we can accelerate those into real applications.

So, I think that directed energy has suffered from being -- from always being just 25 years off. I think we're now not 25 years off. I think there are real applications in the near term, and opportunities to grow those applications in the mid-term. And so, I'm excited about the space.

Senator Heinrich: I appreciate you mentioning microwaves to somebody who used to work at Air Force Research Labs on microwaves as well as lasers. Sometimes we forget that application. And when you look at things like CHAMP and other applications, it is substantial.

For, really, any of you, one of the things I'm concerned about -- with the possible exception of DARPA, actually -- I think there's been a real risk averseness, generally, within the R&D approach of the Department of Defense, at times. And I -- you know, in looking at our nuclear labs, one of the things that has worked there to get around an obvious -- you know, it's easy to be risk-inverse

in this environment. You've seen huge advances, for example, on -- in energy, with things like solar technology, prices plummeting, but one Solyndra can become a political issue. And it's easy to accept that same sort of mindset within defense research.

LDRD, laboratory-directed research and development, has been one of the places where, within the nuclear labs, it really has seemed to be a high-risk but high-reward endeavor that is incredibly valuable, for one, in attracting the right talent into the pool in the first place.

So, I'm curious how the Department views that balance between risk and reward, and what steps are needed to ensure that researchers have the leeway and the flexibility to pursue something that is truly innovative.

Mr. Welby: Senator, across the laboratory complex, we have to recognize that there's a number of constituents we try to service.

Senator Heinrich: Sure.

Mr. Welby: There are near-term transitions into programs of record. There are those medium-term capabilities that seek to be able to demonstrate capability to drive the next program of record. And then there are activities that are further to the left that are really trying to be disruptive. And we have been focusing the laboratories, over the last year, on trying to be explicit

about how we manage those three portfolios, how we think about those things that are near-term and in service of programs of record, how we think about those things that are shaping, kind of, the next program, and those things that are much more foundational.

Just a couple of examples of things that we're doing. We -- in -- across laboratories, we've now created resources available to the laboratories out of the OSD-level budgets, where we've asked the laboratories to compete -- to compete on ideas for who has the greatest game-changer. And we've offered to amplify service budgets in areas where we can see that real impact. Internal competitions, right? But, to get teams challenged and thinking about competing with each other, kind of, across laboratory complexes.

The trick is, of course, at the end, we tend to team those folks together to get all the best and brightest of the ideas across, because we're really in one game, but it's encouraged folks to think differently.

And, within the services, as well, each of the services has been trying to drive more innovation through their own long-term S&T pools. And I'm very excited about how that's taking place.

Senator Heinrich: Doctor?

Dr. Prabhakar: Maybe just to tag onto that. DARPA's very much in the high-risk, high-payoff business.

Senator Heinrich: Sure.

Dr. Prabhakar: And I never take for granted the room that we get to do that, starting with our bosses, starting with Steve, but all the way up to the Secretary, and definitely from Congress. And that -- you know, I think -- I feel very privileged to lead an organization that has delivered on that mission for long enough that you all give us rope. All we have to do is come up with the next revolutionary capability.

But, within the agency, as well, I don't take for granted how we nurture that. And Steve's exactly right that, you know, you do need to manage a high-risk organization in a very different way.

Senator Heinrich: Right.

Dr. Prabhakar: But, continually nurturing that culture, making sure that our business processes reflect the mission and that culture, it's everything from the conversations I have with my program managers when I walk by their offices to the way that they work to get their programs approved. So, I think it's something that needs concerted focus, but --

Senator Heinrich: Yeah.

Dr. Prabhakar: -- I think we know how to do it, and I think it's a -- it is an essential ingredient in the mix.

Senator Heinrich: Great.

Senator Fischer: Thank you, Senator Heinrich.

Senator Manchin.

Senator Manchin: Thank you, Madam Chairman.

And thank you all.

I'd like to ask -- I think this is to Mr. Welby, if I may, Secretary. Secretary Carter recently announced a major initiative for outreach to high-tech companies in Silicon Valley, as you know. DOD has -- also has a small business innovation research program that taps into technology innovations from all around the country. The SBIR program helps small business compete to bring value-added products and services to our military. This program is extremely helpful for the economy of West Virginia, because we have a corridor which really participates in that. So, I'd like to ask, How are we coordinating efforts of engaging these small companies to work with DOE? And my reason for saying that, some of them get into the procurement process, they have to tag along with a large major in order to get any pittance of a little bit of work and become subservient to that. Is there any method of getting them directly into the flow, if you will?

Mr. Welby: Senator, I also highly value the small business innovative research activities. I think that my experience working with companies in the small business innovative research area has allowed them to grow rapidly

and actually contribute in important ways to major --

Senator Manchin: Right.

Mr. Welby: -- defense acquisition programs.

I mentioned earlier the Direct to Phase II activities, which all us to make initial grants to companies at a much larger scale than simply, "Here's 100K to kind of -- to go develop a proposal," the very early study grants that SBIR has typically worked through to cut a year off the time to get people up to scale and to be really playing with real -- at real working levels, up to a million dollars for an initial grant, which is a lot for a small company, initial space.

The -- one thing I should -- I want to point out about the kind of engagements we have with this Defense Innovation Unit Experimental, for example, is, again, it's not geographically tied. We want them to be engaged over a broader portion of the country. And we've not given them acquisition authority. That organization is really intended to help shepherd small companies through the process, make introductions to help them understand the process, to, if you will, act as a shepherd to kind of help them work their way through the system. We're experimenting with that idea that getting small companies, getting the kind of core innovation drivers that we see in small business through our system is a contact sport and requires significant help,

folks who speak their language, who understand the innovation ecosystem, understand companies' commercial ambitions, as well, and can still talk DOD to them. And so, we're trying to understand how that works. That's the experimental portion of DIUX. It really is an experiment to see how we can gauge better.

But, we are trying to find new opportunities to introduce small-business work throughout our enterprise. We're continuously reinforcing our small-business participation objectives in all of our programs.

Senator Manchin: You all go out and solicit this? I mean, go talk to some of the areas, where they're -- not just Silicon Valley, but, I mean, other --

Mr. Welby: I do. And our team does. And we are thinking hard about --

Senator Manchin: Can we get you down to West Virginia? Can I get you down?

Mr. Welby: Sir, I'd love the opportunity to come visit. And I'd --

Senator Manchin: Hey, Rick, sign him up.

[Laughter.]

Senator Manchin: We'll get you down there. It's not that far away.

To Dr. Prabhakar, one of the joys of being a Senator is being able to nominate some of the best and brightest to our

military academies. It's really, really something special, when you see these young, bright people coming from all over the country and getting this opportunity. So, I would ask -- DARPA regularly engages with civilian universities, which we're very appreciative of that, too, for the advanced research efforts. So, how -- what's the percentage of how you all engage with our military academies versus the private? Because we know it's going to be used -- and I'm understanding that, basically, they do a senior project, all the military academies, to participate in cutting-edge defense research. These are people not only that are participating, but going to be fulfilling them. So, do you put more of an emphasis on academies than you do private?

Dr. Prabhakar: Senator, our starting point with everything that we do at DARPA is to go out and find the technical talents that are going to have the ideas and the ability to go execute on them. And through that, we work with universities of all sorts, but also, of course, a lot with companies of all --

Senator Manchin: You all pay --

Dr. Prabhakar: -- sizes.

Senator Manchin: You pay, right?

Dr. Prabhakar: Our -- we fund those projects and those companies. We're actually only --

Senator Manchin: But, you're already funding -- we

already fund the military academies. We already paid once.

Dr. Prabhakar: And I -- I think it's a great question you've raised, because I think about the people who are attending those military academies --

Senator Manchin: Yeah.

Dr. Prabhakar: -- frequently. They are going to be the warfighters who use the --

Senator Manchin: That's exactly right.

Dr. Prabhakar: -- technologies that we are brewing. And so, we reach out to them in a variety of ways. In recent years, as an example, we conducted a competition among the academies in the cyber arena. That's one, in particular, where the -- you know, there's a lot of interest, but also a great need to continue to educate warfighters that are going to be adept in the cyber environment. So --

Senator Manchin: Could I --

Dr. Prabhakar: -- they are very much part of our community.

Senator Manchin: Would it be possible to get a report, basically, on the amount of money that you all do put out in doing these -- engaging in these research --

Dr. Prabhakar: Yeah, I'd be happy to look into that.

Senator Manchin: -- versus --

Dr. Prabhakar: Just to set your --

Senator Manchin: -- versus the academies.

Dr. Prabhakar: I just -- I'd be happy to get you that data.

Just to set your expectation, the amount of research that's done of the sort that we typically fund at the academies is fairly limited, because their focus, of course, is educating these young folks who are going to become our future warfighters. So, I would be happy to get you that data.

[The information referred to follows:]

[SUBCOMMITTEE INSERT]

Senator Manchin: But, what you're going --

Dr. Prabhakar: But, that's now where the research --

Senator Manchin: -- you're going to --

Dr. Prabhakar: -- is typically done.

Senator Manchin: So, you're telling me right now, you don't put much in the academies.

Dr. Prabhakar: I don't think you'll find a significant amount of money flowing there. But, again --

Senator Manchin: Let me ask you this --

Dr. Prabhakar: -- their role is different --

Senator Manchin: Cadets and --

Dr. Prabhakar: -- from what we do.

Senator Manchin: -- midshipmen start their senior project, they have -- they have to have a senior project.

Dr. Prabhakar: Yup.

Senator Manchin: Okay? Do they know there is a pathway that they could take something of high cutting-edge, such as what you all are looking for? I mean, to me, I -- maybe I'm wrong, I don't know. I just believe that we've got some outstanding -- you know, I'm not saying universities -- I mean, we have research, WV and all of them.

Dr. Prabhakar: Yup.

Senator Manchin: But, I'm saying, we already own this. We -- this belongs to us. And those are 4- to 5-year

employments afterwards, so we know they're going to be the ones who are going to be implementing everything we're doing.

Dr. Prabhakar: Yes, I agree that they are an important part. But, again, DARPA'S role --

Senator Manchin: I know.

Dr. Prabhakar: -- is about research; it's not really the education of that part of -- you know, that critical part of our workforce.

Senator Manchin: I gotcha.

That's -- no further questions,

Senator Fischer: Thank you, Senator Manchin.

I think it's safe to say that the goal of this initiative is to preserve and enhance our technology-based military superiority. And that's part of the meaning of the term "offset." We're not going to be fighting our adversaries tank-to-tank anymore. And so, technology does provide us that advantage and the offset to -- with capabilities for others.

Dr. Roper, you know, I'm concerned that we become so reliant upon technology that that reliance can be exploited, and it can be exploited very cheaply, in some instances. And I think space is a good example for us to look at in that regard. Our adversaries can jeopardize our constellation for a lot less money than developing new

technology for us to build here and take advantage of that. So, how do you ensure that the greater incorporation of technology doesn't turn into a dependence? And how do you ensure that we don't allow our adversaries this opportunity to be able to undermine what we're trying to do in a really -- basically, a cheap way?

And, Dr. Prabhakar, I'd like to ask you that, as well.

Dr. Roper: Thank you, Senator. It's a great question. And so, I'll address the space component of it, but I'd like to then broaden to the bigger question --

Senator Fischer: Yes.

Dr. Roper: -- of, you know, where is -- where does technology end and other advantages begin?

So, I think, as indicated by a lot of the discussion this morning, we're moving into a regime where relative technology advantage is going to be lowering amongst the great powers in the world. So, the U.S., China, Russia --

Senator Fischer: Our adversaries are catching up to us.

Dr. Roper: Catching up. And we're also living in a world where technology is speeding up, so the impact of commercially available technologies is going to be large. It's also going to be available to everyone. And so, this is going to force the Department, as well as our adversaries and competitors -- it's going to force us to become fast

adapters. So, when we look at areas where the environment's going to be contested -- and space is one of those -- there's obviously the disadvantage of not having the legacy way that we've projected power be something that can be continued into the future, but we'll be moving into a future where there is hope for us. It's very likely that we'll start having distributed space architectures and future where maybe individual satellites are contestable, but the architecture, as a whole, isn't. That'll force us to start using statistics as a metric, where you're not -- you can't calculate the reliability of a single thing, but you're doing it in aggregate. That's something very common for many industries. The cellular companies that sell to us are used to having a statistical approach to their availability, as opposed to a singular one.

What I think this means is that warfighting is going to be messy. We're not going to be able to go in and have very simple mathematics and physics help us calculate the margin of battle. Things are going to be constantly changing. Satellites that are available won't be. Networks that are available won't be. And if we're wise, we'll have architectures in place where we hop between different assets that are available.

I think that's where we actually get off the stage with our biggest advantage. That's a messy environment. Not

every country is going to be able to get their operators ready to deal with it. So, the greatest advantage we have, and the reason I think we'll pull this offset off, is that we're coming out of 20 years of operational experience that no one in the world can match. And so, we're saying to the world, we're going to change, we're going to go into this messy environment with our eyes open, and we're going to dominate in it. And that's based on giving operators, one, the technology to be able to adapt in that environment, but trusting them to be able to use it and master it.

So, I think the biggest ill that we could do, as a Department, is to have all the shiny bells and whistles in the technology world, which are important, override what's underwriting it, which is our human operator foundation.

Senator Fischer: Thank you.

Dr. Prabhakar.

Dr. Prabhakar: Yeah, I think Will's completely correct with what his -- especially his concluding point. I often think about how reliant, even in our civilian lives, we've all become on GPS, where I only will just follow that blue dot or listen to those instructions. And, of course, that's a great example of needing to remember that technology is a very powerful tool, but it doesn't allow you to suspend judgment. And we're seeing some examples where that's really gone wrong.

Technology is, of course, only going to be one component in the solutions that we're talking about here. We very much see part of our job, of course, driving the technology, but also thinking in terms of, How do we make it secure and reliable? Cybersecurity is a very big part of that. And, of course, we have a significant portfolio that focuses on that.

But, at the end of the day, it really is about how humans use the technology. And I think, as we have moved from more of a gadget focus to, "How do you think about winning the war?" it has really driven our thinking to rarely think about the whole system of how humans and machines are going to interact together. And that's a much harder problem and a much richer problem, but I think it's going to be important to getting to solutions that really do work.

Senator Fischer: And, Mr. Welby, I've seen a factsheet that was put out by the Department, and it discusses those investments that I believe the Doctor was just talking about, with the human and the machine collaboration that's going on. It states all of these components will be connected to a cyber-hardened human-machine command-and-control network. You know, we're not really good at keeping adversaries out of our networks. Let me rephrase that. We are good at it, at keeping them out, but they still get in.

So, how are we going to have confidence that we have the ability to build this cyber-hardened network? And do you think that the network should come before we think about the pieces that rely upon it? Should we make sure we have the security there before we get the bells and the whistles that depend upon it?

Mr. Welby: Senator, I believe that there's a real opportunity here to codesign these capabilities in ways we have not in the past. One of the really interesting things that's going on is this notion of autonomous systems, systems that I can give direction to, and that I can have confidence that they're going to have certain behavior and then check back in with me at some future point. And that offers a way to think about how systems can actually operate on -- even on unreliable networks. By reducing the bandwidth required to, for example, tell the operate system; by having the ability to have systems interact with humans by exception, just as I would with -- send a soldier up a hill, call me if you see something that you need assistance with -- I can start to think about machines that might be able to do that.

We -- we're talking about manned-unmanned teaming and trying to understand how that works, what kind of bandwidth is required, where and when systems need to interact. I think it's very important in scoping the networks required

to support those.

We did some recent studies, where we looked at just how little bandwidth was required to ensure control over -- in a simulated environment or some notional unmanned-manned system concepts. And we were very enthusiastic about the ability to shrink that amount of bandwidth required in very interesting ways. It -- the smaller the pipe, the easier it is to protect. And so, we're thinking about very novel ideas in that space.

Senator Fischer: There's a discussion going on in the Commerce Committee about spectrum, since you're talking about bandwidth. You said you're shrinking bandwidth that's necessary for the Department of Defense. Would you say you don't need all that you have? Put you on the spot here.

Mr. Welby: Today, I think we need all we have, and more.

Senator Fischer: You need it all.

Mr. Welby: We need it all. And particularly for radar is really one of the critical things. Our large-bandwidth sensors are really a challenge. Spectrum auction has caused the Department to have to shift in very complex ways, and we're continuing to work through that. Comma, with my technology hat on, I am very excited about agile spectral use in the future and ways we can start to think about the technologies that will help shift, not just the military

sector, but maybe in -- on someday, the commercial sector to be much more efficient users of spectrum. And I am enormously excited about the initiatives that DARPA has started here in the last 2 weeks to set up prizes associated with very novel use of the spectrum, an arena to challenge folks to come in with entirely new concepts for agile radio development, and to think about new ways that we can architect our commercial and military systems to be really efficient users locally, regionally, and globally to make the most use of the spectrum we have. The demand for spectrum is only going in one direction. Wide bandwidth applications on the commercial side, wide width applications on the military side are going to grow. But, in the fight, which is what we were talking about a moment ago, we're going to want to be able to -- if we lose that spectrum, to still be able to fight through. And we think there's very interesting ways we can do that.

And if, Arati, you want to say a word about the spectrum challenge.

Dr. Prabhakar: You can tell Steve is a DARPA alum, because he summarized our new DARPA program perfectly.

Senator Fischer: I was going to say, because we have such a truly limited amount -- a finite amount of spectrum that's out there, and to find a more efficient way to use it would be beneficial, Of course, for our national security,

but also for our businesses that are out there, as well.

Thank you.

Senator Kaine.

Senator Kaine: Thank you, Madam Chair.

And I apologize for being late. Was at another subcommittee hearing, so I may ask questions that you've already covered. But, it's good to be with you, and thank you for your service.

I'm interested in the interface between the DOD requirements and commercial requirements in a very -- you know, complex commercial environments. Generally, the security requirements of the DOD exceed the commercial space, or will -- or, in many ways, is the commercial sector market develop the industry and some of the security ahead of the DOD mean?

Dr. Prabhakar: I'll take a stab at that. You know, if you peel apart what DOD needs, in terms of information security, cyber security in particular, we need everything that the commercial sector needs, because we use commercial networks and computers and systems for all of our operations, and we have cybersecurity needs for our very sophisticated electronics and computing that's embedded in every -- you know, every missile, every aircraft, every ship, et cetera. And so, I -- across DOD, I think we have the challenge of adopting, as quickly as we can, the leading

edge of commercial cybertechnologies, and we continue to press -- you know, the Department continues to press forward on that. Conversely, in some areas where we are able to drive cybersecurity research because of DOD's embedded computing needs, I think there are places where -- and, for example, in some of the DARPA programs, we have focused on this question of, Can you build a cyber retrofit, for example --

Senator Kaine: Yeah.

Dr. Prabhakar: -- for a system that goes on an unmanned aircraft? And we've just had some very good research success in that area. That's an example of research that I think at this point is leading-edge around the world. Eventually, I think it will become an important part of a better foundation of cybersecurity for DOD systems. But, it's the same technology that will also provide a secure way for the Internet of Things to grow. And, you know, the Internet of Things is either going to be awesome, if we can figure out security, or it's going to be a nightmare. And I think -- you know, I think that's an example of a technology area driven for DOD that we can also actually contribute to the broader set of --

Senator Kaine: Sort of -- it's a good segue to the follow up question I wanted to ask. So, if some of the particular requirements we have in the DOD space will really

be driven by our own research, then we obviously need to be robust in funding research. But, to the extent that some of it is going to be commercial capacity that we purchased, then that says something about acquisition and the acquisition workforce. As I deal with folks in the, kind of, private sector, they are quite concerned about, Is the acquisition workforce up to the job? They actually really kind of sympathize with an acquisition workforce. They feel like the DOD, and maybe the Federal, generally, acquisition workforce got hammered pretty hard by furloughs, sequesters, layoffs, and that that may have hurt the acquisition workforce expertise pretty significantly. And so, if we're talking about really cutting-edge, you know, technology to help us with this third offset strategy, and some of it we're going to be acquiring, that's going to put a lot on the shoulders of the acquisition workforce to make wise decisions. Do we have -- you know, DOD-wide, do we have the workforce we need to make the sophisticated acquisition decisions as we purchase these technologies?

Mr. Welby: Senator, across the -- enterprise, working for Under Secretary Kendall, we review, kind of, our workforce metrics continuously. We have a senior steering group that meets monthly, and we review it at the senior level quarterly, to ensure that we have -- that we are -- understand what's happening to the health of that workforce

-- hiring, retention, departures, the overall shape of the workforce. But, increasingly, the thing that concerns me is not numbers, but talent. And specific talent in areas like cybersecurity in areas like robotics --

Senator Kaine: Where competition is pretty tough --

Mr. Welby: Where --

Senator King: -- so other opportunities are out there.

Mr. Welby: I note that last week Google announced -- and I believe the number was 20-percent raise across the board for everybody at Google who had "cyber" in their title. Not that they were being recruited, but just as a preemptive retention bonus. You know, our folks haven't seen, kind of, a 20-percent number, you know, ever, right? And I don't think folks fully appreciate that, in some of the areas that were focused on -- artificial intelligence, the cutting-edge computer-science work in cyber, in synthetic biology, in a number of other areas -- we are getting great people because they love our mission, they love our capability. But, really, they're often giving up, kind of, integer multiples on compensation. And certainly over the course of their career, it becomes harder and harder, as folks try to get families, to think through how they can make that work.

I'm very appreciative for the great people who are working for us every day, but I worry about our ability to

compete for talent in the future. And it suggests we may have to think about other models for how we can recruit, retain, or engage those folks. If the government can't have them internal to our organization, how do we engage them outside? How do we ensure that we've got the right set of knowledge on our side of the table on the acquisition process? How do we have the right set of folks in our lab, thinking about the future for us? I think we're going to be in competition, not only for national security, but in the competition for talent, as our -- as the commercial opportunities grow, as our Nation's vibrant innovation sector on the commercial side competes with the Department of Defense for talent. We're now mining the same spaces, and we're going to have to be creative as we go forward.

Senator Kaine: Let me ask a question. It kind of goes in a different direction on the third offset strategy. So -- and it's really doctrinal or conceptual. Earlier defense strategies -- it's been easier for me to conceptualize how we integrate our allies into our strategies, you know, dealing with the Truman doctrine of the Cold War or even some of what we're doing right now, vis-a-vis engagements in Iraq and Syria. As we think about a third offset strategy that's heavily focused on novel technologies that are unique, swarm capacities, et cetera, how do we conceive of alliances and sharing of information? Or is the sharing of

information, by definition, going to jeopardize your edge in a way that we can't do it? I mean, and that's a pretty broad question, but I've been wondering how we think about alliances and partners in connection with a third offset strategy.

Mr. Welby: Just very quickly, for the sake of time. Allies and partners are going to be enormously important in almost everything we do. As we think about how we go to war, we always go with partners. And we do not see that changing in the future. Much of what we're doing is thinking about how we have the right kind of discussions so that they can contribute and help shape that future. And today we're also looking at our allies and partners as partners, no kidding, in terms of the technology development itself, and how we start to begin to engage early on in capturing their benefit, as well.

I want to give Will a second to this -- on this.

Dr. Roper: I'll be very brief. It's very important, in the near-term response in the offset, to realize that we have two advantages that go back to more of the human side of the equation. One, we've been a preferred partner in the world. And a lot of our allies and partners use the same equipment that we currently train with. We train with them on a routine yearly basis. It's a huge part of our readiness posture. So, as we start reimagining how we use

our systems, there's a great potential to bring in allies and partners, and have that cross-pollinate so that adversaries aren't just facing a U.S. -- a, you know, U.S. adversary, but they're facing a whole coalition approach.

Two is what you mentioned before. There's going to be commercial technology that's going to be cut into the mix alongside traditional military technology. Because it's commercially-based, it would be much more readily available to work on with allies and partners if we don't let exquisite requirements start pushing up what we try to get out of it, from a military capability. Cost is going to be a very important metric in the offset. It's not just red cost, it's going to be blue cost, as well. What are we spending, what are they spending? And then what do we think the refresh rate of that technology will be? So, if we're wise, we will try to find capabilities in the commercial world where we're getting good bang for the buck, and keep an eye, Is it something we can share with allies and partners? If we can, then our coalitions that we build up play for us and not against us.

Senator Tillis: Thank you, Madam Chair.

Dr. Prabhakar, I just -- I was going to comment, if Senator Manchin had been here. I think probably the biggest distinction that you're dealing with between, say, the service academies and some of the other institutions is the

nature of their research and investments that are being made by the Federal Government in the private sector. They create a different group of people that I assume you're collaborating with. So, I think I understand why there would be, necessarily, a different focus and different relationship with the service academies.

Dr. Prabhakar: Just a comment on that. If you look at all academic institutions broadly, of course there are many that focus on teaching and some that focus on research. And our natural partners for the research funding that we -- especially the basic research work that we're doing, tend to be those research universities rather than --

Senator Tillis: Yeah.

Dr. Prabhakar: -- those focused on --

Senator Tillis: Yeah.

Dr. Prabhakar: -- education, which is more where the academies have been. And that doesn't preclude -- there are, in fact, some very good things that we've done there. I just didn't want to leave the impression that that was a major focus --

Senator Tillis: Yeah.

Dr. Prabhakar: -- for us.

Senator Tillis: Yeah. And I under -- so, I just -- and I think -- I understood it; I just wanted to make that point.

And, Dr. Roper, and really for anyone on the panel, the -- and it -- when the Chair talked about "We're not really fighting tank-to-tank anymore," that's completely true. You know, our Air Force, our air capabilities will need to continue to evolve. And I think we can build and iterate on our offensive and defensive capabilities. And probably the same is true for the Navy. But, for the people on the ground, like the folks I have at Fort Bragg and Camp Lejeune, they're being deployed in very different ways. And I think Dr. Welby talked a little bit about the way that we will equip them, the way that they and the equipment and materials they're using could be semi-autonomous, tethered or loosely tethered, or untethered. I kind of understand how that would operate. But, at the end of the day, it's because we're going to have a dispersed group of smaller units on the field. So, the question then becomes, the -- some of -- many of your innovations are likely not to be these big, shiny ships and new missile systems that are going to be deployed on the battlefield, but they're going to be things that are very much connected to the humans and in the environments that we find ourselves fighting now. So, could you talk a little bit about that, and also talk about the research that you're doing that has less to do with offensive and defensive capabilities, but just pure-play force protection for the operators on the field?

Dr. Roper: Sure. Thanks, Senator Tillis.

It's -- there's going to be some, I think, amazing things that we'll be able to do with ground forces, given the commercial technology revolution that's going around us. So, interpersonalwise, we're all carrying around fairly sophisticated high-processing, low-weight electronics that are massively networked and are completely enabled by cloud-based services. The military analog of this is obvious. If we can smartly find a way to transition this over and be able to do secure processing, and not have cyber vulnerabilities be a bigger headache than they are, the enabling capability from the technology themselves. We are working very closely this year with the Army and with SOCOM, some of the folks in your neck of the woods at Fort Bragg, on trying to find the balance between using commercial technology on the battlefront. I think there's a lot of promise there. One example that I'd like to highlight is work that we're doing with the Marine Corps on big data and analytics. So, you can imagine that all of these distributed systems that are going to be spread out over the battlefield are going to be producing data. That data is going to be pooled in a disaggregated way, but eventually pooled centrally. Understanding it, being able to give commanders that leading edge of decision authority is going to be important.

So, the Marine Corps right now is doing experiments with us currently, today, in the Philippines at the Balikatan Exercise, pulling in lots of information that supports that exercise, and synthesizing it using commercially-based big-data tools, something very new for us, and it's new for them. But, taking advantage, as Secretary Welby mentioned, of experimentation and prototyping, especially when the core of the systems we're using are commercially based, is going to be a very prudent way for us to get out and get the human side of the technology alongside, you know, the technology side. So, I see a lot of promise, but we're going to have to move into more of a rapid test-it, modify-it, retest-it in order to stay on top.

Mr. Welby: Quickly. We often focus on those flashy pieces. We talk about tanks and missiles and aircraft. But, just last week, the Secretary announced the new Manufacturing Innovation Institute for Revolutionary Fibers and Textiles, a major initiative that's -- crosses five State initiatives, that incorporates work going on around the country, thinking about fibers in a fundamentally different way. As an Active component in fabrics that might have woven-in electronics, might be able to serve, not just as protective gear, but as part of an ensemble -- an active part of an ensemble to support warfighters, a kit, and with

enormous applications to first responders and to medicare care and to an enormous number -- another set of capabilities. We're not just thinking about how, you know, robots and new weapons kind of enable this future, but also thinking about how we make the individual warfighter more effective. And I think there's a lot happening in that space, be it augmented reality kind of capabilities, be it soldier-borne compute, be it novel textiles and rethinking what a uniform means, thinking about how folks can be more effective, distributed for survivability, and then massing for effect, even if they don't actually come together, but to be able to mass their effects. These are real opportunities to rethink the future of land combat. We're encouraging the Army and Marine Corps to help us think through that future in new ways.

Senator Tillis: Thank you.

Dr. Prabhakar: May I just tag onto these excellent comments?

The nature of ground conflict, of course, continues to change. And if you look at what's happening today and into the future, that environment is one in which we see -- if you watch the Russians, if you watch what's happening on the ground with ISIL, you see this mix of kinetic effects, but, of course, also cyber effects. You see the use of the information domain. And that used to mean dropping

pamphlets or saying things on the radio. Of course, now it's social media. You see a different kind of use of the electromagnetic spectrum and jamming that we've not seen before. And the integrated ability to bring all of that to bear is what our ground troops now will need to be able to deal with. And so, a lot of our work is really thinking about how -- for example, how do you enable a squad to not only survive in that environment, but actually exercise greater influence and have a larger footprint than it does today by leaping ahead of the kinds of things that are coming at us?

Dr. Roper: One last point, Senator. That goes back to where we've -- what we've touched on several times. The military that will be able to push the most amount of trust to the edge, assuming the enabling technology is there, is likely to win. It's an area where we have a significant advantage.

Senator Tillis: Thank you.

Senator Fischer: Thank you, Senator Tillis.

Senator Kaine, did you have other questions?

Senator Kaine: Just one.

Can you explain that last point you just made?

Dr. Roper: It's a important point. So, you know, in -- I think we envision --

Senator Kaine: And repeat it. It -- about the edge.

So, repeat that point.

Dr. Roper: So, as we push, you know, where -- there's always a desire, where you can, to do things in a centralized fashion. I want to have all the data flowing to the brain in the center, and then the commands will push out to the edge. As we discussed today, we're living in a complicated world. We're going to face cyber, we're going to face spectrum denial, we're going to face information operations, as Dr. Prabhakar mentioned. All of that is going to contest various nodes in that network. Data is not going to flow the way we want it to. So, the military that is able to have the most trust to interpret commanders' intent and the technology to allow them to back it up at the edge is going to have a significant advantage in the rapidity of their response. So, if we can move and enable that, we have an advantage over militaries who can't.

Well, when I go around and talk about with our operators, which is my great privilege to do so, and I contrast that with what I see in the rest of the world, I think we have an advantage in the level of trust in our chain of command. And if we put the technology in the hands of soldiers that have our trust, then we're already a step ahead of the game. And a lot of the technologies that you've heard discussed today are about trying to flow that enabling capability out to the edge of conflict, to the edge

of the battlefront.

Senator Kaine: Great. Thank you very much.

Thanks, Madam Chair.

Senator Cotton: Sorry. I was coming over from an Intelligence Committee meeting. But, I know it's been an interesting hearing, just based on the written testimony that was submitted.

Secretary Welby, I want to talk about DCGS-A. In your testimony, one of the areas you highlight are technologies and concepts that enable faster and better decisionmaking and coordinated operations at range and across the battlespace. Do you think the Department or the services should continue to develop major automated information systems?

Mr. Welby: Senator, I believe that major automated information systems, there are places where the Department needs to be developing military-unique capabilities that don't exist anywhere else. I think where the Department is leveraging capabilities that are available from the commercial sector, we should not be in the business, and should be leveraging commercial innovation to the greatest extent possible. We see this in areas such as electronic health records, where we've shifted our focus to leverage commercial to the greatest degree. We see it in some of our log systems, where we had those kind of capabilities. I

think we're seeing it increasingly in intelligence and data-fusion systems, where we can leverage commercial to a greater degree.

Senator Cotton: DCGS-A has been developed since the late 1990s, and it's been beset by cost overruns and schedule delays. Do you think this is one of those areas where we should perhaps move to commercial or private-sector solutions?

Mr. Welby: Senator, I'm not fully fluent in the Army's current approach to that. I know they are reconsidering their strategy, in terms of that program.

Senator Cotton: Dr. Roper, do you have a opinion on this matter?

Dr. Roper: On the DCGS-A, as a whole, no, Senator. I will say that, for the information tools that we're developing to leverage big data and analytics, we're relying heavily upon commercial tools, as well as those developed by our government DOD laboratories, as well as those developed by DARPA. I think developing architectures that enable as much of a rapid refresh of commercially-based tools would be wise, given the pace of development in the world.

Senator Cotton: An 80 or 85-percent solution would be acceptable today?

Dr. Roper: It is for our operators, sir.

Senator Cotton: I think it was Patton, maybe

MacArthur, who said, in a -- something that was quoted in Infantry Field Manual 7-8, that a good plan today is better than a perfect plan tomorrow.

Dr. Roper: To your point, Senator, the marines who are using our tools right now -- and I'm getting feedback from them each day -- we've never had this ability to coordinate on the information front, so they're learning, they're writing the training manual as we go. So, if we strive for exquisite solutions ahead of the operators' ability to use them to their fullest intent, we may have 100-percent solution that's actually clocking at 80 percent on the battlefield. So, we have to balance the technology leap as well as the operator leap.

Senator Cotton: Do you think it make -- would make sense to develop a program that had 120 different apps?

Dr. Roper: It's appealing, given how enabling that is for us in our personal lives. That's very similar to how the tool I referenced works. It's called a -- an Information Common Operation Picture, or ICOP, and it does work based on an app-based approach, where no one single piece of software developed, in most cases, by small businesses, provides operators precisely what they want. So, on the government side, we developed the integrating architecture and a display so that you can change out things behind the hood, but it looks the same way to operators on

their screen. Now, that's for one particular application for looking at large amounts of publicly available information and making sense of it. How well those extrapolate to bigger architectures, including warfighting architectures, is a question I'm not able to comment on well.

Senator Cotton: Would it surprise you that the project manager found that, of the 120 apps, commanders and soldiers used, on average, 5 of them?

Dr. Roper: I think it would, Senator.

Senator Cotton: And why is that?

Dr. Roper: Well, just seeing how many apps I use in my own life, we tend to find -- if it's useful, we tend to apply them personally. So, the reason for that is not one that I can comment on, but it does surprise me.

Senator Cotton: I mean, I'm sure, if we put a video game and an ESPN app on there, that soldiers would find a way to use those. But, if it's just the mission in front of them, I have to say I'm not terribly surprised that they're going for the simple route, since that's usually the best way to success in the Army.

I'm reminded of a story I heard once about Booker T. Washington when he was building his university. It may be apocryphal, but it's one of those stories that's too good to check, because it has an important lesson. That he built

the buildings, everything was ready to go, students were ready to report, and someone pointed out to him they didn't have sidewalks. And they said, "Are you going to build the sidewalks?" And he said, "One day I might." And about 6 weeks in, he took the engineers and the designers out and pointed out where all the grass was dead, and said, "Build the sidewalks there" rather than trying to force the students and the faculty to walk on sidewalks where he thought they should be designed and placed. I think that that probably could carry a good lesson for when we're designing this kind of system.

Thank you all for your testimony. And thank you for your answers to these questions. They're an important matter, and I'm sure the committee is going to be taking it up.

Senator Fischer: Thank you, Senator Cotton.

I'd like to once again thank the panel. This was a fascinating discussion. I thank you for your work. It's important work. As I said earlier, we've always given you good support with this committee because of the support that you give our warfighters.

Thank you.

We are adjourned.

[Whereupon, at 4:02 p.m., the hearing was adjourned.]