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HEARING

ON

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2022

AND

OVERSIGHT OF PREVIOUSLY AUTHORIZED PROGRAMS

BEFORE THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTEENTH CONGRESS

FIRST SESSION

SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES, AND INFORMATION SYSTEMS

ON

REVIEWING DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY STRATEGY, POLICY, AND PROGRAMS FOR FISCAL YEAR 2022: FOSTERING A ROBUST ECOSYSTEM FOR OUR TECHNOLOGICAL EDGE

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REVIEWING DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY STRATEGY, POLICY, AND PROGRAMS FOR FISCAL YEAR 2022: FOSTERING A ROBUST ECOSYSTEM FOR OUR TECHNOLOGICAL EDGE

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES, AND INFORMATION SYSTEMS,
Washington, DC, Thursday, May 20, 2021.

The subcommittee met, pursuant to call, at 12:04 p.m., in room 2118, Rayburn House Office Building, Hon. James Langevin (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. JAMES LANGEVIN, A REPRESENTATIVE FROM RHODE ISLAND, CHAIRMAN, SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES, AND INFORMATION SYSTEMS

Mr. LANGEVIN. I would like to welcome members who are joining today's hearing remotely.

Members who are joining remotely must be visible on screen for the purposes of identity verification, establishing and maintaining a quorum, participating in the proceeding, and voting.

Those members must continue to use the software platform's video function while in attendance, unless they experience connectivity issues or other technical problems that render them unable to participate on camera.

If a member experiences technical difficulties—okay, the microphone is now on? All right. Very good. So with that did you get the—okay. Very good.

I'm going to begin with the—just the technicals about the remote hearing and then we'll continue on.

I'd like to welcome members for joining today's joint hearing remotely. Members who are joining remotely must be visible on screen for the purposes of identity verification, establishing and maintaining a quorum, participating in the proceeding, and voting.

Those members must continue to use the software platform's video function while in attendance unless they experience connectivity issues or other technical problems that render them unable to participate on camera.

If a member experiences technical difficulties, they should contact the committee staff for assistance. The video of members' participation will be broadcast in the room and via the television, internet feeds.

Members participating remotely must seek recognition verbally and they are asked to mute their microphones when they are not

speaking. Members who are participating remotely are reminded to keep the software platform's video function on the entire time they're attending the proceeding.

Members may leave and rejoin the proceeding. If members depart for a short while for reasons other than joining a different proceeding, they should leave the video function on.

If members will be absent for a significant period or depart to join a different proceeding, they should exit the software platform entirely and then rejoin if they return.

Members may use the software platform's chat feature to communicate with staff regarding technical or logistical support issues only.

I've designated a committee staff member to, if necessary, mute unrecognized members' microphones and to cancel any inadvertent background noise that may disrupt the proceeding.

Finally, the chair recommends members—the chair reminds members of the committee that they're required to observe standards of courtesy and decorum during committee proceedings.

This requirement includes the responsibility to protect public safety and health, particularly, during a pandemic. Members, staff, and attendees are required to wear masks at all times in the hearing with the following exception.

A person who is attending this proceeding in person may remove his or her mask briefly following recognition by the chair for the purposes of speaking into a microphone. Any person who removes his or her mask for this purpose must replace it at the conclusion of his or her recognized remarks.

The chair expects all members, staff, and attendees to adhere to this requirement as a sign of respect for the health, safety, and well-being of others. The chair views the failure to adhere to this requirement as a serious breach of decorum.

So with the technical readings out of the way, we're going to get going with the hearing and with that, I'd like to welcome everyone to this hearing today on the Department of Defense's fiscal year 2022 strategy, policy, and programs for science and technology.

While we, unfortunately, do not yet have the President's budget request for this year, this hearing will provide an important opportunity to examine the Department's efforts to maintain the United States competitive technological edge in the face of great power competition.

I would like to thank Ranking Member Banks for working with me to organize this hearing and thank our witnesses for joining us.

And before us today we have Ms. Barbara McQuiston, Acting Under Secretary of Defense for Research and Engineering; Dr. Phillip Perconti, Deputy Assistant Secretary of the Army for Research and Technology; Ms. Joan "JJ" Johnson, Deputy Assistant Secretary of the Navy [for] Research, Development, Test, and Engineering; and Ms. Kristen Baldwin, Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics for Science, Technology, and Engineering.

So I welcome all of our witnesses and I thank you for your contributions to our national security. Following the open portion of the hearing, the subcommittee will reconvene in a closed classified members-only session in the CVC 200 with representatives from

DARPA [Defense Advanced Research Projects Agency] and the military services research entities.

In today's strategic environment, the United States historic military and economic competitive advantage is not guaranteed. We are no longer competing against technologically inferior adversaries.

Instead, we face persistent and dangerous challenges from highly capable and advanced great power competitors who seek to undermine the status quo of U.S. leadership and global power.

Maintaining U.S. dominance in all warfighting domains requires robust investment, innovation, and talent development across America's science and technology enterprise.

We must lay the groundwork today for the threats of tomorrow by investing in DOD [Department of Defense] science and technology programs across the research laboratories, academic institutions, and industry partners that collectively bring a whole-of-society approach to maintaining the United States technological edge.

While our witnesses cannot speak about specific funding levels today, I am interested to hear their perspectives on the future of the Department's S&T [science and technology] funding.

So the core of our technological edge is our early basic and applied research. This is the science that lays the foundation for cutting-edge technology 20 to 30 years down the road.

So we have seen with the COVID–19 pandemic just how critical this early research is. The messenger RNA, or mRNA, COVID vaccines that we have today were catalyzed by defense research investments 5 to 10 years ago, long before the current pandemic. Indeed, the first coronavirus vaccine to start human testing came from a DARPA investment in Moderna.

DARPA's ability to substantially contribute to our Nation's response to pandemics is the product of more than a half a century of DOD S&T funding. If we wait to invest in science only when crisis is upon us, then we are setting the Nation up for failure and we cannot allow that to happen.

So despite the importance of DOD-funded research and development, the Department's S&T budget buying power has effectively shrunk in the past decade. Cuts are often made to these important early research accounts to prioritize more near-term efforts in technology development.

Yet, our rivals are committed to concerted S&T funding, thinking it will undermine U.S. leadership. We cannot expect to compete with them if we keep shortchanging our research accounts.

I hope that the President's budget will reflect serious investments in S&T. Our men and women in uniform deserve nothing less.

Indeed, our greatest assets as a nation is our people. We must cultivate our science and technology workforce. We must promote STEAM [science, technology, engineering, art, and mathematics] education at early ages to expose individuals of all backgrounds to the world of science, engineering, and math in hopes that they will pursue an education and career in critical emerging technologies.

We must also train the existing workforce in machine learning and computer science, and change hiring authorities so that the Department can rapidly hire top STEAM talent.

We must also make it easier, not harder, for international researchers in our universities to stay in the United States. The committee has prioritized workforce development through the last several National Defense Authorization Acts and encourages the Department to continue to promote STEAM education; adequately fund DOD research laboratories; partner with academia, including Historically Black Colleges and Universities and Minority-Serving Institutions; and diversify the defense innovation base through partnerships with small businesses.

This will ensure that we have an S&T workforce and innovation base comprising the best talent that reflects the diversity of our Nation.

Bottom line, great power competition is also a race for talent. We cannot afford to lose this top talent to our adversaries, and I'm determined, and I know the subcommittee is determined, that we won't.

Further, the U.S. Government, academia, and the private sector must foster mutually beneficial relationships to encourage innovation within the Department of the Defense. We must remember that Silicon Valley got its name from government investments in research and development and participation with academic institutions, which in turn grew new technology and encouraged technological talent to spin out innovative companies to put their research into practice.

Then the Department bought the products of those new companies, which kept them alive to continue their work. Today, to support the transition of mostly academic research into a sustainable technology and across the "valley of death," the Department must figure out how to be a buyer of cutting-edge market products, even if just for research use in labs and academia at the moment.

Our national security technology enterprise must grow in accordance with our American values, those rooted in a free, open, and democratic society. We must develop and apply technology ethically, engage with our partners and allies in a free and open research environment, and promote a culture of innovation and risk taking.

The Department must lean forward and not be afraid to fail. I called it smart failure. When we learn from our failures, we can make progress.

Pushing boundaries, challenging bureaucracy, and expediting the development of critical defense technologies are key to remaining competitive and agile in an increasingly complex strategic environment.

So with that, I again want to thank our witnesses for their participation in today's hearing and their concerted focus on supporting the Department's S&T efforts.

I'll now turn to Ranking Member Banks for his opening remarks. Before I do that, I know that there's been a change in ranking members recently and I just want to thank Representative Stefanik for her years of collaboration and commitment to the subcommittee.

I know she's on to other responsibilities now, but she'll stay as a member of the subcommittee. But I thank her for extraordinary work and commitment and to leadership on this subcommittee. As

I said, I look forward to working with her as a member of the subcommittee.

And I welcome Mr. Banks as the new ranking member. You have big shoes to fill, Mr. Banks, but I know you're up to the challenge and I look forward to work with you as a partner and as we collaborate together on behalf of the country to effectively improve our national security.

I yield to the ranking member.

[The prepared statement of Mr. Langevin can be found in the Appendix on page 31.]

STATEMENT OF HON. JIM BANKS, A REPRESENTATIVE FROM INDIANA, RANKING MEMBER, SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES, AND INFORMATION SYSTEMS

Mr. BANKS. Thank you, Mr. Chairman, for that warm welcome. I'm excited about this new assignment and I intend to fill those big shoes and working with you, and you have an incredible reputation in having served here for four and a half years. It's really a privilege to serve alongside you in this endeavor.

It's my pleasure to join this subcommittee as the new ranking member. The work of this subcommittee is extremely important, as today's hearing highlights.

Our warfighting capabilities are contingent on our ability to modernize the Department of Defense and to recruit and equip our men and women in uniform with the most effective and secure technologies.

This mission cannot wait. Our adversaries and near-peers are focused on beating the U.S. using every tool available to them, legal or not, to modernize their militaries.

They are heavily investing in emerging technologies by pouring money into research and development, recruiting top scientists, and by stealing our intellectual property.

Whether it is artificial intelligence, quantum science, hypersonics, directed energy, biotechnology, 5G, or cyber, we must lean into developing, procuring, and deploying these technologies, and developing new ones in order to compete, but more importantly, to maintain our superiority.

The battlefield now spans boundaries and time. Our adversaries can use these emerging technologies to bring the theater to our shores, not just in the future but today.

We must—we would be foolish to ignore this threat. We must invest and plan for the short, mid, and long term in order to stay on the leading edge and defend and secure our homeland.

This means that we need the President's budget to prioritize science and technology, directing the Department to invest in the tools necessary for modern conflict and laying out a strategy to do so.

We must also enable the Department to get the innovations they need regardless of if they come from a large or small company. The men and women of our Armed Forces are key. We need to train and equip our troops to use these new technologies as well as retain and recruit the scientists that we need to develop it.

I look forward to working with Chairman Langevin, the Department, industry, and our troops to ensure that the United States maintains our superiority.

Thank you to our witnesses for being here today. I look forward to our discussion and working together to advance this mission.

Thank you once again. I yield back.

Mr. LANGEVIN. Thank you, Ranking Member Banks, and we will now turn it over to our witnesses for their opening statements, followed by a question and answer period.

Ms. McQuiston, you are now recognized.

STATEMENT OF BARBARA McQUISTON, ACTING UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING, OFFICE OF THE SECRETARY OF DEFENSE

Ms. MCQUISTON. Thank you.

Mr. LANGEVIN. Am I pronouncing your name correctly?

Ms. MCQUISTON. McQuiston, yes.

Mr. LANGEVIN. Okay. Very good.

Ms. MCQUISTON. Good afternoon, Chairman Langevin, Ranking Member Banks, and members of the subcommittee. Thank you for providing the opportunity to address you today.

Research and Engineering [R&E] serves as the chief technology officer for the Department of Defense with responsibility to ensure technology superiority for our forces.

We believe investments in science and technology, innovation, rapid modernization, experimentation, and fielding of technology today will pay dividends tomorrow.

As both Secretary Austin and Deputy Secretary Hicks have stated, the People's Republic of China is the pacing challenge. We must meet that challenge by investing in both science, technology, and fielding disruptive capabilities at both speed and scale.

In doing this, innovation will be our asymmetric advantage. The United States is leading the world in innovation, but other nations are moving quickly to close that gap. To maintain the advantage, DOD must identify technologies that will impact the battlefield and quickly develop those technologies into fieldable capabilities.

S&T investment now are tomorrow's solutions. As mentioned earlier and seeing from my previous time in government at DARPA, early research in vaccines led to the development of mRNA technology, enabling today's COVID–19 vaccines.

This shows the tremendous impact DOD investments achieve, not just for our military but for our Nation as a whole. To continue this track record of success and guarantee a strong tomorrow, DOD must reaffirm its commitment to science, technology, and innovation.

R&E is committed to meeting Secretary Austin's priorities in defending our Nation, taking care of people, and succeeding through teamwork.

R&E supports our scientists and laboratories, creating new frontiers with leading-edge science, developing the workforce, and expanding STEM education opportunities.

We will support opening career paths for our Nation's STEM workforce for both national security and economic security. DOD's commitment to basic research is also imperative.

R&E's Multidisciplinary University Research Initiatives program, MURI, funds basic research using multiyear university grants aimed at addressing DOD's hard problems and training its next generation of researchers.

We're looking for the best and the brightest from all disciplines. Programs like Minerva expand how DOD is seeking to engage with scholars from the social sciences to improve national defense. Programs like Viceroy, where partnerships with academic institutions teach cyber skills to DOD employees, helping to prepare the workforce for today and tomorrow's challenges.

For the United States to lead the world in creativity, science, and academics, we must expand DOD partnerships with universities, including HBCUs [Historically Black Colleges and Universities] and minority-serving institutes, and invest in strengthening these institutes.

We must do more to attract the best talent to DOD from everywhere. There's no doubt that a workforce that looks like all of America will better contribute to a stronger national defense.

Along with investing in basic research, cultivating diversity, and developing tomorrow's workforce, we're fostering an innovative culture through experimentation and testing.

Innovation is key to drive changes across the military. The recent creation of the Innovation Steering Group by Deputy Secretary Hicks and chaired by R&E will identify opportunities and gaps to facilitate innovation across the Department.

DOD can draw from innovation across from the services and capture innovation from all sectors of the economy. Small business, start-ups, and other disruptive entities offer significant contributions to the future of technology.

For this investment, the rate of return is high. For small business, we have a 22 to 1 return on investment. A recent study reported that over the previous 23 years, DOD's investment of $14.4 billion resulted in an economic impact of $347 billion to the U.S. economy with $28 billion of sales generated to the military.

To leverage this engine of innovation, DOD's Small Business and Technology Partnerships recently announced a list of 137 critical research topics to solicit solutions to DOD challenges.

DOD creates new frontiers in S&T and plays an important role maturing early-stage technology. De-risking technology in advanced manufacturing can have a multiplier effect attracting commercial investment, opening new markets, and moving technology forward.

DOD plays a strong role in shaping the future of technology, supporting rapid investment, offering enormous benefits to the warfighter, and creating significant benefits to both our national and economic security now and in the future.

Thank you very much.

[The prepared statement of Ms. McQuiston can be found in the Appendix on page 35.]

Mr. LANGEVIN. Thank you, Ms. McQuiston.

Dr. Perconti, you're now recognized.

STATEMENT OF DR. PHILIP PERCONTI, DEPUTY ASSISTANT SECRETARY OF THE ARMY FOR RESEARCH AND TECHNOLOGY, DEPARTMENT OF THE ARMY

Dr. PERCONTI. Yes. Chairman Langevin, Ranking Member Banks, distinguished members of the subcommittee, thank you for your continued support and for this opportunity to discuss Army science and technology.

The 17 Army labs and centers spearheaded by the Army Futures Command, AFC, are working with academia and industry to develop new technology for near- and mid-term modernization and performing exciting new research to discover and unlock knowledge that will enable yet-to-be-imagined warfighting capabilities for the far term.

We're transforming the Army S&T business model. We're moving away from walled silos of excellence to a model that emphasizes the importance of early collaboration and frequent communication across the enterprise.

Under the joint leadership of the Assistant Secretary of the Army for Acquisition, Logistics and Technology, and the commanding general of AFC, we are collaborating in unprecedented ways.

For example, the AFC's Team Ignite initiative in Army scientists and engineers are changing the way warfighting concepts and requirements are envisioned, which, in turn, are shaping longer term research projects and goals.

Using competitively awarded cooperative research programs, we're maximizing the exposure of academic and industrial partners to the requirements and acquisition communities as soon as possible, driving innovation through increased understanding.

Army scientists and engineers are working closely with the best and brightest from across the Nation as early as possible in the discovery and innovation cycle.

For example, the AFC Artificial Intelligence Center, located at Carnegie Mellon University's National Robotics Research Center, allows university and Army personnel to work side by side to address Army challenges in AI [artificial intelligence] and autonomy.

America's strength is derived from its ability to bring together a diverse group of people with their thoughts and their ideas. The Army simply cannot accomplish its mission without the skills and contributions derived from providing access to all Americans.

We use our basic research and our small business innovative research portfolios to the fullest extent possible to facilitate such access.

For the Historically Black Colleges and Universities and the Minority-Serving Institution communities, we have started two new initiatives to expand research capabilities and build lasting partnerships—a focused prize competition for students and faculty, and a faculty immersion program.

Likewise, we're reshaping the Army's interaction with non-traditional small businesses using SBIR [Small Business Innovation Research] and prize authorities to simplify the process. Recent SBIR topics has seen a tenfold increase in submissions, some with up to 200 firms per topic.

Thank you in advance for your continued support of the SBIR program.

As the Army Chief Scientist, I work very closely with AFC to build a balanced science and technology portfolio. Our portfolio supports the S&T needed for signature modernization priorities while simultaneously supporting research for fundamental long-term change by ensuring that at least 25 percent are applied research and advanced technology development and 100 percent of our basic research resources go to such projects.

Thank you for your continued support of direct hiring, innovative research, and lab revitalization authorities. These congressionally provided special authorities are heavily relied upon by Army labs to build an S&T workforce that is diverse, competent, and highly educated, and to maintain world-class research facilities and equipment.

For example, last year, our labs brought on 600 civilian employees—that's 58 percent of our scientists and engineer hires—using direct hire authority.

Also, last year the Army started 82 projects for laboratory revitalization and recapitalization. This $64 million investment was 45 percent of the Army's total under the section 2363 authority.

Projects with greater scope are needed, but the $6 million cost limitation in section 2805(d) for laboratory revitalization hinders our ability to support them. An increase in this limitation should be considered.

Army S&T is strongly supported by the Army senior leadership, the Office of the Secretary of Defense, and Congress. So far, the Army continues to hold the S&T budget top line at zero percent real growth.

I, for one, hope this trend continues, and I am very grateful for this subcommittee's continued support. Predictable and consistent funding is absolutely essential for the Army to achieve persistent modernization, and science and technology is modernization's foundation.

Thank you, and I look forward to your questions.

[The prepared statement of Dr. Perconti can be found in the Appendix on page 46.]

Mr. LANGEVIN. Thank you, Dr. Perconti.

Ms. Johnson, you are now recognized to summarize your statement.

STATEMENT OF JOAN "JJ" JOHNSON, DEPUTY ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH, DEVELOPMENT, TEST AND ENGINEERING, DEPARTMENT OF THE NAVY

Ms. JOHNSON. Chairman Langevin, Ranking Member Banks, and distinguished members of the Cyber, Innovative Technologies, and Information Systems Subcommittee, good afternoon and thank you for the opportunity to address the science and technology investment strategy of the Department of the Navy and the Naval Research and Development Establishment.

The Department of the Navy wholeheartedly thanks the Members of Congress for the authorities granted for workforce, mission execution, and capability development and delivery.

These authorities have been particularly beneficial to the Department of the Navy, enabling us to recruit and build a diverse workforce of mission-focused experts, to accelerate technology develop-

ment, and to apply innovative methods for effective management and mission execution at our warfare centers and laboratories.

The Department of the Navy has widened membership of the Naval Research and Development Establishment and expanded the network of innovation organizations both to increase collaboration and to accelerate technological innovation.

In addition to the Office of Naval Research, the Naval Research Laboratory, the Marine Corps Warfighting Laboratory and our 15 warfare centers, the Naval R&D Establishment also includes 5 university affiliated research centers, federally funded research and development centers performing naval work, and the Naval Postgraduate School.

Additionally, through NavalX's 15 Tech Bridges, the Department of the Navy is growing a geographically broad network of partners comprised of local industry, academia, small business, and other government entities focused on delivering solutions to key operational problems and service needs.

The Department of the Navy's ongoing investment in people, tools, technology, and infrastructure enables continuous learning, collaboration, agility, and cutting-edge capability, and ensures the preservation of national security and the resilience of future naval power.

I welcome you to visit our warfare centers, laboratories, and academic partners around the country to see firsthand the capability and capacity of the Naval R&D Establishment.

I'm honored to have the opportunity to testify before you and look forward to your questions.

Thank you.

[The prepared statement of Ms. Johnson can be found in the Appendix on page 56.]

Mr. LANGEVIN. Thank you, Ms. Johnson.

Ms. Kristen Baldwin, you are now recognized for your statement.

STATEMENT OF KRISTEN J. BALDWIN, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE FOR SCIENCE, TECHNOLOGY, AND ENGINEERING, DEPARTMENT OF THE AIR FORCE

Ms. BALDWIN. Chairman Langevin, Ranking Member Banks, and distinguished members of the subcommittee, thank you for the opportunity to provide testimony on the implementation of the Department of the Air Force science and technology strategy and our continued efforts to respond to the warfighter faster, while simultaneously developing the future force.

The Department of the Air Force has fully embraced the National Defense Strategy objectives. Our Nation continues to face a complex set of current and future security challenges, and rapid proliferation of global technology means the speed at which we change must increase.

The Air Force and Space Force must be ready to compete, deter, and win. The Department of the Air Force S&T portfolio provides broad-based enabling and enduring investments addressing near-, mid-, and far-term capabilities and a focused transformational component that matures game-changing technologies for transition.

We have established a Transformational Capabilities Office to lead this part of the portfolio, fueled by emergent technology, com-

petitive business practices, and executed with urgency and risk acceptance.

Within the transformational portfolio are a select number of programs designated as Vanguards. Designed from the start as collaborative teams from S&T, acquisition, operations, and test communities, Vanguards couple multiple budget activities to bridge the gap between S&T and acquisition.

Further transformational opportunities exist in the space domain. Though we have long recognized the importance of space superiority, the Air Force Research Laboratory [AFRL] has taken new steps to demonstrate its commitment to both the Air Force and the Space Force as independent services.

AFRL remains united as one lab supporting two services. This will enable problem solving across multiple domains, multiple disciplines, and cross-cutting solutions.

The Department of the Air Force continues to expand and strengthen partnerships with universities, industry, and other government organizations. We leverage these resources as well as talent, and have both bolstered our relationship with non-traditional industry.

Since partnering AFWERX with our Small Business Innovation Research Center of Excellence, we have awarded over 2,000 contracts worth $700 million to 1,400 small businesses, with over 75 percent of these being new partners to the Air Force.

Our SBIR contracts are also attracting matching funds, and performers are receiving follow-on investments at a ratio of $5 for every SBIR dollar that we invest.

Competition for world-class talent requires agile processes to recruit, hire, and retain personnel. We make great use of the authorities Congress has provided to the S&T community. In particular, direct hiring authority and enhanced pay authority allow accelerated hiring and use of executive recruitment firms for hard-to-fill positions.

We have been able to fill over 20 leadership positions with top-notch talent in cutting-edge areas including communications and networking, modeling and simulation, microelectronics, data analytics, and autonomy.

Every day we seek opportunities to achieve future operational dominance through investment in our scientific priorities, including artificial intelligence, biotechnology, cyber, quantum, microelectronics, hypersonics, and others.

Technology horizon scanning enables us to strategically invest and build complementary efforts with our partners. We foster and value partnerships in manufacturing technology as well.

Domestic producibility and human capital to engineer and integrate technologies is critical to delivering modernized capabilities.

The Department of the Air Force continues to push the boundaries of modern technology while improving the science for tomorrow. Our digital transformation strategy is adopting technology into acquisition practice as well.

Thank you for your strong support of the Air Force and Space Force science and technology, the authorities that you've provided, and this opportunity to testify.

[The prepared statement of Ms. Baldwin can be found in the Appendix on page 68.]

Mr. LANGEVIN. Thank you, Ms. Baldwin.

We will now turn to member questions. I'll recognize myself and then turn to the ranking member.

Let me start, if I could, with Ms. McQuiston. Congress' goal for the breakup of the Under Secretary of Defense for Acquisition, Technology, and Logistics, or ATL, was to create an Under Secretary of Research and Engineering that would be the Department's science and technology visionary and the one with the time and the ability to look past the horizon into the future.

So, Ms. McQuiston, do you think that we are achieving this goal? Why or why not?

Ms. MCQUISTON. First of all, thank you very much for your support for R&E.

I think it's incredibly important to have a chief technology officer, to have science and technology right at the table with all the strategic decisions that are being made and feeding into the entire DOD process.

So right now, I believe that we are working very hard to make sure that that is happening. With the support of the Secretary and the Deputy Secretary, science and technology have a strong voice and a strong action and responsibility within the Department of Defense.

Mr. LANGEVIN. Thank you.

And likewise then, Ms. McQuiston, I want to talk to NDS [National Defense Strategy], the tech annex.

In its final report, the National Security Commission on AI made a case that to maintain military technological superiority, the DOD must have an integrated technology strategy that prioritizes resources for critical capability, enabling technologies to solve the operational challenges outlined in the National Defense Strategy, and they suggest that such a strategy should be realized as a technology annex to the NDS.

So I wanted to ask you, would a technology annex help the Under Secretary for Defense for Research and Engineering work with the services to focus the Department's attention and efforts on next-generation science and technologies?

Ms. MCQUISTON. Next-generation science and technologies are going to be incredibly important to lead innovation with the warfighter and modernization.

We need to actually move ahead on that very quickly in order to rapidly develop and insert technology within the services to the warfighter.

Having a technology annex would be able to, again, emphasize the fact that science and technology plays that critical role.

Mr. LANGEVIN. Thank you.

Next, I wanted to ask of you, Ms. McQuiston, or anyone that would like to also chime in, we hear often of the "valley of death," the inability to scale quickly, rapidly innovate, and to be agile in our research and fielding of capabilities.

How do you believe the planning, programming, budgeting, and execution process should be changed to encourage more iteration

and innovation? Is it time for a larger look at the budgeting process?

Ms. MCQUISTON. Well, we have just kicked off, as I mentioned before, with Deputy Secretary Hicks and chaired by R&E, the Innovation Steering Group, and I'm looking for opportunities to take success cases and cases where we failed at innovation and fielding technology and moving science forward, and also cases where things are very challenging so that we can identify those gaps of opportunity and then address them across the organization.

So people, process, and technology is going to be what we're looking at for inserting innovation across the board. I do believe that there is already sort of the culture and the mind-set realizing that technology and—can have its own sort of tailored approach to how you need to look at acquisition.

So software, for instance, being more agile and being able to have adaptation and development for quick insertion would require looking at the—how you finance that and how you move the program forward.

So that would be a very different scenario than hypersonics as far as how you would structure the program. But it's important to be thinking about these things from day one and to actually look at what process and tailoring these processes to that activity, and I know there's probably a lot of opportunity. We're working within the—currently the flexibilities that we have been given and we appreciate that.

But I'm sure as we identify more opportunities we will actually communicate that, going forward. And I will defer to any of my sister services here if they have any examples they'd like to bring up.

Dr. PERCONTI. Well, sir, I think one question that I would really like consideration for is having, as part of the process——

Mr. LANGEVIN. Can you move the microphone closer?

Dr. PERCONTI. Okay. Sorry.

Having as part of the process the ability to do year of execution and, perhaps, year of execution minus one, resources that could be leaned toward or put into innovation rather than having to deal with a very long cycle time of 2 years for planning and programming, et cetera.

It would be wonderful to have more flexibility, particularly within the laboratories, to be able to quickly ramp up on ideas and technology that are important to us.

When I was the Army Research Laboratory director, we knew we had to start up and ramp up, critically, 5 years before the program was actually put into the budget.

The way we did it was through 2363 funding, my director's ability to manage year of execution research. That enabled us to jumpstart it. It would be very, very interesting to be able to have a larger amount of resources that could go to that.

Of course, the issue is always if you're trying to do something year of execution wise to make sure that Congress is well informed of where we're going and what we're doing with those resources.

So I think you also have to add more reporting, perhaps quarterly or otherwise, to come back to Congress and describe to you where we're going and what—how our priorities are changing sooner rather than later.

Mr. LANGEVIN. Very good. Thank you.

Ms. BALDWIN. If I can just add a few comments on to my colleague, Dr. Perconti.

Mr. LANGEVIN. Yeah. Microphone.

Ms. BALDWIN. As—just to add on a few points to what Dr. Perconti said, you know, time is of the essence when you're thinking about innovation. We would agree. I would agree that a study of the planning, program, budgeting, and execution system is warranted.

We have done so much to study acquisition procedures, procedures in our S&T, to try to make change and accelerate change. Flexibility, not only within the year of execution but across different budget activities and types.

What we're finding in the Air Force is as we try to cross the valley of—bridge the valley between technology and acquisition, it really benefits greatly if you can partner and collaborate early from the get-go between technologists as well as production entities and sustainment activities, all separate budget accounts.

And so flexibility to move and partner with budget accounts is of great importance. The ability to make shifts and, perhaps, to divest as we understand and identify risk and seek to move on is also—is also very important, and I think joint—if there's more opportunities to incentivize joint activities would be of great interest.

Thank you.

Mr. LANGEVIN. Thank you.

Ms. JOHNSON. Thank you, Mr. Chairman.

Just to add on to my colleagues' comments, maybe less about the the PPBE [planning, programming, budgeting, and execution], but some of our flexibilities would include, I believe, more opportunities as we're working with small business and non-traditional partners to create, I would say, small experimentation environments where we can very rapidly bring in modeling and sim [simulation] environments, other technologies, and demonstrate operational relevance at a fairly small scale.

I think that can demonstrate some early capability, which will, again, tighten that connection between the technology community and the resourcing community.

So I believe that part of the investment is to create a sandbox, if you will, where we're able to vet technologies from non-traditional and small companies as well as our own at a very rapid pace.

Thank you.

Mr. LANGEVIN. Thank you. And my last question—then I'll turn to the ranking member—I want to talk about the workforce.

In section 229 of the fiscal year 2020 NDAA [National Defense Authorization Act], Congress directed the Under Secretary of Defense for Research and Engineering to assess, diversify, and strengthen the research and engineering workforce of the Department.

With your experience in both the private and government sides of the science and technology arena, and this is directed to Ms. McQuiston, can you tell us about your perspective on how the Department is doing in nurturing a diverse and inclusive S&T workforce, aspects that are vital to producing novelty and innovation?

And what must the Department do to strengthen its workforce so that it can face the challenges coming over the horizon and when will we be receiving the Department's section 229 report with your implementation plan?

Ms. MCQUISTON. Yes, I would say that there is a lot more work that needs to be done, especially in STEM and special science education and in recruitment of diversity for the workforce.

So we need to enhance civics education and we need to diversify our workforce within Research and Engineering. So, again, looking at what we have from the sections 234 and 229, both a pilot program on enhanced civics education, that report is due out the first year after the full first year of circulation, so that one will come a while later.

But 229 is—the plan is due out August 31st of this year, and 252, the master plan for RDTE [research, development, test, and evaluation] infrastructure, is due out June 30th.

So at this point in time, those are heading for that timeline, and then we're reviewing the National Security Commission on Artificial Intelligence, and so we're looking at that extensive report and many recommendations it made and as—and putting it into the National Defense Strategy and addressing those challenges.

But we have got a lot of work ahead of us.

Mr. LANGEVIN. You do. You've got a lot of work ahead and this is going to be a priority for the subcommittee. We really do need to strengthen and diversify our workforce. Again, it's all about the people.

We can have really great technologies and development in the world. But without the people, we're going to be—we're going to be challenged.

Ms. MCQUISTON. And from the standpoint of looking at, you know, government and recruiting talent, we need more emphasis within universities and recruitment opportunities and research within the laboratories, and then we also need workforce incentives to create opportunities for that workforce and be able to develop it for the long term for government service and defense service.

Mr. LANGEVIN. Very good. Thank you very much.

I yield to the ranking member for questions.

Mr. BANKS. Thank you, Mr. Chairman.

Ms. McQuiston, what is the Department—the Department's strategy and the Biden administration's strategy to engage with smaller start-up companies to foster greater innovation?

Ms. MCQUISTON. Oh, we have supported the SBIR program, which has been quite long-lasting and quite good, and we would like to continue the SBIR, STTR [Small Business Technology Transfer] program.

But we're looking at innovation relative to a variety of new companies that we want to work with. So we have the innovation centers that are working on fielding—DIU, the Defense Innovation Unit, is working directly with start-up companies and new technologies to field and demonstrate the technology for the services.

I think we should continue with that innovation sort of mind-set, and being able to have a commercial mode of operation so that we can demonstrate technology and very quickly adapt it to fieldable technology.

We want to increase the exposure of companies that are not normal traditional DOD providers so that we can capture the new ideas.

But to do that we have to work at a commercial pace. You know, oftentimes, like we were saying before, government timelines—you know, the cost of time is huge.

You can't take a small start-up company and give them—you know, leave them alone for months and expect to capture that technology for the services in a timely way.

We need to really keep our pace up and our support up with the company so that we can capture the technology for our national and economic security.

Mr. BANKS. So that sounds great, and part of our job is to hold you accountable for making all of those things happen.

But is there a pivot in there somewhere? Is there something different that we're doing—that we haven't done before? Or is there a change in focus, a new plan underway to do better?

I mean, it's my sense and the sense of many that we have fallen behind. So how are we—how are we going to catch up?

Ms. MCQUISTON. And as I mentioned before, in the Innovation Steering Group, we're actually capturing where the sort of non-traditional aspects of success have been and then looking at identifying the gaps of opportunities so that we can roll it forward throughout the agency.

But it is a cultural mind-set that also has to change, so processes and people and actually opening up the discussion so that we can capitalize and become a much more fluid and dynamic organization.

Mr. BANKS. I appreciate that. Have you read Representative Moulton and I's Future of Defense Task Force report that was published last year?

Ms. MCQUISTON. I apologize. I have not seen that yet.

Mr. BANKS. We'll get you a copy of it.

Ms. MCQUISTON. Thank you. I appreciate that.

Mr. BANKS. Because we spent the better part of all of 2020 digging into exactly this subject and published a—the rare unicorn on Capitol Hill, a bipartisan—totally bipartisan effort about ways that we could foster greater innovation in the defense space, and it's something that we'd like to come and present to you and talk more about it.

Ms. MCQUISTON. I actually would be very open to that and would look forward to it.

Mr. BANKS. I'd like to talk with the rest of you about DIU and some of your efforts within each of the branches, and I'll start with the Navy because that's where I like to—as a Navy guy that's who I'll start with.

So, Ms. Johnson, what is the DIU doing for you and how does the DIU interact with NavalX? Is it working or where can we improve that bureaucratic structure?

Ms. JOHNSON. Ranking Member Banks, thanks for the question.

So the Navy right now—as an example, the Navy's got 46 commercial contracts for prototypes with DIU. So we are working on, I would say, what's really valuable for us is that DIU is connecting the Department of the Navy with, again, the commercial sector, in

particular, and some non-traditional partners who may have already advanced technologies and they're ahead of us. So we can lift and leverage rather than starting from scratch.

NavalX and the Tech Bridges are relatively new, but they are advancing quickly. So those connectors, NavalX and DIU, from my perspective, are starting to become and should become stronger partners because they—I'd say they have somewhat similar goals in terms of getting to other parts of the commercial sector and making it much easier for those companies and those businesses to do business with the Navy.

So we're continuing to press with DIU. Again, we have got about a 70 percent increase in terms of our contracts with DIU over the prior year.

So we're pressing and we're making those connections with NavalX. So I'd say we're still in somewhat nascent stages, but we are making forward progress.

Mr. BANKS. That sounds pretty good. Sounds like good progress. How about the Air Force?

Ms. BALDWIN. I think in two ways. We have Air Force projects directly with DIU and that's been terrific, and some in the areas of cyber and we have also been successful in transitioning some space technology efforts with DIU but also between our AFWERX and now, more recently, just announced last December stood up a SpaceWERX entity.

It becomes very important that we can communicate very regularly because we are all reaching out to a common, you know, commercial and maybe venture—you know, small business world.

And so we meet—our AFWERX and SpaceWERX team meets regularly not only with DIU but also with NavalX and with Army Future Center and the others to really—and that's something that we want to continue to improve that and exchange data.

You know, it takes time to make sure that we have all of the proposals and the awareness and we're not bidding on the same thing. That's what we have got to make sure that we don't do.

We don't want to do duplication. We want to be very complementary. So we're making excellent strides, and that's where we're going to continue to grow.

Mr. BANKS. Good. So if someone asks you, why do we need AFWERX if we have DIU, how would you—how would you answer that?

Ms. BALDWIN. So DIU has a budget and a—sort of a capped budget and they're out to partner with the particular services. AFWERX is a way to leverage our Small Business Innovative Research programs. So that's one example of a partnership.

AFWERX also is launching AFWERX Prime programs, and so what it is, is there's sort of an opportunity to grow and mature like sort of in the SBIR program Phase I, Phase II, and then Phase III if you get follow-on.

Now we have added through AFWERX a Prime program where we actually can partner with emerging commercial industry base that are—that are just burgeoning sectors but with—if there's a dual-use opportunity, if we can leverage a little bit, invest, and then they can invest with us, there's a real opportunity for growth,

not only in capability for the warfighter but in our domestic industry base.

Mr. BANKS. Before I move to the Army, how are things going at Kessel Run?

Ms. BALDWIN. I'm sorry? For the——

Mr. BANKS. Before I move to the Army, how are things going at Kessel Run?

Ms. BALDWIN. Excellent. So our implementation of software, DevSecOps and Agile practices, is a prime part of our digital transformation strategy that I mentioned.

We have grown our software factories over the last just small number of years. We now have 16. They're coordinated by our Platform One DevSecOps program.

It is now the DOD enterprise capability for DevSecOps and we also are seeing industry partners now making use of this government capability enterprise software development environment.

So that Kessel Run activity is just growing and expanding just the way it should and we now have over a hundred programs engaged in DevSecOps and Agile software programming, you know, through this Platform One and over 700,000 end users.

So it's going very well. Thank you.

Mr. BANKS. You know, I'm often confused by the Army in a lot of ways, but is the equivalent of NavalX and AFWERX Army's Future Command—Futures Command, or is there a different apparatus that would be the equivalent?

Dr. PERCONTI. So the Army Futures Command is a very large command. There is a small subsection called the Army Applications Laboratory, which is a direct report to the CG [commanding general] of AFC General Murray, and under the Army Applications Lab that's the big, I would say, initiative AFC has to get after non-traditional vendors.

So there's been a reasonable amount of interaction between DIU and the Army Applications Lab, particularly with the sharing of databases of non-traditional partners.

And, you know, there are—there are problem sets that the Army Applications Lab [AAL] is attacking that are, you know, more near term within 1 to 2 years, of course, but are very, very ripe for innovation using non-traditional activities.

We just started a big initiative with non-traditionals for autoloaders for our new howitzer that's coming online from ammunition.

So that is a big activity coming out of the AAL with interaction from DIU to get hold of those non-traditional vendors so they can be exposed to opportunities we have.

But it's a—it's a new idea. You know, AFC is only 3 years old now. So this idea of having a central innovation laboratory, if you will, very close to the headquarters is something we are really trying to experiment with and build up.

Mr. BANKS. Thank you. I yield back.

Mr. LANGEVIN. Thank you, Ranking Member.

Mr. Larsen is now recognized.

Mr. LARSEN. Thank you, Mr. Chair.

So the first question I have is for Ms. McQuiston. There's currently a pause in the Defense Federal Advisory Committee on

boards including for Defense Science Board and Defense Innovation Board during a 6-month review.

These are really important boards. What's your recommendation for the vision of these two boards going forward, and when will that pause end?

Microphone, please.

Ms. MCQUISTON. I've always appreciated the Defense Science Board in the past, and we used them quite a bit at DARPA. So I look forward to seeing it going forward in some portion to feed into our strategic——

Mr. LARSEN. In what role—well, what role will you play—do you play in ending the pause?

Ms. MCQUISTON. R&E will be looking at what we need to do to answer any questions or work on the strategy of reconstituting the boards. So we will be actively engaged in advocating that.

Mr. LARSEN. And what questions will you be asked?

Ms. MCQUISTON. I want to make sure that we understand strategically how the boards will operate and be fed in and how quickly they can be reconstituted.

Mr. LARSEN. For all of you—I only got 5 minutes. This not a problem, not a complaint. I'm just—I'm telling you I got 5 minutes as a not chair and not ranking.

So really quick, I need you to just address the fiscal year 2020 NDAA, which directs the Secretary to develop an infrastructure master plan.

And can you quickly give me—I'll start here at the Air Force and work down—just the state of the research labs and what you need to ensure lab and test facility infrastructure.

Air Force.

Ms. BALDWIN. Yes. As you are probably aware, the state of our infrastructure, our bases, are, on average, 50 years old and so—and they—and revitalization of our infrastructure laboratory is essential, not the least—for the least reason for it to attract and retain our world-class talent.

And so we regularly compete for MILCON [military construction] projects. The MILCON process requires us to compete across an entire base. On average, it takes about 10 years to receive a MILCON project.

So in the interim, we are to—for an S&T project to be approved and then implemented—so in the interim we use the FLEX–4 authority that was granted that allows us to provide—do minor MILCON projects to really focus on improving our lab infrastructure.

And as my colleague mentioned in his opening remarks, we are very supportive of if their—the ceiling, which is currently $6 million per project, could be raised. We would be very supportive of that.

Mr. LARSEN. All right. That's good.

Navy. Thank you. Sorry.

Ms. JOHNSON. Thank you. Actually, my answers would be consistent with Ms. Baldwin's. So I have nothing to add.

Mr. LARSEN. No, I'm giving you a chance.

Ms. JOHNSON. Again, we—it's the MINCON [minor military construction], we have already talked about raising that authority—is

going to be critical for us. And, of course, 2363 has been great in terms of infrastructure as one of the four areas we can invest in.

So nothing further to add, sir.

Mr. LARSEN. All right.

Army.

Dr. PERCONTI. Yes, sir. So I'm a big advocate for my colleagues' comments on raising the limit on 2805(d). I'll give you a number. It's $6 million now. I think it should go to $12 million. I absolutely believe that's important.

There's been some discussion about, well, why can't you take MILCON, using other authorities, up to $150 million, I think—why can't you use those resources and put it in your RDT&E budgets to do so.

And for me, as a former lab director, that's a big issue because if I have to take money out of my programs to fund my infrastructure, then I'm doing less research. Then I'm not looking forward. I'm really focused on building infrastructure.

So I would much rather see us take advantage of these other authorities, like the 2363 initiative, like the raise in the ceiling of 2805(d). That would be very, very helpful.

Mr. LARSEN. All right.

Ms. McQuiston, just a curve ball a little bit on this same set of issues.

When will be—when will we be receiving the Department's section 252 report with the master plan?

Ms. MCQUISTON. The 252 report right now is due June 30th. So that's—I believe we're on target for that.

Mr. LARSEN. Okay, it's due June 30th. So you're telling me that we will——

Ms. MCQUISTON. We'll submit the plan no later than June 30th. That's what I have from the detail that I looked into.

Mr. LARSEN. Okay. All right. That's great. A lot of times those deadlines that we give the Pentagon come and go.

Ms. MCQUISTON. Yeah. I'm sure——

Mr. LARSEN. Does it say—does it say 2021?

Ms. MCQUISTON. 2021.

Mr. LARSEN. Okay. All right.

Ms. MCQUISTON. I got it. And if there's any concern, I will get right back to you on that.

Mr. LARSEN. I appreciate that. Thank you.

Yield back.

Mr. LANGEVIN. Thank you, Mr. Larsen.

Mrs. Bice is now recognized for 5 minutes.

Mrs. BICE. Thank you, Mr. Chairman.

My first question—thank you for the witnesses being here—is the Department increasingly engaging with universities beyond basic research and more into applied research, such as through the UARC [university affiliated research center] programs?

Ms. MCQUISTON. I'm sorry, could you ask that again? I was a little confused on this question.

Mrs. BICE. Sure. Are you all—is the Department engaging with universities beyond basic research and more into applied research using the UARCs, the university affiliated research centers?

Ms. JOHNSON. I'll go ahead. The answer is yes. In fact, with the UARCs not only are we engaging in applied research, but we're also actually engaging with UARCs for prototyping and rapid development within the Department of the Navy.

Mrs. BICE. If you could, if the Air Force and Army could also elaborate on that.

Ms. BALDWIN. We have made a great use of partnering with universities. We engage with UARCs from across the Department of Defense that are in existence, and then also, more frequently now we are—we are creating partnerships with universities through consortium and other vehicles such as education partner agreements.

We—for an example of our recent university consortium is with Space. We have got over 60 universities engaged and we will be working with them on—in awarding a number of grants this summer, and we're also working with these—with the University Partnership Program to help to—for training and education for the future Space Force guardians.

Dr. PERCONTI. For the Army, each of our UARCs have budget in the applied research category, you know, 6.2. So that is an annual thing for us.

Also, importantly, we have expanded across the Nation, really, into university engineering centers where focused research is being done not necessarily by professors but by research staff within those engineering centers.

So it's very, very important for us to take advantage of that. We actually view that as a major recruiting tool for us because if you can—if you can hook up a professor from a department with a research staff at an engineering center with employees or students who want to work there and be together, then they understand what your Army problems are.

They understand what opportunities there are, and they absolutely have an opportunity to get some funding for research and for study. So that combination of professor, research staff, government employee, and potential student hires has been very, very powerful.

Mrs. BICE. Thank you.

Ms. MCQUISTON. I'll add that for R&E—and I apologize for not hearing the question correctly—we are looking at university hubs and we have actually pulled several together in hypersonics that are also looking at applied aerodynamics.

We have an AI center, the participation of Carnegie Mellon, and autonomy in Texas A&M. But I believe that we can broaden that—broaden that participation as well with HBCUs and minority institutes and actually creating more of these virtual centers, both for cyber and other applied technologies. I think that should be in the forefront of some of the investments that we make.

Mrs. BICE. Perfect. I'd love to have a conversation with you about that very thing in the future.

My last question is, I am part of the Supply Chain Task Force that's been meeting for the last couple of months, and we talk a lot about workforce.

So my question is, what are the challenges that the Department faces in recruiting and retaining talent, and how can we address that?

Ms. MCQUISTON. Well, recruiting and retaining talent is going to be a critical focus of what we need to do to stay modernized and pursue the science and technology that we need to do.

As I mentioned before, offering opportunities for expanding research and scholar work that could be done within the laboratories, and also looking at opportunities for recruitment and retention of people that we need to—in the new science areas that we need to really target and embrace.

So I look at investing in those areas and modernizing. As we mentioned before, we really need to invest in the facilities and encourage this use to cultivate that next generation.

Dr. PERCONTI. Yeah, I would just say, very quickly, that if you're going to retain scientists and engineers, you have to allow them to do science and engineering, and oftentimes, we hire people into the government and they spend 4 years, 6 years, 8 years, getting degrees and we make them contract monitors.

And that's a real, I think, dilemma for us culturally. We have to really fix that, and if we can then I think the opportunities to retain people will go way up. The likelihood will go way up.

Mrs. BICE. Thank you. My time has expired so I will yield back, Mr. Chairman.

Mr. LANGEVIN. Thank you, Mrs. Bice.

Mr. Moulton is now recognized.

Mr. MOULTON. Thank you, Mr. Chairman.

Ms. McQuiston, as the ranking member mentioned, I co-led the Future of Defense Task Force last year, and a key issue we highlighted was the importance of international partnership in the context of setting common ethical standards for the use of technology.

We talk a lot about the development and deployment of emerging technologies. I know that that is your focus. But it is equally if not more important for us to think about how these technologies are used.

One thing we determined is that there is not enough development of operational concepts for technology before we just try to get the next toy. We need to figure out how we will use the technology and then determine, okay, we have this particular operational concept, this particular need, what's the technology that we need to fulfill that mission.

There's, of course, a terrible first mover advantage for countries that don't care about the ethical use of technology and are willing to deploy it without concern for human rights or third-order effects.

So when China collects massive amounts of biometric data and uses it to track and abuse its Uighur population, it is setting a precedent for biotechnology use and shaping the global standard by default.

So if we don't have these conversations about global technology standards very early on, then the global community will default to whatever low ethical bar another country might set.

If we then come into the game late and set a higher ethical bar, then we're at a strategic and tactical disadvantage as well.

So I know that this conversation often falls to OSD Policy or State Department. But the R&D community seems uniquely positioned to spot potential ethical use issues early and detect development process, which, again, is something that we identified as key.

So what role do you think the R&D community can play—the R&D community can play in shaping these ethical standards of use further down the road?

Ms. MCQUISTON. Well, I think it's really important right now to be looking at emerging and disruptive technology as a wargaming exercise and to be able to develop concepts in which they could be used, and those concepts have to look at risks and threats.

So yes, I agree we need to work with our allies and partners and put together these future concepts, but we need to understand how they could be used, too, when we look at AI, when we look at a lot of our information technology.

As I said before, that we need to look at it from both sides of the fence and also assess the science and technology environment around these capabilities.

So mission engineering, threat forecasting, and modeling and simulation and greater tools for analysis will better feed this sort of space that we need to consider for how we operate our technology and keep us in the forefront and proactive.

Mr. MOULTON. I mean, I think that piece is absolutely key, keeping us in the forefront and proactive. And the point I would leave you with is, though it may not feel like your responsibility to lead this effort, I think the R&D community is an essential contributor to this process.

So State Department needs to do its part. OSD Policy needs to do its part. We are pushing all those entities to do more here because we're very concerned about losing the race to China, not just in tech development but in operation, in ethical use of these standards, and it's critical that we don't lose that race. Continuing——

Ms. MCQUISTON. At R&E we have—oops, I'm sorry.

Mr. MOULTON. Sorry. Go ahead, Ms. McQuiston.

Ms. MCQUISTON. At R&E we have advanced concepts and we have SAIC [Science Applications International Corporation] looking at sort of the threat space as well, and we will continue to do that because as a chief technology officer, that's part of understanding what the enabling technologies can create from the standpoint of joint capabilities and joint threats that we have.

Thank you.

Mr. MOULTON. So just one more question on international partnerships, because military R&D partnerships can become tricky when we're trying to leverage partners' expertise while also keeping certain capabilities shielded from the outside world.

And whether we like it or not, we are not leading in every tech field right now. So some of our allies have technology or research that we could benefit from.

I know that there are many R&D efforts that genuinely shouldn't be shared beyond the Department. But it seems like too often that's just the default position.

Where can the Department do a better job of reaching out to its allies and building those R&D partnerships, and is there anything Congress can do to facilitate that?

Ms. MCQUISTON. Well, I believe that reaching out to our allies is going to be critically important because, as you said, we do not own a technology.

It's actually—the rate at which it's being developed and moving ahead we need to stay in front of and actually be leading edge, which means working with our allies in that.

Being able, I think, to have international partnerships is key and forming them, and also being able to identify the critical technology and how we need to protect it within these agreements.

But being able to do that in a timely way is going to be important as well.

Mr. MOULTON. Thank you, and thank you, Mr. Chairman. I yield back.

Mr. LANGEVIN. Thank you, Mr. Moulton.

Mr. Moore is now recognized.

Mr. MOORE. Thank you, Chairman, and I'm going to continue on with Representative Moulton—in that line of questioning, and just try to take it a little bit, one step further and allow for additional time on it. It's something that I have here as well just, you know, really trying to focus on.

You know, our country's capacities for innovation is limitless. Our scientific and technological prowess, you know, needs to be always on the forefront. So I'm eager to continue this growing work in the S&T ecosystem through, you know, the public and private sector.

But let me continue on with that questioning just getting it to the program of record, right, developing it and using allies. But what—are DOD research organizations working with the Defense Innovation Unit and any other related organizations to help transition and promote those technologies into program of record?

And then you can add in anything else with respect to recommendations on how to improve this process.

And this is for Ms. McQuiston, actually. Sorry, I didn't clarify that.

Ms. MCQUISTON. Thank you. Yes, I believe we need to have a culture of innovation. When we originally talked about AFWERX and a lot of the things going on within my sister services for looking at fielding and testing and experimentation, being able to capture those models and having it organic within the services, I think, is important.

But DIU and capturing the—all the different relationships that we can have commercially and looking across joint operations and joint technology, and then working aggressively to get it into the services and being able to field the technology is going to be critical.

So it's time. Time, time, time is going to be very important to keep track of and actually, again, get ahead of the planning and the financing so we don't have any of these companies fall into the "valley of death" but we actually are able to move swifter in fielding and—in demonstrating and fielding this technology.

Mr. MOORE. Excellent. Thank you.

You know, we have talked about it a lot. I maybe mention it every time we're on a Cyber Subcommittee. As we see the battlefield moving away from physical and into the cyber domain, I think it is incredibly important—incredibly important to provide this to our warfighter.

With that same respect, what's the long-term vision for the Defense Innovation Unit and with respect to any immediate plans to expand beyond current ops so not just partnering and finding, you know, synergies among others, but is there any chance we expand offices?

Mr. LANGEVIN. Microphone.

Ms. MCQUISTON. Sorry. I know we're looking to be able to be in critical areas where technology and commercialization is happening. Right now, we're putting together plans and strategies to feed into the budgeting process.

So I look forward to talking with DIU and seeing where their future plans are.

Mr. MOORE. Excellent.

And just a final question for Ms. Baldwin. Hill Air Force Base is in my district. It's got an annual economic output of approximately $4.5 billion, and small businesses are making up a larger percentage of our northern Utah defense and aerospace economy, something that I, you know, I believe we need to be promoting.

I think they're innovative. I think they're nimble. There's really good opportunities for small business. How are you optimizing the—those opportunities of the Small Business Innovation Research program and Small Business Technology Transfer program to develop and transition technology into current programs?

Ms. BALDWIN. We care deeply about those businesses and our relationships as well, and I can give you an example of we kicked off a challenge—a challenge opportunity with AFWERX in the area of trusted systems design a couple years ago and attracted a great number of small businesses from Utah as well as from across the Nation.

So, deeply important to us, and by coupling those activities through a phased approach where we have an opportunity to award a small contract initially as that proves out and demonstrates capability, we have follow-on opportunities through three phases.

By that third phase, we're investing enough resources and getting leverage dollars that allow those businesses to really gain ground and then transition—have the opportunity to transition to program.

So it's a model that we're proving out very well.

Thank you.

Mr. MOORE. Thank you. I yield back.

Mr. LANGEVIN. Very good. Thank you, Mr. Moore.

Are there any members who have not been recognized that would like to ask questions?

[No response.]

Mr. LANGEVIN. Okay. Hearing none, I want to thank our witnesses for their testimony and the members for their questions.

Members may have additional questions that they will submit in writing and we'd ask that you respond to those questions as expeditiously as possible.

With that, I want to, again, thank our witnesses for the extraordinary work that you're doing. It's just so important that we keep our eye on the ball here, we continue to strengthen the S&T and the R&D ecosystem.

This is vitally important to the future of our national security, the future of our warfighters, and without the right attention and support and progress, our enemies and adversaries will make that progress and we can't allow that to happen.

So with that, this portion of the open hearing stands adjourned and we will reconvene now for the classified portion.

Thank you.

[Whereupon, at 1:22 p.m., the committee proceeded in closed session.]

A P P E N D I X

MAY 20, 2021

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MAY 20, 2021

Opening Statement
Chairman James R. Langevin
Cyber, Innovative Technologies, and Information Systems Subcommittee
Reviewing Department of Defense Science and Technology Strategy, Policy, and Programs for Fiscal Year 2022: Fostering a Robust Ecosystem for Our Technological Edge
May 20, 2021

The subcommittee will come to order.

I would like to welcome the members who are joining today's joint hearing remotely. Members who are joining remotely must be visible onscreen for the purposes of identity verification, establishing and maintaining a quorum, participating in the proceeding, and voting. Those Members must continue to use the software platform's video function while in attendance, unless they experience connectivity issues or other technical problems that render them unable to participate on camera. If a Member experiences technical difficulties, they should contact the committee's staff for assistance.

Video of Members' participation will be broadcast in the room and via the television/internet feeds. Members participating remotely must seek recognition verbally, and they are asked to mute their microphones when they are not speaking.

Members who are participating remotely are reminded to keep the software platform's video function on the entire time they attend the proceeding. Members may leave and rejoin the proceeding. If Members depart for a short while, for reasons other than joining a different proceeding, they should leave the video function on. If Members will be absent for a significant period, or depart to join a different proceeding, they should exit the software platform entirely and then re-join it if they return. Members may use the software platform's chat feature to communicate with staff regarding technical or logistical support issues only.

I have designated a committee staff member to, if necessary, mute unrecognized Members' microphones to cancel any inadvertent background noise that may disrupt the proceeding.

Finally, the Chair reminds members of the committee that they are required to observe standards of courtesy and decorum during committee proceedings. This requirement includes the responsibility to protect public safety and health, particularly during a pandemic. Members, staff, and attendees are required to wear masks at all times in the hearing with the following exception. A person who is attending this proceeding in person may remove his or her mask briefly following recognition by the Chair for the purposes of speaking into a microphone. Any person who removes his or her mask for this purpose must replace it at the conclusion of his or her recognized remarks. The Chair expects all Members, staff, and attendees to adhere to this requirement as a sign of respect for the health, safety, and well-being of others. The Chair views the failure to adhere to this requirement as a serious breach of decorum.

With that, I would like to welcome everyone to this hearing today on the Department of Defense's fiscal year 2022 strategy, policy and programs for science and technology. While we unfortunately do not yet have the President's Budget Request for the year, this hearing will provide an important opportunity to examine the Department's efforts to maintain the United States competitive technological edge in the face of great power competition. I would like to thank Ranking Member Banks for organizing this hearing with me and thank our witnesses for joining us. Before us today we have:

- Ms. Barbara McQuiston, Acting Under Secretary of Defense for Research and Engineering;
- Dr. Philip Perconti, Deputy Assistant Secretary of the Army for Research and Technology;
- Ms. Joan "JJ" Johnson, Deputy Assistant Secretary of the Navy Research, Development, Test, and Engineering; and
- Ms. Kristin Baldwin, Assistant Secretary of the Air Force for Acquisition, Technology and Logistics for Science Technology, and Engineering.

Following the open portion of the hearing, the subcommittee will reconvene in a closed, classified members-only session in CVC-200 with representatives from DARPA and the military services' research entities.

In today's strategic environment, the United States' historic military and economic competitive advantage is not guaranteed. We are no longer competing against technologically inferior adversaries; instead, we face persistent and dangerous challenges from highly capable and advanced great power competitors who seek to undermine the status quo of U.S. leadership and global power. Maintaining U.S. dominance in all warfighting domains requires robust investment, innovation, and talent development across America's science and technology enterprise. We must lay the groundwork today for the threats of tomorrow by investing in DoD science and technology programs, across the research laboratories, academic institutions, and industry partners that collectively bring a whole-of-society approach to maintain the United States' technological edge.

While our witnesses cannot speak about specific funding levels today, I am interested to hear their perspectives on the future of the Department's S&T funding. The core of our technological edge is our early basic and applied research; this is the science that lays the foundation for cutting edge technology 20 to 30 years down the road. We have seen with the COVID-19 pandemic just how critical this early research is. The messenger RNA COVID vaccines we have today were catalyzed by defense research investments five to ten years ago—long before the current pandemic. Indeed, the first coronavirus vaccine to start human testing came from a DARPA investment in Moderna. DARPA's ability to substantially contribute to our nation's response to pandemics is the product of more than half a

century of DoD S&T funding. If we wait to invest in science only when crisis is upon us, then we are setting the nation up for failure.

Despite the importance of DoD-funded research and development, the Department's S&T budget buying power has effectively shrunk in the past decade. Cuts are often made to these important early research accounts to prioritize more near-term efforts in technology development. Yet our rivals are committed to concerted S&T funding, thinking it will undermine US leadership. We cannot expect to compete with them if we keep short-changing our research accounts.. I hope that the President's budget will reflect serious investment in S&T. Our men and women in uniform deserve nothing less.

Indeed, our greatest asset as a nation is our people. We must cultivate our science and technology workforce. We must promote STEAM education at early ages to expose individuals of all backgrounds to the world of science, engineering, and math in hopes they will pursue an education and career in critical emerging technologies. We must also train the existing workforce in machine learning and computer science and change hiring authorities so that the Department can rapidly hire top STEAM talent. We must also make it easier—not harder--for international researchers in our universities to stay in the United States. The committee has prioritized workforce development through the last several National Defense Authorization Acts and encourages the Department to continue to promote STEAM education; adequately fund DoD Research Laboratories; partner with academia including Historically Black Colleges and Universities and Minority Serving Institutions; and diversify the defense innovation base through partnerships with small businesses. This will ensure we have an S&T workforce and innovation base comprising the best talent that reflects the diversity of our nation.

Bottom line: great power competition is also a race for talent; we cannot afford to lose this top talent to our adversaries.

Further, the U.S. government, academia, and the private sector must foster mutually beneficial relationships to encourage innovation within the Department of the Defense. We must remember that Silicon Valley got its name from government investments in research and development and partnerships with academic institutions, which in turn grew new technology and encouraged technical talent to spin out innovative companies to put their research into practice. Then the Department bought the products of those new companies, which kept them alive to continue their work. Today, to support the transition of mostly academic research into a sustainable technology and across the "valley of death," the Department must figure out how to be a buyer of cutting edge market products, even if just for research use in labs and academia at the moment.

Our national security technology enterprise must grow in accordance with our American values—those rooted in a free, open, and democratic society. We must develop and apply technology ethically; engage with our partners and allies in a free and open research environment; and promote a culture of innovation and risk taking. The Department must lean forward and not be afraid to fail. Pushing

boundaries, challenging bureaucracy, and expediting the development of critical defense technologies are key to remaining competitive and agile in an increasingly complex strategic environment.

With that, I'd like to thank our witnesses again for their participation in today's hearing and their concerted focus on supporting the Department's S&T efforts. I'll now turn it over to Ranking Member Banks for his opening remarks.

Statement by Ms. Barbara McQuiston
Performing the Duties of the Under Secretary of Defense for Research and Engineering

Submitted to the
House Armed Services Committee
Subcommittee on Cyber, Innovative Technologies, and Information Systems

Reviewing Department of Defense Science and Technology Strategy, Policy, and Programs for Fiscal Year 2022: Fostering a Robust Ecosystem for Our Technological Edge

May 20, 2021

NOT FOR PUBLICATION UNTIL RELEASED BY THE SUBCOMMITTEE

Introduction

Thank you for the opportunity to address you as the PTDO USDR&E. R&E serves as the chief technology officer for the Department of Defense (DoD) and is responsible for ensuring the technological dominance of the American joint force. R&E is also committed to the priorities of Secretary of Defense Austin in defending the nation, taking care of people, and succeeding through teamwork. We are focused on innovation throughout the DoD and on accelerating modernization across the services.

As both Secretary Austin and Deputy Secretary Hicks have stated, the People's Republic of China is the pacing challenge for the United States military. New technology and innovation will be central to meeting that challenge. Presenting a credible deterrent to potential adversaries requires us to develop and field emerging technologies at speed and scale.

Investments in science, technology, and innovation today can pay dividends tomorrow. One such example of how science can pay off is early DARPA research into mRNA that recently enabled COVID-19 vaccines. This is just one example of the tremendous impact DoD investments can make: not just for our military, but for our nation as a whole. To continue this track record of success and guarantee a strong tomorrow, DoD must reaffirm its commitment to science, technology, and innovation today.

The United States is leading the world in innovation, but other nations, including potential adversaries, are moving quickly to close that gap. Innovation has always been an asymmetric advantage to the United States, but to maintain that advantage, DoD must identify technologies that will impact the battlefield of tomorrow and be prepared to develop those technologies into usable capabilities.

DoD's Modernization Priorities

By developing and transitioning emerging technologies, USD(R&E) plays an essential role in outfitting DoD's warfighter with cutting edge technology. In addition to providing the warfighter with the best technology and tools, USD(R&E) is committed to leveraging commercial technologies, supporting innovative manufacturing capabilities, and improving the return on DoD's investments.

By investing in basic science and technology (S&T), DoD pushes the scientific frontier forward and de-risks investment for private industry. By taking a leadership role in S&T, DoD invests in breakthrough technologies, sends clear demand signals to innovative private companies, and creates opportunities to transition cutting edge capabilities to the warfighter. Developments in micro grid directed energy, autonomy and AI are examples where DoD led research has resulted in commercialization and economic gain outside of the defense space.

Today, USD(R&E) is leading modernization initiatives across 11 critical technical areas, including microelectronics, cyber, autonomy, artificial intelligence, hypersonics, space, biotechnology, directed energy, quantum science, FNC3 and 5G. For these 11 technologies, R&E is responsible for developing roadmaps that will guide these technologies from basic research all the way to fielding.

In the future, USD(R&E) looks forward to assessing its modernization priorities in the context of the forthcoming National Defense Strategy. To set these priorities smartly, USD(R&E) will constantly assess progress, technological maturity, and unique DoD use cases. U5D(R&E) will also ensure that it develops

and fields priority technologies in a smart and efficient manner. Transitioning technology from the laboratory to the warfighter requires clear management, investment and focus. To improve technology transition, USD(R&E) is:

- Investing in basic research and developing tomorrow's workforce;
- Cultivating diversity;
- Fostering an innovative culture;
- Partnering with the private sector; and
- Leveraging the innovation inherent in small businesses; and
- Pushing the boundaries of technology to open new commercial markets.

I look forward to discussing DoD's technology priorities, as well as our efforts to improve technology transition, with sub-Committee today.

Prioritizing Technology Transition

By investing in early stage technology, DoD can act as an incubator for the private sector and can pioneer entire new markets. Today, USD(R&E) is pushing forward on a number of emerging technology areas that may have enormous benefits to the warfighter and are already offering secondary benefit to the nation. Emerging technologies in the areas of hypersonics, autonomy, and directed energy are examples of promising transition.

Hypersonics: The common hypersonic glide body (C-HGB) is currently transitioning to the services and now forms the basis of the Army Long Range Hypersonic Weapon and Navy Conventional Prompt Strike programs. C-HGB is a proven hypersonic glide body developed by Sandia national labs. The effort demonstrated the ability to deliver conventional effects thousands of miles away in 20 minutes or less with a high degree of accuracy and survivability. In addition to the potential capability to the warfighter, the development team transitioning expertise to industry for future development and production of capability.

Autonomy: Schools, offices, military bases, and manufacturing floors may require disinfection between shifts to minimize the spread of infection or contamination. The Decon–X (DX1) disinfecting system has proven its effectiveness in Europe, but currently lacks the mobility and autonomy to disinfect spaces without an operator. This Advanced Robotics for Manufacturing (ARM) project is aimed at adding mobile autonomous capabilities to the DX1 room disinfection system to automate the consecutive treatment of multiple rooms and spaces within workplaces. The addition of mobility and autonomous navigation to the DX1 will enable the robot to move from room to room and perform a series of treatments with little to no human intervention. A demonstration of the robotic system will be available in Fall 2021.

Autonomy: The Low Cost Attritable Strike Demonstration (LCASD) program was developed by the Director of Defense Research and Engineering, Advanced Capabilities (DDR&E(AC)) in collaboration with the United States Air Force with the goal of providing a developmental prototype and low-cost manufacturing techniques for a Program of Record. LCASD and the associated XQ-58A Valkyrie platform will increase Joint Force lethality per the National Defense Strategy by proving a long range, high performance attritable unmanned aerial system that can be used for both strike and intelligence, surveillance, and reconnaissance gathering missions. In addition, the data and software suites from this

project will be used within other unmanned systems. Best practices and lessons learned will inform the nation's defense industrial base on new, low-cost manufacturing methods.

Microgrid: R&E prototype investments have addressed critical needs in the mission areas of contested logistics and directed energy while having impact on our climate and energy footprint. We developed a prototype for a vehicle centric, mobile, fast forming, secure, intelligent microgrid that provides ad hoc, resilient power for next generation directed energy and missile defense technologies. The prototype vehicle microgrid enables on-the-move power generation to enable advanced capabilities for maneuver forces; improved logistics through reduced fuel consumption; and, faster setup, transport, and redeployment of power generation systems. In FY 2020, the prototype transitioned to the Army for use with THAAD and other systems. The potential also exists to employ this technology for civil disaster relief in cases such as in the aftermath of a hurricane or wildfire.

Investing in Basic Research to Develop Tomorrow's Workforce

DoD's commitment to basic research today is foundational to its ability to field cutting edge capabilities and to develop its future S&T workforce. For example, USD(R&E)'s Multidisciplinary University Research Initiatives Program (MURI) funds basic research using three to five-year university grants aimed at addressing DoD's hard problems and training its next generation of researchers. Programs similar to MURI, including Advanced Robotics for Manufacturing (ARM), American Institute for Manufacturing Integrated Photonics (AIM photonics) and the Advanced Regenerative Manufacturing Institute called BioFabUSA, use investments in basic research as a vehicle to develop breakthrough technology, train tomorrow's technology leaders. These programs help DoD modernize its future workforce in critical technology areas, including autonomy, microelectronics, and biotechnology.

Microelectronics: AIM Photonics offered a "Fabless Design of Photonic Integrated Circuits within the AIM Foundry Ecosystem" course for a second time this summer. Over 2,000 students enrolled in the six-week summer edX course in integrated photonic circuit design, with 159 students enrolling in the course and having access to the software tools, using over 14,716 hours of computational time. 95 students submitted photonic integrated circuit designs as part of the course.

Biotechnology: BioFabUSA developed the "TEMPtation" game to introduce students in grades 7-12 to the world of Tissue Engineered Medical Products (TEMPs) and biomanufacturing. This online game ran for several weeks, challenging students to learn about the TEMP industry while winning prizes. The goal was to expose students to careers in this industry while they are still choosing high school and college course work. Forty BioFabUSA members were featured. This activity helps BioFabUSA meet their goal of closing the skills gap in tissue and organ manufacturing by providing training opportunities to non-college bound youth and help prepare for future STEM workforce.

Autonomy: AIM is working to launch the first national resource that will connect workers with vetted training opportunities in robotics for manufacturing: roboticscareer.org. The resource will be structured as a public website and is set to launch in 2021. Over 10,000 robotics education programs across the United States will be identified on the website, with some programs endorsed as meeting the highest standards in the robotics industry in the categories of Relevance to the Industry, Effective Curriculum, and Efficiency of the Training, Impact of the Program, Program Sustainability and Transportability. These standards were developed in partnership with experts in the ARM ecosystem and government.

Cultivating a Diverse Workforce

To maintain its innovation edge, the United States must continue to lead the world in creativity, science, and academics. At DoD, this means looking for the best and brightest from all fields, from the social scientists to mechanical engineers. Beyond subject matter diversity, DoD is also committed to expanding its engagement with small businesses, start-ups and disruptive forces in the business and technology space. And when it comes to people, USD(R&E) prioritizes diversity in its workforce and promotes diversity in the scientific and academic community.

For example, the USD(R&E) Lightweight Innovations for Tomorrow (LIFT) program supports Heroes' Alliance, a Detroit nonprofit focused on empowering youth in urban communities through education and workforce development. LIFT has partnered with Heroes' Alliance to house their Cooperative Learning Center - an after-school science, technology, engineering, and math (STEM) program focused on vehicle technology where students from six Wayne and Oakland County high schools design, build, test and race electric and solar vehicles.

USD(R&E) also recently launched the Center of Excellence in Networked Configurable Command, Control and Comminutions for Rapid Situational Awareness (COE-NC4) at the University of California, Riverside. COE-NC4 is a $7.5 million program administered by the Army Research laboratory and part of USD(R&E) historically black colleges and universities and Minority-Service Institutions. The COE-NC4 supports the Department's commitment to building a diverse pipeline of science, technology, engineering, and mathematics talent. This center will integrate underrepresented students into essential research efforts by way of design projects, colloquia, and internships at defense laboratories and provides participants with a pathway to graduate studies while fostering awareness of critical research that impacts our national security.

Another way DoD is fostering a more diverse workforce comprised of highly skilled and dedicated individuals is through our SMART Scholarship program outreach at Historically Black Colleges and Universities and Minority-Serving Institutions (HBCU/MI). Since 2018, 57 DoD STEM scholars who took part in the DoD HBCU/MI Program and Service component initiatives have accepted jobs with defense laboratories. DoD's partnerships with HBCUs/MIs not only strengthens the nation by building a workforce more reflective of the nation, but helps build a stronger national defense.

Additionally, USD(R&E)'s MxD was selected to join a national project led by The Century Foundation and the Urban Manufacturing Alliance to advance racial equity in manufacturing. The groups, selected through a competitive process and funded by Lumina Foundation, strategize solutions to the U.S. manufacturing sector's national recruitment challenges, deepen relationships between employers and communities, and develop credential-based training programs. MxD's selection and participation in this project are possible through the positive reputation and track record of MxD Learn's workforce development portfolio.

Fostering an Innovative Culture

Culture is a critical component not only of DoD's workforce, but also of innovation as well. There are many parts of DoD where innovation is a strong part of the established organizational culture. However, DoD must continually expand and strengthen a culture of innovation throughout the Department. To do

this, USD(R&E) will seek to replicate recent successes, including space, cyber, and social science programs—Hack-A-Sat, VICEROY, and Minerva—and drive change across the military Services.

Space: The Hack-A-Sat program was developed by the Director of Defense Research and Engineering, Advanced Capabilities (DDR&E(AC)) in collaboration with the United States Air Force with the goal of determining vulnerabilities in DoD satellites. Hack-a-Sat energized hackers from around the world by offering the public the opportunity to legally hack into actual DoD satellites, a unique crowd-source approach to learning of emerging infrastructure threats. By watching the world's best hackers at work, DoD identifies cutting-edge hacking strategies and developing new offensive and defensive approaches to space and cyber protection. Later this fiscal year, DoD space and cyber experts will use their observations of the hackers to develop a set of new CONOPS for space and cyber operations.

Cyber: The "Virtual Institutes for Cyber and Electromagnetic Spectrum Operations Research and Employ" (VICEROY) Program objective is to accelerate and focus the development of foundational expertise in critical cyber operational skills for future military and civilian leaders. The program augments traditional college curricula with high-impact, experiential learning opportunities that are specifically tailored to meet current and future cyber workforce demands. The goal is to create more ROTC and civilian graduates who are workforce ready for the Cyber Mission Forces, DoD Information Network Operations, and the Research and Engineering Science and Technology Enterprise. This effort is managed by OUSD(R&E) and executed in partnership with the Air Force Research Lab's Information Directorate and their Partnership Intermediary, the Griffiss Institute. VICEROY follows a consortia model where regional "virtual institutes" are formed through strategic partnerships between institutions of higher learning, local industry, and local and federal government.

Social Science: The Minerva Research Initiative (MRI) is a social science basic research grants program that aims to improve DoD understanding of the social, cultural, behavioral, and political forces that shape regions of the world of strategic importance to the U.S. MRI is innovative and unique in DoD as it spans both the R&D and Policy sides of the Department. Leadership across the Department collaborates to identify and support basic social science research issues in need of attention and to integrate those research insights into the policy-making environment. MRI is actively seeking out research topics that are clearly aligned with national defense priorities. Through this program, the DoD complements other R&E programs by maintaining a strong interest in research proposals generated from our HBCU/MI partner institutions, and from other appropriately diverse teams, such as Professional Military Education Institutions, especially as they contribute their valuable perspectives on the social dynamics of the policy and technology challenges facing the nation.

Partnering with the Private Sector

Strengthening public/private partnerships is a priority for USD(R&E). The department has a number of programs to expand public/private partnerships and will be looking to expand these opportunities in the future. DoD is currently pursuing public/private partnerships to develop a number of programs in priority emerging technology areas such as directed energy, cyber, microelectronics, biotechnology and space.

Directed Energy: High Energy Laser weapons (HEL) are an example of how DoD is able to de-risk technology. Multiple entities across the DoD have developed common goals for HEL weapons resulting in a High Energy Laser Scaling Initiative. This initiative is funding four companies to develop four different 300 kW class HELs to be used by the Services for demonstrations and testing. In addition, this program is a good example of DoD joint experimentation as the program is managed by OUSD (R&E) with substantial involvement from the Services and MDA. This avoids three separate and potentially competing Service Programs. Through these investments, DoD is able to demonstrate to industry what is possible and what is needed to provide DoD with military class lasers. The goal of HELSI is to provide the Services with the confidence they need to begin ordering HELs from an industry with proven capability.

Cyber: IQM Research Institute, an independent, Michigan-based 501c(3) non-profit organization has been instrumental in connecting DoD technology with cybersecurity Vice Presidents at major automobile companies and associations. The results include the identification cybersecurity concerns and the development of future standards to help close security gaps.

This OUSD(R&E)-funded activity identifies collaborative cybersecurity research and development opportunities within the commercial and DoD vehicle cybersecurity ecosystems. It recommends DoD-developed technological solutions for potential transition or transfer into future commercial platforms, as a means of promoting long-term enhancement and sustainment of vehicle cyber resiliency.

An additional benefit of these engagements has been an impact on R&E strategy for vehicle cybersecurity investment under the "Robust Low-level Cyber Attack-resilience for Warfighting Vehicles" project. This project ensures that technologies being developed are high-impact, high probability of transition success, and insert technology into early stages of the supply chain, in order to promote a higher return on investment.

Microelectronics: Our national defense relies on domestic manufacturing of microelectronics. The department is working closely with commercial partners to enhance and advance domestic production. The Department has two programs aimed at increasing domestic productive of microelectronics. The Rapid and Assured Microelectronics Prototyping (RAMP) program, is aimed at advancing leading-edge microelectronics design methods and incentivizing fabless companies to onshore production. The State-of-the-art (SOTA) Heterogeneous Integrated Packaging (SHIP) effort is leveraging Intel's state of the art commercial packaging design and manufacturing capabilities for developing defense specific heterogeneous multi-chip packages. These support DoD specific requirements including extremely high processing in restricted size, weight & power (SWaP) environments, the need to move terabytes of data in real-time, and customization and optimization for DoD specific applications. Multi-chip package prototype demonstrators have been selected in partnership with the defense industrial base to customize commercial flows and establish an environment that supports design and production for DoD programs. Design concepts from over 20 programs were represented including Navy shipboard radar, electronic warfare/software-defined-radio, Army air to ground radar, advanced sensor applications, AI hardware acceleration and hardware security/cyber resilience.

Biotechnology: The DoD Manufacturing Technology Office, along with the Principal Director for Biotechnology within OUSD (R&E), awarded a 7-year Cooperative Agreement to BioMADE to develop a Manufacturing Innovation Institute (MII) dedicated to biomanufacturing for non-biomedical applications. BioMADE joins a network of eight other DoD MIIs. MIIs are public private partnerships that bring together industry, non-profits, and academia with federal and state agencies to accelerate

innovation by investing in industrially relevant manufacturing technologies with broad applications. Each MII provides support to propel research and development products to commercialization and economic viability. In partnership with government, industry, and academia, BioMADE will ultimately build a sustainable, domestic, end-to-end bioindustrial manufacturing ecosystem that will enable domestic bioindustrial manufacturing at all scales, develop technologies to enhance U.S. bioindustrial competitiveness, de-risk investment in relevant infrastructure, and expand the biomanufacturing workforce to realize the economic promise of industrial biotechnology. Not only will this bioindustrial manufacturing ecosystem support a more resilient domestic supply chain and ecosystem, this same ecosystem will accelerate technology development for essential DoD needs.

Biotechnology: A collaboration between DoD ONR Global and UK's DSTL is focused on developing novel battery technology that leverages synthetic biology to improve battery performance. This work, performed by Naval Research Laboratory, University of Utah, and the commercial company Touchlight, has the potential to revolutionize portable battery technology by avoiding safety risks of current technologies, reducing weight to improve transport, and providing renewable energy capabilities, all while producing a power output capacity that outcompetes lithium ion batteries. By partnering with a US Ally and supporting leading researchers and innovators, we can de-risk technology for the DoD that also has strong commercial and economic importance to the US.

Space: The Defense Innovation Unit (DIU) strengthens national security by accelerating the adoption of leading commercial technology throughout the military and by growing the national security innovation base. The Peacetime Indications & Warning project, within DIU's space portfolio, recently awarded contracts to two first-time DoD vendors to provide low-cost, commercially available radar and small-satellite imagery with advanced computer vision algorithms. In the same vein, the Missile Defense Agency (MDA), followed a commercial hosting model for the rapid development and fielding of small sensors which process intercept data and deliver near-real-time assessments to the Ballistic Missile Defense System. This capability yielded payloads in orbit in half the time of traditional space programs with an estimated $700M cost savings to the Government. Both capabilities enhance the Department's situational awareness around the world, facilitate timely analysis of emerging threats, and allow for data and information-sharing with allies and partners.

Leveraging the Innovation Inherent in Small Businesses

DoD strives to capture innovation from all sectors of the economy. Small businesses, startups, and other disruptive entities offer significant contributions to future technology development and the rate of return is quite high. For small business there has been see a 22:1 rate of return for the investment. To leverage this innovation, DoD Small Business and Technology Partnerships (SBTP) recently announced a list of 137 critical research topics to the small business community in order to solicit bids to solve DoD issues. Small businesses will present proposals for funding and development with the goal of transitioning technology to the field.

In order to unlock and reveal emerging novel capabilities across industry, academia, small businesses, and non-traditional offerers, USD(R&E) issues a Global Needs Statement (GNS). The Global Needs Statement focuses on Secretary of Defense priorities, addressing near-peer competition, and delivering operational prototypes. USD(R&E) created an agile special notice process that lowers barriers to entry

and encourages direct industry-government exchanges to enhance participation from small business and non-traditional contractors.

In 2020, over 1300 partners submitted proposals to address DoD modernization and joint interest areas, many of these submissions from non-traditional contractors. Through industry engagement such as this, as well as through dedicated prototyping efforts, the Advanced Capabilities Directorate has delivered 36 new capabilities, enabled 19 new capabilities, and transitioned an additional 40 highly-innovative prototypes to users from across the innovation space, including small businesses, non-traditional performers, academia, and UARCs.

Investment in small business R&D is not only paying dividends to the warfighter, but it's also making a real and significant impact to many Americans each and every day. DoD small business R&D investments has fostered new and innovative products for the civilian market, allowed our nations scientists and engineers to take risks that they might not have taken on cutting edge projects, and made real and lasting impacts that have contributed to national prosperity. Over the last 23 years, DoD's $14.4 Billion investment in small business R&D has directly resulted in $347 Billion in nationwide economic output and created over 1.5 million jobs.

Pushing the boundaries of technology to open new commercial markets

In addition to partnering with the private sector and leveraging small business innovation, DoD plays an important role de-risking early stage technology. By de-risking immature technology, DoD's investments have a multiplier effect later as new commercial markets open. Today, USD(R&E) is pushing the market forward in a number of emerging technology areas, including AI, biotechnology, and autonomy. Areas such as these offer enormous benefits to the warfighter, and can to offer significant secondary economic benefits to the nation.

AI: The Department of Defense's Defense Innovation Unit (DIU) is seeing good results on a program that uses AI combined with commercial off-the-shelf wearable-devices to identify if the wearer has contracted COVID-19 up to two days before symptoms show. Early testing is promising and shows that COVID detection is possible up to 48 hours before the first symptoms appear. This capability is not only useful to the military as it plans to deploy and manage the health of service members, but also can benefit the larger health care system.

Biotechnology: The America Makes Manufacturing Innovation Institute connected the additive manufacturing industry to the medical care provider community to accelerate design and clinical review of 3D-printed PPE medical devices in short supply. The project used a centralized process developed at America Makes, and in partnership with the Food and Drug Administration, National Institute of Health (NIH), and Veterans Affairs to match capabilities with health care needs in the NIH 3D Print Exchange for open-sourced designs to be fast-track reviewed.

NextFlex, in partnership with Aionx, utilized novel RNA sequencing technology from CSI to prove the environmental contamination existence and transmission pathway; and refined and expanded production capacity of antimicrobial mats called cleanSURFACES. Any time microbes contact a mat's surface, an embedded circuit board sends a micro-electric impulse along printed conductive traces to that location to activate antimicrobial silver and copper ions that quickly eradicate the contaminants.

Manufacturing times Digital (MxD) is working with BioFabUSA in collaboration with the FDA and two pilot manufacturers to develop and validate digital twins of their production, which allows emergency scenario exploration without operational impact. This multi-institute project will optimize supply chain and production pharmaceutical life sciences manufacturing gaps and promote advanced digital design capabilities to expand U.S. pharmaceutical manufacturing capacity.

Autonomy: The department is also developing promising results with unmanned air vehicles (UAVs). These offer valuable overhead imaging both in commercial applications and on the battlefield. The Air Force's Agility Prime program will further extend those applications to personnel mobility where over 200 companies are leveraging advances from hybrid and electric cars to create electric vertical takeoff and landing aircraft. This military research is a promising technology for transition into the consumer market.

New traffic rules are needed to fully realize the commercial potential of UAVs. The nearly complete Resilient Autonomy Joint Capability Technology Demonstration (JCTD), a collaboration between the Office of the Undersecretary of Defense for Research and Engineering, NASA, and the FAA seeks to solve future air traffic challenges. This NASA led collaboration extends an autonomy architecture initially developed to avoid air-to-ground collisions, which has saved the lives of at least ten F-16 pilots.

The JCTD seeks to develop a robust architecture and methodology for certifying fully autonomous systems, testing the maturity of the technology and informing airworthiness requirements to enable future autonomy in unpiloted aircraft. Under the Resilient Autonomy approach, the system prioritizes human safety over preventing damage to property while damage prevention is prioritized over the completion of the mission by following a set of programed rules of behavior. These rules of behavior allow better mission management while always maneuvering within the acceptable performance limits of the aircraft.

Thus far, the software has been provided to several DoD users including the Special Operations Command (MQ-1C Gray Eagle), the Air Force Research Laboratory (Skyborg), and the Army's Unmanned Aircraft Systems Project Management Office (for potential application Future Vertical Lift). Additionally, the software has also been provided to the FAA who are looking at application to a general aviation aircraft integrated with a commercial autopilot.

Conclusion

To guarantee the unquestioned superiority of the United States' armed forces, USD(R&E) is committed to building a strong foundation of science and technology today to produce cutting edge technology of tomorrow. While the United States continues to lead the world in science, technology and innovation, it is no secret that potential adversaries are attempted to catch up and surpass the United States. To maintain a technological edge on the battlefield of tomorrow USD(R&E) is focusing on priority emerging technology, building a strong foundation to enable the transition of technology from the laboratory to the warfighter and strengthening our national economy.

Ms. Barbara McQuiston
Performing the Duties of the
Under Secretary of Defense for Research and Engineering

Ms. Barbara McQuiston joined the administration on March 22nd and is currently performing the duties of the Under Secretary of Defense for Research and Engineering.

Ms. McQuiston previously spent nearly a decade in government service at the Defense Advanced Research Projects Agency (DARPA). While at the agency, she served in the Defense Science Office, the Strategic Technology Office, and finally as a Special Assistant to the Director for Energy. Ms. McQuiston received the Office of Secretary of Defense Medal for Exceptional Public Service for her leadership roles from 2006 to 2010. In addition to her time at DARPA, Barbara has more than 30 years of commercial experience. Her work in the private sector has included various research roles, technology management, commercial development, and strategic planning. She has also worked on the development of innovative information, communications, biological, medical, and environmental technologies. Additionally, she has also advised capital management funds and has negotiated and managed technology transfer agreements in both the public and private sector.

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RECORD VERSION

STATEMENT BY

DR. PHILIP PERCONTI
DEPUTY ASSISTANT SECRETARY OF THE ARMY FOR RESEARCH AND TECHNOLOGY, OFFICE OF THE ASSISTANT SECRETARY OF THE ARMY (ACQUISITION, LOGISTICS, AND TECHNOLOGY)

BEFORE THE

SUBCOMMITTEE ON CYBER, INNOVATIVE TECHNOLOGIES, AND INFORMATION SYSTEMS
HOUSE COMMITTEE ON ARMED SERVICES

FIRST SESSION, 117TH CONGRESS

ON REVIEWING DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY STRATEGY, POLICY, AND PROGRAMS FOR FISCAL YEAR 2022: FOSTERING A ROBUST ECOSYSTEM FOR OUR TECHNOLOGICAL EDGE

MAY 20, 2021

NOT FOR PUBLICATION UNTIL
RELEASED BY THE COMMITTEE ON ARMED SERVICES

Chairman Langevin, Ranking Member Stefanik, and distinguished members of the Subcommittee, thank you for your continued support and for the opportunity to discuss Army Science and Technology (S&T) strategy, policy and programs–all designed to realize U.S. Army modernization priorities, founded on a robust S&T ecosystem, to enable our Soldier's technological edge. The Army's modernization enterprise, spearheaded by the Army Futures Command (AFC), includes a network of synchronized Laboratories and Engineering Centers, the major ones include: the AFC Combat Capabilities Development Command, the AFC Medical Research and Development Command (MRDC), the U.S. Army Corps of Engineers' Research and Development Center (ERDC), and the Space and Missile Defense Command's Technical Center (SMDTC).

Together with our partners sitting with me today, Army Labs and Centers are working with academia and industry to develop new technology that is driving near and mid-term modernization, and performing exciting research to discover and unlock knowledge that will enable yet to be imagined warfighting capabilities for the far-term.

Today, I will focus my remarks on how the Army is transforming the S&T business model, revitalizing the Army's Small Business Innovation Research (SBIR) program, increasing outreach to Historically Black Colleges and Universities/Minority Serving Institutions (HBCUs/MSIs), and cultivating exciting new basic research areas, and then I will briefly discuss our people and our laboratory infrastructure.

We are transforming the Army S&T business model—moving away from walled-off, "siloes-of-excellence" to a model that emphasizes the importance of early collaboration and frequent communication between the Requirements, S&T, Acquisition, Testing, Sustainment communities, our academic and industry partners, and most importantly our Soldiers. Under the joint leadership of the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) and the Commanding General (CG) AFC, these communities are changing by collaborating in unprecedented ways: Army scientists and engineers are changing the way warfighting concepts and requirements are envisioned; which are, in turn, shaping longer term research projects and goals; Program Executive Offices are maturing an unprecedented number of

technologies emerging from S&T with reduced risk to performance, schedule and cost; and the AFC Cross Functional Teams (CFTs) are driving the entire enterprise to expediently deliver on our signature modernization programs to meet the demands of joint multi-domain operations.

Within the Army's S&T enterprise, we form partnerships using competitively awarded, cooperative research programs that maximize the exposure of our academic and industrial partners to the requirements and acquisition communities as soon as possible, driving innovation through increased understanding. We want Army scientists and engineers working side-by-side with the best and brightest scientists, engineers, and entrepreneurs from across the Nation as early as possible in the discovery and innovation cycle. Building upon the success of the Army Research Laboratory's (ARL) Regional labs, located in Los Angeles, Chicago, Boston, and Austin, the Army has created new innovation hubs focused on Research and Development (R&D) to support both well-defined and emerging Army priority areas. For example, the AFC Artificial Intelligence Center, located at Carnegie Mellon University's National Robotics Research Center in Pittsburgh, allows University and Army personnel to work closely together, focusing the brightest minds in the fields of Artificial Intelligence and Autonomy on Army problems. The Army is also partnering with Texas A&M and the University of Texas at Austin to conduct research and to develop unique laboratories for hypersonics, directed energy, and robotics.

I would be remiss if I didn't mention AFC's Project Convergence (PC), the Army's multi-year Campaign of Learning, where Army scientists and engineers stand side-by-side with industry partners, Army Acquisition professionals, and the AFC CFTs to evaluate new technologies using large-scale, Soldier-centered field experiments, seeking to integrate capabilities across the joint force to conduct Multi-Domain Operations. Under this project, the S&T community is given unprecedented access to our ultimate customers–Soldiers. PC is changing the model for conducting R&D in the Army–in a good way.

In Fiscal Year (FY) 22, we will open a competition for three new Basic

Research Centers to acquire knowledge and to train the next generation of American students who might be called to Federal Service to perform R&D in emerging modernization priorities:

1. Ultra-wide Band-Gap Radio Frequency (RF) Electronics Center: To study synthetic diamond electronic materials that can withstand extreme operating conditions to establish spectrum dominance over every frequency, range and environment.

2. Army Energetics Basic Research Center: To accelerate discovery of energetic materials that allow for tailorable effects and provide more explosive power in smaller packages. And the:

3. Army Center for Synthetic Biology Center: To develop fundamental understanding of materials spanning genetics, metabolism and the environment, and to develop models for new synbio applications to solve Army problems.

Our university partnerships are highly attuned to the state of today's world-order, and our collaborations with university professors and students are protected to ensure development of diverse, best-in-class American Science, Technology, Engineering and Math (STEM) talent. America's strength is derived from its ability to bring together a diverse group of people, with their thoughts and their ideas. The Army simply cannot accomplish its mission without the skills, dedication, and contributions derived from providing access to all Americans. We use our Basic Research portfolio to the fullest extent possible to facilitate such access.

The Army is committed to expanded collaboration with the HBCU/MSI community. We've started two new initiatives to expand research capabilities and build lasting partnerships: an HBCU/MSI-focused prize competition for students and faculty, and an Army HBCU/MSI Faculty Immersion Program. The prize competition will feature an Army research grant accelerator, where winning faculty and students will be awarded research grants sponsored through the Army Research Office. The Faculty Immersion Program will allow HBCU/MSI faculty to work in Army labs, followed by a period of supported research at their home institution.

Like our Sister-Services, we are fundamentally reshaping the Army's interaction with small businesses with an emphasis on non-traditional vendors, using the SBIR

program. The AFC Army Applications Lab's Special Program Awards for Required Technology Needs (SPARTN) program and the Army's Applied SBIR program are reducing the barriers to entry for SBIR awards and prizes by connecting small businesses with Army Acquisition Professionals using cohort and transition broker team models to connect small businesses performing R&D to Army Program Managers with well-defined needs. These models reduce the barrier to entry through hands-on explanation of some of the more challenging aspects of working with the Army for proposal submission, which can often seem like an insurmountable bureaucratic process. More importantly, these models are yielding more predictable, reliable, and cost effective pathways for technology adoption by helping small businesses focus on PEO-identified capability gaps, and identifying tech insertion points and funding opportunities. Recent SBIR topics have seen a ten-fold increase in submissions, some with up to 200 firms per topic, using a simplified and more intuitive application process (according to the firms). Thank you in advance for your continued support of the SBIR program.

The xTech Program is the flagship Army-wide prize competition, designed to identify and assess technology solutions using rapid vetting of non-traditional small businesses, startups and innovators. The xTech Program eliminates the "pay-to-play" roadblock faced by many cash-strapped businesses by providing: rapid, non-equity dilutive seed prizes, comprehensive feedback from Army experts, and direct exposure to Army and commercial stakeholders through networking, education and mentorship. Since 2018, the program has vetted over 2,000 small business technologies for potential use in Army systems, provided feedback on 16,000 proposals by 1,800 Army Subject Matter Experts, and awarded $11 million in seed prizes, that led to over $40 million in follow-on contracts.

The Army has established a joint governance structure whereby the ASA(ALT) and the CG AFC co-chair the Equipping Program Evaluation Group (EE PEG) to provide resource-informed decision making during the planning,

programming, and budgeting phases. The Army's Acquisition Executive, the ASA(ALT) is responsible for all matters Army Acquisition, Logistics and Technology. The AFC CG has the lead in prioritizing, directing, and executing all S&T efforts, operations, and organizations.

As the Deputy Assistant Secretary for Research and Technology, I support the ASA(ALT) as the Army Chief Scientist and the Service S&T Executive. I work very closely with my AFC "Battle Buddies," to develop the Army's S&T strategy, to plan and program resources, and provide Army Headquarters oversight for a sub-set of the EE PEG's Research, Development, Test and Evaluation (RDT&E) accounts, including the S&T budget activities 6.1 thru 6.3, technology maturation funds (6.4), manufacturing technology (6.7) and the SBIR program.

Under the joint EE PEG governance model, the Army is building a balanced S&T portfolio for near and mid-term technology insertion, for technology breakthroughs and for Basic Research. Our S&T strategy pays careful attention to supporting the signature 31 + 4 modernization priority efforts, while simultaneously supporting research aimed at fundamental, long-term change by investing at least 25% of our applied research and advanced technology development and 100% of our basic research resources to support such projects.

Overall, the Army's S&T portfolio has been strongly supported by the EE PEG co-chairs and the Army Senior leadership, the Office of the Secretary of Defense (OSD), and Congress. So far, the Army continues to hold the S&T budget top-line at zero percent real growth. I, for one, hope this trend continues, and I am very grateful for this subcommittee's continued support. Predictable and consistent funding is absolutely essential for the Army to achieve persistent modernization, and Science and Technology is modernization's foundation.

As the Army S&T Executive, I serve as the interface to Under Secretary of Defense for Research and Engineering (USD(R&E)) representing Army S&T equities, and ensuring S&T alignment with our Sister-Service labs' to address existing and emerging OSD S&T priorities. For example, we are supporting the development of Climate Change plans focusing on research to reduce the emission of green-house

gases. The Army's major emerging contribution is technology to electrify military vehicles, enabling a significant reduction in fuel usage through efficiency, while reducing the need for vehicles to idle to generate electrical power.

Army S&T has faced the COVID-19 pandemic head-on, while still significantly contributing to the modernization of our force. Today, I'd like to highlight for the record a few recent accomplishments of three of our Army Labs.

1. The AFC MRDC supports Army Medicine as the Army's R&D voice in defending the force against COVID in this whole-of-government effort. In the recent past, Army Medicine responded to the Severe Acute Respiratory Syndrome (SARS), Ebola, and Zika outbreaks. Since the outbreak of this pandemic, MRDC labs have leveraged their previous experience to participate in developing a vaccine candidate, therapeutics, and diagnostics in government/private partnerships with significant impact.

2. ERDC supports the Army by providing civil and military engineering, geospatial sciences, water resources, and environmental sciences research and development. ERDC also manages the DoD's High Performance Computing Modernization Program (HPCMP). The HPCMP made important contributions to the Nation's COVID-19 response by providing subject matter experts and HP Computer time for massive simulations of airflow inside cargo aircraft, analysis of potential treatment compounds, and COVID-spread modeling in support of FEMA.

3. Even during COVID, SMDTC's work has provided essential support to the Army's Rapid Capabilities and Critical Technologies Office (RCCTO) mission to deliver Army Air & Missile Defense Directed Energy prototypes to provide additional protection against existing and emerging threats to maneuverable and fixed forces. SMDTC's technical contributions in high energy laser component testing, and system modeling and analysis has helped position for technical success the Directed Energy Maneuver Short Range Air Defense (DE-MSHORAD) and the Indirect Fires Protection Capability High Energy Laser (IFPC HEL) programs, in order to meet rapid fielding requirements by FY23.

Army labs are powered by an S&T workforce that is diverse, technically competent, and highly educated. It is vital for the health of the enterprise to develop and retain a knowledgeable, high performing S&T workforce through a robust recruiting program, timely onboarding (including clearances) of S&T employees, and the reshaping of skill sets to meet emerging challenges. The Congressionally provided special personnel hiring authorities have been critical for Army laboratories to remain agile and competitive with the private sector. In the past year, Direct Hiring Authority has allowed Army labs to hire approximately 600 civilian employees (58% of scientist and engineer hires) in critical fields such as neuroscience, electronics, computer science, materials and aerospace engineering, as well as hiring physicists, biologists, chemists, mathematicians, and social scientists. Thank you for your continued support of these direct-hiring authorities.

To attract and retain world-class scientists and engineers, Army labs must have world-class research facilities and equipment. Due to myriad contributing factors, many research and test facilities have become obsolete and would greatly benefit from revitalization and recapitalization. We are making slow, but steady progress by relying on a spectrum of Congressional authorities to resource and modernize facilities. Army laboratories have benefitted greatly from the authorities granted in sections 2363 and 2805(d) in Title 10 of the U.S. Code. Last year, the Army laboratories invested $164 million in support of section 2363 projects. Of that total investment, $74 million (45%) supported 82 infrastructure revitalization or recapitalization projects. This authority provides the Laboratory Directors greater flexibility in the allocation of resources for laboratory infrastructure construction and facilitates the Army to maintain world-class facilities; however, section 2363 infrastructure projects must comply with the $6 million cost limitation in section 2805(d), Laboratory Revitalization. To enable Army laboratories to meet larger infrastructure, repair and sustainment projects an increase in this limitation should be considered.

In conclusion, I would like to thank the members for their time and oversight of Defense Laboratories and Engineering Centers. Your continued strong support of a world-class science and engineering workforce, modernized research lab and center

infrastructure, and innovative technology transition programs ensures that the Department has the tools for continued success. The acquisition and exploitation of new scientific knowledge is crucial to the of advancement warfighting capabilities and we must safeguard these endeavors as a critical National resource. Army S&T is at the forefront of acquiring knowledge essential to its land warfare mission and of developing technology-enabled capability that will transition to meet the Warfighter dominance needs of the future. Thank you.

Dr. Philip Perconti, SES
Army (Research & Technology) Deputy Assistant Secretary

Dr. Philip Perconti was selected as the Deputy Assistant Secretary of the Army for Research and Technology and Army Chief Scientist in November 2019. He is responsible for policy and oversight of the Army's Research and Technology program, which spans 16 Laboratories and Research, Development and Engineering Centers, employs nearly 12,000 scientists and engineers, and has an annual budget that exceeds $2.4 billion.

In this position, Dr. Perconti is charged with identifying, developing, and demonstrating technology options that inform and enable effective and affordable capabilities for the Soldier. His science and technology portfolio covers basic research to demonstrating component, subsystem, manufacturing technology, and technology system prototypes. It is executed by the Army's research, development and engineering laboratories and centers; academia; and industrial and international partners.

Prior to this assignment, Dr. Perconti served as Director of the U.S. Army Research Laboratory (ARL), the Senior Executive responsible for setting the strategy, mission and programs for the Army's Corporate Research Lab, he focused resources, defined technical competencies, prioritized, and leveraged partners through collaborations to execute and transition high-impact research to meet Soldier technology needs. He was responsible for six major technical business units, with over 3000 government & contractor employees and over $1.2 billion annual budget. He had direct oversite and responsibility for the U.S. Army Research Office (ARO), sponsoring over $300 million/year for University Affiliated Research Centers, grants and other university initiatives.

Dr. Perconti ran the ARL Sensors & Electron Devices Directorate. He was responsible for leading and transitioning the Army's primary basic and applied research programs in sensors, electronics, sensor information processing, and power and energy technologies. In addition, he led ARL's S&T campaign for Materials Research. His duties included operation of unique electronics and photonics materials fabrication and characterization facilities. He started the Army's major research initiatives in Quantum Information Sciences and Artificial Intelligence.

Dr. Perconti ran the Science and Technology Division at the Night Vision & Electronic Sensors Directorate (RDECOM/C5ISR). He led the Army's applied research and manufacturing technology programs for uncooled and high performance cooled infrared sensors; the uncooled technology is used in multiple Soldier night vision and targeting sensors; the cooled (3rd) Gen technology is entering production for the next generation of infrared targeting and reconnaissance systems.

Dr. Perconti was selected in 2013 to the Senior Executive Service. He holds a Doctor of Science degree from The George Washington University. He is a Federal Laboratory Consortium Laboratory Director of the Year and is Northeastern Maryland Technology Council Visionary Leader. He is a Technical Fellow of the Military Sensing Symposium. Dr. Perconti has published extensively on many aspects of military sensing, machine learning and countermine/counter IED technology. He has authored and co-authored over 50 publications, including three book chapters. He holds two patents.

NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES SUBCOMMITTEE ON
CYBER, INNOVATIVE TECHNOLOGIES AND INFORMATION SYSTEMS

STATEMENT OF

MS. JOAN JOHNSON

DEPUTY ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH, DEVELOPMENT, TEST AND ENGINEERING

BEFORE THE

CYBER, INNOVATIVE TECHNOLOGIES AND INFORMATION SYSTEMS SUBCOMMITTEE

OF THE

HOUSE ARMED SERVICES COMMITTEE

MAY 20, 2021

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CYBER, INNOVATIVE TECHNOLOGIES AND INFORMATION SYSTEMS

Introduction

Thank you for the opportunity to address the science and technology (S&T) investment strategy of the Department of the Navy (DON) and the Naval Research and Development Establishment. Since this nation's founding, the United States has depended on naval power to defend its shores and protect free and open ocean commons. As our nation grew, naval power has been enabled by innovation, skilled seamanship, courage, careful planning, and maintaining a technological edge. Today, as we face rapid change in the global security environment—including increased access to technological knowledge and attempts by potential adversaries to dominate emerging weapon technologies—the national security posture is adapting with a sense of urgency and innovation. The DON continues to emphasize acceleration and agility in everything we do to keep our technological advantage and to deliver capabilities faster than our adversaries.

Naval Research and Development Establishment (NR&DE)

As the Deputy Assistant Secretary of the Navy for Research, Development, Test and Engineering (RDT&E), I have responsibility for Naval R&D leadership, policy, and oversight as well as oversight for the technical missions of the naval labs. The NR&DE includes not only the Naval Warfare Centers (Air Warfare, Information Warfare, Surface Warfare, Undersea Warfare, Expeditionary Warfare), the Office of Naval Research (ONR) and the Naval Research Laboratory (NRL), but also now includes the Marine Corps Warfighting Laboratory (MCWL), the Naval Postgraduate School, University Affiliated Research Centers (UARCs) at University of Hawaii, University of Washington, University of Texas, Penn State University and Johns Hopkins University, and Federally Funded Research and Development Centers performing naval work. Providing unique value to the Navy and the nation, the NR&DE commits to innovate, collaborate, and deliver superior capability at the speed of relevance; to identify and develop robust, affordable technical solutions for readiness and modernization; and to apply continuous improvement to drive program success. The NR&DE cultivates unique, yet connected, learning ecosystems that ideate and produce creative solutions critical to enabling the rapid development, delivery, and sustainment of game-changing capabilities for the Navy and Marine Corps.

People

The NR&DE's strength lies in our people – they are our asymmetric advantage. Therefore, we must recruit, train, and retain a ready, relevant, diverse workforce comprised of scientists and engineers as well as business and administrative personnel to strengthen our technical advantage. The Naval Warfare Centers (WCs) and NRL employ a robust Capabilities Health Assessment methodology to identify the pipeline of professionals representing a broad spectrum of core competencies required to execute current and future mission priorities across the full-spectrum life cycle of weapons systems development and sustainment –from basic and applied research, to design and development, test and evaluation, and in-service engineering.

Over 35,000 scientists and engineers are part of the NR&DE. More than 28,000 of these technical professionals are civilian employees within the WCs and NRL, working seamlessly with nearly 7,700 professionals within the UARCs. Given the disruptions and opportunities exposed by COVID-19, we are exploring additional innovations to the future of work. One key area we are reimagining at this very moment is the Naval Science, Technology, Engineering & Math (STEM) program. The NR&DE workforce must reflect the diversity of American society. Through STEM opportunities and research networks to Historically Black Colleges and Universities /Minority Institutions (HBCU/MI), the NR&DE is working to attract talent previously underrepresented in S&T.

Diversity and equity are indispensable to the DON's success. The richness and breadth of ideas and solutions generated by a diverse workforce, collaborating in an environment where individual contributions are visible and valued, will enable the DON to reach its peak potential. In FY 2020, 35 percent of WC and NRL new hires were minorities (by Ethnicity and Race Indicator (ERI)). In the past four years (FY 2016-2020), the WCs and NRL have added more ERI minorities to the higher ranks (27 percent increase), as well as a 32 percent increase of females. To remain ahead, we must continue to modernize the NR&DE talent management framework through solid diversity, equity and inclusion efforts, employee satisfaction, retention, and succession planning. Thanks to the valuable legal authorities provided by Congress in hiring, pay, scholarships, contracting, and other areas of the Science and Technology Reinvention Laboratories (STRLs), the WCs and NRL continue to attract and retain key talent.

Capabilities

Flowing from the National Defense Strategy, to the Office of Secretary of Defense's Research and Engineering Modernization Priorities, the Chief of Naval Operations' Navigation Plan, and the Navy, Marine Corps, Coast Guard Tri-Service Maritime Strategy, our approach is to address technical risk in the Navy's future portfolio by conducting more warfighter informed prototyping, experimentation, and demonstrations. Many of the technologies that are available in the near term are enabled by five to fifteen years of basic and applied research. We are realizing successes today in Directed Energy, Unmanned Systems, Artificial Intelligence and Machine Learning (AI/ML), Microelectronics, Quantum Technologies, and Autonomy as a result of deliberate S&T investments prioritized over the past 20 years. To address near-term needs, we are applying critical thinking and agility, combined with sound systems engineering principles, to identify and implement new ways to use existing weapons systems to deliver different effects, thereby expanding warfighting capabilities at speed while reducing cost.

Autonomy

To support effective Distributed Maritime Operations (DMO), the NR&DE is expanding research and development efforts to develop, mature, and transition AI/ML technologies designed to enhance our ability to identify, predict, and respond to threats; and digital science modeling and simulation technologies to enhance analysis. As a necessary evolutionary response to the new warfighting paradigm, the NR&DE is working to re-envision unmanned systems as Intelligent Autonomous Systems (IAS). IAS are comprised of autonomy and its intersections with both unmanned systems and AI. Autonomous systems provide additional warfighting capability and capacity to augment our traditional combatant force, allowing the option to take on greater operational risk while maintaining a tactical and strategic advantage.

By exploiting the technical revolution in autonomy, advanced manufacturing, and artificial intelligence, the naval forces can create many new unmanned, optionally-manned, and minimally-manned platforms that can be employed in a distributed, networked manner. The IAS approach is particularly relevant in the maritime domain, where the battlespace spans from the seabed to space, and engagements occur across hundreds, even thousands of miles. The development and adoption of IAS is critical to the Navy and Marine Corps' ability to collect and sift the incredible amount of data required for modern warfare in the 21st Century.

Energy Resilience and Climate Change

The Navy and Marine Corps have placed additional emphasis on energy resilience and climate change in the R&D community. We develop naval forces that are capable of responding and handling the increased demand for the Navy's military and humanitarian services as well as overcoming future climate based impairments to deliver lethal capacity.

Seventy-five percent of naval energy and fuel use is operational, used by ships, aircraft, and combat vehicles deployed all over the world. In that context, we also develop capabilities that will reduce the amount of green-house gas emissions naval forces produce through more efficient use of energy. Weapons systems with increased range, longer time-on-station, and smaller logistics tail are central to a more lethal and capable naval force. A resilient ship is one that is more efficient, providing improved persistence on station with the same fuel use.

The Naval R&D community is developing technology that supports climate sensing and mitigation. ONR leads the science and technology development of environmental assessment and prediction as well as advanced energy technology development to adapt our future platforms and advance naval warfighting capability. In partnership with industry, many of the engineers in our WCs and NRL are striving daily to make our platforms more efficient whether developing stern flaps and integrated hybrid propulsion for ships, advanced batteries for unmanned underwater vehicles, or improving solar technology.

Digital Engineering

The DON embraces Digital Engineering as a means to maximize agility, interoperability, reusability, and scalability across the Navy. The Navy and Marine Corps Digital Systems Engineering Transformation Strategy, released in June 2020, specifies activities to enhance our engineering acquisition practices. Our strategy aligns with Department of Defense Digital Engineering Strategy goals, transforms how we support acquisition, and informs designers, developers, managers, and technical authority stakeholders with continuous access to authoritative data. It shifts the practice of systems engineering from traditional document-centric activities to digital-centric activities. It also supports common application across the Navy and Marine Corps, as well as provision and access to digital models and data applied in a Model-based Systems Engineering approach to improve the understanding, quality, consistency and

timely delivery of warfighter capability across all domains, and across all stages of the program lifecycle.

We have established an Integrated Modeling Environment (IME), possessing a suite of Model-Based Systems Engineering (MBSE) tools available to users, programs, and our engineering communities, hosted at the Naval Air Systems Command. Since its inception in 2019, we have grown to over 1,400 IME users, and 1 million hours of cumulative use (as of May 2021). We have also conducted MBSE training sessions for over 7,500 engineering professionals, who are applying those new skills to support the development and acquisition of new systems. We continue to expand our efforts, working with our industry partners to provide a standard of practice that delivers affordable, lethal capabilities to the warfighter at the speed of relevance. Our plans include connecting the IME to the Department of Navy High Performance Computing Network. This will provide potential for "digital threads" of information to be conveyed and used for physic-based models, architectural models, digital testing, digital twins, and data analytics supporting decision-making across the life cycle of programs from inception to development, production, and sustainment.

Project Overmatch

As stated in the CNO's NAVPLAN, our operating concepts require platforms, weapons and sensors to be connected in order to successfully execute Integrated All-Domain actions from a distribute and forward deployed force, as envisioned with the Navy's DMO concept. The success of DMO and the Marine Corps' Expeditionary Advanced Base Operations / Littoral Operations in a Contested Environment concepts is dependent on a robust Naval Operational Architecture (NOA), which also enables naval forces to integrate with the Joint Force for Joint All-Domain Command and Control. Project Overmatch focuses existing efforts and NR&DE expertise to field the NOA in this decade. Overmatch will develop networks, infrastructure, data architecture, tools, and analytics that support the operational and developmental environments that enable warfighter centered design and rapid capability delivery. The NR&DE is the primary engine of technical expertise behind the Overmatch driven NOA capability development, particularly in the technology areas of software defined networking and modern software development practices that enable more seamless digital integration of disparate, distributed systems.

Directed Energy

Directed Energy (DE) weapons will be essential to countering urgent threats from our nation's adversaries. Sustained investment in basic research has allowed the U.S. to remain at the forefront of DE weapons development. The products resulting from basic research - conducted by the NR&DE, commercial firms, and academia - form the foundation of present-day directed energy systems and will enable the next-generation of systems. The Department's investment in DE began in the 1990s in exploring high energy laser technologies and architectures as well as the related issues of high power optics, atmospheric propagation, and effects of lasers on targets. Although it takes years for science to transition to a deployable system, without that fundamental research we are assured that the U.S. would have lost its global technological edge.

Delivering At the Speed of Relevance

Advanced Naval Technology Exercises (ANTX)

Advanced Naval Technology Exercises (ANTX) are designed to identify technologies that can be transitioned to the warfighter within 12 to 18 months. Through the collaboration of industry, academia, and government R&D organizations, ANTXs provide an environment for the warfighter to assess the operational utility of technical innovations as well as a forum for informational exchanges and risk reductions for larger Fleet and Marine Corps exercises. Most importantly, an ANTX allows innovative and non-traditional industry partners to demonstrate their technologies and concepts in near-operational environments and get direct feedback from naval scientists, engineers, Sailors and Marines.

In FY 2020 we executed an ANTX hosted by Naval Air Warfare Center Aircraft Division (NAWCAD). The ANTX was executed over a three-month period to accommodate COVID-19 protocols. The event supported two follow-on OTAs and two CRADAs to continue work with industry and academia. Additionally, the DON recently completed the Naval Integration in Contested Environments ANTX. The event focused on Expeditionary Advanced Base Operations in support of DMO. The event was led by the NR&DE, primarily by Naval Information Warfare Center Atlantic, MCWL, and Naval Surface Warfare Center Crane. The event was conducted at Camp Lejeune from April 5-16, 2021, following strict COVID-19 protocols. The event explored 65 technologies and is currently compiling assessments

performed by engineers, technicians, Sailors and Marines. This ANTX provided an opportunity for the government participants (operational and technical) to experience the innovative technologies being developed by industry, and provided a forum for intellectual exchange between all participants.

Later this year, the Navy plans to conduct another ANTX hosted by NAWCAD. The theme of the event is Joint War At Sea / DMO. The event will be conducted in a Live, Virtual, and Constructive environment and will explore 35 technologies. The Navy is reaching out to Industry and Academia on three technology areas to determine the "art of the possible". The three areas of focus are Resilient Data and Network Communications, UAS Autonomous Technologies and Autonomous Tools and Alternative Position Navigation Timing (Alt-PNT). As part of the FY 2021 NAWCAD ANTX, the Warfare Center will be hosting an Aviation Cyber Rodeo slated for August 2021. The event will focus on aviation cyber test capabilities of NAWCAD, support aviation test events, and disseminate information about vulnerabilities and capabilities to participants.

NavalX and Tech Bridges

Scaling innovation toolsets is key to enhancing the impact of R&D. NavalX, the DON's agile cell, was established in 2019 to consolidate lessons learned from activities such as ANTXs and centrally facilitate rapid adoption of proven agility-enhancing methods across the DON. The small NavalX team guides, empowers, and connects our workforce to achieve pivot speed at an enterprise scale by building workforce capability and hosting workshops, prize challenges, industry events and pitch days to share methods to scale and develop skills. By coalescing talent in networks of collaboration and breaking down silos, NavalX helps accelerate the pace of discovery, learning and experimentation between collaborative partners and the DON.

Through its Tech Bridges initiative, NavalX is building a network comprised of innovation organizations, local industry, academia, small business, and other government entities to increase collaboration, knowledge sharing, and innovation. By connecting DON initiatives, increasing local access to innovation ecosystems, and reducing the barrier between the DON and non-traditional partners, this initiative will accelerate solutions to the warfighter. The Tech Bridge network is comprised of 15 locations both in the U.S. and abroad. Over the past year, this network generated more than 20,000 connections, $50 million in projects such as prizes

challenges and SBIR projects, and enabled more than 126 different projects in subjects like AI/ML; 5G-enabled technologies; advanced materials and manufacturing; maintenance and sustainment; autonomy; and data management.

Infrastructure

The NR&DE is host to a broad spectrum of state-of-the art facilities, laboratories, and ranges that represent the full spectrum of RDT&E capabilities across all warfighting domains. The WCs alone consist of more than 500 unique laboratories and facilities, and five major test ranges. A ready, relevant, mission-focused workforce equipped with unique hands-on expertise and know-how, coupled with government-owned, integrated, multi-level security laboratories, facilities and ranges, provides innovative solutions for rapid prototyping and fielding and technical execution for programs of record. The closed-loop Live Virtual Constructive environments resident within the NR&DE replicate and support multiple missions up to and including the high-end fight.

The DON continues to expand partnerships with industry and non-traditional entities through OTAs, CRADAs, SBIRs, and other agreements, which enables industry to include small business to leverage the unique infrastructure capabilities within the NR&DE to develop, demonstrate, and mature technologies in an operationally relevant environment.

Continued investment in the sustainment and modernization of these one-of-a-kind facilities is imperative to delivering the capability and capacity necessary to support both current and future readiness. Whereas the collective capability of this laboratory enterprise is unmatched anywhere within industry, some of the infrastructure dates back as many as 75 years. Aging infrastructure continues to drive increased requirements for sustainment, restoration, and repair. 10 USC 2363 (formerly known as "Section 219") enables the investment in infrastructure, combined with LRP authorities, continues to be a critical enabler to boosting sustainment, restoration, and modernization of critical laboratory infrastructure.

Improving Technology Security

Historically, the Navy and Marine Corps have enjoyed an overwhelming military capability advantage over adversaries. That advantage is based on the development and delivery of effective systems to the operational Navy. We collaborate with, and depend upon, our defense

industrial base to protect and deliver sensitive, classified programs. These mature, sensitive programs are rooted in fundamental research, facilitated by a dynamic, collaborative, fast-paced "open" research environment, exploring principles of basic and fundamental science. While this open approach is an advantage, it also creates a vulnerability. Therefore, we continue to work with OSD and across the Services to address these challenges in a more systematic way and in consideration of constantly evolving technologies.

Congressional Authorities

The DON wholeheartedly thanks members of Congress for the authorities granted to use for workforce, mission execution, and capability development and delivery. These authorities have been particularly beneficial to the DON, allowing us to develop innovative methods for effective management and mission execution at our warfare centers and laboratories. For example:

Title 10 USC 2363 (formerly Section 219 of Public Law No. 110-417)

This authority continues to pay dividends for the DON, providing the STRLs with another mechanism to enhance technology transitions, advance the technical workforce, expand technical knowledge, and improve infrastructure. In FY 2020, innovation in the following areas were achieved: Counter Small Unmanned Systems, Microelectronics, Machine Learning with Synthetic Imagery, and Digital Thread Additive Manufacturing.

Section 233 of Public Law 114-328

Section 233 granted DoD the ability to pilot changes in methods for more effective development of technology and management functions at eligible centers. The WCs and NRL nearly doubled the number of Section 233 initiatives by implementing a total of 34 management initiatives, which led to greater efficiencies and effectiveness, decreasing processing time by nearly 1.3 million days. The DON appreciates the efforts of the Committee to extend this valuable authority until 2027.

Workforce

The WCs and NRL frequently use Title 5 USC 9905, as amended by the FY 2020 National Defense Authorization Act (NDAA) Section 1109 -- Modification of direct hire authorities for the Department of Defense. NAVSEA alone has used this authority 330 times to date. In FY 2020, we were able to reduce the average time to hire to 65 days, which is approximately 20 days shorter than the overall Navy average over the same time.

The WCs and NRL consider the FY 2016 NDAA Section 1109 -- Pilot Program on Dynamic Shaping of the Workforce to Improve the Technical Skills and Expertise at Certain Department of Defense Laboratories -- to be a valuable authority. The DON STRLs have used VSIPs and VERAs several times in 2020, which has facilitated the shaping of the workforce to better align with future core competencies.

Conclusion

American security rests upon our ability to control the seas and project power ashore. In our digital age, it also requires power projection in space, cyberspace, and along the electromagnetic (EM) spectrum. Successful modern sea control demands all-domain power of our Naval and Joint Force, and we are determined to ensure our Forces are armed with technically superior capabilities.

Within the NR&DE, our continued investment in people, tools, and infrastructure to enable continuous learning, collaboration, agility, and cutting-edge capability to delivery at speed for our naval forces will ensure the preservation of national security and the maintenance of future naval power. I invite you to visit us and our Warfare Centers, NRL, ONR, laboratories, and the UARCs around the country to see firsthand the advances under development. I am honored to have the opportunity to testify before you, and I look forward to your questions.

Joan L. Johnson
Deputy Assistant Secretary of the Navy Research, Development, Test, and Engineering

Ms. Joan Johnson serves as the Deputy Assistant Secretary of the Navy for Research, Development, Test and Engineering (DASN (RDT&E)) under the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN (RD&A)). Ms. Johnson is responsible for executive oversight of all matters related to RDT&E Budget Activities, Science and Engineering, Advanced Research and Development, Prototyping and Experimentation, and Test and Evaluation. She is also responsible for oversight and stewardship of the Department of Navy Research and Development Establishment, which includes the naval laboratories, warfare centers and university affiliated research centers.

Formerly the Executive Director of the Naval Air Warfare Center Weapons Division (NAWCWD), she was responsible for research, development, acquisition support, test, evaluation, and in-service engineering for the total weapon system. Ms. Johnson directed a civilian workforce of more than 6,000 professionals.

Ms. Johnson began her career in industry as a software / systems engineer, researching, developing and integrating software and systems solutions for airborne avionics and Electronic Warfare systems. She also served as Engineering Program Manager and Software Engineering Department Manager for teams developing Electronic Warfare suites for the U.S. Navy, Army and Air Force.

Ms. Johnson entered government service in February 2000 at NAWCWD China Lake. Soon, she was promoted to the position of Weapon System Support Activity Lead for the AH-1 Super Cobra attack helicopter program, where she was responsible for execution of full lifecycle support for the AH-1 Super Cobra mission systems and weapon systems. In December 2003, Ms. Johnson was promoted to head of the Systems Engineering Management Division, providing supervision and leadership to product team leads, chief engineers, and senior engineers supporting weapon systems acquisition, development, and sustainment for naval aviation.

Ms. Johnson entered the Senior Executive Service in August 2008, as Director of Software Engineering for the Naval Air Systems Command (NAVAIR) and Head of the Systems Engineering Department at NAWCWD. In 2013, she became Director of the Weapons and Energetics Department for NAVAIR and served in that position until January 2016, when she assumed the executive leadership of NAWCWD.

Ms. Johnson earned her Bachelor of Science in Chemical Engineering from the University of Virginia. In 2007, she was a recipient of the Naval Air Warfare Center Weapons Division Michelson Laboratory Award for significant contributions to Naval and Marine Aviation. She received the Navy Meritorious Civilian Service Award in 2011 and the Naval Air Warfare Center Weapons Division Dr. L.T.E. Thompson Award in 2013. Johnson has been a member of the Acquisition Professional Community since 2002.

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THE UNITED STATES HOUSE ARMED SERVICES COMMITTEE

IMPLEMENTATION OF THE DEPARTMENT OF THE AIR FORCE SCIENCE AND TECHNOLOGY STRATEGY, POLICY, AND PROGRAMS

Department of the Air Force
Presentation to the
Armed Services Committee
of the United States House
Subcommittee on
Cyber, Innovative Technologies, and Information Systems

Statement of:

Ms. Kristen J. Baldwin, Senior Executive Service (SES)
Deputy Assistant Secretary of the Air Force (Science, Technology, & Engineering)

Hearing Date: May 20, 2021

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RELEASED BY
THE UNITED STATES SENATE ARMED SERVICES COMMITTEE

Chairman Langevin, Ranking Member Stefanik, and distinguished Members of the subcommittee, thank you for the opportunity to provide testimony on the implementation of the Department of the Air Force (DAF) Science and Technology (S&T) Strategy and our continued efforts to respond to the warfighter faster, while simultaneously developing the future force.

As the nature and sources of conflict have become more diverse and less predictable, our nation continues to face a complex set of current and future security challenges, including the resurgence of great power competition from China and Russia. The rapid proliferation of global technology means the speed at which we change must increase. It is clear that supremacy in the air and space domains—a given for any U.S. military operation since the end of the Cold War—can no longer be presumed without deliberate investments in leap-ahead technology. Consequently, the National Defense Strategy shifts our priority, including that of S&T, to high-end warfighting.

The DAF has fully embraced National Defense Strategy objectives. The Air Force and Space Force must be ready to compete, deter, and win in this rapidly changing and increasingly complex security environment.

Developing and Delivering Transformational Strategic Capabilities

The DAF S&T 2030 Strategy calls for an S&T portfolio consisting of a broad-based, enabling and enduring component, and a new transformational component that develops and delivers game changing solutions for entirely new warfighting capabilities.

In response to this call, we established a Transformational Capabilities Office (TCO) to lead the transformational S&T portfolio to develop multidisciplinary, system-of-systems solutions.

The transformational component is focused on developing leap-ahead capabilities that change DAF operations, fueled by emergent technology but pursued from a system-of-systems level, and executed with focus, urgency, and risk-acceptance. It is differentiated by being driven by future force design, cross-disciplinary in nature, and formulated and managed at the Air Force S&T enterprise level. The S&T 2030 Strategy set an initial target for the transformational component to account for 20 percent of the DAF S&T annual budget. As these disruptive "first in class" systems mature, critical work aligning S&T and advanced component development is necessary and appropriate to bring these innovative technologies into programs of record through robust experimentation and prototyping. These multi-budget activity efforts shorten technology transition timelines, mitigate risk, and reduce acquisition cost.

We have implemented a number of new procedures to identify, prioritize, and govern the transformational component investment. The DAF Warfighter Technologist (WARTECH) process engages with warfighters and technologists to collectively ideate and jointly mature transformational component proposals that address future force requirements. The TCO also manages new competitive processes to ensure a continuous pipeline of ideas. These novel "Seedlings for Disruptive Capabilities" and "Explore" efforts pursue high risk areas of the Air Force and Space Force future designs and drive investments and partnerships that contribute to transformational solutions. The TCO achieved Initial Operational Capability in September 2020, and through the above processes, generated 235 submissions, matured over a dozen Seedling and WARTECH projects, and is executing three multidisciplinary Vanguards.

Vanguards

Within the transformational component portfolio are a select number of premier programs. These Vanguard programs represent a new model for accelerating the pace of

transitioning solutions. From the start, Vanguard program offices are built differently – a collaborative team of personnel from the S&T, acquisition, operator, and test communities. Vanguards also aim for significant technical achievements, not only for component technologies but also integrated systems and systems-of-systems that demonstrate the viability of leap-ahead capabilities to warfighters and the future force. To date, there are three active Vanguard programs moving towards maturity and transition: Skyborg, Navigation Technology Satellite-III (NTS-3), and Golden Horde.

Skyborg is an enabler for airborne combat mass by building an autonomy foundation for a family of layered, unmanned air vehicles. The program is built on a partnership between the Program Executive Officer for Fighters and Advanced Aircraft, the Air Force Research Laboratory (AFRL), and warfighters. Using open system architectures, digital tools, rapid software development, modularity, and expandability, Skyborg represents an innovative way to employ combat capability at a fraction of the cost of traditional systems. Initial hardware and software are currently in the development and integration phase and expected to be flown this summer and fall.

NTS-3 is developing advanced techniques and technologies to detect and mitigate interference to positioning, navigation, and timing capabilities and is increasing satellite navigation (SATNAV) system resiliency for military, civil, and commercial users. From geosynchronous orbit, NTS-3 will conduct one year of experimentation to augment Global Positioning System (GPS), space-qualify multiple integrated advanced technologies, and test concepts of operations for end-to-end resilient satellite navigation. These include electronically-steered phased array antennas, flexible and secure signals, software-defined GPS receivers, ground control segment automation, and use of commercial ground antennas. To date, the

Vanguard has successfully completed software implementation of the first advanced SATNAV signal in the NTS-3 experimental receivers. In partnership with industry, we have entered the manufacturing and test phase and are building components that will create the reprogrammable and modular SATNAV payload and flexible phased array antenna system that will broadcast high-power signals during the on-orbit demonstration. Shipping of the satellite bus from our partners' manufacturing facility to the test and integration facility is anticipated later this year and integration of the advanced payload to the bus in subsequent months. Launch is slated for Fiscal Year 2023.

Golden Horde is demonstrating the mission effectiveness of networked collaborative weapon capabilities for our warfighters. Networked collaborative weapons share data, interact, and develop and execute coordinated actions or behaviors across an entire group of weapons. The program successfully completed a flight test in February 2021, which included four Small Diameter Bomb weapons in collaborative flight and synchronized time-on-target. We are now beginning a new phase to plan and build a digital environment, with a government-owned reference architecture where various collaborative autonomous networked technologies can be rapidly tested and improved.

Rapid transition of emerging technologies into warfighters' hands is imperative to ensuring the DAF stays ahead of potential adversaries. Robust experimentation and prototyping enables risk reduction of disruptive technologies and employment of existing systems in new ways to understand the operational competitive advantages and quickly integrate them into our force structure. These investments provide critical insights into operational utility and technical feasibility of a new warfighting concept, and inform appropriate acquisition pathways. The DAF Strategic Development Planning and Experimentation (SDPE) Office, located within AFRL,

executes these prototyping and experimentation activities, focusing on the most significant operational needs identified by senior DAF leadership, and teams from Space Force Futures & Integration and Air Force Futures.

A few examples will help illustrate the impact of our current prototyping and experimentation work. The Global Lightning effort is empirically testing the operational utility and competitive advantages of using commercial space-based internet to deliver robust gigabit-per-second class data rates and low latency communications to support tactical missions, in conjunction with traditional military communications. Our strategy has been to select a small number of platforms (i.e., AC-130, KC-135, and F-35) and rapidly deployable ground terminals, conduct field testing, and then transition to operational deployments. This successful effort has already resulted in five transitions into programs of record, with initial capabilities on track for fielding in 2023. Global Lightning is also a great example of cooperation across the Services and Commands, and has featured testing events with Army, Navy, Defense Advanced Research Projects Agency (DARPA), U.S. Northern Command (USNORTHCOM), Air Combat Command, and other partners.

Additional successes include fielding of directed energy weapons as part of an operational theater deployment to assess utility in real-world applications; successful two-ship flight experiment in support of the Skyborg Vanguard at China Lake, California, in November 2020 that validated autonomy behaviors and the modeling and simulation environment; and demonstration of the Rapid Dragon palletized munitions prototype in support of an initial capability for cargo aircraft to deploy existing long-range munitions. Joint Air-To-Surface Standoff Missile – Extended Range live-fire tests from a C-130 are scheduled for December 2021 and from a C-17 in March 2022.

In addition to accelerating development of individual system capabilities we also need to bring families of systems (or systems-of-systems) together into a unified DAF technical architecture. Two primary lines of effort will produce this holistic architecture. First, we will create and mature architectures that are oriented both horizontally across mission areas and vertically within programs and platforms themselves. Second, we will experiment with and test these systems-of-systems through Architecture Demonstration and Evaluation events. Architecture Demonstration and Evaluation events not only focus on networking solutions in support of Joint All Domain Command and Control (JADC2), but also provide the ability to identify mission-critical gaps and potential solutions that might not have been found through program specific developmental and operational testing. By building a common department-wide technical architecture using open systems and open standards we will be able to adapt and upgrade components, systems, platforms, and systems-of-systems quickly in response to threats or opportunities as technological advances are made.

DAF S&T--One Lab for Two Services

The DAF is committed to the missions and superior capabilities of the Air Force and Space Force. As concepts and capabilities emerge for the space warfighting domain, S&T is agnostic. Technological breakthroughs routinely provide multidisciplinary benefits. Autonomy, quantum, and microelectronics technological advances cut across domains and will benefit both the Air Force and the Space Force. Rapid densification carbon-carbon was initially explored for intercontinental ballistic missiles, but is now transitioning to space launch vehicles and solid boosters.

The AFRL will remain one laboratory supporting both the Air Force and the Space Force. To facilitate integration and coordination, we established an additional position within AFRL,

the Deputy Technology Executive Officer (TEO) for Space S&T. The Deputy TEO is charged with integrating the development and execution of Space S&T efforts across all domains and technology areas. The Deputy TEO engages with the space enterprise to align AFRL's technical portfolio to spacepower core competencies. Through the Deputy TEO, research and development advancements across government, commercial, and academic sectors are leveraged to optimize space S&T.

Deepening and Expanding the S&T Enterprise

In Fiscal Year 2021, the DAF expanded and strengthened its partnerships, drawing technology out of universities, industry, and other government organizations. We leveraged resources and talent in basic research, as well as made great strides in bolstering our relationship with non-traditional industry.

Partnerships

Leading in innovative partnerships, AFWERX continues to transform the way we work with commercial companies. AFWERX experienced several modifications last year, including a move to Air Force Materiel Command, where AFRL provides organize, train, and equip functions, while the Service Acquisition Executive maintains overall strategic oversight. In December 2020, the approval of SpaceWERX was announced followed by the merger of AFWERX with the Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Center of Excellence in January of this year.

Starting in 2018, the DAF explored ways to lower barriers for commercial tech companies to enter into the defense market. By partnering the AFVentures process with our SBIR/STTR team in 2020, we awarded over 2,000 contracts worth $700 million to 1,400 small businesses, with over 75 percent of the recipients being new partners with the DAF.

In addition, the DAF explored ways to further enhance military missions by accelerating emerging commercial markets. To that end, Agility Prime was launched under AFWERX to operationalize electric vertical takeoff and landing vehicles (i.e., "flying cars") from the commercial market. Agility Prime has been leveraging the DAF's unique technology, testing, and safety resources to mitigate current commercial market and regulatory risks, as well as attract investors, build confidence, and expedite commercialization. We appreciate the support of Congress on this effort.

Through the use of Technology Interchange Meetings (TIM) with U.S. companies, the DAF leverages approximately $5 billion of investments in its Independent Research and Development (IR&D) program. On average, AFRL annually conducts five major TIMs, connecting with approximately 50 industry leaders per year, to couple areas of focus between the DAF and IR&D initiatives and to further leverage industry investments toward Air Force and Space Force mission needs. In Fiscal Year 2020, COVID significantly impacted classified IR&D engagements with a number of our industry partners.

In April, the DAF requirements and technology leaders hosted the first bi-annual Strategy Interchange Meeting (SIM). This multi-day event was open to large, medium, and small businesses, academia, and national laboratories and provided an opportunity for exchange with DAF leaders and discussion of strategic direction, priorities, future capability needs, and technology challenges. Plenary and one-on-one sessions were held with participants to discuss emerging concepts and innovative solutions.

International partnerships remain a strategic imperative and the DAF continues to work with partner nations to collaboratively develop and adopt game-changing technologies to meet near peer adversary innovation and investment. In Fiscal Year 2020, DAF subject matter

experts were involved in over 220 activities and technical interchange opportunities, attending virtual conferences, participating in scientist exchange programs, and attending various events for the North Atlantic Treaty Organization (NATO) and the Five Eyes (FVEY). Currently, over $500 million of the DAF S&T is associated with international partner agreements and grants across multiple nations. These partnerships extend and leverage international expertise in all of the DoD modernization priorities. For example, the DAF in partnership with OUSD(R&E) Mission Prototypes (MP) is collaborating with the Royal Australian Air Force (RAAF) on the Southern Cross Integrated Flight Research Experiment (SCIFiRE). SCIFiRE leverages nearly two decades of the DAF S&T investments in the field of hypersonics and will advance air-breathing hypersonic technologies into affordable, full-size prototypes providing flexible and long-range capability, culminating in flight demonstrations in operationally relevant conditions. The deliberate partnership with Australia could lead to future co-development and/or co-production of various systems and subsystems to increase industrial base capacity.

Research and Tech Protection

Preserving our technological advantage requires a comprehensive approach that fosters technology development, integration, and fielding, while protecting critical mission capabilities and technologies against unwanted transfer or interference, without discouraging the participation of the talent and partners that we wish to attract and engage. Open collaborations are critical to the DoD, yet we must protect against those who would seek to exploit the openness that is the basis for our innovation potential, economic strength, and national security of the U.S. We must uphold our fundamental principles of integrity, openness, reciprocity, merit-based competition, and transparency. This requires alignment across the DoD and our Agency

partners, the defense and commercial industrial base, academia, and equally important, our international allies and partners.

The DAF acquisition, technology, and intelligence stakeholders are collaborating to improve threat awareness, inform process controls, and implement best practices and standards. We are an active participant in an OSD-led research protection group comprising all Services and other Defense Agencies. We are piloting the application of open source analysis to examine risks associated with research grants, including conflict of interest and conflict of commitment. These efforts are informing strategies and processes that will implement government-wide guidelines for critical technology protection.

Human Capital

The DAF S&T Strategy recognizes technological superiority depends on the talent and innovative spirit of our workforce. Competition for technical talent will continue to intensify and the DAF is committed to building a highly-qualified and diverse team. AFRL is implementing a new human capital approach that institutionalizes strategic foresight; incorporates scanning, piloting, and application of best workplace practices; seamlessly integrates the human capital lifecycle; and fortifies the alignment of a Human Capital Strategy to the enterprise learning, organizational agility, and capability delivery needs of the organization. Importantly, this approach also incorporates a data-driven decision making framework focused on workforce enablement, productivity, optimization, organizational agility, collaboration, and satisfaction. This approach was reviewed and endorsed by two independent panels of academia, industry, and government science and technology experts via the Fall 2020 Scientific Advisory Board and again at the Spring 2021 Air Force Studies Board.

The competition for the right talent drives us to focus our processes and policies to recruit, hire, and retain top talent. We are appreciative that the National Defense Authorization Acts of the past several years have provided additional personnel authorities to the S&T community. In particular, the Science and Technology Reinvention Laboratory (STRL) Direct Hire Authority (DHA) flexibilities allow us to quickly hire and use executive headhunter recruitment firms for hard-to-fill senior leader positions. With these authorities we have been able to fill over twenty Air Force positions with top-notch talent in cutting-edge areas, including Communications and Networking, Modeling Simulation and Analysis, Microelectronics, Data Analytics, and Autonomy. Maintaining our advantage also requires hiring technology leaders at industry-comparable speeds. The AFRL has expedited hiring timelines, and also expanded the use of many flexible personnel management authorities, to include more use of telework options and alternate work schedules such as Flexitour, Maxiflex, and Compressed across the enterprise. In our pursuit of removing roadblocks and continuously scanning for best practices, AFRL most recently adopted five new S&T Reinvention Laboratory (STRL) flexibilities from other DoD Laboratories. Additionally, AFRL spearheaded the push for an STRL omnibus federal register to obtain seven novel incentive authorities to help us obtain and retain world class diverse talent.

The AFRL's Office of Scientific Research (AFOSR) provides more than 1,500 grants valued at approximately $450 million to over 200 U.S. universities annually. Our outreach to Historically Black Colleges and Universities/Minority Serving Institutions (HBCU/MSI) provides $4.5 million in grants annually. While AFOSR is an excellent example, other AFRL mission organizations contribute significantly above these numbers to meet their specific mission needs, including over $20 million in additional grants to HBCU/MSIs.

Science, Technology, Engineering, and Math (STEM) K-12 outreach is also an important component to building the workforce of the future. The DAF conducts more than 3,000 STEM outreach events per year, leveraging local, state, and federal organizations to reach nearly 125,000 students and teachers across the country. This outreach allows us to attract students to possible DAF careers. To create a more cohesive STEM ecosystem-focused program, the Air Force K-12 STEM Team is engaging in a three-year strategic plan initiative focusing on a holistic education framework for creating both local and national STEM experiences. Our goal is to create a bridge between current K-12 STEM outreach efforts and undergraduate/graduate internship and scholarship programs that will promote increased diversity and inclusion in the future DoD talent pool.

Digital Transformation

The DAF recognizes near-peer nations are accelerating the evolution of their warfighting capabilities at a rapid pace through significant investment in research and development and digital transformational initiatives. Meanwhile, our ability to field capabilities continues to slow down due to our ever-increasing weapon system complexity. Not only must the U.S. develop new, disruptive capabilities, we must address how we develop and acquire technologies and get them to the field at the speed of relevance. Acceleration will depend on three key imperatives:

1. We must enable capabilities to operate in shared cross-organizational, virtual environments that all the services, industry, and our academic partners can use.
2. We must apply smart coding and containerization to bring automation and secure functionality to end users and warfighters.

3. We must follow "eCreate" practices in the development of our systems to identify issues earlier, iterate faster, and optimize solutions in a safe, and less expensive, virtual environment.

This transformation is built upon a "digital trinity" of digital engineering, agile software development, and open systems architecture. Fully digital approaches will be used to assist in managing our engineering, research, mission, and business system development. Agile software development will provide assured continuous improvement in security and capability delivery. Open systems architecture will maximize our mission flexibility, drive acquisition competition, enable access to innovative technologies, and lead the way to relevant modernization. Also at the core of our digital transformation efforts is developing and maturing our workforce to adopt an advanced level of digital proficiency. Enabled by this Digital Trinity, and a digitally capable workforce, this transformation is the only way to avoid delivering today's technology for tomorrow's fight.

S&T Portfolio

The DAF S&T budget supports the people and facilities needed to conduct three major missions: enable the long-term DAF vision through maturation of technology, develop subject matter expertise via conducting research and development in those areas, and transition product and knowledge through a variety of means including industry, programs of record, and the warfighter directly. Using technology horizon scanning capabilities and demand signals from Major, Field, and Combatant Commands, we execute a balanced technical portfolio maturing technical solutions for current and future challenges. To facilitate transition of knowledge and products, the AFRL works closely with stakeholders throughout the Department enterprise,

industry, and other Services. This engagement includes active participation in the OSD Communities of Interest focused on the modernization of the military.

Despite COVID-19, we had an exceptional year responding to both emergent and enduring technology needs for the DAF while pushing the leading edge of S&T. Aligned with the DoD Modernization Priorities, below are more details on the many high quality science and engineering efforts across the DAF.

Artificial Intelligence & Autonomy

Artificial Intelligence (AI) is increasingly critical to national security and achieving the current and future Air Force and Space Force missions. Recent successes in autonomy and AI include the operational deployment of AI models to analysts in the Air Force Distributed Common Ground System (DCGS), resulting in a 90 percent reduction in time required to produced labelled data; demonstrating a prototype that optimizes the control of satellite communication beams; conducting data processing on the edge and enabling the dissemination of tactical information for real-time decision making with a reduced bandwidth by a factor of 100 to 1,000X; and delivering a software upgrade that increased analyst productivity by making an existing manual, time-consuming process autonomous. This new automation reduced the work per file by 99.97 percent and greatly increased U.S. Southern Command mission effectiveness to track drug smugglers. In December 2020, the Air Force demonstrated the ability for AI to assist our intelligence, surveillance, and reconnaissance mission by having an AI system fly as a co-pilot for the U-2 Dragon Lady. While the AI only controlled the sensors and tactical navigation systems, the event showed that trusted AI systems will play a critical role in future Air Force operations.

Also of note is our leadership in Trusted AI, where we are hosting a Trusted AI Workshop series to bring together national experts from industry and academia to outline the technical challenges associated with certifying self-aware learning systems to safely and reliably operate in society with the appropriate level of autonomy.

Biotechnology

Our biotechnology portfolio takes advantage of advances in the tools and understanding of this growing area, and seeks to transcend current constraints to build new materials for military systems, enable new methods for sensing and monitoring, augment performance, protect the warfighter from extreme environments, and ensure readiness. For example, physiological sensors and predictive analytics have enhanced operator and environmental state assessment, leading to increased readiness for multiple operational communities, including special operators, aircrew, and maintainers. Other recent successes employ synthetic biology to overcome supply issues of critical materials systems, develop biomolecules with enhanced optical properties for laser eye protection, and use biocementation for dust mitigation/prevention of brown outs. Peer competitors continue to pursue biotechnology and human performance as a cornerstone of their military strategy; as such, the service laboratories, including AFRL, are closely coordinated through OSD-led communities of interests to leverage each other's investments, areas of expertise, and focus areas. We are also collaborating with a number of international partners to advance materials and human performance research.

Cyber, Advanced Communications, and 5G

Cyber operations are of increasing importance to all Air, Space, and joint missions, and central to Air Force and Space Force objectives for Joint All Domain Operations. The AFRL's Cyber Science and Technology investment is focused on basic and applied science in

electromagnetic and cyber convergence, as well as assurance of complex systems. We have shaped the development and integration of advanced command, control, communications, intelligence, and cyber capabilities to meet warfighter needs for future multi-domain effects delivered through the cyber domain. We would be happy to share more information in a classified setting.

In recognition of 5G's significantly greater capacity, enhanced data rates, and lower latency compared to today's 4G long-term evolution (LTE) cellular networks, we are partnered with the Office of the Under Secretary of Defense for Research and Engineering on several initiatives leveraging 5G capabilities, including distributed and mobilized command and control, improved flight-line operations, augmented reality for improved training, and dynamic spectrum sharing with several Air Force systems. These are joint-service activities that include our Army and Navy partners, as well as our industrial base contractors. We also work with our international partners through cooperative agreements to explore the challenges and potential of 5G technology.

We bring together industry partners for collaboration in these areas though innovative outreach vehicles through events such as Hack-a-Sat and Tech Warrior: Cyber Ops. In-house talent also works closely with academia though visiting professorships, internships, and educational partnership agreements to shape foundational research. Development of the junior scientific workforce's cyber skills is also a priority, and AFRL-sponsored training like the Machine Learning Boot Camp ensures a continuous pipeline of talent in this critical area.

Directed Energy

Directed Energy (DE) weapons harness the power of the electromagnetic spectrum to enable Airmen and Guardians to effectively and affordably strike critical targets across multiple

domains at the speed of light. To meet today's small unmanned aerial system (sUAS) threat, AFRL is developing DE systems that can sequentially defeat multiple UASs singly and in swarms. As part of the DAF Directed Energy Experimentation Campaign, we continue progress on the first-ever extensive overseas field evaluation consisting of four counter-sUAS weapons—three high energy laser systems and one high power microwave system. The three laser systems, together known as High Energy Laser Weapon System (HELWS), have completed weapons system characterization tests, are deployed in the hands of the warfighter, and represent the first-ever Air Force operational DE systems. The first high powered microwave system for counter-sUAS, Tactical High Power Operational Responder (THOR), has undergone its own risk reduction and system characterization efforts and preparation for overseas deployment, allowing users to provide operational feedback and enable improvement to future systems.

Microelectronics

Maintaining and enhancing a technological advantage in microelectronics over our peer adversaries is essential for our national defense but greatly challenged by the globalization of this technology area. Thanks to the congressional authority that enabled us to hire top talent with enhanced pay authorities, we are postured to address this challenge through rapid adoption of leading commercial advances and development practices, enhancement of a digital engineering infrastructure, and targeted extension of a robust supply chain for DoD-unique needs and microelectronic solutions.

We are adopting microelectronics development processes that mirror the best of U.S. commercial industry leaders and extend our cloud-based infrastructure to support rapid innovation among academic, small business, and industrial base partners. We piloted digital

engineering evaluation techniques and digital thread technologies to enable the use of state-of-the-art microelectronic devices in our systems by providing the needed trust and assurance.

We continue to explore emerging microelectronic advances leveraging commercial semiconductor processes for high-end, DoD-specific operating environments, and capitalize on our organic government expertise and facilities to propel these forward.

Quantum

The DAF is prioritizing the acceleration of quantum technologies by committing resources in response to demand signals and establishing the vision to make the operational use of quantum a reality. As such, the Acting Secretary for the Air Force in accordance with Section 220 of the National Defense Authorizations Act for Fiscal Year 2020 designated AFRL as a Quantum Information Science Research Center. The center engages with public and private organizations, including academia, to enhance and accelerate the research, development, and deployment of quantum information science as well as quantum information science-enabled technologies. The DAF continues to align with OSD's modernization strategy and invest in the four primary application areas of quantum information science (QIS): timing, sensing, communications/networking, and computing. In the area of quantum timing the AFRL is developing deployable air/space atomic clocks with picosecond per day drift for more precise synchronization of platforms, weapons, and sensors in contested environments. The AFRL is also leveraging commercial investment in quantum computing hardware and focusing on investigating quantum algorithms to solve computationally-hard problems faster than conventional computing systems.

We are taking a strategic stance on long-term foundational advancements in order to drive and establish the future industrial base that will enable the U.S. to dominate the battlefield

of the future. Together with industry, academia, and government, we are building a quantum ecosystem by developing the supply chain through the recently-completed Virtual Quantum Collider and the One-Million Dollar International Quantum U Tech Accelerator to accelerate the rate of advancements in the field. Through these efforts, we awarded 35 contracts of $150,000 each to 23 small businesses and universities for a total exceeding $5 million to accelerate our learning and implementation of these technologies.

Space

The DAF S&T Portfolio is addressing threats posed to the space domain and developing new technologies to maintain superiority over our near peer adversaries. In support of Space Domain Awareness, the Starfire Optical Range and the Maui Optical and Supercomputing Site facilitate detection and characterization of dim and maneuverable objects in space. Another focus is the space element of JADC2, advancing space communications and implementing a future hybrid space architecture, shifting from single application satellite constellations to interconnected constellations that disaggregate functionality and provide resiliency in the face of advanced and projected threats.

The commercial space sector has enabled new approaches to technology maturation. An example is AFRL's modular rocket engine program. This affordability-driven initiative with small launch service providers will reduce the time it takes to develop and field a new engine by 80 percent and cut costs by 50 percent. It also enables industry to quickly modify their commercial products to capitalize on emerging DoD requirements for tactically responsive space access.

AFRL's continued leadership in space S&T is exemplified by numerous Public-Private Partnerships and Cooperative Research and Development Agreements (CRADAs) with over a

dozen commercial space companies interested in access to DAF facilities and expertise. The AFRL and Space and Missile Systems Center will conduct a rapid launch ground operation demonstration with industry partners this year, fostering deeper understanding across the enterprise of the challenges with rapid launch operations.

Hypersonics

Our near-peer adversaries will contest access to all warfighting domains – air, land, sea, space, and cyberspace. Therefore, we must field a combination of weapon systems and effects with greater speed, reach, and survivability to deter, fight, and win the wars of the future. Hypersonic systems, which fly at speeds of Mach 5 and greater, offer the potential to significantly reduce our response times and engage time-sensitive and high value targets in highly contested environments with greater effectiveness. The DAF continues to partner with DARPA to develop, demonstrate, and transition critical technologies for air-launched hypersonic cruise missiles and boost-glide weapons by FY22. Together, we are transitioning glide vehicle, solid rocket motor, ordnance, and manufacturing technologies from the Tactical Boost Glide (TBG) and High Speed Strike Weapon Technology Maturation (HSSW Tech Mat) programs to the Air-launched Rapid Response Weapon (ARRW) rapid prototype program.

Vitally important as well, the DAF works closely with the DoD, Department of Energy, National Aeronautics and Space Administration, industry, universities, and allied partners to prioritize, execute, and coordinate science and technology development for hypersonic weapons, air platforms, and tactically responsive space access.

Manufacturing Technology

Our Advanced Manufacturing Office provides a focus on transition of advanced manufacturing technologies (e.g., additive manufacturing, digital thread, automation and

robotics, augmented/virtual reality). Activities include standardized guidelines and processes, and engagement with our Air Force and Space Force Program offices and Materiel Enterprise to place them into practice.

To fully accomplish technology modernization, we must ensure we have the ability to manufacture the components. Whether supporting a prototype of a weapon or a Vanguard, microelectronics, or an upgrade to a current system, new technological components all must be producible, ultimately at the volume and speed needed by our warfighters. The DAF is an integral partner in the management of six of the DoD's Manufacturing Innovation Institutes (MII). Involvement with industry experts and the MIIs provides the opportunity to inform and leverage resources, and creates awareness of the DAF's needs with broad networks of companies and universities. These networks of small and non-traditional providers also foster development of future human capital necessary to sustain our domestic manufacturing enterprise.

Conclusion

The DAF continues to push the boundaries of modern technology while improving the science for tomorrow. Above all, we have a workforce that is truly special, driven by a tireless devotion to learning difficult specialties, making significant discoveries, and applying expertise and creativity to novel problems. Thank you for your strong support of the Air Force and Space Force S&T, the authorities you have provided, and this opportunity to testify.

Kristen Baldwin
U.S. Air Force
Deputy Assistant Secretary (Science, Technology, and Engineering)

Kristen J. Baldwin, a member of the Senior Executive Service, is Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering, Office of the Assistant Secretary of the Air Force (Acquisition, Technology and Logistics), the Pentagon, Washington, D.C. Ms. Baldwin provides guidance, advocacy, and policy for the Air Force's annual $2.6 billion science and technology program and $1 billion developmental prototyping and experimentation program, conducted at 40 research sites worldwide. She provides engineering and technical management direction on digital engineering, cyber resilient weapons, corrosion control, capability development planning, and the functional management of more than 14,000 military and civilian scientists and engineers. In addition, she is responsible for providing technical advice and counsel to the Air Force Acquisition Executive on a broad range of engineering and technical management areas. As part of this role, she oversees the Air Force's international science and technology outreach via various bi-lateral and multi-lateral engagement fora, including the NATO Science and Technology Organization and the NATO Air Force Armaments Group.

Before this appointment, Ms. Baldwin served as the Deputy Director for Strategic Technology Protection and Exploitation within the Office of the Under Secretary of Defense for Research and Engineering. She was the Department of Defense (DoD) lead for maintaining technology advantage by mitigating exploitation and vulnerabilities of critical missions, programs, technologies, and the industrial base. Ms. Baldwin oversaw program protection policy and related hardware and software assurance, anti-tamper, and eritical technical information proteetion practices.

A member of the Senior Executive Service since 2007, Ms. Baldwin has also served as Acting Deputy Assistant Secretary of Defense for Systems Engineering; and Deputy Director, Software Engineering and System Assurance. Before joining the Office of the Secretary of Defense, Ms. Baldwin served as a science and technology advisor in the Army's Office of the Deputy Chief of Staff for Operations and Plans. She began her career at the U.S. Army's Armament Research, Development, and Engineering Center, Picatinny Arsenal.

Ms. Baldwin is a recipient of the Meritorious Presidential Rank award in recognition of exemplary service, and the National Defense Industrial Association Lt Gen Thomas R. Ferguson, Jr., Systems Engineering Excellence Award. She holds a Bachelor of Science in Mechanical Engineering from Virginia Tech and a Master of Systems Management from the Florida Institute of Technology.

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

MAY 20, 2021

QUESTION SUBMITTED BY MR. LANGEVIN

Mr. LANGEVIN. Last year Minerva, the social science program that is vital to cyber and terrorism research, was zeroed out. We had to restore $17M in funding. Has R&E decided to prioritize this type of research this year?

Ms. MCQUISTON. The advancement and application of social Science is important to the Department's mission. The Minerva Research Initiative is a unique approach to basic social science research in areas of importance to national defense. The Department included $4M in the Fiscal Year 2022 president's budget request to support the Minerva Research Initiative, and it is the Department's intention to make budgeting for social science research a priority in FY23 and beyond. Minerva has provided valuable capabilities to the Department in the past and I have every expectation that it will continue to do so in the future.

QUESTIONS SUBMITTED BY MR. FRANKLIN

Mr. FRANKLIN. Each branch has its respected form of small business innovation research (SBIR); how can we streamline the process and encourage efficiency and competition?

Ms. MCQUISTON. DOD is committed to streamlining and modernizing the processes of its Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) programs. My office oversees the participation of 16 DOD Components in the Department's SBIR/STTR programs, and a key part of that mission is to develop policy to streamline and modernize program processes. My office holds regular DOD SBIR/STTR Program Manager's meetings with the intent of fostering coordination and de-confliction across the Components and providing a forum for collaboration of best practices for outreach, contracting, and program improvement. Another example of one of our recent efforts to modernize and streamline the program is the replacement of our legacy portal, which was at the end of its useful life and could not operate within a secure environment. My office awarded an SBIR Phase III to develop the Defense SBIR/STTR Innovation Portal (DSIP), which offers a suite of tools to enable the Department to better manage the program and provides new administrative capabilities we have not had before.

Mr. FRANKLIN. How can we assure the necessary level of information security is being maintained (ie CLASSIFIED information) with partnered institutions/universities without creating a negative impact on innovation

Ms. MCQUISTON. The Department must be judicious in applying information security requirements in a manner that does not stifle innovation with our partners in industry and universities. Because there are more categories of information than just classified or unclassified, we must use a tiered approach to information security so that we can secure information about our most sensitive capabilities while still allowing collaboration in the early stages of research. Some of our most innovative ideas come from unclassified fundamental research which has very few security protocols associated with it.

For fundamental research, we require that researchers operate in a transparent manner that is in keeping with academic norms of research integrity. Once specific military applications or national security concerns are identified in research, that research may be regarded as controlled unclassified information (CUI). For CUI, the Department may choose to fund a DOD lab to continue the work, or DOD may choose to continue funding a university with capabilities to provide additional security measures; in such a case, the university is willing to accept restrictions on people and publications, as well as to adopt information technology security measures. R&E is currently working with The Office of the Under Secretary of Defense for Acquisition and Sustainment to finalize the Cybersecurity Maturity Model Certification standards which would serve to protect any Controlled Technical Information (such as CUI) from cyberattacks or other means of collection by adversaries.

Mr. FRANKLIN. Many of you have expressed your respective branches investing in STEM programs for students; how many of those students are being retained in our Federal workforce?

Ms. MCQUISTON. The Department has a variety of workforce initiatives in STEM education, especially at the postsecondary levels, mainly in the form of fellowships, scholarships, and internships.

The best example of how the Department has been able to transition and retain those students into the federal, and specifically DOD workforce, is through the Science, Mathematics, and Research for Transformation (SMART) Scholarship Program. The SMART program awards highly competitive scholarships-for-service to undergraduate and graduate students in 21 STEM academic disciplines and hires the students, upon graduation, into DOD's workforce.

Since the program inception in 2006, SMART has awarded 3,367 scholarships to students pursuing undergraduate and graduate degrees in STEM disciplines. SMART has transitioned a total of 2,277 students into the DOD workforce. To date, the program has a 91% success rate of students completing, or on track to complete their service commitment.

Mr. FRANKLIN. Each branch has its respected form of small business innovation research (SBIR); how can we streamline the process and encourage efficiency and competition?

Dr. PERCONTI. The Army's Small Business Innovation Research (SBIR) program is nested within the broader Department of Defense (DOD) SBIR program; and is executed in concert with each individual DOD Components' programs. While the Army SBIR program is focused on Army modernization and Army PEO/PM capability gaps, the overarching construct and requirements for the program are dictated by the Small Business Administration and the Office of the Undersecretary of Defense for Research and Engineering (OUSD, R&E) Small Business and Technology Partnerships Office. The Army is looking forward to taking full advantage of the simplified processes implemented by OUSD(R&E), including a common submission portal and proposal requirements to streamline the SBIR process while encouraging efficiency and competition across the small business community.

Mr. FRANKLIN. How can we assure the necessary level of information security is being maintained (ie CLASSIFIED information) with partnered institutions/universities without creating a negative impact on innovation

Dr. PERCONTI. While we are very mindful of avoiding any negative impacts on innovation and having meaningful partnerships with academia, the Army is supportive of DOD efforts to obtain relevant authorities that would allow us to collect and analyze sufficient information on research performers and thereby evaluate potential conflicts of interest and conflicts of commitment prior to grant award and periodically thereafter. We believe a whole of government approach is required to truly tackle the problem—e.g., sharing grant/cooperative agreement award information across funding agencies (DOD, DOE, NSF, NIH, etc.) and/or creating mechanisms that would allow for sharing adverse information across agencies.

Mr. FRANKLIN. Many of you have expressed your respective branches investing in STEM programs for students; how many of those students are being retained in our Federal workforce?

Dr. PERCONTI. The Army appreciates the Committee's continuing support of the Army Educational Outreach Program (AEOP). The AEOP offers students and teachers a collaborative, cohesive portfolio of Army-sponsored STEM programs to engage, inspire and attract the next generation of STEM talent via kindergarten through college programs and provides insight into DOD STEM careers. In FY20, AEOP successfully pivoted to all virtual (due to COVID) with ~18,000 students and teachers across the county. 90% of alumni indicated interest in pursuing a STEM career and 59% indicated interest in pursuing an Army/DOD STEM career. In FY21, we have expanded the AEOP apprenticeships to include postgraduate and postdoctoral fellowship programs, further strengthening the pipeline from our STEM outreach programs to potential future federal employment. The DOD Science, Mathematics, and Research for Transformation (SMART) scholarship-for-service program provides a combined education and career opportunity to students pursuing STEM degrees. The SMART program is highly valued for attracting, recruiting, and retaining early-career high impact scientists and engineers, and allows Army laboratories to shape education and training for incoming employees. In FY2019 and FY2020, Army laboratories sponsored 147 SMART scholars. Since the SMART program was initiated in 2006, the Army has sponsored 1,013 SMART scholars at the Army laboratories and technical organizations. Of those, 377 (37%) remained as Army employees when their service obligation ended.

Mr. FRANKLIN. Each branch has its respected form of small business innovation research (SBIR); how can we streamline the process and encourage efficiency and competition?

Ms. JOHNSON. The SBIR/STTR program is a critical tool in our acquisition tool kit to smartly engage with American small business, quickly identify technology so-

lution opportunities, swiftly develop those opportunities into scalable solutions, and rapidly deploy those solutions to the warfighter.

To optimize effectiveness of the SBIR/STTR investment portfolio, the Department's SBIR program has undergone a reengineering effort to reduce the burden on both industry and the acquisition community while enabling agility to exploit emerging and innovative technology opportunities and quickly deliver necessary technologies to the Fleet and Force. The primary objectives of the new program are to incubate a broader base of ideas, accelerate the best ideas to operational demonstration, and bridge operational prototypes to high-value outcomes for the Fleet/Force.

Mechanisms to support the new objectives include broader topics, streamlined proposal submission processes, accelerated evaluation and award decisions, faster payments to awardees, and contracting to support technology development through rapid capability fielding. These mechanisms are being introduced through multiple pilots, such as the Advanced Development and Acquisition of Prototype Technology (ADAPT) and NAVY Technology Acceleration (both now underway), to develop and validate best and better practices.

NavalX is shepherding new companies into funded opportunities with the DON, including the SBIR portfolio. The DON SBIR program office also hired a Commercialization Manager to assist with SBIR transitions in 2020. The Commercialization Manager has been hosting a series of roundtables with Tech Bridge coordinators and regional SBIR leads to determine ways to further generate opportunities for the industrial base. These initiatives include a Navy-wide common transition resource site for SBIR companies; and a regional "menu" of equipment, labs, and services related to testing and evaluation. These will be supported by the Tech Bridges in close partnership with the DON SBIR program office.

Mr. FRANKLIN. How can we assure the necessary level of information security is being maintained (ie CLASSIFIED information) with partnered institutions/universities without creating a negative impact on innovation

Ms. JOHNSON. Cleared Defense Contractors (CDCs) are subject to the National Industrial Security Program codified in 32 CFR Part 117 effective February 24, 2021. Accordingly, the physical, information, network, and personnel security at CDCs are subject to regular inspections, as well as continuous government Cybersecurity Service Provider monitoring. These third-party DOD entities are the foundation for ensuring that CDCs adequately protect classified information.

Regarding partnerships with Universities and Small Businesses, the effectiveness of security procedures relies on a shared understanding of the specific research requiring protection. Protectable research includes information deemed critical by the Navy due to potential military application, as well as patents and intellectual property owned by the performer. These procedures rely on the expertise of government personnel and University and Small Business subject matter experts– this active collaboration results in the identification of research information requiring protections for the benefit of all research participants.

The Office of Naval Research (ONR) is developing standards for evaluating cost and benefit calculations associated with international collaboration. To the greatest extent possible, these standards are intended to be communicated to performers (both established and prospective) at Universities and Small Businesses to facilitate a clear understanding of circumstances ONR recognizes as potential risks to research integrity and undue influence.

ONR is hiring a Director of Innovation Protection Policies. This new position focuses on understanding the international research innovation environment, and proactively disrupting malign foreign intent with respect to capital investment. The Director of Innovation Protection Policies collaborates extensively with the Navy Industrial Base Integration and Security Office focused on foreign investment mitigation. Additionally, NavalX is partnering with the Foreign Investment Tiger Team (FITT) and NCIS to draft and distribute cautionary information regarding the business and national security risks of taking investment from adversarial groups.

ONR provides clear and concise guidance for handling classified and controlled unclassified information, that is shared with non-government partners using codified written agreements, such as Cooperative Research and Development Agreement, which delineates parameters for information sharing and protection. These agreements discuss expectations and outcomes, to include clauses for ramifications if the agreement criteria is not adhered. Further, the DD Form 254, Contract Security Classification Specification, is used to convey government security requirements to their non-government partners when performance dictates access to classified information. This document lays out the specific types of protected information that the Cleared Defense Contractors can have access to and any contact/agreement specific criteria for the protection of that information. Both agreements and the Con-

tract Security Classification Specification help alleviate ambiguity while empowering the non-government entity to manage their classified holdings.

Mr. FRANKLIN. Many of you have expressed your respective branches investing in STEM programs for students; how many of those students are being retained in our Federal workforce?

Ms. JOHNSON. The DON warfare centers and the Naval Research Laboratory (NRL) engage in robust programs of STEM education and outreach for students and educators from kindergarten through graduate school. The students we inspire today to pursue STEM may well become members of our workforce of tomorrow, or participants in the many academic and industrial partnerships that apply their creativity to solve naval challenges for the Navy of the future. NAVSEA's STEM educational outreach efforts resulted in 106 programs in FY 2020, involving a total of 2,003 technical team members across the enterprise and 35,000 engagement hours. The programs reached 63,000 students and 2,000 teachers—and all in spite of the coronavirus pandemic. Programs include SeaGlide, SeaPerch, RoboNation, Major League Hacking, Submarine races, science fair judges, etc.

There are a number of successful student programs that DON organizations utilize to attract top students that do not have the mandatory hiring requirement like the DOD Science, Mathematics, and Research for Transformation (SMART) program. Students also participate in the following programs: STEM Student Employment Program (SSEP), Pathways, Naval Research Enterprise Intern Program (NREIP), Historically Black Colleges and Universities and Minority Institutions (HBCU and M/I) summer internship program, Science and Engineering Apprentice Program (SEAP), Volunteers, and Post-Secondary Student Program.

Students can also participate in multiple programs. For example, Mr. Reese Koe is an early career data scientist working for the Naval Surface Warfare Center (NSWC), Port Hueneme Division, who started as a SEAP intern, then became an NREIP intern, and then was accepted as a SMART scholar. He has Bachelor of Science degrees in mathematics and physics and a Master's degree in information and data science.

Dr. Corey Bergsrud, an engineer at NSWC Crane Division, has seen the benefits of STEM programs from both sides of the equation. A participant in the NREIP and SMART Scholarship programs, Bergsrud has supported a variety of internship programs, including SEAP, NREIP, SMART, STEM Student Employment Program (SSEP), and National Security Innovation Network (NSIN) X-Force Fellows, since joining the command full-time in 2016.

SMART has become a preferred method for recruiting and growing talent in critical areas. Each year additional naval facilities request approval to select students. Of the 1,949 students in the portal for possible selection in 2020, 56 percent have listed a participating naval facility as either their first, second, or third preference site selection. Most of the SMART scholars (77 percent) remain past their service commitment. In FY 2020, 25 percent of NRL's permanent science and engineering hires came from these student programs.

Mr. FRANKLIN. Each branch has its respected form of small business innovation research (SBIR); how can we streamline the process and encourage efficiency and competition?

Ms. BALDWIN. The Department of the Air Force (DAF) ensures strong linkage between the Air Force Office of Small Business Programs, the Office of the Under Secretary of Defense, Research, and Engineering, and the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) Office, and engages in DOD-level events and activities that facilitate branch collaboration and SBIR/STTR process improvements. Additionally, AFWERX participates regularly in Government-wide events, such as the Small Business Administration (SBA) National SBIR Week and SBA TechConnect SBIR/STTR Fall Innovation Conference, which are excellent sources of best practices and teaming opportunities. The DAF has implemented organizational and process improvements to the SBIR/STTR program and AFWERX to institutionalize innovation. The AFWERX AFVentures program is recognized as a model for attracting greater private sector investment in defense technologies. AFVentures instituted a SBIR/STTR Open Topic opportunity for small businesses that has broadened competition and increased the number of non-traditional small business performers. This opens the aperture for the DAF to consider more diverse avenues to more quickly and efficiently bring solutions to bear on military mission challenges. For FY18 and FY19, the Open Topic program resulted in 2,299 SBIR/STTR contracts awarded to over 1,400 companies.

Mr. FRANKLIN. How can we assure the necessary level of information security is being maintained (ie CLASSIFIED information) with partnered institutions/universities without creating a negative impact on innovation

Ms. BALDWIN. The Department has well established controls in place to ensure the security of classified information, including procedures that enable industrial and academic institutions to partner through use of appropriate facilities, equipment, and networks. Protection of controlled unclassified information and intellectual property is of significant concern. It is important to have a balanced, surgical approach to information protection that ensures appropriate control of critical technology, while retaining the ability for broad engagement with the commercial and global technological and innovation community. The Department of the Air Force is implementing DOD policy and guidance associated with the protection of critical technical information, including making use of supply chain risk management, industrial security, operational security, insider threat reporting, and cyber security practices to mitigate risk of adversary exploitation. To minimize unnecessary disruption, practices are implemented in a risk-based fashion, guided by critical program and technology priorities. We are collaborating with DOD and federal agencies to increase awareness of exploitation tactics and expand threat information sharing. Universities and businesses are making it a point to be aware of security risks and are engaging with the Department on best practices for research security and integrity. Active awareness and information sharing are key to the protection of technology.

Mr. FRANKLIN. Many of you have expressed your respective branches investing in STEM programs for students; how many of those students are being retained in our Federal workforce?

Ms. BALDWIN. The Department of the Air Force (DAF) conducts more than 3,000 Science, Technology, Engineering, and Math (STEM) outreach events per year, leveraging local, state, and federal organizations to reach nearly 125,000 students and teachers across the country. The most successful programs have been the Palace Acquire (PAQ) program with approximately 82% retention, Science, Mathematics and Research for Transformation (SMART) scholarships with approximately 70% retention, and the Premiere College Internship Program (PCIP) with approximately 58% retention. These programs are used by both the Air Force and the Space Force and provide students with valuable workplace experience which can lead to a Federal civilian professional career in STEM. The Department is exploring ways to better track and increase retention of these students in the STEM pipeline. This is one benefit we expect to achieve from recently established Pathways, and Leadership, Experience, Growing Apprenticeships Committed to Youth (LEGACY) programs. These programs are designed with incremental STEM growth in mind, from K–12 junior apprentices to undergraduate apprentices and follow on internships, allowing students and the Department to benefit from a continued relationship. Following initial success in the Wright-Patterson Air Force Base locality, we are now seeking broader implementation of these programs.

QUESTIONS SUBMITTED BY MR. MORELLE

Mr. MORELLE. What more can we do to engage with small businesses and harness their talents and capabilities?

Ms. MCQUISTON. The DOD Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) program has served as an excellent mechanism to engage with small businesses and harness their talents and capabilities. DOD invests nearly $2B annually through the SBIR/STTR programs, which harness the innovation of domestic small businesses and accelerate the introduction of their pioneering technologies into the Department. But the DOD needs to do more to facilitate the transition of these efforts into programs of record, fielded systems, or to other customers within the Federal government. I will continue to champion SBIR/STTR projects and empower my team to help find DOD customers for SBIR/STTR technologies capable of providing our warfighters with new and disruptive capabilities.

Mr. MORELLE. Research institutions play a critical role in attracting and developing the brightest minds who then dedicate their careers to solving our most challenging problems through innovative solutions—these great minds keep the U.S. on the global stage as leaders of innovation.

What type of investments in future technical talent should the Department be making? What STEM programs should be better supported and how?

Ms. MCQUISTON. A strong future technical workforce requires bolstering domestic talent development and recruiting and retaining foreign talent. It requires a comprehensive approach that anticipates and responds to DOD STEM workforce needs in the near-, mid- and long-term. Domestically, we must invest in early STEM education, support technical talent throughout their careers, and increase outreach to

underrepresented groups. DOD needs to continue to invest in and find ways to encourage increased focus on K–16 STEM education and outreach. Specifically, this means engaging students and educators in meaningful STEM experiences, serving students who are military-connected and underrepresented in STEM, engaging the active DOD S&E workforce in STEM education efforts, and addressing the barriers that continue to hinder underrepresented groups from STEM education success. DOD also needs to continue to invest in programs that support graduate students and post-doctoral fellows. An example of where DOD can improve is by expanding the young investigator program to support additional post-doctoral fellows and creating more grant opportunities for undergraduate and graduate students in areas of importance to the Department. Additionally, DOD should continue to emphasize and prioritize outreach to Historically Black Colleges and Universities (HBCUs) and Minority Serving Institutions (MIs) and programs like Defense Established Program to Stimulate Competitive Research (DEPSCoR) which may be leveraged to develop talent that has not traditionally engaged with the Department of Defense.

Mr. MORELLE. What more can we do to engage with small businesses and harness their talents and capabilities?

Dr. PERCONTI. The Army recognizes the need for small business technology and ingenuity to prepare the Army for the future. The Army is leveraging all available statutory authorities by connecting small businesses with Army Acquisition Professionals using cohort and transition broker team models to connect small businesses performing research and development to Army Program Managers (PMs) with well-defined needs. These models reduce the barrier to entry through hands-on explanation of some of the more challenging aspects of working with the Army for proposal submission, which can often seem like an insurmountable bureaucratic process. More importantly, these models are yielding more predictable, reliable, and cost effective pathways for technology adoption by helping small businesses focus on Program Executive Officer (PEO)-identified capability gaps, and identifying tech insertion points and funding opportunities. The Army's strategy for the portfolio, including alignment with Army Modernization priorities, focuses on PEO/PM transition and private sector market growth opportunities that will build a mutually-beneficial portfolio for both the Army and the private sector.

Mr. MORELLE. Research institutions play a critical role in attracting and developing the brightest minds who then dedicate their careers to solving our most challenging problems through innovative solutions—these great minds keep the U.S. on the global stage as leaders of innovation.

What type of investments in future technical talent should the Department be making? What STEM programs should be better supported and how?

Dr. PERCONTI. The Army must continue to invest in STEM education to ensure a continuing supply of the next generation of scientists and engineers, and leverage the special workforce authorities at the laboratories to invest in our STEM workforce and continue investing in our laboratory infrastructure to ensure the Army remains an attractive venue for a long-term and impactful scientific career. Army laboratories compete with a highly competitive private sector to build and maintain the Army's STEM workforce. Collaborations with university professors and students are essential to ensure development of diverse, best-in-class American STEM talent. The Army cannot accomplish its mission without the skills, dedication, and contributions derived from providing access to all Americans. The Army's Basic Research portfolio of investments is utilized to the fullest extent possible to facilitate such access, expanding research capabilities, and building lasting partnerships. For more than 50 years, the Army has supported a wide range of educational opportunities in science, technology, engineering, and mathematics (STEM) for our youth, college and graduate students, as well as our valued teachers. Since 2004, these highly efforts were consolidated under the Army Educational Outreach Program (AEOP) which offers a collaborative, cohesive portfolio of Army-sponsored STEM programs to engage, inspire and attract the next generation of STEM talent via kindergarten through college programs and provides insight into DOD STEM careers. AEOP strategically funds programs that maximize student and teacher access to unique DOD assets to support the Army's STEM education priorities, including STEM literate citizenry, STEM savvy educators, and a cohesive, coordinated, and sustainable STEM education outreach infrastructure across the Army. AEOP programs prioritize the participation of underrepresented and underserved communities in STEM fields to curate a diverse, agile and highly competent STEM talent pool representative of the nation's demographics to tackle the nation's most challenging problems.

Mr. MORELLE. What more can we do to engage with small businesses and harness their talents and capabilities?

Ms. JOHNSON. To improve the SBIR process for small businesses, the DON applies best practices learned from Technology Acceleration and Accelerated Delivery and

Acquisition of Prototype Technology (ADAPT) pilots to the DON SBIR/STTR Programs. In FY 2021 the Navy is scaling better practices developed during the pilots by including participation from firms with majority ownership in part by adopting simplified proposal requirements (50 percent shorter), including broad topics, and making larger first Phase I payments 66 percent faster. Scaling these practices will encourage greater participation from a broader variety of innovators and will facilitate accelerated evaluations and awards, both of which will result in meeting a greater number of Naval needs faster.

DON continues to recognize efficiencies from the Focused Contracts Center, established in 2016, consistently making Phase I awards in 45 days and Phase II awards in 150 days. Historically, DON SBIR/STTR Phase III awards have accounted for about one-half of all commercialization in the DOD SBIR/STTR Programs. On average, the Department funds and awards over $500M in Phase III annually, with FY 2020 being a highly successful year for Phase III awards, nearing almost one billion dollars.

In addition to optimizing the SBIR program, the DON has seen an increasing number of small businesses getting awards through Other Transactional Authority Consortia, Broad Agency Announcements, and Prize Challenges. The Prize Challenge Authority is proving more accessible to non-traditional companies who have not received contracts with the Navy or Marine Corps before. Prize Challenge authorities offer flexibility of process and solicitation criteria and do not require an accounting system that is government compliant before the selection process. Additionally, Tech Bridges have been working internally to capture best practices and proliferate the use of these authorities in partnership with ONR.

We are working hard to take full advantage of the authorities we have. We do have issues when it comes to colors of money. If Congress would pilot a flexible funding line for innovation that was colorless, the DON could take advantage of more innovation. Private investors do not have the same restrictions when it comes to funding talent and future capabilities, and can fund from seed to commercial product, quickly. Companies like Uber were paid for their ideas and ability to execute, pivoting quickly as they engaged with potential customers. The vision was transportation accessible for all, and the product was iterated on to become the hardware and software solutions that continues to expand, today. A line of colorless money would enable us to similarly foster and adopt innovation.

Mr. MORELLE. Research institutions play a critical role in attracting and developing the brightest minds who then dedicate their careers to solving our most challenging problems through innovative solutions—these great minds keep the U.S. on the global stage as leaders of innovation.

What type of investments in future technical talent should the Department be making? What STEM programs should be better supported and how?

Ms. JOHNSON. In order to meet the scientific and technical challenges of tomorrow, we must continue to build and grow a continuous pipeline of STEM students today. Not only must we sustain Naval STEM efforts in the long-term but we must create new STEM opportunities focused on underrepresented students in STEM to increase diversity, equity and inclusion so that the next generation of STEM professionals is representative of the face of America. One of the challenges today is that there is significant variability across the DON with regards to management of and participation in STEM education and outreach initiatives. In particular, STEM education and outreach is often seen as a collateral duty for STEM coordinators at our naval facilities. Our scientists and engineers are often volunteering their time to participate in STEM events. Sustaining our efforts is not sufficient. We need to significantly grow our STEM efforts to reach underrepresented students in STEM and increase diversity in STEM. We need to examine this at the national level and execute at both the national and local levels. The Naval STEM Coordination Office is pursuing new STEM diversity efforts via Historically Black Universities and Colleges and Minority Institutions. Our naval laboratories, warfare centers, and facilities are focused on outreach to underrepresented students in their local communities. Across the DON, we need consistency in expectations of our STEM programs, allowing for customization at the local level. We also need long-term sustained resources for our STEM coordinators and scientists and engineers to deliver trusted STEM education and outreach efforts in their communities. We need to set STEM goals for command leadership to meet throughout the course of their tour and we need to find ways to incentivize our scientists and engineers to participate in STEM efforts. STEM outcomes are often not immediate, but these long-term investments will deliver the diverse, talented STEM pipeline that is critical to the United States and the Department of the Navy. Specifically, issue a policy that STEM outreach efforts can use the virtual platforms that are used by the schools to further engagements. Currently, the DOD and DON have restrictions in place on virtual platforms

for security purposes, but this often hinders STEM outreach to local communities. This is particularly important as we reach beyond our normal commuting area and into underserved/rural communities. Furthermore, to hire students who are studying outside of the laboratory's geographic location, activities could fund travel and per diem which can be costly. Increased synergy with HBCUs and other universities with underrepresented students and regional organizations whether they are academia, economic development corporations or regional chapters, (e.g. Society of Women Engineers) can yield significant return on investment in the development of STEM pipelines and workforce development.

Lastly, our DON STEM education and outreach efforts are directly dependent on the Department of Education's ability to develop a robust foundation in mathematics and the sciences that we can build on.

The following are ways the STEM program can be better supported.

- Undergraduate research projects are an effective and affordable means to have students solve Department relevant problems, build and apply their technical capability, and educate them on Department careers. Creating a program to compete, award and support Department mentor engagement would foster a strong technical pipeline ready to hit the ground running.
- Internships (SEAP & NREIP) are valuable methods of educating and recruiting future qualified workforce. The Warfare Centers provide funding to augment the allocation to ONR. Additional allocation to ONR to support internships, including summer living stipends, above the current allocation would prove beneficial.
- Incentivize the use of programs in collaboration with one another. For example, award a Summer Faculty or Postgraduate Fellowship in tandem with an NREIP student award to a faculty-student pair from an HBCU/MI institution to better strengthen collaboration, success and continued engagement beyond the summer work.

Mr. MORELLE. What more can we do to engage with small businesses and harness their talents and capabilities?

Ms. BALDWIN. The Department of the Air Force has established a number of efforts to better access emerging technologies from our nation's small businesses.

- The Department of the Air Force participates in pitch day events, industry day events, and Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) conferences to engage small businesses to harness their talents and capabilities toward Air Force and Space Force capability needs.
- AFWERX instituted a SBIR/STTR Open Topic opportunity for small businesses that has broadened competition and increased non-traditional small business performers. In FY18 and FY19, the Open Topic program resulted in 2,299 SBIR/STTR contracts awarded to over 1,400 companies with 75 percent of the recipients being new partners.
- AFWERX hosts collider events the last week of each month which bring together hundreds of small businesses with members of the Department to facilitate "collisions" that lead to deal-flow for companies and solutions for the Department. These events can be in-person or virtual, and rotate between locations and technology focus areas.

Mr. MORELLE. Research institutions play a critical role in attracting and developing the brightest minds who then dedicate their careers to solving our most challenging problems through innovative solutions—these great minds keep the U.S. on the global stage as leaders of innovation.

What type of investments in future technical talent should the Department be making? What STEM programs should be better supported and how?

Ms. BALDWIN. The Department of the Air Force (DAF) considers attracting and developing future talent a priority. We have identified a number of targeted future science and engineering workforce skill priorities based on the National Defense Strategy and recognized talent needs. Engineering talent areas include cybersecurity engineering, software, digital engineering, data science, and computer modeling; and technology areas include hypersonics, directed energy, artificial intelligence, biotechnology, and microelectronics. Science, Technology, Engineering, and Math (STEM) K–12 programs are an important component to building the workforce of the future. The DAF conducts more than 3,000 STEM outreach events per year, leveraging local, state, and federal organizations to reach nearly 125,000 students and teachers across the country. The Department also engages universities and research institutions to advance technology maturity, while also introducing students and graduates to the Air Force and Space Force. These activities include senior capstone design projects focused on DAF challenges, fellowships for promising U.S. scientists to pursue doctoral degrees in critical research areas, and programs to sup-

port scientists and engineers who have recently received Ph.D. or equivalent degrees. Future partnership programs should continue to be pursued, targeting technology modernization priorities.

The Department of the Air Force has a variety of STEM programs for students that create an avenue for future science and engineering (S&E) talent. The most successful programs have been the Palace Acquire (PAQ) program with approximately 82% retention, Science, Mathematics and Research for Transformation (SMART) scholarships with approximately 70% retention, and the Premiere College Internship Program (PCIP) with approximately 58% retention. These programs are used by both the Air Force and the Space Force and provide students with valuable workplace experience which can lead to a Federal civilian professional career in STEM. The Department is exploring ways to better track and increase retention of these students in the STEM pipeline. This is one benefit we expect to achieve from recently established Pathways, and Leadership, Experience, Growing Apprenticeships Committed to Youth (LEGACY) programs. These programs are designed with incremental STEM growth in mind, from K–12 junior apprentices to undergraduate apprentices and follow on internships, allowing students and the Department to benefit from a continued relationship. Following initial success in the Wright-Patterson Air Force Base locality, we are now seeking broader implementation of these programs.

QUESTIONS SUBMITTED BY MR. MOORE

Mr. MOORE. I am interested in learning how to ensure the cutting-edge innovation coming from R&D efforts efficiently transition into programs of record. Few things disincentivize innovation more than technologies and products languishing in the proverbial "valley of death" in the acquisition process. Are DOD research organizations working with the Defense Innovation Unit and other related organizations to help transition and promote innovative technologies into programs of record? And what recommendations do you have for this committee to improve this process?

Ms. MCQUISTON. A number of DOD research organizations are currently working with DIU to prototype, transition and scale innovative technologies into programs of record. Some example projects follow:

- Air Force Research Lab/DTRA/DARPA: DIU's Rapid Analysis of Threat Exposure (RATE) project provides pre-symptomatic, early warning of COVID–19 infection to cue earlier testing, isolation, and testing. We collaborated with DARPA to deploy a technical demonstration of localized data collection on a ship at sea (USS Portland), flowing data entirely over DOD networks. We worked with AFRL to transition the Independent Review Board from the Navy and continue to work with the team on transitioning to a program of record.
- Air Force Research Lab, NASA, and NRO AS&T: DIU's Quantum Inertial Measurement Unit Experiment (QuIX) project to develop an assured Positioning, Navigation, and Timing (PNT) alternative to GPS for strategic space assets and potentially strategic air assets.
- DARPA, Space Development Agency, and Air Force Research Lab: DIU's Multi-Orbital Logistics project to develop an in-space services and logistical capability for low cost, responsive access beyond Low Earth Orbit (LEO).
- Air Force Research Lab and NRO AS&T: DIU's High Specific Energy Storage project to create significantly higher endurance batteries for powered space systems and sensors, which also has subsequent applications for terrestrial operational energy requirements and programs of record. DIU's Defense Engagement Team (DET) serves as a bridge between DIU and the greater DOD and, in part, focuses on educating DOD organizations about dual-use commercial technologies and DIU's process to prototype and scale successful technology. The DET also enables stronger connections between research organizations and programs of record to ensure vetted technology has a path to transition. More needs to be done to incentivize research organizations and programs of record to "buy what we can, build what we must." This approach optimizes DOD resources to take advantage of buying higher TRL technologies to provide more cost-effective and timely solutions to the warfighter, while investing in building unique military capabilities for the long term.

Mr. MOORE. I believe that organizations like the Defense Innovation Unit are the future of the DOD's expanding technological focus. As warfare moves beyond the physical battlefield into cyber domains, it will become increasingly important to incorporate America's technological might into the warfighter. What is the long-term vision for the DIU and are there any immediate plans to expand beyond their current offices?

Ms. MCQUISTON. After five years, DIU continues to strengthen the nation's security by increasing the military's adoption of commercial technology. We support DIU's increasing contracting requirements to get new and more technologies through a streamlined process. We also support the development of a skilled, dual-hatted roster of National Guard members and reservists who help DIU tap into technology ecosystems around the country. DIU's six technology portfolios are focused on areas critical to the Department's battlefield advantage where the commercial sector is leading technological development: Advanced Energy and Materials, Artificial Intelligence, Autonomy, Cyber, Human Systems, and Space. Advanced Energy and Materials is DIU's newest portfolio, established in October 2020. DIU continues to take the pulse of dual-use commercial advancements alongside military needs to inform the Unit's portfolio structure and priorities from software and code, in the cyber domain, to hardware such as secure, trusted small unmanned aerial systems. As DIU and other innovation entities mature, we see stronger coordination and cooperation both at the project level but also regionally, to tap into more of the accelerators and startups this country, and our partners and allies have to offer.

Mr. MOORE. Attritable aircraft, which provide fighter-like capabilities at missile-like cost, have the potential to be a substantial force multiplier for U.S. Air Forces in future theaters; especially the Pacific, given the evolving airspace denial capabilities of potential adversaries. Since the efficacy of these vehicles depends on the ability to procure them in high volumes, minimizing cost for all aircraft systems, not just the airframe, will be critical to creating a viable program of record. As such, how is the Air Force ensuring that low-cost subsystem technology, such as propulsion, matures at pace with attritable airframes undergoing testing?

Does the operational risk to 5th Gen fighter aircraft increase in future contested environments if we fail to field attritable systems due to affordability?

Ms. BALDWIN. There is consistent coordination and collaboration among efforts developing low cost subsystem technologies and development of attritable airframes, including coordination between Air Force Research Laboratory (AFRL), engine manufacturers, and attritable airframe builders. The AFRL is executing a portfolio of initiatives to advance attritable aircraft goals, including projects focused on the development of low cost medium-scale engines, and power and thermal management systems. Modeling, mission simulation, and analysis has shown 5th Gen fighter aircraft teamed with attritable/reusable systems experience increased survivability as well as combat effectiveness. These analytical results persist when fully informed for blue and near-peer adversary capabilities and with humans-in–the-loop. War gaming and analysis also indicates attritable aircraft can be a force multiplier in joint operations, including in stressing scenarios the joint force may confront in a highly contested future operating environment.

Mr. MOORE. In my district, Hill Air Force Base and the surrounding defense community provides an annual economic output of $4.5 billion with small businesses making up an increasingly larger share of Northern Utah's defense and aerospace economy. How are you optimizing the opportunities of the Small Business Innovation Research program and Small Business Technology Transfer program to develop and transition technology into current programs?

Ms. BALDWIN. AFWERX is organized to monitor and manage the full SBIR/STTR process lifecycle, including a focus on technology transition and partnerships post-SBIR/STTR contract award. This is accomplished through partnerships with Technology Directorates within the Air Force Research Laboratory (AFRL), Air Force and Space Force acquisition centers, Air Force Major Commands, and Space Force Field Commands to coordinate transition goals and opportunities. AFWERX hosts collider events each month which bring together hundreds of small businesses with members of the Department to facilitate "collisions" that lead to deal-flow for companies and solutions for the Department. These events can be in-person or virtual, and rotate between locations and technology focus areas. AFWERX Prime accelerates investment in emerging dual-use technologies, including leveraging the SBIR/STTR process to identify and scale research and development opportunities with matching commercial investment. Building on promising companies introduced to the DOD ecosystem with small Phase 1 SBIR investments, Prime provides investment scaling, enabling quicker technology transitions into programs.

QUESTIONS SUBMITTED BY MR. FALLON

Mr. FALLON. In 2020, the Air Force fielded an interactive VR engine maintenance training system with the 58th Special Operations Wing at Kirtland AFB to combat the lack of available on-base maintenance training assets and enhance skills retention amongst MC and HC–130J engine maintainers. The VR system, which simu-

lates an engine for students to practice maintenance procedures on, can provide critical remote access to procedural instruction and has boosted training retention since fielding.

Given the applicability of this technology across multiple turbomachinery applications and all military branches, does the Department have a plan to proliferate VR Engine Maintenance training more broadly across the DOD? How can the Department ensure this powerful VR technology is not branch-segmented? For instance, made available to Air Force C–130Js units but Marine Corps KC–130Js units—both of which fly similar aircraft.

Ms. MCQUISTON. As the complexity of weapons systems increase and legacy weapon systems age, new and innovative technologies and processes must be continuously integrated into the DOD's sustainment enterprise, to improve the effectiveness and efficiency of providing materiel availability to U.S. warfighters. Making sure that our aircraft maintainers and personnel with similar complex maintenance and engineering responsibilities have readily available opportunities to enhance their skill set and be ready to perform their jobs when needed is critical to the readiness of our military. I look forward to supporting the development of these and similar sustainment technologies and finding ways to incorporate new capabilities such as VR engine maintenance across the force while deconflicting any potentially duplicative programs.

Mr. FALLON. From the R&E vantage point, what are the most significant challenges in transitioning technologies to your A&S counterparts to bridge the proverbial "valley of death"? Is it authorities, funding, organizational structures, culture?

Ms. MCQUISTON. Transitioning cutting edge technologies into material solutions for our warfighters in a timely and resource efficient way has been, and is among the most pressing challenges the Department faces.

As the rate of innovation and technology advancement accelerates, it becomes increasingly difficult to assess, understand, and be confident in the level of maturity that a particular technology will achieve in the 2-year POM cycle. It's exceedingly difficult to have accurate foresight in this regard and plan it into a POM.

Another specific challenge is related to testing. The Department needs to get better at making sure that the technologies we're developing and testing in the lab also get testing in environments more relevant to the conditions in which they are intended to function. Testing data and feedback from potential end users is also extremely valuable to collect and have in the early stages of solution development. This will undoubtedly give program managers more confidence in adopting those technologies into their programs of record.

I look forward to working with Congress and discussing ideas to how to bridge this "Valley of Death" and ensure that the capabilities we are delivering to the warfighters are using the best that today's technology has to offer.

Mr. FALLON. What are some specific examples of what you are doing to bridge the issue of the "cost of time" and "valley of death"?

Ms. MCQUISTON. Time is a finite resource and finding ways to use it as efficiently as possible presents the Department with an opportunity to gain a strategic advantage over our competitors and adversaries.

Specifically, the Department needs to get faster at incorporating today's cutting-edge technologies into prototypes and transition and scale them into programs of record that will deliver transformational capabilities to our warfighters. DIU and DARPA for instance are working on efforts with other DOD research organizations on several projects intended to shorten the timeline from concept to prototype to capability.

One of the hardest but simplest things the Department can do to bridge the issue associated with the "cost of time" and overcoming the "valley of death" is that we can incorporate some of the best practices from our private sector colleagues who have learned that moving on quickly, away from something that is not working, saves resources that can be invested in solutions that have better chances of success. This is not to suggest that the Department shouldn't accept risk when there is the potential for substantial reward, but it needs to be done in a smart way and the Department needs to be prepared to adjust quickly when risk becomes hindrance.

Mr. FALLON. From the R&E vantage point, what are the most significant challenges in transitioning technologies to your A&S counterparts to bridge the proverbial "valley of death"? Is it authorities, funding, organizational structures, culture?

Dr. PERCONTI. There are two significant challenges for transitioning technology from the Research and Engineering (R&E) community to Acquisition. The first is aligning technology maturation in R&E with the developmental timeline of the Acquisition Program of Record. The second is aligning Acquisition funding to take the

R&E developed technology across the valley of death and incorporate it into the program of record for further development and integration.

Additionally, from the Army science and technology (S&T) perspective, the challenge to bridge the proverbial "valley of death" is multifaceted and includes culture, S&T understanding of Acquisition, and the Acquisition of S&T by Army Program Executive Offices. From a culture perspective, the S&T and innovation portfolio requires a strategic focus on PEO/PM transition points and private sector market growth opportunities, nested within alignment to Army Modernization priorities. Further, focusing on Army problems and the future fight, researchers need to understand how the Army acquires new capability/warfighter technologies, while balancing research and engineering decisions on how we fight, how we procure technologies and systems, and how we sustain equipment. On the receiving end, Acquisition professionals need to understand how research works, be engaged in the development process, and relay need and how a technology might be used/sustained back to the researcher.

Mr. FALLON. What are some specific examples of what you are doing to bridge the issue of the "cost of time" and "valley of death"?

Dr. PERCONTI. The Army is leveraging all statutory authorities and flexibilities to bridge issues relating to the cost of time and valley of death for the Army's technology acquisition programs.

For instance, for the Technology Maturation Initiative (TMI) program, the Army has restructured the leadership of the program to be hands-on on the development, oversight, execution, and transition of the projects. ASA–ALT is working with Army S&T and the PEOs to partner every project from inception/building the vision and scope, running the projects, and transition to ensure engineering decisions are both based on technology and requirements/changes of the programs of record. The project teams include the SMEs from both S&T and PEOs and each project includes both prototype deliverables and a transition commitment (with planned funding) upon successful evaluation of the prototypes/deliverables from the TMI project.

TMI is focusing on three categories of projects to bring technologies across 'the valley of death'. The first is Supersystem projects addressing technologies that span multiple programs of record, PM/PEOs, or no one program of record owns the requirements of use of the advanced technology. The second category is emerging technology to take on higher risk technologies then PEOs/PM are currently planning on their critical path. These higher risk technologies bring increased capability and/or lower cost addressing PoRs documented requirements. The third category is out of cycle/disruptive technologies that quickly emerged from traditional or non-traditional sources, that can be applied to solve PoR requirements.

The Army's Small Business Innovation Research (SBIR) program is also in the midst of a significant culture and operational pivot, including instilling a coherent strategic underpinning for the portfolio, alignment with Army Modernization priorities, focus on PEO/PM transition and private sector market growth opportunities to build a mutually-beneficial portfolio (for both the Army and the private sector). Predictable, reliable, and cost effective pathways for technology adoption help small businesses focus on PEO-identified capability gaps, and identify tech insertion points and funding opportunities to expedite and prioritize transition opportunities to program executive offices, minimizing the cost of time and valley of death.

Mr. FALLON. From the R&E vantage point, what are the most significant challenges in transitioning technologies to your A&S counterparts to bridge the proverbial "valley of death"? Is it authorities, funding, organizational structures, culture?

Ms. JOHNSON. Successful transition of technology from a field-ready prototype or demonstration to an operationally relevant, sustainable capability involves numerous challenges. Contributors to those challenges include varying expectations between the S&T and program of record communities relative to what is required for transition; cost of transition; time required to mature technology; and the fact that some technology doesn't develop as needed.

S&T investments typically produce a representative model or prototype system, tested in a relevant environment, but not a qualified, certified "production ready" system, which places significant risk on a potential transition partner to carry the relatively low-maturity technology forward with many unknowns. We need to do a better job of developing viable transition plans that allow technologies originating from S&T efforts to seamlessly flow into acquisition program of records. Developing robust transition plans would increase the likelihood that resources will be made available to fund the technology maturation efforts needed to increase the Technology Readiness Level (TRL) and demonstrate the operational relevance of prototype technologies. If done well, this would reduce the cost, schedule, and technical risk associated with transition and thereby increase the probability of successful transition to a program of record.

Mr. FALLON. What are some specific examples of what you are doing to bridge the issue of the "cost of time" and "valley of death"?

Ms. JOHNSON. The DON has several efforts to help address challenges associated with the "valley of death." One of the efforts is advancing opportunities of NavalX Tech Bridges. NavalX Tech Bridges connect, reinforce and sustain acceleration ecosystems across the DON. Over the past year, this network generated more than 20,000 connections, $50 million in projects such as Prize Challenges and SBIR projects, and enabled more than 126 different projects in subjects like artificial intelligence and machine learning; 5G-enabled technologies; advanced materials and manufacturing; maintenance and sustainment; autonomy; and data management. NavalX signed 11 partnership intermediary agreements in order to bring more trusted third parties to perform due diligence on innovation markets. By guiding, empowering, and connecting our workforce and growing connections and partnerships with the private sector, we will enable the naval team to accelerate emerging technology discovery, development, and delivery.

Also, the DON is decomposing the NAVPLAN to further inform the S&T communities thereby addressing some of the challenges associated with the "valley of death." The NAVPLAN is Navy's direction for readiness, lethality, capacity, and sailor development. The identification of 16 Strategic Objectives ensures alignment and consistent messaging for the Naval research industrial base and the resource sponsors, offers the opportunity to move faster, and opens the innovation space. With alignment comes a more effective and efficient way to meet the capability needs of the DON.

Rapid evolution of new technologies allows earlier insertion in the execution schedule. Contracting mechanisms, such as the Other Transaction Authority (OTA), have expanded the vendor base and increased its ability to prototype new technologies from the private sector. It also allows more rapid evaluation of technologies.

Additionally, the Naval Warfare Centers and Naval Research Laboratory are using their 10 § 2363 funding to demonstrate and experiment with new technologies before presenting them to programs of records. We also use events like the Advanced Naval Technology Exercises (ANTX) to test and evaluate capabilities before technology insertion. ANTXs are designed to identify technologies that can be transitioned to the warfighter within 12 to 18 months. Through the collaboration of industry, academia, and government R&D organizations, ANTXs provide an environment for the warfighter to assess the operational utility of technical innovations as well as a forum for informational exchanges and risk reductions for larger Fleet/USMC exercises. Most importantly, an ANTX allows innovative and non-traditional industry partners to demonstrate their technologies and concepts in near-operational environments and get direct feedback from naval scientists, engineers, Sailors and Marines. In addition to the NavalX efforts, which look into the external technical innovation ecosystem to identify and partner with industry and academia to accelerate the development and movement of external technologies into Navy programs, the Naval Research Laboratory (NRL) and other Navy labs are also looking inward to the existing Navy and broader Federal investments into homegrown technology development. For example, with over 1200 active patents, a growing array of trade secrets protected under the authority of Section 801 of Public Law 113–66, and many additional technologies and capabilities aside from that specific intellectual property, NRL is looking to find ways to better protect and leverage the Government's investments in its own strong technical base. Through those efforts, NRL (and other Navy labs) partner with programs such as FedTech's Defense Innovation Accelerator, putting internally-developed technologies in the hands of motivated U.S. entrepreneurs to assess commercial viability of technologies facing the "valley of death," and if appropriate, partner to move those technologies into industry to create products and services to benefit both the U.S. public and the warfighter.

Mr. FALLON. From the R&E vantage point, what are the most significant challenges in transitioning technologies to your A&S counterparts to bridge the proverbial "valley of death"? Is it authorities, funding, organizational structures, culture?

Ms. BALDWIN. The "valley of death" between technology and programs of record is real and is a continuing struggle. Bridging it requires multiple organizations and stakeholders working collaboratively in development planning activities that facilitate transition of promising technologies into programs of record to deliver warfighting capabilities. Development planning within the Department of Air Force (DAF) has achieved historic success integrating requirements, technology, analysis, planning, programming, and acquisition organizations to inform research, development, test, and engineering investments with decision quality information and provides a foundation for future programs of record. The DAF continues to normalize these processes to facilitate this integral post-laboratory, pre-program of record development planning work essential to crossing the "valley of death."

Mr. FALLON. What are some specific examples of what you are doing to bridge the issue of the "cost of time" and "valley of death"?

Ms. BALDWIN. The Department of Air Force technology transition program invests in a portfolio of prototyping and experimentation initiatives executed by the Strategic Development Planning and Experimentation (SDPE) office to bridge the "valley of death." For example:

- Global Lightning is integrating new apertures and communication equipment into a number of specific weapon systems (e.g., AC–130, KC135) and assessing operational utility of resilient space-based highbandwidth connectivity. Based on these operational utility assessments several additional weapon systems within the Air Force and the Navy are seeking to integrate this capability.
- Rapid Dragon is determining operational utility and competitive advantage of palletized munitions to deliver mass quickly to the fight. Real-world data from experimentation activities compress the time it would normally take to develop and field this capability. Recent flight test results have drawn interest across the Air Force and the DOD to develop an initial capability for cargo aircraft, using existing long-range munitions.
- Base Defense experimentation efforts are aimed at evaluating the operational utility and competitive advantages of directed energy weapons (DEW) and kinetic effects in a layered defense against cruise missiles. As a result, DEWs have recently been fielded in theater to assess real-world applications with Combatant Commands (COCOMs).
- Autonomous Attritable Aircraft Experiment (AAAx) is determining operational utility and competitive advantage that artificial intelligence (AI) can provide against peer and near-peer adversaries. This effort accelerates transition of AI technology across the "valley of death" by directly informing an acquisition strategy to field these systems with maximized impact

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