[H.A.S.C. No. 116–21]

HEARING

ON

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2020

AND

OVERSIGHT OF PREVIOUSLY AUTHORIZED PROGRAMS

BEFORE THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES HEARING

ON

FISCAL YEAR 2020 BUDGET REQUEST FOR DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY PROGRAMS: MAINTAINING A ROBUST ECOSYSTEM FOR OUR TECHNOLOGICAL EDGE

HEARING HELD
MARCH 28, 2019

U.S. GOVERNMENT PUBLISHING OFFICE
36–882 WASHINGTON : 2020

SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES

JAMES R. LANGEVIN, Rhode Island, *Chairman*

RICK LARSEN, Washington
JIM COOPER, Tennessee
TULSI GABBARD, Hawaii
ANTHONY G. BROWN, Maryland
RO KHANNA, California
WILLIAM R. KEATING, Massachusetts
ANDY KIM, New Jersey
CHRISSY HOULAHAN, Pennsylvania
JASON CROW, Colorado, *Vice Chair*
ELISSA SLOTKIN, Michigan
LORI TRAHAN, Massachusetts

ELISE M. STEFANIK, New York
SAM GRAVES, Missouri
RALPH LEE ABRAHAM, Louisiana
K. MICHAEL CONAWAY, Texas
AUSTIN SCOTT, Georgia
SCOTT DESJARLAIS, Tennessee
MIKE GALLAGHER, Wisconsin
MICHAEL WALTZ, Florida
DON BACON, Nebraska
JIM BANKS, Indiana

BESS DOPKEEN, *Professional Staff Member*
ERIC SNELGROVE, *Professional Staff Member*
CAROLINE KEHRLI, *Clerk*

CONTENTS

FISCAL YEAR 2020 BUDGET REQUEST FOR DEPARTMENT OF DEFENSE SCIENCE AND TECHNOLOGY PROGRAMS: MAINTAINING A ROBUST ECOSYSTEM FOR OUR TECHNOLOGICAL EDGE

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON INTELLIGENCE AND EMERGING
THREATS AND CAPABILITIES,
Washington, DC, Thursday, March 28, 2019.

The subcommittee met, pursuant to call, at 11:06 a.m., in room 2212, Rayburn House Office Building, Hon. James R. Langevin (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. JAMES R. LANGEVIN, A REPRESENTATIVE FROM RHODE ISLAND, CHAIRMAN, SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES

Mr. LANGEVIN. The subcommittee will come to order. I want to welcome everyone to today's hearing on the fiscal year 2020 President's budget request for the Department of Defense science and technology programs. I am pleased that for the first time in many Congresses we have the highest S&T [science and technology] leadership from the Department providing testimony. By having the top leadership, this hearing aims to elevate the discussion of S&T to the same level of importance as to how many fighters, ships, and satellites the Department is buying.

The Department's S&T ecosystem is complex and comprises agencies; offices; laboratories; federally funded research and development centers; university affiliated research centers; academic partnerships; test and evaluation entities; and partnerships with the private sector, including small businesses. This S&T ecosystem is charged with delivering the best capabilities to the warfighter in the near, mid and long term.

For such an important portfolio, the fiscal year 2020 President's budget request totals $14.5 billion, which is only 2.7 percent of the Department's base budget and only 3.2 percent above the fiscal year 2019 requested funding level. Adjusted for inflation, the fiscal year 2020 request is only 1 percent higher, despite the increasing cost escalation of highly specialized technical labor, like scientists and engineers with advanced degrees and Ph.D.s.

To say it another way, normalizing for inflation and labor cost escalation, this S&T budget has effectively been shrinking for years. And this is the budget that must lay the groundwork for today, for our future technological edge in the next 10 to 20 years.

I also want to point out that, unlike the shrinking of the S&T request, the Department's fiscal year 2020 investment in advanced component development and prototypes funding grew by 5.8 percent from the fiscal year 2019 request, or by 27 percent. Although I strongly support efforts to get new technologies across the "valley of death" into the hands of our service members as soon as possible, we must be cognizant of the fact that we must also invest in the long-term basic and early-stage applied research that will allow for revolutionary advancements down the line.

In the past three National Defense Authorization Acts alone, Congress has granted almost two dozen authorities to improve the Department's S&T workforce, facilities, and infrastructure to champion inhouse innovation for the future of force modernization, warfighting, operational concepts, and acquisition. I remain disappointed that many of those authorities have gone underutilized or unused by the Department. This is also hard to reconcile with the National Defense Strategy, which highlights long-term strategic competition with China and Russia and the need for an unparalleled national security innovation base. It is no secret that China is stealing our intellectual property to further their objective to be a research and engineering powerhouse and compromise our warfighting edge. Make no mistake about it, however, China is not the only nation conducting these types of activities. China is, though, one of the few state actors that has coupled such tactics with considerable investments and resources behind a national strategy that involves a whole-of-government effort and leverages society to promote indigenous innovation. Yet the President's budget request decreases S&T and R&D [research and development] funding across the executive agencies, including the Department of Energy's Office of Science, and the National Institute of Standards and Technology, and the National Science Foundation.

If the U.S. is to remain a global leader in technology, we cannot simply play defense. We must also play offense. Investments in science and research and other development efforts across the whole of government are necessary and vital to maintaining a technological edge.

So, beyond the R&D specific funding, we must also invest in STEM [science, technology, engineering, and math] education, programs to develop junior talent into future tech leaders, and implement policies that promote a sound economic, political, and strategic environment on U.S. soil where global collaboration, discovery, innovation in public institutions and industry can thrive.

I recognize that the open dialogue and debate of academia can be anathema to the secrecy we rely on in the Department of Defense. But we must also recognize and embrace the competitive advantage our free society gives us to out-innovate and develop better products faster than anyone else in the world.

Setting ourselves apart from our strategic competitors also means abiding by our American values and keeping our policy as, or more, developed than the technology itself.

The functional work for the current understanding of artificial intelligence done in the 1950s and 1960s was funded by DARPA [Defense Advanced Research Projects Agency] and the Office of Naval Research and aided by the convening power of universities.

Now, we have been working on this technology for over half a century. Yet, in the John S. McCain 2019 NDAA [National Defense Authorization Act], Congress had to create a National Security Commission on Artificial Intelligence to expedite the policy, strategy, and implementation plan that absolutely must be thought through for our Nation to effectively and ethically use these capabilities. For AI [artificial intelligence] and for each of the other seven rapid technological advancements outlined in the NDS [National Defense Strategy], I am looking to the Department to lean forward on strategically developing policies on how we should use and deploy those future technologies and how these emerging capabilities will contribute to our new national strategies—new security strategies. Such effort is especially important with hypersonics and directed energy, which present a myriad of policy and political considerations and challenges.

Finally, I must emphasize that we will not attain the technological edge we need if we refuse to take risks in our R&D portfolio and if we do not empower risk-takers who are willing to push the boundaries on innovation. I realize that this will not come easily for the Department of Defense because the overriding culture is one of never failing. After all, in many aspects of the Department's mission, failure means people will die. However, in the S&T space, an attitude that conservative means we will never conceive of the technological leaps that will ensure our warfighters never go into a fair fight. It is incumbent upon the leadership in the Department to avoid perpetuating an overly conservative culture in the S&T enterprise. And I hope to hear from our witnesses today what they are doing to encourage reasonable risk-taking. In turn, so long as the Department is transparent about such failures, Congress and this subcommittee in particular must be willing to provide top cover for those that fail fast, fail smart, fail forward, and internalize the lessons learned from those failures.

So, before us today we have the services' technology and acquisition executives. These individuals must divide their attention, creating—fielding the best technology to the warfighters as quickly and as effectively and efficiently as possible in the near and the mid term and protecting the scientists and innovators working on the test—the next generation of S&T that will enable the Department to keep its technological edge over the long term.

In section 901 of the fiscal year 2017 NDAA, Congress split the former Under Secretary of Acquisition, Technology, and Logistics into two and created the Under Secretary of Defense for Research and Engineering [R&E] to empower the Department leadership to drive towards better innovation, advancing science and technology, and reducing risk intolerance in the pursuit of new technologies.

Dr. Griffin, the first USD [Under Secretary of Defense] R&E since its charge, is the chief technology officer for the Department and is responsible for the research, development, and prototyping activity across the DOD [Department of Defense] enterprise. He is mandated with ensuring technological superiority for the Department of Defense.

Dr. Bruce Jette, the Assistant Secretary of the Army for Acquisition, Logistics and Technology; Mr. James "Hondo" Geurts, the Assistant Secretary of Navy for Research, Development, and Acquisi-

tion; and Dr. Will Roper, Assistant Secretary of the Air Force for Acquisition, Technology and Logistics are the three service acquisition executives responsible for executing and overseeing the services' research, development, and acquisition activities. So I welcome you all here today.

I look forward to hearing from our witnesses on the fiscal year 2020 S&T request and note that following this discussion, we will continue in a closed, classified, follow-on discussion with representation across the spectrum of the S&T ecosystem—the Defense Advanced Research Projects Agency, the Department's laboratories and academic partnerships, the Strategic Capabilities Office, and the Defense Innovation Unit.

So, with that, I will now turn it over to Ranking Member Stefanik for her remarks.

[The prepared statement of Mr. Langevin can be found in the Appendix on page 39.]

STATEMENT OF HON. ELISE M. STEFANIK, A REPRESENTATIVE FROM NEW YORK, RANKING MEMBER, SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES

Ms. STEFANIK. Thank you, Chairman Langevin.

And thank you to the witnesses for being here today.

I want to stress how important our investment in science and technology and the innovation ecosystem is to our national security. The National Defense Strategy frames the current security environment as one of, quote, rapid technological advancements that is changing the character of war [end quote]. Now, more than any time in recent history, our military superiority is determined by our technological superiority. We are entering a new era of strategic competition where our ability to harness the power of our innovation ecosystem is being challenged by our adversaries.

I am concerned that our S&T investments represent an alarmingly small percentage of our overall defense budget and a shrinking percentage of our total RDT&E [research, development, test, and evaluation] budget and at the same time that our adversaries are significantly increasing their S&T spending.

While I am encouraged by the Department's investment in near-term advanced component development and prototyping, this cannot come at the expense of DOD's investment in our future. A properly resourced S&T enterprise reduces risk and technological surprise and, when properly executed, can generate disruptive new technologies that transform the way the Department does business, deters conflict, and wages war.

I also want to highlight the importance of basic research to our future military capabilities. In fact, at a hearing I chaired in December on artificial intelligence, Dr. Lisa Porter cited DOD's 40 years of funding of AI basic research as the single most important factor for why we still maintain a slight lead over China's AI capabilities. As the pressure grows to accelerate and apply new technologies to today's problems, we must continue to balance this with the investment in future R&D. Any degradation in our future R&D will put the U.S. at a competitive disadvantage 10 to 20 years from

now and weaken the bench of domestic science and technology expertise, which is already, as we know, in very short supply.

Now more than ever, our science and technology enterprise plays a strategic role that is fundamental to our national and economic security. We must invest in it, and we must also protect it. Industrial espionage, cyber theft on a massive scale, illicit technology transfer, and foreign influence on our campuses are just a few of the malicious practices that our adversaries, most notably China, are using to undermine our national and economic security.

Our universities, service laboratories, research and development centers, and pioneering small businesses are particularly vulnerable in our democratic and open society. We must do more to educate, inform, and protect our defense innovation ecosystem from these threats or we run the risk of arming our adversaries with technologies they will use against us in future conflict.

Finally, we cannot allow our own bureaucracy to constrain the services from acquiring new technologies or the talent needed to implement these breakthroughs. Congress has made strides over the last several years to provide flexibility to the Department in hiring, funding, and sustaining our science and technology enterprise. I am particularly interested in understanding how these authorities are being utilized and what more we can do to improve our defense innovation ecosystem.

Thank you again to our witnesses here today, and I yield back to the Chair.

Mr. LANGEVIN. Thank you, Ranking Member Stefanik. I want to thank you for your remarks.

And we will now hear from our witnesses, and then move to the question-and-answer session.

With that, I would like to now recognize Secretary Griffin for an opening statement.

STATEMENT OF HON. MICHAEL D. GRIFFIN, UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING, OFFICE OF THE SECRETARY OF DEFENSE

Secretary GRIFFIN. Thank you. Chairman Langevin, Ranking Member Stefanik, and members of this subcommittee, I want to thank you for the opportunity to discuss the ways in which we are advancing defense modernization in response to the threats posed by our adversaries. I have a few brief opening remarks. I have submitted my written testimony. I would like my written testimony to be entered into the record, if you so approve.

Mr. LANGEVIN. Without objection.

Secretary GRIFFIN. Thank you.

I don't have to explain to this committee the threats that we face from Russia and China. Our adversaries have self-declared, and our only choice is to respond appropriately or to cede the primacy of the rules-based order that the United States established in the aftermath of World War II and has nurtured for now three full generations.

Congress has paid very careful attention to these existential threats by our adversaries and has taken action to meet them. Through authorization, law, and funding, you have done your part to address these challenges, and we thank you for that support.

For our part, we must work to change the processes, culture, and investment decisions of the DOD to regain and maintain the technical dominance that deters our adversaries. It is the role of the Under Secretary of Defense for Research and Engineering, working with the service acquisition executives who are here today, to align the Department's investment portfolio to that end.

The 2018 National Defense Strategy outlines a clear path to the technical advantage we seek. It prioritizes hypersonics, directed energy, space, autonomy, cybersecurity, quantum science, microelectronics, artificial intelligence, biotechnology, machine learning, network command and control and communication. This is a smorgasbord of items; all are important. To pursue these priorities, the President's fiscal year 2020 budget includes $14.1 billion for cross-department science and technology.

Our request for—as one example of what we are doing with this funding, our request for $2.6 billion for hypersonics in fiscal year 2019 and our request for $11.2 billion over the next 5 years will allow us to increase flight testing and field operational capability years earlier than we had previously planned. DARPA continues to build on work begun almost 60 years ago with its $2 billion multi-year AI Next campaign.

To respond to the adversarial activity we observe today by China and Russia in space, the Department has created the Space Development Agency to design and field critical space technologies more rapidly than has been the case recently. These are just a few of the ways in which we are pursuing defense modernization.

We will not succeed by fighting tomorrow's conflicts with yesterday's weapons. It is not our goal merely to match those who reject the values we espouse and the freedoms we protect. Instead, we are working to build and sustain a level of dominance so overwhelming that no adversary will start a fight because they know they will lose. That is our goal.

Thank you.

[The prepared statement of Secretary Griffin can be found in the Appendix on page 43.]

Mr. LANGEVIN. Thank you, Secretary Griffin.

Now Secretary Jette is recognized.

STATEMENT OF HON. BRUCE D. JETTE, ASSISTANT SECRETARY OF THE ARMY FOR ACQUISITION, LOGISTICS AND TECHNOLOGY, DEPARTMENT OF THE ARMY

Secretary JETTE. Thank you. Chairman Langevin, Ranking Member Stefanik, and distinguished members of the subcommittee, thank you for the opportunity to appear before you to discuss the U.S. Army's program for science and technology for fiscal year 2020.

The subcommittee's vital role in supporting Army S&T ensures the U.S. Army shall continue to modernize to meet future readiness requirements to encounter emerging and future threats. As Secretary Esper discussed in testimony Tuesday of this week, Army's Futures Command was formed to define the operational vision for multidomain operations; identify the technology requirements near, mid, and far; and to provide management of the technology enterprise. Your demonstrated commitment to our program

was clear in your support of our fiscal year 2019 budget submission for $2.3 billion in S&T, which represented a stable inflation-adjusted growth and laid the foundation for closing critical technology gaps. Congress added $1.3 billion, allowing us to advance even further and faster as we focused on those technologies outlined in the NDS, some of which Dr. Griffin just mentioned, which will provide a decisive overmatch.

Thank you for your support and thank you for passing the budget in time for the fiscal year. The Army's fiscal year 2020 budget request for $2.4 billion S&T again remains inflation-growth protected. Approximately 83 percent is aligned with the Army's six modernization priorities focused on maturing technology, reducing program risk, developing prototypes to better define affordable and achievable requirements, and conduct experimentation with soldiers to refine new operational concepts.

The Army's 12,000 civilians and scientists are critical assets in identifying, developing, and demonstrating technologies, and leveraging more commercially based research, and executing military-unique research. Through NDAA authorities, we have implemented a number of efforts to build, enhance, and retain our workforce, for which I would also like to thank you.

The Army relies on its laboratories to foster innovation to help transition basic research. The laboratories directly support military operations through various services and limited product development and production. State-of-the-art facilities are imperative to the success of Army basic, applied, and advanced technology development and research.

Chief among the reforms is the new intellectual property [IP] policy, which fosters greater communication with industry, researchers, and entrepreneurs early in the process, clarifying our data requirements and, I would say, addressing some of the concerns of protecting the IP.

Having patents in IP myself as a small entrepreneurial business owner only a year and a half ago, I know the important role IP plays in the ability to leverage the broader spectrum of cutting-edge technologies out there. With great support from the Secretary, we also are focusing on talent management in both our military and civilian workforces. Our laboratory system has been leveraging those authorities you provided to recruit and retain top talent to keep the Army on the cutting edge. Grants, when combined with such efforts as open campus and industry outreach programs, have expanded the pool of exceptional talent, to include 18 Nobel Prize winners and most recently the 2018 Nobel Prize in chemistry, Dr. Frances Arnold.

The Army continues to benefit from the many additional programs and has extended its outreach to nontraditional partners.

Thank you again for strong support for the Army's programs, the authorities you provided, and the opportunity to discuss Army S&T. I look forward to your questions.

[The prepared statement of Secretary Jette can be found in the Appendix on page 53.]

Mr. LANGEVIN. Thank you, Secretary Jette.

Secretary Geurts, you are recognized for 5 minutes.

STATEMENT OF HON. JAMES F. GEURTS, ASSISTANT SECRETARY OF THE NAVY FOR RESEARCH, DEVELOPMENT AND ACQUISITION, DEPARTMENT OF THE NAVY

Secretary GEURTS. Chairman Langevin, Ranking Member Stefanik, and distinguished members of the subcommittee, thanks for the opportunity to appear before you today to address the Department of the Navy's science and technology efforts and how they support both the National Defense Strategy and, more importantly, our sailors and Marines.

It is a real exciting time for science and technology ecosystem, and it's truly my honor to be here to represent all of them with you today.

I have a few brief opening comments, and then I request my full statement be entered into the record.

Mr. LANGEVIN. Without objection.

Secretary GEURTS. The Navy's fiscal year 2020 budget request includes $2.3 billion in basic and applied research, which represents a key enabler to ensure the Department of the Navy maintains and expands its comparative overmatch against our competitors. It maintains our strong commitment to science and technology to further our advantage for our sailors and Marines.

I would like to thank the subcommittee and Congress for passing the fiscal year 2019 budget on time. On-time receipt of the full budget allowed us to expedite the delivery of technology, lethality, and readiness to our sailors and Marines while achieving cost savings through efficient contracting. It also helped us accelerate our contracts through a broad network of science and technology partners in the ecosystem, including academia and small businesses, all of whom suffer disproportionately when we go into a continuing resolution period.

I would also like to thank Congress for the wide range of science and technologies authorities it has provided the Department of the Navy. Authorities such as section 233 have allowed us to reduce our contracting timeline by over 27 percent in the first year alone and saved us over 154,000 processing days.

Section 219 authorities have allowed us to invest an additional $250 million annually in science and technology workforce development programs, basic and applied research, technology transition, and facility revitalization. These authorities are remarkable and are really making a difference to ensure we can both recapitalize our capital assets as well as focus on our priority, which are our people.

For the 18th year in a row, the Navy has led all government agencies in the number of patents, thanks largely to these authorities.

As we continue to leverage these authorities and increase our iteration speed, we are also executing innovative and sustainable business and architectural strategies so that the discoveries made in S&T have a quick, fast lane to get deployed to the field. Ensuring this clear fast lane from discovery to deployment allows us to harness the amazing science and technology discoveries into rapidly fielded capabilities so we can maintain and grow our advantage.

Winning in a great competition requires us to maximize all the assets we have and derive the most value we can from the taxpayers' dollars. I would like to recognize the strong collaboration and teamwork we have achieved across the services and with Dr. Griffin. We are working very closely together, learning from each other, removing redundancies, and allowing us to accelerate capabilities to the field for all of our services.

Thanks for the strong support this subcommittee has always provided our sailors and Marines. And thanks for the opportunity to appear before you today. I look forward to answering your questions.

[The prepared statement of Secretary Geurts can be found in the Appendix on page 60.]

Mr. LANGEVIN. Thank you, Secretary Geurts.

Dr. Roper, you are now recognized.

STATEMENT OF HON. WILLIAM B. ROPER, JR., ASSISTANT SECRETARY OF THE AIR FORCE FOR ACQUISITION, TECHNOLOGY AND LOGISTICS, DEPARTMENT OF THE AIR FORCE

Secretary ROPER. Chairman Langevin, Ranking Member Stefanik, and members of the committee, thank you very much for holding a hearing on this very important topic.

Mr. Chairman, you hit it on the head: Science and technology needs to be more important to us if we are going to keep the military edge that we have enjoyed from the last century into this one.

I have prepared a written statement. I ask that it be entered into the record, but I am just going to give some brief oral remarks, if that is okay.

Mr. LANGEVIN. Without objection.

Secretary ROPER. Mr. Chairman, preparing for an S&T hearing is really good for the soul. It gives you a chance to drill down to what people are doing in our laboratories and in small business work. It is amazing to see the broad array of ideas that are being cultivated by our scientists and engineers. And it makes you excited about what the future is going to be for the Air Force.

A lot of the technology areas you know, hypersonics and directed energy and space, we talk about these a lot, and they are critically important to us. But it is fun to discover some things you didn't know, like the Air Force is looking at bio-inspired materials that will let us make sensors inspired by geckos' ears, making them smaller and more compact or that we are using centuries-old ideas about origami to make antennas that can fold up and deploy in space, cool ideas that are being developed across the country. And these are just a few of the things that I enjoyed seeing in my prep.

Our science and technology budget is at $2.8 billion for this year, up 6 percent from last. We certainly hope to do better in the future, but this shows the commitment that the Air Force has to maintaining investment in science and technology so that the future Air Force remains dominant.

Our Secretary is conducting a full review of science and technology in her 2030 study. We expect the results will be announced in the next couple of weeks. But expect sweeping reforms in how we address this critical part of the Air Force.

Everyone has hit in this opening part of the hearing the most important thing we have to bring to this portfolio, and that is a competitive mind-set. This is not broadcasting seeds that we can't carefully tend. This must be the place where we grow technologies that our future airmen and the services who rely upon them will depend upon. We must treat it more strategically and make each day count. We have to compete for talent. And this subcommittee and Congress have given us the authorities to do that, but we need to use them more aggressively. Whether it is direct hire authority or direct hire for STEM, enhanced pay authority, the Air Force has gotten out of the starting blocks using them, but we need to fully use the authority to make sure that our laboratories are staffed by people that are world leading.

But we can't just compete inside our laboratory walls. We need to get outside of them. We are part of a much broader technology ecosystem. We are expanding our work with universities, having fully embedded laboratory personnel onsite, using the university as a place that conducts research just as if it was part of a government facility. Universities like Purdue have helped us on hypersonics, creating higher Mach wind tunnels where we can do cutting-edge research.

New Mexico Institute of Mining and Technology is working with us on electronic warfare, and we are in discussions with MIT [Massachusetts Institute of Technology] on an AI center so that we leverage the best that universities bring.

We have to acknowledge that the world is changing. Technology is not being developed just inside of government facilities. We have to understand that universities, as well as commercial startups, play an increasingly larger role in this ecosystem. We have focused very hard this year on making it easy for tech innovators to work with us, lowering the contracting time from months down to being able to have a company pitch to us, approve their idea, put them on contract, and pay them in less than 15 minutes. We have to have competitive speed, given the competition for ideas in the technology world.

But it is not just the kinds of technologies you may think about—AI, bio—that [we are] are seeing. Small business can now play an increasing role in high-end technology development. One of our small businesses has been awarded the first X-plane designation ever given to a small business. The X–60 Alpha, which is a reusable hypersonic test bed, will allow us to collect better data to infuse back into fundamental research. Pretty awesome a small business is doing that for us.

We also have to compete ideas. There are so many technologies that could change the future of military: AI, autonomy, quantum, directed energy. So we need to make sure ideas are not just peanut-buttered across everything but are strategically placed on capability areas that will be war-winning. We have created new programs, like SkyBorg, to make artificial intelligence real, not just a laboratory demonstration, fieldable, usable AI.

We are working on collaborative weapons so that we get the benefit of networking that so many of us experience in our everyday lives, and there are many more examples that I am sure we will discuss today.

Ranking Member Stefanik, you used a really good word in your opening remarks. You used the word "ecosystem." And it is a nice-sounding word, but if you think about it, an ecosystem is not a very hospitable place. It is people competing for scarce resources that can be used by all. We need to think of ourselves as part of an ecosystem where we can play a valuable role to universities and businesses and government facilities in this country but where those same technologies can be enjoyed by our adversaries and used against it. And it has to be our sacred duty to plant seeds in today's budget that will be reaped by those that come after us. Thank you.

[The prepared statement of Secretary Roper can be found in the Appendix on page 71.]

Mr. LANGEVIN. I thank all of our witnesses.

We are going to questions now and then followed by the closed session.

My first question is for all of our witnesses, the Department has advertised that this is the largest R&D—RDT&E budget in some time. And yet the S&T request that we are here to talk about today, which includes activities in 6.1, 6.2, and 6.3, has effectively decreased in buying power. And S&T is seen as the source of future innovations essential to the United States ability to compete with near-peer adversaries. If adjusted to account for inflation and highly skilled labor cost escalation for scientists and engineers, then if you look at it, the Department has been on an overall downward trend in its S&T budget.

Conversely, the Department's fiscal year 2020 request for advanced component development and prototype, 6.4, funding, grew by $5.8 billion from the fiscal year 2019 request or 27 percent. So I am certainly a supporter of prototyping and risk-taking, but we also need to invest in our future science and technology. So, given the new challenges on the horizon and the promise of powerful emerging technologies, why should we be effectively decreasing investments in DOD S&T?

Dr. Griffin, let's start with you. I would like to hear a comment from all of our witnesses.

Secretary GRIFFIN. Yes, sir, thank you.

Well, I cannot argue with your figures. You are, of course, correct. I will note that many of the scientists and engineers to whom you refer can work across the boundaries of 6.1, 6.2, 6.3, 6.4. So I don't think our individual talent pool is at risk because of the prioritization that we are doing. And if you look at RDT&E as a global enterprise from 6.1 through 6.7, we are actually up—across base and OCO [overseas contingency operations], we are up 9 percent. And across base alone, we are up over 8 percent. So I prefer—I do very much understand your point about the difference between S&T and prototyping. I do tend to look at the RDT&E enterprise as a continuous stream. And in that sense, we are up. So I will stop there and let my colleagues comment as well.

Mr. LANGEVIN. Okay. Dr. Jette.

Secretary JETTE. Mr. Chairman, our objective in the Army has been to make sure that we have taken the money for 6.1, 6.2, and 6.3 and adjusted it for inflation and inflationary factors and sala-

ries and those types of things and then try to make sure we keep that at a level playing field.

We sacrificed in our 6.4 for some time, and we have now increased, and that is one of reasons our 6.4 budget has significantly increased.

One of the things we are doing to try to get at the issue of salary disparities between some of the greater talent that we might want to reach out to, is to leverage some of the authorities that you have given us, pay banding, renewable term, educational partnerships for individuals that may not want to leave full time their university institutions. So, rather than trying to purely obtain the talent on a full-time basis, we can leverage other methodologies. So we think at this point that we have been able to structure our overall budget to keep ahead of the loss of talent. In fact, we think we have a good talent pool going and particularly with some of our outreach programs over 240 universities that we work with, we think that we are also bringing in a number of interns to and direct hires. It appears at this point, though, I would say, our talent pool is pretty stable and sound.

Mr. LANGEVIN. Secretary Geurts.

Secretary GEURTS. Yes, sir, absolutely a critical point. I guess we are attacking the overall issue from a couple of different directions, which I will kind of cover in top level and can certainly follow up in more detail, either in questions or in followup. The first thing is, how do we maximize the investment that we have made? So $2.3 billion, while not a huge amount of growth from previous years, is still a lot of money. And so my first goal is to maximize the return in value we get for that funding. That is through getting rid of inefficiencies in our processing, making sure we have those funds focused on the most critical needs for the Navy and the Marine Corps and for the Department of Defense.

The second piece is, are we really maximizing the tools we have? Partnership intermediary agreements, cooperative agreements, other tools to bring in folks to the ecosystem. So, if I look at our numbers just in terms of CRADAs [cooperative research and development agreements], last year we had 478; we already have 266 new ones. So we are continuing to see that raise increase. Use of OTAs have gone from 8 to 42 in one year.

The third element is creating a clear path from discovery all the way through to deployment. And so we have reorganized the back end of our R&D portfolio to really focus on two things: future naval prototypes, which is a path in terms of getting that S&T pipeline into the programs of record so we can get it into our acquisition programs; and then also innovative naval prototypes, things where we don't have requirements yet, ideas, things we want to challenge, take high risk, and move that into the system. Creating those pipelines then really leverages that 6.1, 6.2 and these other agreements with industry to give them a clear path to the sailors or Marines that we have.

And, finally, it is boldly experimenting, boldly and relentlessly experimenting, and allowing that basic research, that applied research to get in the hands of a sailor or Marine as quickly as possible. Because many times we find what they designed the technology for may not be ultimately where it has the most value into

our ecosystem and vice versa. We may not have asked for something until we see it. That is how we are really trying to get at maximizing that investment. As we maximize that investment, we will continue to look at adding more as the years come.

Mr. LANGEVIN. Mr. Roper.

Secretary ROPER. Mr. Chairman, I think the Air Force has really tried to approach the valley of death issue with this budget. We have had great technology work going on for—since our inception, going on for decades. But in the collapse of the Soviet Union, we lost a peer adversary that forced, as a mandate, to keep competitive edge, that forced high-tech technology into new systems. And with prototyping funding going down year after year, we got accustomed to there being significant funding in S&T and then significant funding in program of record. So you are seeing the Air Force put a lot of its investments this year into the 6.4 prototyping fund, it's $1.64 billion to try to get things like hypersonics, directed energy, AI out of the laboratories into the field, into operators' hands where they can be used. We hope that once there are programs of record in place, that creates a natural draw and demand from the S&T enterprise to keep modernizing, keep pushing the envelope of technologies because there is a place to transition it in field for warfighter.

I expect that over time, as we get a lot of the mature technologies out of our research lab—I would also like to recognize a lot of our important innovation partners, DARPA, SCO [Strategic Capabilities Office], and DIU [Defense Innovation Unit], are here today. We take the best ideas where we find them. And we want to make sure that we have the funding in place for prototyping to make sure that we can apply them to mission. But I expect that, over time, we will start rightsizing across the whole RDT&E portfolio to make sure that we have optimized for that transition. We can't transition 20 programs a year. We have to determine the number that makes sense for us to keep our dominant edge and then rightsize the rest of the S&T underneath it. But the focus for me this year is going to be transition rate. It is time to create some new, new programs in the Air Force. I am hoping we will do that in our 2021 budget request.

Mr. LANGEVIN. Thank you all. I just hope we will not lose sight of striking the balance of optimization. I don't want to do one at the expense of the other, especially when we are talking about developing those leap-ahead, next-generation technologies. We can't eat our seed corn. We have got to make sure that we are planning for the future and properly investing in the R&D part, along with the prototype and getting things out of the lab and into the warfighters' hands as soon as possible.

As I mentioned in my opening statement, concurrency in policy and tech development is critical to successful employment capabilities and being a global leader and establishing norms for use of technologies, yet too often policy lags behind tech development. So, to the witnesses, in your view, what actions does the Department need to take to promote currency in policy employment concepts, training, doctrine, and other matters as technology matures?

Secretary GRIFFIN. I guess I can start. One of the things we are trying to do on the research and engineering side of the house is

to work more closely with the Joint Staff as they plan execution concepts. They need to know what technologies could be available if they want them. And we need to know how they would like to fight, if we could give it to them. We have made I would say very significant efforts in improving regularizing, increasing the frequency of those interactions so that, as we plan the future force, we know what the people who have to fight want and they know what we have a chance to give them. Working very aggressively on that.

To that end in fact, just to pick one arena, in that of directed energy, we recently started a program to put a high-energy laser on a littoral combat ship. Initially, this will be a demonstration. If it works out well, we can take it to the next step, but it is time to get these systems out of laboratory and into the field, and that is where we are going.

Mr. LANGEVIN. Anybody else care to comment.

Secretary GEURTS. Yes, sir, I think the way we are approaching it, to Dr. Griffin's point, and my experience at SOCOM [Special Operations Command], the faster you can get something in the hands of the warfighter, the faster you can understand where you have the real practical policy implications and start working our way through that. So efforts like our Sea Hunter, where we autonomously transited from San Diego to Pearl Harbor and back with a DARPA-developed product that the Navy is now working on, is a great example. As Dr. Griffin said, getting lasers, we are putting 150 kilowatt laser on the *Portland* this summer. Get it out in the hands of the fleet. Let them experiment. The two other tools we use are innovative naval prototypes. Those are things that we do not yet have a requirement for but looked like they may be disruptive technologies. And we found the faster we can put them out in the field, the faster we understand where those policy pieces we need to work on or where the technology disruption opportunities are, and that is kind of our focus.

Secretary JETTE. Mr. Chairman, we have done a number of things to try and address the issues that you have raised. One of them is a policy that we put in place, it is commonly known amongst us as the 60/40, 80/20 policy. It gives us the freedom where you take 6.1, 6.2, 6.3 money, in the past, often you tried to find a way to link all your funding to something that you are going to do later. The later in the 6.2, 6.3, 6.4, you ended up needing a transition agreement; very formal process, so formal that what it did was it constrained our innovation, particularly at the lower levels and our ability to look at things that might not be so clearly tied to a current operational need. In our current approach, things like 6.1 money is 100 percent optional. Just give me a good reason why we are doing it that might have military utility. You don't have to tie it to an existing program or a defined need. The same type of approach for 6.2 is somewhere in the ballpark of 50/50; 6.3 starts to get it closer to 80/20; and 6.4 tends to be something that we are trying to get focused against a particular outcome. This way, it gives us a little bit of structure but assures freedom on the part of developers to be able to think outside the box and outside of the current requirements.

We have done a couple of other things that I think are important. One of them is we have the Army's established Army Futures Command. The objective of the Army's Futures Command is to do a from stem-to-stern integration of the concepts. I have got operational concepts. I am looking for technologies, and I want the technology development community to then influence the operational concepts. So it is a spiral type of approach to coming up with new directions that we need to focus. And then when we do develop the new technology, how best we apply that? How do we develop the doc on the TTPs [tactics, techniques, and procedures], and who exactly does that? So that it is not that we just give them a new item—I have fielded many things. Sometimes you give it to somebody, they do not have a real good idea of how to use it; it is no better than what they had and maybe even worse.

We have instituted the Rapid Capabilities and Critical Technology Office to try and accelerate, particularly in the area of AI, hypersonics, space, directed energy, our SAP [Special Access Program] programs to get them more under control, make sure that we know that they are focused and make sure that they are properly resourced. And we put—you mentioned in your discussion, how do we increase the willingness to take risk? Organizationally, people are not particularly fond of taking risk, not in the government. It is just not one of those things that is core characteristics. So we establish a policy where we require people to put stage gates in. This comes out of something that I used in the commercial sector in a lot of work that I did. You move your highest risk to the front; fail early if you need to. Highest risk to the front, and then you have off-ramps at various stage gates. And if you run into a place where you found that something is not going the way you want, you can all jointly make a decision: Was it a true failure, or do we have to adjust our target? So we are putting a number of these different pieces in place to try and see if we can get at this overall methodology by which we attack these technology problems.

Mr. LANGEVIN. Well, I think the doctrine policy is just as important in many ways as developing capabilities as well, making sure they are responsibly used.

So, unless you have anything to add, Dr. Roper.

Secretary ROPER. I think most of my colleagues covered it, Mr. Chairman. I will just say briefly, in addition to trying to tackle the Valley of Death issue and create a gradient from the lab to the field, we are working hard to turn ourselves inside out. We have to determine the right way to have an S&T enterprise in a global ecosystem. So we have made great strides over the last year, increasing our work with universities and with small businesses. But we are really focused just inside of this Nation, and we should. We have got cutting-edge companies, the best in the world here, but it is going to be increasingly important to think about, how do we play a role in the global ecosystem as technology is developed everywhere? It can be developed by a company in country X; it can be used by anyone. And so we really need to focus on time to market, not technology exclusivity anymore. And that is going to mean thinking differently about how we work with universities and companies and individuals that are not in the U.S. And we are hoping

to earn our way to those problems by being able to work very well with the innovators that we have in the U.S.

Mr. LANGEVIN. Okay. Thank you.

I have additional questions that I will ask before we go to closed session on the condition of the labs. Also, I want to talk about authorities that may be going underutilized.

With that, I hold those and turn to the ranking member for questions—her questions.

Ms. STEFANIK. Great. Thank you, Mr. Chairman.

I am going keep my questions to 5 minutes so we can get to other members.

My first question is for Dr. Griffin. Last year, when you testified before this committee, you highlighted that there were over 500 separate artificial intelligence projects within the DOD. Fast forward about a year, the Department has undergone a significant realignment of its AI portfolio with the establishment of the JAIC, the Joint AI Center, which reports to the CIO [Chief Information Officer]. How has your outlook on AI changed over this time period? Do you have a better understanding on what AI projects are underway? And what more can we do to accelerate the implementation and deployment of AI capability to the warfighter?

Secretary GRIFFIN. The count I offered in that hearing was based on an inventory we took at the time. I have no reason to disagree with it. I think the point of that comment is that it shows how broadly distributed the possible applications of AI and intriguing research areas exist. And we are trying to take full advantage of those.

Ms. STEFANIK. Let me just clarify my question. It wasn't to say, is that the number still today? It was more to say that we shifted from having a lot of different programs to a more comprehensive approach and a joint approach in terms of, how do we learn the lessons across DOD and centralize it in a hub-and-spoke model through the JAIC?

Secretary GRIFFIN. Okay. Thank you. That helps. The Joint AI Center under the CIO has as its task the taking of research efforts which have proven to be successful or look like they could be successful in the near term and apply them to urgent or existing—I won't say just warfighter, but urgent or existing challenges of the operational community, everything from reforming business practices to pulling targets out of ISR [intelligence, surveillance, and reconnaissance] data to signals out of clutter, et cetera.

The other focus—and I believe that Lieutenant General Shanahan, who heads that activity, working for Mr. Deasy, our CIO, I think he is all in. I think the people in the center are all in on doing this.

On the research and engineering side, we have the task of bringing those tools into being. The tools that the JAIC is using are things which have emerged from quite literally 60 years of AI work, mostly at DARPA. Now, as it happens, when you move into the closed session, you have those experts with you, and I am not one of those. I would urge you to quiz them.

At the R&E level, we are trying to make sure we are covering the whole field, from research to today's applications. So that is one of the modernization priorities in the National Defense Strategy.

As you may know, my deputy, Dr. Porter, and I have organized the research and engineering establishment around those priorities. The core of our organization is an assistant director for each of the NDS modernization priorities. We regard AI as so critical that the Assistant Director for AI will report directly to the two of us as opposed to going through other channels in the organization. Again, the goal is so that we have right in our front office a holistic knowledge of what is going on in AI across the Department but more importantly, across the entire field because the U.S. Government expenditures in research on AI, while extraordinarily significant, are by no means the total sweep of such expenditures. Let me stop there.

Ms. STEFANIK. Thank you for that. I have 1 minute left.

Mr. Geurts, shifting gears here, additive manufacturing is increasingly becoming an important transformative capability across the services. And the DOD recently announced the investment of $60 million of RDT&E in the Digital Manufacturing and Design Innovation Institute to continue to transform digital manufacturing. I believe strongly that additional investment in additive and digital manufacturing will strengthen our domestic industrial base and therefore bolster our supply chain resiliency and accountability. I have a great example of the leader in my district, Norsk Titanium. Can you talk about how additive manufacturing is transforming logistics across the Department and how we can leverage those business leaders across the country who are investing in additive manufacturing?

Secretary GEURTS. Yes, ma'am. I will give you a couple of top level remarks and then happy to discuss it in more detail. It is transforming us both—you know, we have an expeditionary force. We are distributed all around the world. We have ships far away from logistics bases. We have Marines in expeditionary bases. So we have fully leveraged that to get after this logistic—we have 3D printers on ships. We have 3D printers with our Marines. We are 3D printing cement bridges. We are employing this across our entire ecosystem. And we have really, I would say, spent a lot of time on how to get certified parts and describe what parts and what families of parts can be printed locally with 3D printers and working through that whole piece very aggressively.

Ms. STEFANIK. Thank you. I want to abide by my time. I will follow up that in the second round. Thank you. I yield back.

Mr. LANGEVIN. Mr. Larsen is now recognized.

Mr. LARSEN. Thank you, Mr. Chairman.

Dr. Griffin, I took your advice and entered the key words "ITAR [international traffic in arms regulations] free satellite" in my favorite internet search engine, and I found the synonym "knowledge-free policy." And that gets to your point in your testimony about the U.S. removing itself from the marketplace. By withdrawing much of our own industrial base in the global market, we restrict the competitive environment for our own domestic firms, which over time has the effect of eroding technological advantage we want to protect. That does—those are your words from your testimony. It seems that might apply to the people side as well. And I want to get your views on how we should approach contracting with universities or with companies, as we heard contracting with

companies, even if they are in the United States that either have researchers or owners or entrepreneurs who are either from competitor countries or maybe are even second generation in the U.S. What is the approach we ought to be taking based on your idea that limiting doesn't necessarily get you the policy result you want?

Secretary GRIFFIN. Sir, that is a subject very dear to my heart, as you saw in my testimony. And I—we have only a few minutes to cover it. I will do my best.

Mr. LARSEN. You have less than that because I have another question.

Secretary GRIFFIN. Yes, sir. We have to strike a balance between short-term security needs and long-term security needs. The United States got where it got, which is the world's global power still, by unfettering our innovators by being a place where other innovators wanted to come and stay, by allowing the free movement of capital and ideas to the maximum extent possible. There are absolutely things we need to protect. I am not naive about that. I am in fact paid to know what our adversaries are doing. With that said, we need to define the smallest possible areas around which we erect high walls in our industrial base, and for the rest of it, we need to let the competitors compete in the belief that our Nation will prevail.

Mr. LARSEN. So, if I can stop you there, we tend to apply that principle to things.

Secretary GRIFFIN. It applies equally to people, sir. It applies to people. I just the other day signed out a clarifying memo on how we are going to handle grants from the DOD, what we are going to know about the people who are working on those grants. That is a not insignificant topic, but our goal has got to be to attract the best and the brightest to our country and to keep them here.

Mr. LARSEN. You have laid out in one of your paragraphs in your testimony to address a leakage of leading-edge IP from our academic institutions, we need more counterintelligence resources; we need to educate our universities of threats of industrial espionage and assure they employ their best practices to protect sensitive research. Does the DOD have a specific program to educate universities and other elements of academia on best practices on counterintelligence? Are we active in that regard?

Secretary GRIFFIN. We are working that as I sit here, sir. We have a DOD-wide protection—protecting critical technology task force led by Air Force Major General Murphy. My piece of the organization is the executive secretariat for that. We have been and will continue to have conversations with university administration about what to do and what to protect and how to go about it.

While I am in favor of the maximum—of fostering the maximum amount of competition we can arrange because of the benefits I believe it brings, I equally believe that we should be very aggressive in searching out and punishing IP theft and espionage. In fact, if we stop trying to protect every single thing we might want to protect, that will allow us the resources to go after those individuals and those efforts which are targeting our IP.

Mr. LARSEN. So you are currently not taking a one-size-fits-all or an approach where you are cutting off universities and research 100 percent?

Secretary GRIFFIN. We are not doing that, nor do we want to cut off foreign student enrollments 100 percent. We want to look for the bad actors and deal with them as bad actors. But withdrawing ourselves from the globally competitive marketplace will in the long run damage rather than aid U.S. national security, in my opinion, sir.

Mr. LARSEN. Well, it happens to be my opinion as well. It may not be the majority opinion, but it is——

Secretary GRIFFIN. I have never been accused of worrying over much about that, sir.

Mr. LARSEN. Neither have I. Thank you.

I yield back.

Mr. LANGEVIN. Thank you, Mr. Larsen.

Mr. Banks is now recognized for 5 minutes.

Mr. BANKS. Thank you, Mr. Chairman. Thank you, Mr. Chairman, for holding this important hearing as well.

Look, with more and more of our R&D being led by the commercial sector, the challenge is integrating commercial state-of-the-art capabilities into national security systems, as all of you have already said.

The Department's efforts in microelectronics is a perfect example. The Department's microelectronics initiative for national security and economic competitiveness and the Trusted and Assured Microelectronics programs are focused on developing a trusted supply chain of state of the art for our critical national security programs.

As you know, the Indiana ecosystem is a significant contributor to that. Our Naval Surface Warfare Center Crane and universities like Purdue, who Dr. Roper mentioned a little bit ago, Notre Dame, and Indiana University all support these efforts.

So, with that, Dr. Griffin, going forward, what do you see as the role of DOD in supporting development of technology areas with national, commercial, and economic impact like microelectronics and 5G?

Secretary GRIFFIN. DOD has played, has a continuingly critical role to play in those developments. I have been out to Crane within the last 10 or 11 months. I forget exactly what date. I was blown away by the progress they are making on things that we can't talk about in this hearing. If you pursue that same line of questioning in the closed hearing of DARPA, I think they might offer you some exciting information.

But, broadly speaking, the DOD has a critical role to play. I—however, I do have to put on the table that the issue is broader than just trusted pieces of hardware. I am going to be careful to restrict my comments to unclassified, those of an unclassified nature, and so those who have heard me offer these examples before will be rolling their eyes and saying, "There he goes again," but these are unclassified examples and they are relevant.

So I think 2 years ago everybody saw—most people saw an extensive treatment in Wired Magazine of a collateral damage caused by a Russian cyber attack on the Ukraine which spilled over into the Maersk shipping line, and that globally important company came within one computer of losing all of their records. That one computer happened to be located in Africa and had been offline because of a multiday power failure.

So Maersk was able to reboot its system because there was one computer in their whole network that had not been contaminated. Last summer, I think everybody saw the front page news from the FBI: Please turn off your router because it is necessary in order to reboot the software to get the Russians off your network.

We have talked to our—I mentioned Dr. Porter earlier. She recently had occasion to talk to some of our Eastern European allies, relatively newly freed from Russian domination. They have Russians all over their network. What is my point here? The Russians aren't making and selling any hardware. Nobody is buying any Russian microelectronics, and they are still a network threat everywhere we look. So it is about the hardware.

Mr. BANKS. Let me move on there. We can unpack that more in a different setting.

Secretary GRIFFIN. Yes, sir.

Mr. BANKS. According to an Axios article published today, Chinese telecom giant Huawei is poised to claim close to half of the 5G market. AT&T CEO [chief executive officer] Randall Stephenson also stated about Huawei, quote, "You can't separate national security from competitiveness and innovation," end quote.

What portion of the 5G market do U.S. companies currently have?

Secretary GRIFFIN. I don't know, sir. I can take that for the record. 5G is in its infancy. It is not—it is deployed, I think, in South Korea and on the Facebook campus, but it is not a finished product.

[The information referred to can be found in the Appendix on page 96.]

Mr. BANKS. Okay. Your office is managing the DOD 5G effort, correct?

Secretary GRIFFIN. We are developing the DOD 5G strategy, yes, sir.

Mr. BANKS. So how do you synchronize all of our DOD efforts in a space that is primarily commercial?

Secretary GRIFFIN. That, of course, is the key question. And so we see as our function the enabling of commercial enterprises to help them compete in what is a worldwide competition. But our companies view themselves as competing with other companies irrespective of where they are located. They don't view themselves as being in a country-to-country competition.

Huawei is an established competitor at this point. AT&T and Verizon and Sprint and T-Mobile and other companies do and will want to compete successfully with them, and I think by collaborating with them in specific areas, we can help them do that.

Mr. BANKS. Thank you very much. My time is expired.

Mr. LANGEVIN. Thank you, Mr. Banks.

Mr. Kim is now recognized for 5 minutes.

Mr. KIM. Hi. Thank you so much for taking the time to come out and talk with us. This is very enlightening to me to hear your different perspectives.

And it is kind of similar, going off of the last line of questioning here, for me, as I am approaching this, and we are understanding that even the title of this hearing, we are talking about the technological edge, and each and every one of you have talked about it

in that context as well, and we know that overhanging everything you are talking about is this discussion about near peers and Russia and China and others in terms of where they are at.

So, from my perspective here, I want to tell you that it is hard for me to understand our budgeting and the work that you are doing if it is—if it were at the right pacing and the right levels without understanding, you know, where that stands vis-a-vis that competitive edge.

You know, Dr. Roper, I think I really enjoyed how you crystallized it in a couple different frames here, and I wanted to just dive into that. You were talking about that competitive mindset, which includes, you know, the staffing competing for the talent. You talked about the competitive speed, including, you know, the speed with which we get—bring things to the warfighter, and then also that competitive ideas that make sure that we are on that edge.

So I guess I would like to start with you and just get a sense, with those three competitive, you know, categories, should we say, what is your assessment of how we stack up against our—the near peers, China and Russia, that is overhanging a lot of the discussion that we have today? You know, are we ahead? Are we keeping pace? Do we have some catching up to do? It will help provide me with some context as I am trying to assess the budget levels that we are talking about.

Secretary ROPER. Congressman, I will keep comments at a high level to not go into details we shouldn't discuss openly.

I am comfortable with where we are now but not comfortable with the trend. So China has made significant advances in innovation and technology, but we are a country that has been good at it for decades. The impediment that I see is that technology development has transitioned from being mainly led by the U.S. Government in the Cold War to now being developed across the world.

So we have to change from being a technology inventor to a technology user. And we are not going to quit inventing technologies, but primarily we need to be able to ingest and get new technologies to market and our systems.

So I think the paradigm we have got to adjust to is not being a military that has technologies no one else has or will have, but having technologies first and keep putting our hand up on the baseball bat faster and faster than any other opponent.

And I like our chances because we are an innovative country with innovative universities and innovative companies to work with. We need to get everyone connected. We need to get the bureaucracy out of the way we do contracting and small business work and get moving.

Mr. KIM. I appreciate that.

And, Dr. Griffin, I would like to go to you for your assessment here, you know, in this unclassified setting, just to get your overall impressions of where we are stacking up.

Secretary GRIFFIN. Well, my overall impression is that overall the United States is still the world's superpower, the world leader in most technologies of interest to the Department of Defense. There are some areas where we have some catching up to do.

In a completely unclassified setting, I can say go to the internet and look up the Chinese DF–26 [Dong-Feng 26]. It is a hypersonic

missile that, in an unclassified setting, you can see that they refer to it as a carrier killer. It is operational. It can range Guam from the Chinese mainland. That is a concern. We don't have similar systems yet. We will.

On the other hand, it is often touted that, because China is spending a huge amount of money on AI, that they are ahead of us. They are not. Our best assessment is that, although we are spending much less, we are spending it wisely and that this is still an American province.

We cannot take comfort from parity. We cannot take comfort from the fact that in some areas we are ahead. We have to recognize—and I will give credit to Will for pointing out that much of what is going on in the R&D world today is being done commercially as opposed to being solely the province of the national security community.

So, if it is in the commercial world, it is available to everyone. So we need to take advantage of that. We need to do it quickly. We need to keep up our own efforts on those areas which are not commercial. There is no finish line here.

We will not maintain the national security capability that has, broadly speaking, kept peace in the world for 75 years, we won't reach a point where we own that and no one else can touch it. There is no finish line. It is a work in progress and always will be if we want to support peace and freedom in the world.

Mr. KIM. Well, I appreciate that. I yield back.

Mr. LANGEVIN. Thank you, Mr. Kim.

Mr. Waltz is now recognized for 5 minutes.

Mr. WALTZ. Thank you, Mr. Chairman.

And thank you, gentlemen, for coming out today.

Just to very quickly just share with you kind of, you know, we all are influenced by how we approach a problem, right. Mine is as a special operator, spent time in the Pentagon in the building and then as a small business owner where it was incredibly frankly painful to do business with the U.S. Government, with probably about an additional 25 to 30 percent of overhead just to handle all of the regulatory stuff required.

So I have seen this movie from a couple of different angles. A few questions. Our S&T ecosystem, I agree, is one of the best in the world. We are great. We are fantastic as a government at throwing money and resources at a problem.

And just as, you know, as I look across the DOD labs and centers, dozens and dozens of these, as I look at what we have tried to do in the last few years to fix the problems in those labs by creating additional parts of the ecosystem, like SCO and DIUx [Defense Innovation Unit Experimental], I mean, how are you, Dr. Griffin, getting your mind around and getting it—bureaucratically getting our arms around everything that we are throwing at this problem, from the labs to SBIRs [Small Business Innovation Research programs] to academia.

You have stuff that is not even mentioned like CTTSO [Combating Terrorism Technical Support Office] at SOCOM, DARPA, all of these centers, how the heck do you know what is going on? How is that bubbling up? How are you synchronizing that entire ecosystem?

Secretary GRIFFIN. If I have somehow created the impression that I know what is going on, please let me——

Mr. WALTZ. I hope so.

Secretary GRIFFIN [continuing]. Disabuse you of that notion.

Mr. WALTZ. Because you are asking for yet more resources to throw at it.

Secretary GRIFFIN. We are. And we are trying very hard to make sure we do understand the overall landscape and that we can address exactly the issues you have raised.

I have run two medium-sized companies, and one of them was a GPS [Global Positioning System] company some years back, and I sold—the company sold GPS navigation products to the U.S. Government. We also made commercial, handheld GPS units, and we also made survey equipment.

We did not allow the survey equipment folks and the handheld commercial unit manufacturing folks to have anything to do with the people who made missile guidance and navigation stuff because they were contaminated by U.S. Government processes, and if we allowed those two to mingle, the only practical effect was going to be I was going to ruin my commercial company.

Mr. WALTZ. I totally understand the problem. Just——

Secretary GRIFFIN. I get your point. So, to that end, sir, we have recently expanded the entire Defense Innovation Unit, its scope, and its authority, and its funding because the goal of that group is to offer a low-impedance approach to pieces of the commercial industrial base who could be but don't think of themselves as defense contractors. That is one of the things we are doing.

Mr. WALTZ. Oh, that is great. So I would just leave with you a few other questions. We just have to be very careful. We do it across the government. It is not blaming anyone here. Rather than fixing a problem within our government we throw additional pieces on top of it. So, if you could just submit for the record, it is still not clear to me, SCO, DIUx, the labs and really what they are doing better and differently.

[The information referred to can be found in the Appendix on page 96.]

Mr. WALTZ. Dr. Roper, you mentioned in—the last time we were here, you made a statement that I found interesting, and frankly concerning, as someone who has been out on the ground the last 20 years, that if we prepared for great power competition, that we would therefore—you submitted we would therefore be prepared and continue to be prepared for counterterrorism, stability operations.

I think if that were the case, we wouldn't have found ourselves scrambling post-9/11 things like JIEDDO [Joint Improvised Explosive Device Defeat Organization], MRAP [Mine-Resistant Ambush Protected vehicle], all of those other technologies. And as someone who was on the ground, who we didn't have what we needed, and often what we did, when it arrived, we threw it in the CONEX [shipping container] because it wasn't what we needed.

I am concerned, and I just would like to know, you know, obviously building things that fly high, fast, and far is very different than understanding culture, language. We have special operators—I know you know this, Mr. Geurts—on the ground in 60 countries.

What do we do in—we can't take our eye off that ball, and I am concerned the pendulum is swinging too far.

Secretary ROPER. Congressman, I appreciate you raising that because I certainly don't want to imply that, in a generic, abstract sense, that if you are designing for the high-end threat, you are always good for the violent extremist threat. But in this case, as we think about conflicts in the future, potential conflicts in Europe or in Asia, by designing——

Mr. WALTZ. Keep in mind, we are still in these conflicts.

Secretary ROPER. Absolutely.

Mr. WALTZ. As much as people would like to wish them away, and a lot of people in this town would, we are still there.

Secretary ROPER. Absolutely.

And, Mr. Chairman, I will ask just your forbearance to answer the Congressman's question, if you wouldn't mind. Thank you, sir.

Mr. LANGEVIN. Just briefly.

Secretary ROPER. So, in one case, to give you an example, we are working on the advanced battle management system, which is to provide support to Marines and soldiers that are on the ground, similar to what JSTARS [Joint Surveillance Target Attack Radar System] does today. We are designing that to be able to go into areas where things are going to try to contest our ability to operate there, but we are mindful that we need that system to also be able to go into the Middle East and Africa to do mission today.

So we are very mindful. If we design for the high-end threat, there has to be an offshoot for the uncontested environment. So my statement is a forward-looking statement, not a rearward-looking one. So I appreciate you asking that question, sir.

Mr. WALTZ. Thank you.

Mr. LANGEVIN. Thank you, Mr. Waltz.

Ms. Houlahan is now recognized for 5 minutes.

Ms. HOULAHAN. Thank you, Mr. Chairman.

And thank you, gentlemen, for coming here today. And I think I join many of the other colleagues who came before me, including our chair, in our concern about the fiscal year 2020 budget and the cuts that I think are in there for S&T and DOD related research.

Many of the technologies that I worked on when I was Active Duty in the military are now in the field today. We benefited from investing 20, 30 years ago, and the warfighters of today are reaping those rewards. And it is really important that we continue that sort of effort to be forward thinking.

I have three questions, and so I will ask the three of them. I believe they are mostly for Dr. Griffin, and the final one is for you all together. The first one is on artificial intelligence and recognizing the importance of the DOD relationship with industry, with universities, and research and development in the labs.

My first question has to do with what you are doing to make sure that we align and better engage basic research in our laboratories and universities in supporting the advancement of AI technologies and initiatives. So that is my first question which relates to AI.

My second one relates to advanced manufacturing. I was an entrepreneur and an engineer, and about 15 years ago, I was in the

footwear industry working with 3D technology working to innovate with printing footwear using 3D printers overseas.

And so, 15 years later, I am really intrigued by—still intrigued by supply chain improvements and initiatives that reduce costs for us, that increase our flexibility and our supply chain and reduce our reliance on foreign manufacturing.

And so my second question has to do with what opportunities exist in research and advanced manufacturing that can help transform the DOD and the industrial base and what research activities are underway to support them and to the degree that you can answer that question in this setting.

And then my final question for the entire panel actually has something to do with what the chairman introduced with, which he said he was pleased to see the highest leadership here today. And I also am pleased. I am very grateful to see you here.

But what I also see is something different because what I see is a bunch of White men, and what I am interested in is what we are doing to make sure that we elevate people of color and women to those highest positions of responsibility, STEM and STEAM [science, technology, engineering, the arts, and math] education. What sort of specific initiatives are we doing within our communities to make sure that I, as a young engineer and now as a Congresswoman, would like my children to be able to see a different face in front of me when I next see people here?

So that would be my final question, and I have about 2½ minutes if you wouldn't mind helping me with those answers.

Secretary GRIFFIN. We are actively working in AI across the entire industrial base, universities, laboratories, companies. I mentioned earlier that the U.S. Government investment in AI is not the biggest dog there. So we get that, and we are working with them.

With regard to advanced manufacturing, 3D printing, all of that, what are our options, I am going to have to that that for the record. I am—as I like to say, sometimes I am a simple aerospace engineer from a small town, and I am not up on 3D printing and manufacturing, so we will take it for the record.

[The information referred to can be found in the Appendix on page 94.]

Secretary GRIFFIN. With regard to the leadership, the USD R&E Deputy Under Secretary, Dr. Lisa Porter, as her name was brought up by Ranking Member Stefanik in another context, unlike me, she is not an old, White guy. And she is sitting at home cringing now watching this because I would be happy to have her being here instead of me. Trust me.

Ms. HOULAHAN. No. And I completely appreciate that. It is, you know, making sure that it is more than just one person that we can point out, you know, making sure that we have a pipeline of people who look different than all—than, you know, who reflect the face of our Nation.

Secretary GRIFFIN. Well, Dr. Nikolich will be testifying in the closed session. His deputy is Mary Miller, whom you, I believe, know. She is a long-time employee.

The Assistant Director for Microelectronics is Nicole Petta. Microelectronics was raised by Mr. Banks earlier. Nicole ran a divi-

sion for me in a company that I previously ran. I managed to trick her into coming to the DOD to help.

Ms. HOULAHAN. Are there programs——

Secretary GRIFFIN. I think we are doing everything we can.

Ms. HOULAHAN. Are there specific programs aside from specific seats that—you know, maybe, Mr. Geurts, it seems as though you might have an answer to that.

Thank you, sir, for your time.

Secretary GEURTS. Yes, ma'am. I am happy to bring you some more of the details.

Ms. HOULAHAN. Thank you.

Secretary GEURTS. We have got a number of programs, our Chief of Naval Research Deputy, senior civilian for our research, is a female. But to your point, we are not going to compete and win if we cannot fully leverage diversity in all of its elements, and so we would be happy to talk about that. We have got an Asia-Pacific partnership STEM program. We have got a lot of other ones we can describe for you. It is such an important topic.

Ms. HOULAHAN. Thank you.

And if I could just have 10 more seconds, I just wanted to conclude by asking if we could, in fact, get more information about the 3D printing. And I would love to hear a little bit more about how we are engaging the universities and R&D labs more effectively for the record. That would be great. So thank you so much for your time.

Secretary GRIFFIN. Yes, ma'am. We will take that for the record.

[The information referred to can be found in the Appendix on page 95.]

Mr. LANGEVIN. Thank you, Ms. Houlahan.

Mr. Brown is now recognized.

Mr. BROWN. Thank you, Mr. Chairman.

Starting on a lighter note, Dr. Jette, great to see you. I will not report back to the Army that you used a naval metaphor stem to stern to talk about the approach of the Army Futures Command. Yeah, it is a joint force. I get it.

So my question, so I also have concerns that in the 6.1, 6.2, 6.3 categories where we seem to be, you know, underfunding, that is where we are planting the seeds for the military's future technology.

In the 6.4 funding area, advanced component development and prototypes, let me ask you this: What percentage of that prototyping is done inside established systems of acquisition oversight for programs of record, and how much of that prototyping is done outside of a program of record? Any ballpark?

Secretary GRIFFIN. I do not know. I will take that for the record. If my colleagues happen to have that at their fingertips, I welcome their answer.

[The information referred to can be found in the Appendix on page 94.]

Mr. BROWN. And the reason why I raise it, and I think, Dr. Jette, you will be able to speak to it is because, you know, as I understand it, the GAO [Government Accountability Office] has expressed a concern that when it comes to prototyping—and they were looking at the Army Futures Command—that a lot of proto-

typing more and more seems to be done in a relevant simulated environment versus in an operational environment. And they expressed the concern that we are moving to weapons systems development at a lower level of maturity. Does that have to do with where the prototyping is taking place?

Secretary JETTE. Congressman, I think that, first, to give you an idea, I mean, the vast majority of our prototyping is done in a controlled approach, so there is a program manager or a lead integrator that is responsible for doing a prototype, and probably on the order of 90/10.

So we try to make sure that, as we are doing prototyping, it is not just willy-nilly and that it is also associated with a program—a plan to some success if the program plan is, in fact, successful.

Mr. BROWN. So, given that it is not willy-nilly, you still have the difference between a relevant simulated environment and an operational environment. I am sure you are familiar with the concern that the GAO expressed. And what is the response of the Department of the Army?

Secretary JETTE. Well, so I think there are two approaches the Army is taking to that. First, we work very hard at trying to make our simulated environment as close to those characteristics of the actual environment we expect to see or are seeing as possible.

And we have organizations specifically designed to do that, and it is part of our test and evaluation master plans that we put together: How close are we to what we need from the operational perspective to make sure that we have actually tested the equipment in an environment that is relevant? So that is a significant part of how we come up with the test plans.

The second piece is that we do an awful lot of prototyping. The other 10 percent, in many ways—we have the Rapid Equipping Force. We answer calls from theater for various types of equipment. And those in many ways also form a variant of a prototype because they are usually small sets, certain missions, certain numbers. We go out. We study how they are doing in the actual operational environment and then return them.

I think the—probably the other one thing is we have a lot of partners internationally, other countries who have various issues in their environments, and we work closely with them to try and see how they are using their innovative components early.

Mr. BROWN. Let me see if I can just get one more question in. Is there an idea—and, again, I always go back to what the GAO kind of recommends or highlights to Congress. And they are recommending a high-level DOD-wide strategy that communicates strategic goals and priorities and delineates roles and responsibilities among DOD's prototyping and innovation initiatives.

They claim that there is not such a strategy. What is your response to that? Is there an overarching DOD-wide science and technology strategy that delineates roles and responsibilities, and is it in writing?

Secretary GRIFFIN. I guess the best I could tell you, sir, is that from their R&E under secretariat that is a work in progress.

Mr. BROWN. Okay.

Secretary GRIFFIN. The National Defense Strategy has been referred to here several times earlier. That is our guidebook for what

modernization should look like. We are trying very hard across the Department to reorchestrate our development portfolio in line with those modernization priorities.

We are judging new programs according to whether they fit within this priority scheme or not, not that they can't be funded even if they don't, but that that certainly is a relevant fact. We are trying to realign our S&T and portfolio and right through RDT&E to fit what it is that the Nation's overall defense modernization strategy supports. We are not done yet. The NDS was released 14 months ago.

Mr. BROWN. And will that—and, Mr. Chairman, just one followup.

The end result, will that be a work product? Will that be a document that can be reviewed and evaluated?

Secretary GRIFFIN. I think we will be able to put together the end products from a number of these different areas and bring them to you if you wish, sir. I don't believe we are—I am not working on preparing one document which summarizes all of it in one place.

Mr. BROWN. Okay.

Thank you, Mr. Chairman.

Mr. LANGEVIN. Okay. Thank you, Mr. Brown.

We are going to go into a brief second round, but I want to start with a question for all of you. According to the 2017 report by the Defense Science Board, most lab directors feel that they are unable to maintain the facilities and infrastructure at a reasonable standard.

So I want to know, can each of you please discuss the state of your research labs and how the budget addresses concerns about maintaining the labs at the standard necessary to conduct cutting-edge research.

Secretary GRIFFIN. Chairman Langevin, I guess I will start. We have had challenges in this area. When we get military construction money it goes for a very wide range of priorities, all of which are real, and only some of it goes to laboratories and facilities.

So I have had occasion to see—in my 14, 13 months in the job so far, I have had occasion to see quite a number of facilities and laboratories which are in the process of being upgraded. I have seen many more which need it, and it isn't happening soon. I think I should stop there. It is a very difficult problem. We don't have all the money for laboratory and facilities upgrades that we would like. We are working on it.

Mr. LANGEVIN. We need to keep focused on that. We can't——

Secretary GRIFFIN. I could not agree more, sir.

Mr. LANGEVIN. Okay. Dr. Jette.

Secretary JETTE. Mr. Chairman, this is an area of concern certainly for the Army. If you just take a look at the capitalization in the laboratory systems and the funding that is directly applied to that, we have insufficient funding to make sure that the labs remain up to date if that is the only method by which we actually do so.

One of the benefits we have is you have given us authorization in 2363 to tack 2 to 4 percent onto our research and development efforts, take that money back in, and then provide it to the lab di-

rectors to do upgrades and enhancements that are necessary to keep the lab at a cutting edge.

We fully implemented that. It took a little bit to get it past some cultural issues, but that, in fact, is working well and helping us. We do have a number of MILCON [military construction] projects, and we are I wouldn't say accelerating but we are getting a few more per year.

Picatinny has $41 million in Explosive Ordnance Disposal Technology Facility. Soldier Center at Natick has $44 million in Human Research Engineering Lab. There is—Aviation & Missile Center has a propulsion systems lab for $30 million in 2022. ERDC [U.S. Army Engineer Research and Development Center] has, in 2023, communications center for 14.8, and 2024, a risk assessment lab for 30.

So we are trying to work with the labs to help them identify specific things that we can get through the MILCON process.

Mr. LANGEVIN. Secretary Geurts.

Secretary GEURTS. Sir, briefly, the average age of our facilities in the labs is 61 years old. So the problem is real. It is something we have been attacking. As Dr. Griffin said, you are competing the average age of the Navy dry docks and piers is 62 years. So, you know, there is certainly competition for it.

I would like to thank the committee. You have given some additional funds in 2018, $20 million, which allowed us to burn back 25 percent of our backlog in minor MILCON, which was really powerful for the labs, and we have taken full advantage of that.

I do think there is more opportunity. We are looking at both using some of the authorities, like the 219 authority, to allow us to do some more without going through the former MILCON process for some of the minor mods. There are probably some opportunities to relook at that authority to see if there is a little more flexibility.

And then, finally, we are looking at some new models, as Representative Stefanik talked about the ecosystem. It is not clear we have to wholly own every one of these facilities if there is a way we can work with some of our partners and come up with win-wins in terms of joint research facilities and whatnot. So we are just on the front end of that. We are looking at all the available means to take on this problem because we will not stay relevant and attract talent if we don't.

Mr. LANGEVIN. Great.

Secretary ROPER. Mr. Chairman, I will say briefly, I think it will always be a systemic problem that modernization of laboratories will have a difficult time competing against MILCON that is for immediate readiness, a warfighter who needs something done immediately.

So I am very appreciative of the authorities that this committee and Congress writ large has given us to use RDT&E funds to do minor modernization, minor MILCON, so the section 219 authority. We have been able to do modernizations at AFRL [Air Force Research Laboratory], about $83 million worth that would have never made the MILCON budget.

I believe these authorities are set to expire in the future, in 2025, so I would ask to be able to work with you and other members to

either extend the authority or remove the cap and potentially raise the threshold of funding we are able to spend.

I think it makes sense for modernization of facilities that do science and technology to be funded out of science and technology work. The laboratory is much more than a building. It is a factory for new ideas and technologies. So we should have a different way of working with it. Thank you.

Mr. LANGEVIN. All right. Thank you all.

So I am going to state this question, and then I would like you—for the record, and then I would like to have you respond to that one, this last one in writing.

But, Secretary Geurts, you have told us that the Navy is leaning forward on fiscal year 2017 NDAA, section 233, which allows each acquisition executive to waive policies and guidance of the Science and Technology Reinvention Laboratories, the STRLs, to allow for the development and implementation of alternative and innovative methods for effective management and operations in your laboratories, warfare centers, and system centers.

Your letter from October 2018 mentioned that the Navy implemented 12 management initiatives, including expanded personnel authorities, revised contracting and procurement thresholds and provided business process relief. To our knowledge so far, you are the only service to use this authority.

So, from you, I just wanted to ask, again, for the record, what kinds of implementation have you already seen in your STRLs with these authorities, and do you have suggestions on how it and any of the authorities given can be improved to facilitate quicker development and delivery of cutting-edge technologies to the warfighter?

For Dr. Jette and Dr. Roper, I want to know, what is preventing the Army and the Air Force from also taking advantage of section 233 authorities?

And then, Dr. Griffin, for you, finally, what can you do to better help and incentivize the services to use section 233 and other authorities to improve lab management and operations? Time doesn't permit for us to get to that—these right now, in this session right here, but I want those for the record, if you would please.

[The information referred to can be found in the Appendix on page 93.]

Mr. LANGEVIN. With that, I will turn to the ranking member for final questions.

Ms. STEFANIK. Thank you.

I wanted to follow up on my first line of questioning, Mr. Geurts, regarding additive manufacturing. You talked about the Department's understanding of how transformative this is to many of the challenges we face. Can you talk about how we can leverage private sector additive manufacturers and use their investments that they have made to benefit the Department?

Secretary GEURTS. Yes, ma'am. Just as a followup, we have already declared thousands of parts as 3D printable, certified for use. And so the first easy answer to that is then you go for the first provider who can provide that part at the best price, 3D printed, from wherever they live.

So I think the first item is getting the parts certified for 3D printed, getting the specifications set for those, and then allowing the marketplace to compete and build those parts for us.

As I said, we are also working on the networking and the R&D aspect of it. I am sorry the Representative left there. We have got $23 million in our 2020 budget in R&D just for the research and development of 3D printing technologies and $66 million across the FYDP [Future Years Defense Program]. A lot of that is so we can network all of our 3D printed files together, create models.

One of the challenges is how to certify a part where the 3D printed technology that has been certified traditionally. That is where that research is going. So those are two pretty close ones. And then we are the executive agent for a 3D printing center for the government, and we are using that as well to get to practical ways to get that out.

And then I would comment that Dr. Jette's policies on intellectual property and 3D also play into this.

Ms. STEFANIK. Absolutely.

I also wanted to give Dr. Roper an opportunity to comment because I know you have thought a lot about additive manufacturing and 3D printing from your perspective. Did you want to comment on my question?

Secretary ROPER. Yes, ma'am. When you are waiting months, sometimes years, for airplane parts, you think a lot about different ways to make them. It is making a huge difference already in the Air Force. We have certified broad swaths of parts that can be printed and put on aircraft. We are trying to go after certifying materials and machines so that even parts we haven't thought about can be made and certified and get a de facto air worthiness agreement.

We created an entire permanent executive officer, a three-star that is responsible for bringing in innovation into sustainment. That is 70 percent of our budget, and we are not focusing innovation there. So now we are starting to do that.

They have transitioned 3D printing and additive manufacturing and additive repair into our depots. They have done other innovation and sustainment initiatives, like predictive maintenance, which is AI applied to maintenance.

I think the thing I am seeing, Congresswoman, is that when you are pushing the fundamental science and engineering, that is something that is not being done in the broader ecosystem. Companies are holding onto their tradecraft, and since we don't own IP in the government, we are publishing everything we are doing and are having companies come to us to try to apply technologies that we have developed to their own individual investments.

And I won't say the specific companies here, but I would be happy to share with you offline. But companies that are working on cutting-edge engines are coming to the Air Force to determine how are we printing high-temperature materials. And the reason that they know to come to us is that we publish our results. So I think the government can play a huge catalyst role in the broader ecosystem for additive just by driving the fundamental technology.

And then, to Secretary Geurts' point, once we have our processes and certifications in place, we should let the market do its job,

which is bring our prices down and get ultimate readiness up to the warfighter.

Ms. STEFANIK. Thank you for that.

In my minute remaining, Dr. Griffin, I wanted to go back to you. Shifting gears, I wanted to ask about 5G. You have tapped your deputy, Dr. Lisa Porter, to spearhead the initiative in your Department. And there has been a lot of public debate on 5G and what should be done to contain China's global influence in this space but little coverage on what more we need to do domestically to mature and deploy 5G technology.

Can you talk about your Department's approach when it comes to 5G and specifically what we need to do to jump start our technology to compete in the 5G space?

Secretary GRIFFIN. Very briefly and we can—I am sorry. I can answer very briefly, and we can take more for the record.

Yes, the R&E establishment in DOD has been assigned the lead for developing a DOD strategy, and as you mentioned, Dr. Porter has the baton for that.

What needs to be understood, despite all the hype, is that 5G is in its infancy everywhere in the world. It is in its infancy. It encompasses both standards and hardware, and much of that is hardware yet to be developed. The so-called Internet of Things depends upon the routine use of much shorter wavelengths, higher frequencies than is in common practice today.

So there is a huge development challenge. There is a huge infrastructure build-out challenge. We will need—in comparison to, as a very rough number, 10,000 cell towers in the United States today, we will need north of 10 million cell towers or equivalent base stations. So there is an infrastructure build-out challenge.

DOD and the U.S. Government broadly can be part of the solution. We want to be. We think the part that we can play is in the development of some of those fundamental technologies. DARPA is the world leader in the development of millimeter wave technologies, the kinds of frequencies and wavelengths that we will need for 5G.

So the technology end is one piece of it. Another piece of it is providing the testing ground, if you will, for how we are going to actually build out and deploy some of these things. Security is going to be—cybersecurity is going to be an extremely important part of this, and DOD can't afford to use any technology, no matter how attractive, if we can't make it secure.

So offering to our developers, commercial developers, government developers, whatever, offering them the geography and the opportunities for experimentation, putting things into practice, prototype systems, without the necessity of gaining State, local, county permits to erect a tower, that could be extremely powerful.

So, on those fronts, broadly speaking, I think is where our ability to contribute lies. It does not—it emphatically does not lie in having the DOD take custody of a national telecoms build-out, infrastructure build-out. That is not the right path.

Ms. STEFANIK. I wanted to just add one comment. You talked about how we can be and we want to be part of the innovation and solution when it comes to 5G. I want to add a note that I think we have to be when this is a global race for 5G technology. And

as you correctly point out, the security risks, specifically the cybersecurity risks that come from 5G, it is incredibly important that we have a strategy to mature and deploy 5G technology that meets our security standards.

And, with that, I yield back.

Mr. LANGEVIN. I thank the ranking member.

I want to thank all of our witnesses for your testimony today. I ask that you follow up on the questions I posed at the end, and other members may have questions that they will submit for the record. And I ask you to try to get back us to with those answers in a timely manner.

With that, thank you all for your testimony, the work that you are doing.

This hearing stands in recess—adjourned, and now going into the closed session.

[Whereupon, at 12:52 p.m., the subcommittee proceeded in closed session.]

A P P E N D I X

MARCH 28, 2019

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MARCH 28, 2019

Intelligence and Emerging Threats and Capabilities Subcommittee
Chairman James R. Langevin
Opening Statement

Fiscal Year 2020 Budget Request for Department of Defense
Science and Technology Programs:
Maintaining a Robust Ecosystem for Our Technological Edge

March 28, 2019

The subcommittee will come to order. Welcome to today's hearing on the Fiscal Year 2020 President's Budget Request for Department of Defense (DoD) Science and Technology (S&T) Programs.

I am pleased that for the first time in many Congresses we have the highest S&T leadership from the Department providing testimony. By having the top leadership, this hearing aims to elevate the discussion of S&T to the same level of importance as how many fighters, ships, and satellites the Department is buying.

The Department's S&T ecosystem is complex and comprises agencies; offices; laboratories; federally funded research and development centers; university affiliated research centers; academic partnerships; test and evaluation entities; and partnerships with the private sector – including small businesses. This S&T ecosystem is charged with delivering the best capabilities to the warfighter in the near, mid, and long-term.

For such an important portfolio, the FY20 President's Budget Request totals $14.5 billion, which is only 2.7% of the Department's base budget and only 3.2% above the FY19 requested funding level. Adjusted for inflation, the FY20 request is only 1% higher despite the increasing cost escalation of highly specialized technical labor like scientists and engineers with advanced degrees and PhDs.

To say it another way – normalizing for inflation and labor cost escalation, this S&T budget has effectively been shrinking for years. And this is the budget that must lay the groundwork today for our future technological edge in the next ten to twenty years. I also want to point out that unlike the shrinking of the S&T request, the Department's FY20 investment in advanced component development and prototypes funding grew by $5.8 billion from the FY19 request, or by 27%. Although I strongly support efforts to get new technologies across the valley death and into the hands of our service members, we must be cognizant of the fact that we must also invest in the long-term basic and early-stage applied research that will allow for revolutionary advancements down the line.

In the past three National Defense Authorization Acts (NDAAs) alone Congress has granted almost two dozen authorities to improve the Department's S&T workforce, facilities, and infrastructure to champion in-

house innovation for the future of force modernization, warfighting operational concepts, and acquisition. I remain disappointed that many of those authorities have been underutilized by the Department.

This is also hard to reconcile with the National Defense Strategy (NDS) which highlights long-term strategic competition with China and Russia and the need for an unparalleled National Security Innovation Base.

It is no secret that China is stealing our intellectual property to further their objective to be a research and engineering powerhouse and compromise our warfighting edge. Make no mistake however, China is not the only nation conducting these activities.

China is, though, one of the few state actors that has coupled such tactics with considerable investments and resources behind a national strategy that involves a whole-of government effort and leverages society to promote "indigenous innovation."

Yet, this President's Budget Request decreases S&T and R&D funding across the Executive Agencies including at the Department of Energy's Office of Science, the National Institute of Standards and Technology, and the National Science Foundation.

If the U.S. is to remain a global leader in technology, we cannot simply play defense, we must also play offense. Investments in science and research and other development efforts across the whole-of-government are necessary and vital to maintaining a technological edge.

Beyond R&D specific funding we must also invest in STEM education, programs that develop junior talent into future tech leaders, and implement policies that promote a sound economic, political, and strategic environment on U.S. soil where global collaboration, discovery, innovation, public institutions and industry can thrive. I recognize that the open dialogue and debate of academia can be anathema to the secrecy we rely on in the Department of Defense. But we must also recognize – and embrace – the competitive advantage our free society gives us to out-innovate and develop better products faster.

Setting ourselves apart from our strategic competitors also means abiding by our American values and keeping our policy as – or more – developed than the technology itself. Foundational work for the current understanding of Artificial Intelligence (AI) done in the 1950s and '60s was funded by DARPA and the Office of Naval Research and aided by the convening power of universities. [1]

We've been working on this technology for over half a century. Yet, in the John S. McCain FY19 NDAA (Public Law 115-232) Congress had to create a National Security Commission on Artificial Intelligence to expedite the policy, strategy, and implementation plan that absolutely must be thought

---

[1] Babb, Colin E., "How We Got Here – A Small Tale of the Autonomy and the Sea", Future Force: Spring Edition 2014

through for our nation to effectively and ethically use this capability.

For AI, and for each of the other seven rapid technological advancements outlined in the NDS, I am looking to the Department to lean forward on strategically developing policies on how we should use and deploy these future technologies, and how these emerging capabilities will contribute to new security strategies. Such effort is especially important with hypersonics and directed energy, which present a myriad of policy and political considerations and challenges.

Finally, I must emphasize that we will not attain the technological edge we need if we refuse to take risks in our R&D portfolio and if we do not empower risk-takers who are willing to push the boundaries on innovation. I realize this will not come easily for the Department of Defense, because the overriding culture is one of never failing – after all, in many aspects of the Department's missions, failure means people will die.

However, in the S&T space, an attitude that conservative means we will never conceive of the technological leaps that will ensure our warfighters never go into a fair fight. It is incumbent upon the leadership in the Department to avoid perpetuating an overly conservative culture in the S&T enterprise, and I hope to hear from our witnesses today what they are doing to encourage reasonable risk-taking. In turn, so long as the Department is transparent about such failures, Congress – and this subcommittee in particular - must be willing to provide top-cover for those that fail fast, fail smart, fail forward, and internalize the lessons-learned from those failures.

Before us today are the Services' technology and acquisition executives. These individuals must divide their attention between fielding the best technology to the warfighters as quickly and as efficiently as possible in the near and mid-term, and protecting the scientists and innovators working on the next generation of S&T that will enable the Department to keep its technological edge over the long-term.

In section 901 of the FY17 NDAA (Public Law 114-328), Congress split the former Under Secretary for Acquisition, Technology and Logistics (USD(AT&L)) into two and created the Under Secretary of Defense for Research and Engineering (USD(R&E)) to empower Department leadership to drive towards better innovation, advancing science and technology, and reducing risk-intolerance in the pursuit of new technologies.

Dr. Griffin, the first USD(R&E) since this change, is the Chief Technology Officer for the Department and is responsible for the research, development, and prototyping activities across the DoD enterprise. He is mandated with ensuring technological superiority for the Department of Defense.

Dr. Bruce Jette, the Assistant Secretary of the Army for Acquisition, Logistics and Technology; Mr. James "Hondo" Geurts, the Assistant Secretary

of the Navy for Research, Development & Acquisition; and Dr. Will Roper, Assistant Secretary of the Air Force for Acquisition, Technology and Logistics, are the three Service Acquisition Executives (SAE) responsible for executing and overseeing the Services' research, development and acquisition activities.

I look forward to hearing from our witnesses on the FY20 S&T request and note that following this discussion, we will continue in a closed, classified, follow- on discussion with representation across the spectrum of the S&T ecosystem -- the Defense Advanced Research Projects Agency, the Department's laboratories and academic partnerships, the Strategic Capabilities Office, and the Defense Innovation Unit.

STATEMENT OF

MICHAEL D. GRIFFIN

UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

before the

HOUSE ARMED SERVICES

SUBCOMMITTEE ON EMERGING THREATS AND CAPABILITIES

FY2020 SCIENCE AND TECHNOLOGY POSTURE HEARING

28 MARCH 2019

INTRODUCTION

Chairman Langevin, Ranking Member Stefanik, and Members of this Subcommittee: thank you for the opportunity to discuss the role of the Office of the Under Secretary for Research and Engineering (OUSD R&E) in advancing defense modernization in response to resurgent adversaries making dogged investments to outpace us and win the long game.

I am joined today by the Service Acquisition Executives to highlight the ways in which the Department of Defense (DoD) is working to change its processes, culture, and investment decisions to ensure we maintain the technical dominance necessary to deter our adversaries for as long as they choose to posture themselves as adversaries. As the Chief Technology Officer for the Department, it is my job to align the Department's investment portfolio in accordance with the modernization priorities outlined in the National Defense Strategy (NDS). I cannot do it alone. We must work together to counter the threats posed by our adversaries.

CHINESE AND RUSSIAN THREATS

I believe we all understand that we are now in an era of renewed great power competition. Our adversaries have self-declared, and our only choice is to respond appropriately, or cede the primacy of the rules-based order that the United States established in the aftermath of World War II and nurtured for three full generations.

Today China and Russia are actively challenging the current status quo while advancing indigenous military technologies at disturbing rates. China has doubled its defense budget in the last decade, has built and armed islands in the international waters of the South China Sea, has weaponized technologies from space and hypersonics to cyber and directed energy, and commits rampant theft of intellectual property, all to impose its will upon sovereign nations across the globe. Russia invaded Georgia and Ukraine, flouted the INF treaty, committed cybercrimes on a global scale, and publicly touts the development of new strategic nuclear hypersonic systems. Both nations have invested significantly in systems designed to disrupt, damage, and degrade U.S. space assets, holding at risk the systems we depend upon both to sustain our economy and to enable the American way of war.

The United States pioneered many of these technologies years or even decades ago, yet we chose not to develop them into military capabilities. But our adversaries get a vote, and their votes have been cast. The United States must respond.

MODERNIZATION PRIORITIES OF THE NATIONAL DEFENSE STRATEGY

The 2018 National Defense Strategy (NDS) outlines a clear approach to regaining and maintaining our once unquestioned technical advantage through investments in key modernization priorities: hypersonics, directed energy, space, autonomy, cyber, quantum science, microelectronics, biotechnology, artificial intelligence and machine learning (AI/ML), and fully-networked command, control, and communication. To pursue these priorities, the

President's Fiscal Year 2020 (FY20) budget request includes $14.1 billion for the cross-department Science and Technology enterprise, a 3% increase from the 2019 request. As Acting Secretary Shanahan noted, the FY20 budget directs more than $7.4 billion to the development and fielding of technologies for the future fight.

The Department has moved decisively to outpace our adversaries across these priorities:

Hypersonics

Hypersonic capabilities remain a major Department-wide modernization focus, and DoD is accelerating hypersonic systems development and demonstration. The $2.6 billion requested for hypersonics in FY20 represents an increase over the FY19 enacted amount. Moreover, DoD is nearly doubling our long-term investments from $6 billion to $11.2 billion over the next five years. We have significantly increased flight testing, as we intend to conduct approximately 40 flight tests over the next few years, to accelerate the delivery of capability to our warfighters years earlier than previously planned.

Space

Given the increased adversarial activity of China and Russia in space, the Department is changing how we field critical capabilities. The newly-formed Space Development Agency's (SDA) task is to field critical space technologies outside normal acquisition processes and at a more rapid pace. The FY20 budget request for SDA is $149.8 million, reflecting the creation of a lean organization that will complement existing DoD space organizations.

As its first priority, SDA will work with elements across the Department and industry to develop proliferated low Earth orbit (P-LEO) space sensors system in support of a number of mission areas.

Directed Energy

Achieving near-term directed energy technology progress is vital—moving from laboratories to weapons platforms. Our plan, in coordination with the services, accelerates operational weapon system development. Through our Laser Scaling Program, four teams are on the path to build 300 kW high-energy lasers by 2022, increasing to 500-1000kW capability over the next decade. We have partnered with the Special Operations Command to accelerate programs for airborne and land-based laser strike weapons, with initial operational capability by Fiscal Year 2024.

Artificial Intelligence and Machine Learning

In the field of AI/ML, the Defense Advanced Research Projects Agency (DARPA) continues to build on work begun almost 60 years ago, when they developed the expert-system technologies utilized in everyday tools such as tax preparation software. More recently, DARPA launched its $2 billion AI NEXT campaign, a multi-year effort to grow the current "second wave" of AI while exploring and creating the future "third wave." This work will be critical to making AI/ML less brittle, more accurate, and a more reliable partner for human operators by reinforcing and supplementing decision making. DARPA, along with the Defense Innovation Unit (DIU) and the broader R&E enterprise, are working with the new Joint Artificial Intelligence Center to

apply existing AI technologies to real-world problems, and scale and deploy successful applications.

Cyber Security

Our adversaries recognize cyber as a weapon, and therefore so must we. Defense against intrusions, as well as the development of tools and techniques to hold adversary assets at risk, is another critical priority for the R&E enterprise. We must also partner with colleagues in the intelligence community and other U.S. government agencies.

Further, as we expand our capabilities in space, with AI/ML, and moving into 5G wireless technologies, we expand the avenues for adversary action against our networks and systems even as we expand the opportunities these new approaches bring. Distributing and diluting our hardware attack surface, whether in space or in the "internet of things," does no good if we ignore the vulnerabilities of the expanded cyber attack surface. Our initiatives in AI/ML, space, 5G, and other attractive new technologies must be accompanied by an awareness of and attention to the cyber vulnerabilities they create. Cybersecurity initiatives will thus be critical across the range of NDS modernization priorities.

Microelectronics

The U.S. presently lacks the domestically owned foundries that have in the past produced uncompromised, state of the art semiconductors for both commercial and national security applications. Equally important is the need to focus on technologies that allow us to operate securely in an environment where hardware, systems and networks are known to be compromised. Industrial base development in this area is critical, and we are working with industry to assess and understand their challenges. We will continue our efforts with the Office of the Director of National Intelligence and the Department of Energy National Nuclear Security Administration to develop fiscally responsible and realistic options, including investments, incentives, and regulatory approaches, to provide long-term, economically-viable sources to meet our needs for state-of-the-art microelectronics.

Quantum Science

While quantum science and technology will be important in the future, they are still in their formative stages. Despite media hype, we are many years from functional quantum computers. However, there is justifiable optimism that quantum clocks, magnetometers, and inertial navigation sensors could be available in a few years. Such devices could greatly reduce our dependence on space-based or other external systems for critical position, timing, and navigation functions, an important consideration for military operations in a GPS-denied environment. In R&E, we will work with USG partners from the National Science Foundation to the intelligence community to contribute to quantum computing advances, but our focus will be on deployment of clocks and development of sensors.

THE OUSD R&E ORGANIZATION

Section 901 of the FY17 NDAA re-established position of Under Secretary of Defense for Research and Engineering (USD R&E) for the first time since 1986, formally splitting the Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics into two components. The USD R&E is charged with directing research and development funding priorities across the Department, with conducting independent technical risk assessments of major programs, and is the DoD Chief Technology Officer. Our job is to shape the future force in such a forbidding manner that no adversary ever believes that today is the day they can confront America and win.

The 2018 NDS is our guide, further informed by seasoned judgement and awareness of the evolving threat. The OUSD R&E organization is built around the NDS modernization priorities, and is composed of two major entities: Research and Technology (R&T), which includes oversight of the labs, Federally Funded Research and Development Centers, University Affiliated Research Centers, and academic research, and Advanced Capabilities (AC), which accelerates and prototypes more mature technologies. AC also oversees the Department's conduct of developmental test and evaluation, and investment in the associated range infrastructure through the Test Resource Management Center (TRMC). Each entity is headed by a Director for Defense Research and Engineering (DDRE), and between them, DDRE (RT) and DDRE (AC) comprise the research, development, engineering, prototyping, test and evaluation responsibility of the Office of the Secretary of Defense (OSD).

Within these two major arms are the critical foci of the new R&E organization: the Assistant Directors for each modernization priority, individuals charged with serving as Department-wide "portfolio managers" for each priority. They work closely with the military services and defense agencies to establish and advise Department leadership on budgetary and programmatic priorities, to avoid unintended programmatic duplication and unnoticed capability gaps, and to ensure that we are focusing our resources as best we can in their areas of responsibility. The exception is the Assistant Director for AI/ML. Because of the importance and interdisciplinary nature of the AI/ML enterprise, it will report directly to the Under Secretary and Deputy.

Several agencies crucial to the national research and development enterprise fall within the R&E enterprise: DARPA, DIU, the Strategic Capabilities Office (SCO), the Missile Defense Agency (MDA), the Strategic Intelligence Analysis Cell, and the new SDA.

MDA, with a $9.4 billion FY20 budget request, is charged to develop a more capable, more reliable, and more lethal missile defense system. This request includes $157 million for hypersonic defense and $304 million for technology maturation initiatives. MDA also has a critical role in responding to the evolving threat environment in space, as well as contributing to Department-wide technology initiatives, such as ongoing laser scaling efforts.

DARPA, with a $3.5 billion FY20 budget request, has a 60-year legacy of developing breakthrough technologies and capabilities that both avoid and impose technological surprise. DARPA remains in my opinion one of this nation's brightest crown jewels. I am honored to be able to assist and support that agency in carrying out its mission.

SCO, with a $1.4 billion FY20 budget request, identifies, demonstrates, and provides near-term capabilities to deliver new effects for the warfighter. By working closely with the military services and combatant commanders to leverage existing technologies for new and disruptive uses, SCO moves the needle on regaining the element of surprise.

DIU, with a $164 million FY20 budget request, seeks out commercial products and capabilities with the potential for military application, but which have not or would be otherwise unlikely to come to the attention of DoD. By offering a connection to the potential military user, with an expedited contracting process, DIU provides a channel to some of the highest technology, fast-paced, and adaptive segments of the U.S. industrial base. DIU will manage the National Security Innovation Capital (NSIC) program, pursuant to the Congressional direction of Section 230 of the FY19 NDAA, which will focus on dual-use hardware, a sector underserved by U.S. venture capital. In an effort to put similarly-focused organizations under a single leadership structure, I have asked DIU also to assume responsibility for the National Security Innovation Network (NSIN), formerly MD5, the National Security Technology Accelerator which focuses on human capital and commercializing technology from DoD labs.

SIAC, with an FY20 budget request of $26.1 million, collaborates with the Joint Staff, Services, and the Intelligence community to provide an operational, technical, and threat-based analytic foundation to help inform technology strategies and decisions across the R&E enterprise.

PROTECTING CRITICAL TECHNOLOGY

OUSD R&E executes numerous technology protection initiatives designed to foil adversary attempts to exfiltrate national security information and intellectual property (IP). We are, by now, all too familiar with the many examples of both illicit behavior and behavior which is technically legal but designed by adversaries to benefit from the hard-won knowledge and experience gained by U.S. innovators.

I, too, am concerned about these things, and I have spent a good portion of this testimony discussing the means by which we intend to help combat these threats. I would now like to turn the coin over and examine the other side.

I have watched for a generation and more as we have tried to protect our unquestioned earlier advantage in aerospace technology through export control mechanisms such as the International Traffic in Arms Regulations (ITAR) and Export Administration Regulations (EAR). While these and related attempts to ensure American security by controlling access to our markets have been effective in the short term, they have not been effective in the long term.

It is my judgement, my personal opinion, that the practical effect of our export control regulations has been that other nations – allies as well as adversaries – have simply decided to invest in the development of their own capabilities, which they have then taken to the global marketplace – a marketplace from which the US has removed itself. Worse yet, by withdrawing much of our own industrial base from the global market, we restrict the competitive environment for our domestic firms, which over time has the effect of eroding the technological advantage we

so eagerly want to protect. I invite anyone to open their favorite internet search engine and enter keywords such as "ITAR free satellite"; the results are sobering.

My experience in aerospace causes me to be very concerned that, when we talk about restricting competition on the newer playing fields of microelectronics, artificial intelligence, next-generation communication networks, etc., we are merely changing the older "aerospace nouns" for newer nouns, while leaving all the same verbs in place. I believe that we must go with the strategy that got us to where we are today: we are the nation, we are the people, ours are the enterprises from whom and which others want to steal. Our adversaries are trying to steal our IP, we are not trying to steal theirs. China wants to send its students to our universities; we aren't trying to send our students to theirs. It is when others no longer want what we have that I will truly begin to worry.

I am not proposing that we open everything we know to the goal of unfettered global competition. We must wisely implement export controls so as to protect both critical technology and U.S. competitive advantage. There are some things that simply must be protected, and some actors from whom such protection is most important. But we must be explicit about what we want to protect, from whom we want to protect it, and clever about how we do so, especially in regard to emerging technologies. For example, we should not wall off artificial intelligence, but we may want to protect certain data sets. We need to devise protections that are dynamic and do not hinder U.S. competitiveness, and government cannot do it alone. As we consider the implementation of the Export Control Reform Act of 2018, we should engage both academia and the private sector to establish an effective regime that preserves rather than erodes U.S. competitiveness in the global marketplace.

We also need to address the leakage of leading-edge IP from our academic institutions. We need more counterintelligence resources, and we need to educate our universities to the threats of industrial espionage and ensure they employ best practices to protect sensitive research.

Finally, we need to ensure that there is sufficient national and long-term investment in science and technology. We will continue to stay ahead of our adversaries if we believe, and invest, in ourselves and in the strategy that got us here.

CONCLUSION

Both Department and Congressional leadership clearly understand the emerging threat posed by China and Russia because of their ever-increasing adversarial behavior across multiple fronts. As the NDS states, we cannot expect success fighting tomorrow's conflicts with yesterday's weapons. Our adversaries have watched as we have been embroiled in numerous local and regional conflicts. They know how we fight.

If we are to respond, if we are to maintain the global rules-based order that we, in company with our partners and allies, have led for three generations, we must respond. We must up our game. It is not our purpose to draw even with those who reject the values we espouse and the freedoms we protect. We seek dominance, we seek unquestioned advantage, so that on every single day

every single adversary declines to start the fight – because they know they would lose. OUSD R&E, in collaboration with the military services, defense agencies, and combatant commanders, will work to ensure that dominance is sustained.

Dr. Michael D. Griffin
Under Secretary of Defense for Research and Engineering

Dr. Michael D. Griffin is the Under Secretary of Defense for Research and Engineering. He is the Department's Chief Technology Officer, and is responsible for the research, development, and prototyping activities across the DoD enterprise and is mandated with ensuring technological superiority for the Department of Defense. He oversees the activities of the Defense Advanced Research Projects Agency, the Missile Defense Agency, the Strategic Capabilities Office, Defense Innovation Unit Experimental, the DoD Laboratory enterprise, and the Under Secretariate staff focused on developing advanced technology and capability for the U.S. military.

Mike was previously Chairman and Chief Executive Officer of Schafer Corporation, a professional services provider in the national security sector. He has served as the King-McDonald Eminent Scholar and professor of Mechanical and Aerospace Engineering at the University of Alabama in Huntsville, as the Administrator of NASA, and as the Space Department Head at the Johns Hopkins University Applied Physics Laboratory. He has also held numerous executive positions in industry, including President and Chief Operating Officer of In-Q-Tel, CEO of Magellan Systems, and EVP/General Manager of Orbital ATK's Space Systems Group. Griffin's earlier career includes service as both Chief Engineer and Associate Administrator for Exploration at NASA, and as the Deputy for Technology at the Strategic Defense Initiative Organization. Prior to joining SDIO in an executive capacity, he played a key role in conceiving and directing several "first of a kind" space tests in support of strategic defense research, development, and flight-testing. These included the first space-to-space intercept of a ballistic missile in powered flight, the first broad-spectrum spaceborne reconnaissance of targets and decoys in midcourse flight, and the first space-to-ground reconnaissance of ballistic missiles during the boost phase. Mike also played a leading role in other space missions at the John Hopkins University Applied Physics Laboratory and NASA's Jet Propulsion Laboratory.

Griffin has been an adjunct professor at the University of Maryland, Johns Hopkins University and George Washington University, teaching spacecraft design, applied mathematics, guidance and navigation, compressible flow, computational fluid dynamics, spacecraft attitude control, estimation theory, astrodynamics, mechanics of materials, and introductory aerospace engineering. He is a registered professional engineer in California and Maryland, and the lead author of some two dozen technical papers and the textbook Space Vehicle Design.

He is a member of the National Academy of Engineering and the International Academy of Astronautics, an Honorary Fellow and former president of the American Institute of Aeronautics and Astronautics, a Fellow of the American Astronautical Society, and a Senior Member of the Institute of Electrical and Electronic Engineers. He is the recipient of numerous honors and awards, including the NASA Exceptional Achievement Medal, the AIAA Space Systems Medal and Goddard Astronautics Award, the National Space Club's Goddard Trophy, the Rotary National Award for Space Achievement, the Missile Defense Agency's Ronald Reagan Award, and the Department of DoD Distinguished Public Service Medal, the highest award which can be conferred on a non-government employee.

Griffin obtained his B.A. in Physics from the Johns Hopkins University, which he attended as the winner of a Maryland Senatorial Scholarship. He holds master's degrees in aerospace science from Catholic University, electrical engineering from the University of Southern California, applied physics from Johns Hopkins, civil engineering from George Washington University, and

business administration from Loyola University. He received his Ph.D. in aerospace engineering from the University of Maryland, and has been recognized with honorary doctoral degrees from Florida Southern College and the University of Notre Dame.

Mike is a 4000+ hour commercial pilot and flight instructor with instrument and multiengine ratings, and holds an Extra Class Amateur Radio license.

RECORD VERSION

STATEMENT BY
THE HONORABLE BRUCE D. JETTE, Ph.D.
ASSISTANT SECRETARY OF THE ARMY FOR
ACQUISITION, LOGISTICS AND TECHNOLOGY AND
ARMY ACQUISITION EXECUTIVE

BEFORE THE

SUBCOMMITTEE ON INTELLIGENCE AND
EMERGING THREATS AND CAPABILITIES
COMMITTEE ON ARMED SERVICES
UNITED STATES HOUSE OF REPRESENTATIVES

ON

THE FISCAL YEAR 2020 BUDGET REQUEST FOR DEPARTMENT OF DEFENSE
SCIENCE AND TECHNOLOGY PROGRAMS

FIRST SESSION, 116TH CONGRESS

MARCH 28, 2019

NOT FOR PUBLICATION UNTIL RELEASED BY THE
COMMITTEE ON ARMED SERVICES

INTRODUCTION

Chairman Langevin, Ranking Member Stefanik, and distinguished members of the Subcommittee, thank you for the opportunity to appear before you today to discuss the U.S. Army's approximately $2.4 billion request for Science and Technology (S&T) funding for Fiscal Year (FY) 2020. The Subcommittee has a vital role in supporting Army S&T and ensuring that the U.S. Army modernizes to meet future readiness requirements, and your demonstrated commitment to our program is most appreciated.

The Army S&T vision directly supports the goals of Army readiness to provide Soldiers with the capabilities needed to win decisively. The publication of the *2018 National Defense Strategy of the United States of America* (NDS) marked an inflection point for the U.S. Army, and a shift from irregular warfare to great power competition. The NDS prioritizes China and Russia, describing China as the primary long-term threat, and Russia as the primary near-term threat. Aligned with NDS, the Army is pursuing a new operational approach, Multi-Domain Operations (MDO), to ensure we stay ahead of our competitors and remain ready and lethal into the future.

Last year's Army Modernization Strategy outlined how the Army will revitalize our modernization efforts to meet these challenges to our military advantage, and to create the capabilities needed to execute MDO. The strategy was established upon the vision for the future Army and the framework of our overarching strategy to balance near-, mid-, and far-term investments. In doing so, the Army is depending on its vital S&T program to help prepare for the future, mitigate the possibility of technical surprise, and ensure that we are able to remain dominant in any environment.

IMPORTANCE OF S&T TO ARMY MODERNIZATION

The Army's S&T program has a large role in enabling the six priorities of the Army Modernization Strategy: (1) Long Range Precision Fires, (2) Next Generation Combat Vehicles, (3) Future Vertical Lift, (4) Army Network, (5) Air and Missile Defense,

and (6) Soldier Lethality. In the Army's FY20 budget request, approximately 83 % of S&T Applied Research and Advanced Technology Development funding is aligned with the Army's modernization priorities. Organizationally, the Army S&T program is working closely with Army Futures Command (AFC), the four-star command tasked with spearheading the Army's modernization efforts, and the Cross Functional Teams under AFC that are aligned with each of the priorities. Our S&T program is focused on maturing technology, reducing program risk, developing prototypes to better define affordable and achievable requirements, and conducting experimentation with Soldiers to refine new operational concepts.

The major S&T efforts in support of the Army's Modernization Priorities include:

- Long-Range Precision Fires to provide massed, mobile, operational-level kinetic strike options to restore overmatch and disrupt near-peer threat capabilities on a complex, contested, and expanded battlefield, including options for extended range.

- Next Generation Combat Vehicles to develop technologies for the Optionally Manned Fighting Vehicle and Robotic Combat Vehicle that realize lighter weight, improved sustainment, and cost-per-unit savings over current platforms – as well as increase the capability of existing formations and improve their ability to survive and win in the complex terrain of the future battlefield.

- Future Vertical Lift to develop technologies to provide next-generation aviation platforms with increased speed, extended range, extended station time, and the ability to operate in complex, distributed, expanded, and contested battlefields.

- Army Network to develop the hardware, software, and infrastructure technologies needed to enable a unified network and resilient mission

command on the move, retaining and exploiting the initiative against a peer adversary in an inherently contested cyber and electromagnetic environment.

- Air and Missile Defense to reduce the cost curve of missile defense, restore overmatch, survive volley-fire attacks, and operate within sophisticated Anti-Access/Area Denial and contested domains.

- Soldier Lethality to improve Soldier and small unit performance, reduce surprise, increase protection, and enhance lethality in close combat on an intensely lethal and distributed battlefield and within complex, urban terrain.

INFRASTRUCTURE

The Army's 12,000 civilian scientists and engineers at laboratories across the country are critical assets in identifying, developing, and demonstrating technology options that inform and enable effective and affordable capabilities for our Soldiers today and in the future.

The Army relies on its laboratories to foster innovation, develop and demonstrate new technologies, assess competing technology options, and help transition basic research investments as they mature. This is one of the primary reasons why state-of-the-art facilities are imperative to the success of Army S&T.

The three primary areas for infrastructure modernization include:

- Modernizing organic technical infrastructure for state-of-the-art research laboratories and equipment;

- Engaging in Public-Public and Public-Private infrastructure collaborations; and

- Embedding Army Scientists and Engineers in the Public and Private sector, using the Army Research Laboratory (ARL) open campus business model.

Not only are these facilities important to enabling research and development, they are critical in the Army's ability to recruit new employees, develop existing employees, and retain them. I would like to thank Members of Congress for the numerous staffing flexibilities provided to the Army laboratories. Direct Hiring Authority, Renewable Term Appointments, and the Laboratory Demonstrations Project have been critical to growing the Army's technical workforce and sharpening our technical acumen in emerging research areas.

REFORM

The Army, with the support of Congress, has undertaken a number of reforms to improve the way we do business. Chief among these reforms is the Army's new Intellectual Property (IP) Policy, which fosters greater communication with industry early on in the process so that we can be clear about our data requirements. IP plays an important role in our ability to develop new weapon systems and maintain the technological advantage.

We are also focused on talent management, especially the ability to recruit and retain top-talent in order to keep the Army on the cutting-edge of technology. Our plans in this area are designed to:

- Develop senior S&T leaders to enable effective execution of S&T programs;

- Reshape the existing technical workforce to meet emerging S&T challenges, dedicated to retraining current Army S&T professionals to prepare them to perform work in higher demand technical areas;

- Recruit new personnel, and timely onboarding of S&T employees; and

- Leverage the best-and-brightest from across the Army S&T Enterprise, bringing together scientific professionals – Government, academic, and industrial – to address technical problems; these novel public-private partnerships are expected to enable rapid technology developments necessary to outpace emerging threats.

The Army has also expanded its industry outreach program. We are actively reaching out to non-traditional businesses with innovative ideas that are willing to engage with the Army via numerous mechanisms, including the Small Business Innovation Research (SBIR) program, the Small Business Technology Transfer Research (STTR) program, Other Transaction Authority (OTA) consortia, the Army Expeditionary Technology Search (xTechSearch) prize competition, the Defense Innovation Unit (DIU), the Army Research Laboratory Open Campus initiative, and traditional mechanisms such as Broad Agency Announcements (BAAs) or Cooperative Research and Development Agreements (CRADA) with Army laboratories.

CONCLUSION

Today, we find ourselves at a perilous place in history. Our focus is on great power competition, and the Army is moving quickly to address modernization shortfalls. Time is not on our side. We must invest in Army S&T to meet the challenges of the future. With continued support from Congress, including predictable, adequate, sustained, and timely funding, the Army will build a force ready to deter potential adversaries, and if deterrence fails, to rapidly deploy, fight, and win.

Thank you again for this opportunity to discuss Army S&T and for your strong support for the Army's program. I look forward to your questions.

The Honorable Dr. Bruce D. Jette
Assistant Secretary of the Army (Acquisition, Logistics and Technology) and
Army Acquisition Executive

Dr. Bruce D. Jette was confirmed by the United States Senate as the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT)) on December 20, 2017, and sworn into office on January 2, 2018. In this position, he serves as the Army Acquisition Executive, the Senior Procurement Executive, the Science Advisor to the Secretary of the Army, and the Army's Senior Research and Development official. He also has principal responsibility for all Department of the Army matters related to logistics.

Dr. Jette leads the execution of the Army's acquisition function and the acquisition management system. His responsibilities include providing oversight for the life cycle management and sustainment of Army weapon systems and equipment from research and development through test and evaluation, acquisition, logistics, fielding, and disposition. He is also responsible for appointing, managing, and evaluating program executive officers and managing the Army Acquisition Corps and Army Acquisition Workforce. In addition, he oversees the Elimination of Chemical Weapons program.

Prior to his confirmation, Dr. Jette served as President and Chief Executive Officer of Synovision Solutions, LLC, an innovative company he founded to provide management and technical consulting, engineering services, and project management in support of military and governmental agencies, as well as commercial industry.

A decorated veteran of 28 years of active duty, Dr. Jette retired as a Colonel following a career that included several armor and cavalry company commands, two overseas tours, various staff assignments at the battalion and brigade level, and over two years of operational deployments to Afghanistan, Iraq and Kuwait. Highlights of his previous acquisition service include founding the U.S. Army Rapid Equipping Force; serving as Program Manager for Soldier Systems which led to the establishment of Program Executive Office Soldier; and being honored as U.S. Army PM of the Year for his success as Product Manager for all Army airborne electronic warfare systems.

Dr. Jette is a graduate of the United States Military Academy with a Bachelor of Science degree in Nuclear Engineering and Chemistry. He also holds both a Master of Science degree and a Doctorate in Electronic Materials from the Massachusetts Institute of Technology. He was an Adjunct Professor at the Edmund A. Walsh School of Foreign Service Security Studies Program at Georgetown University.

His numerous military awards and commendations include the Distinguished Service Medal, Legion of Merit (3), Bronze Star Medal, Meritorious Service Medal (3), Army Commendation Medal, Army Achievement Medal (2), National Defense Medal (2), Operation Iraqi Freedom Campaign Ribbon, Operation Enduring Freedom Ribbon, Army Service Ribbon, Army Overseas Ribbon (2), Parachutist Badge, Army General Staff Award, and Order of Saint Maurice (Legionnaire).

NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

STATEMENT OF

THE HONORABLE JAMES F. GEURTS
ASSISTANT SECRETARY OF THE NAVY
(RESEARCH, DEVELOPMENT AND ACQUISITION)

BEFORE THE

INTELLIGENCE, EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

OF THE

HOUSE ARMED SERVICES COMMITTEE

ON

THE DEPARTMENT OF THE NAVY FISCAL YEAR 2020 BUDGET REQUEST FOR
SCIENCE AND TECHNOLOGY PROGRAMS

MARCH 28, 2019

NOT FOR PUBLICATION UNTIL RELEASED BY THE
HOUSE ARMED SERVICES COMMITTEE
INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE

Introduction

Chairman Langevin, Ranking Member Stefanik and distinguished members of the Subcommittee, I appreciate the opportunity to appear before you today to discuss the Department of the Navy (DON) Science and Technology (S&T) efforts and how they support our Sailors and Marines. Science and Technology is the critical building block in the National Defense Strategy for the future Fleet and Force. The Fiscal Year (FY) 2020 S&T Budget requests $2.3 billion for our Navy and Marine Corps team and represents a key enabler to ensure the Department of the Navy maintains and expands its comparative overmatch against our competitors.

The DON S&T portfolio ensures the Navy maintains technological superiority, avoids technological surprise, fosters knowledge expansion, and spurs innovative technological breakthroughs. The Naval Research Enterprise is uniquely positioned to develop and accelerate priority-driven technology and rapidly deliver revolutionary advantages for the current force and the future force to preserve naval superiority.

The Naval Research and Development Establishment (NR&DE)

The Naval Research and Development Establishment (NR&DE) includes 20 commands from the Naval Air Warfare Centers, Naval Surface Warfare Centers, Naval Undersea Warfare Centers, Space and Naval Warfare Systems Centers, Office of Naval Research (ONR) and the Naval Research Laboratory (NRL). It is comprised of diverse and highly educated scientists, engineers and technicians (including more than 2,000 PhDs).

The NRD&E works closely with talented individuals from industry, academia and across the government. We successfully partner with these individuals and institutions to ensure our Sailors and Marines have the most advanced capabilities now and in the future. During FY 2018, ONR awarded more than 900 new grants. The caliber of the research can be exemplified by the 2018 Nobel Prize winner in Chemistry, Dr. Frances Arnold from the California Institute of Technology, where she became only the fifth woman—and the first American woman—to take home the chemistry award. Through her career, the Department supported Dr. Arnold with various grants, and her research has led to discoveries and breakthroughs with important implications for both the Navy and society at large. Since 1952, more than 60 Nobel laureates

have been sponsored by the DON for their work in everything from laser technology to graphene.

Effective naval power requires a combination of capacity, capability, and lethality. Improvements in each of those elements requires cutting-edge science, technology, research and development. For Naval forces, much of this work is performed by our corporate laboratory, the Naval Research Laboratory, and at the warfare centers. Over half the work performed by NRL is in fundamental S&T research – in partnership or collaboration with academia and researchers in other government laboratories and activities. The Warfare Centers focus more on technology and engineering, often in partnership with industry and government program offices.

NRL and the warfare centers conduct research, translate the results into technologies, and facilitate transfer of these technologies to other Navy, Defense Department (DoD), federal, and industrial organizations for incorporation into more effective operational military systems. NRL and the warfare centers also conduct highly-innovative, competitively funded, basic and applied research. While this early phase work represents a modest portion of NRL and the warfare center's working capital fund budget, history has shown that it often proves vital to improving warfighting capabilities, developing cost-cutting processes, preventing technological surprise by potential adversaries, and occasionally introducing revolutionary new capabilities.

Science and Technology Alignment to the National Defense Strategy

The National Defense Strategy emphasizes the particular importance of naval power in an emerging great power competition era. The Department cannot expect success fighting tomorrow's conflicts with yesterday's weapons or equipment. S&T investments are focused on establishing an unparalleled 21st century National Security Innovation Base that effectively addresses the scope and pace of our competitors' and adversaries' ambitions and potential capabilities. These investments support the modernization of key capabilities outlined in the 2018 National Defense Strategy in order to meet tomorrow's capability and capacity needs.

The Department's S&T priorities for this budget include development of the next generation of directed energy and electric weapons; swarming mission-focused autonomous systems; artificial intelligence and machine learning; advanced manufacturing; high performance

materials and energetics; networked sensors and weapons; cyber security; quantum science and computing; and development of hypersonic boosters.

Fundamental Research

Many technologies we now take for granted might not have existed without our predecessors' investments in long-term government scientific exploration. The development of high-power shipboard lasers, like SSL-TM, necessitated basic theory and experiments on laser beam combination that began over two decades ago at NRL. Another illustrative example is the emergence of Gallium Nitride (GaN) as the critical wide-bandgap semiconductor technology; enabling multiple Navy major defense acquisition programs including Next Generation Jammer and Air and Missile Defense Radar. Anticipating future military requirements, NRL researchers initiated R&D for this material in the 1990s, leading to multiple breakthroughs and GaN technology maturation that enabled its successful use today. The FY 2020 budget continues to push the frontiers of knowledge. Researchers in the NR&DE continue this legacy through full-spectrum basic and applied research on cutting-edge problems, such as quantum sensing and neuromorphic computing with memristive systems. These explorations include the successors of those who discovered GaN. The present generation of NRL researchers is hard at work, searching for tomorrow's ultra-wide-bandgap semiconductor materials that will outperform anything seen to date.

The Department's FY 2020 investment in naval relevant, high risk basic research and early applied research increases in the following areas: artificial intelligence in autonomy and decision making; ocean sciences and ocean acoustics. Another key initiative in fundamental research is Task Force Ocean. The Chief of Naval Operations established Task Force Ocean, directing the naval research community to reinvigorate their partnership with the academic oceanographic research community. This partnership is being strengthened through research grants, sponsorship of graduate students and post-doctoral researchers, a dedicated "Scientist-to-Sea" program, and a Tactical Oceanography Symposium series, in order to ensure the U.S. Navy's advantage in tactical exploitation of the environment for maritime superiority is maintained.

Future Naval Capabilities (FNC)

The Future Naval Capabilities program is designed to develop and transition cutting-edge technologies to acquisition programs of record. The program delivers these technologies for integration into platforms, weapons, sensors or specifications to improve Navy and Marine Corps warfighting and support capabilities. FNCs are now streamlined to a three-year process from concept to delivery of technology to a program of record. The FNC process provides a strong linkage between the S&T community, the resource sponsors and the Fleet and Force. The previous process could take up to five years.

In 2018, nineteen FNC products transitioned to acquisition programs of record across the DON. Also in 2018, eight FNC products were deployed to the Fleet and Force from programs of record in areas including rocket imaging seekers, avionics training displays, logistic support tools, and detection and classification algorithms. For FY 2020, the Department has selected 19 Future Naval Capabilities. These efforts will incrementally improve sonar systems, radar systems, electromagnetic maneuver warfare, Fleet training technologies, diver safety, unmanned systems and others.

Innovative Naval Prototypes (INPs)

Innovative Naval Prototypes are disruptive technologies for which a formal requirement does not yet exist. These are higher risk, but also have a higher payoff when they succeed. These technologies, such as the Solid State Laser and the Sea Hunter, will deliver capability to the warfighter faster than traditionally developed programs. They are or will soon be deployed, providing opportunities for our S&T community to learn directly from the warfighter and improve the delivered capabilities of these programs, as well as existing programs of record. The Sea Hunter transit with a battle group will provide insights into teaming of autonomous platforms with deployed warships and the value these combined capabilities can provide to the battle group commander. INPs are matured using traditional S&T dollars and then demonstrated using Advanced Component Development and Prototypes funding to transition the INP to the Fleet. Your continued support for these efforts will ensure our superiority on the battlefield.

Doing Business Better

The Navy is taking advantage of authorities granted by Congress to invest in our unique workforce – comprised of the brightest and most creative people in the world. Innovation and agility cannot be centralized in the DON, and must span across our organizations.

In order to achieve this, the Department has established the Naval Expeditions (NavalX) Agility office. NavalX Agility is designed to further develop our workforce by lowering the barrier towards using agility-enhancing methods in organizations as well as provide a storefront to industry for new innovation technologies and content. The Department has identified over 50 non-traditional methods, tools, and technologies currently in use across the DON, but often only in isolated offices. These methods span from discovery to engineering to deployment, and include items such as Prize Challenges, Rapid Prototyping, Warfighter-Driven Experimentation, Other Transaction Agreements, Mid-Tier Acquisition, and Agile Acquisition Management. NavalX will codify these methods into playbooks which will be developed and shared across the DON, allowing the workforce to better understand which methods are fit to which purpose. Over time, these methods will become a routine part of doing business within the DON, enabling us to deliver capability with the at-scale agility necessary to achieve our National Defense Strategy.

To increase agility and better align the naval research enterprise with the naval strategy, the Department is prototyping industry standard data storage, retrieval and analysis tools and also partnering with the Air Force Research Laboratory to bring robust data analytics to the naval science and technology portfolio.

To reduce cost, improve performance, and increase responsiveness we have implemented a Manufacturing Technology Program investing in new processes to advance manufacturing technology. One example is the development of optimized manufacturing processes for cost reduction and production rate improvements for F-35 canopy transparencies, which include automation of thermoforming, polishing, repair, and inspection / acceptance processes. Small Manufacturing Technology investments continue to provide return on investment for our major programs of record.

Small Business Innovation Research

The DON Small Business Innovation Research (SBIR) Program continues to stimulate technical innovation and increase small business participation in federally funded research and development by providing competitive awards to enterprising companies that would otherwise be on the sideline of our service priorities. Many SBIRs have transitioned to our Fleet and Force including Progeny Systems MK 54 MOD 1 Lightweight Torpedo and Infrascan's Infrascanner Portable Medical Diagnostic Device. Progeny's Lightweight Torpedo Sonar Assembly enhances the torpedo's ability to detect slow moving targets in shallow water and contested environments. The MK 54 MOD 1 provides increased weapon effectiveness against all submarine targets. It does this without increasing system volume, weight or power, which minimizes the changes required to launch from fixed and rotary wing platforms. Infrascanner is a hand-held device used on the battlefield for fast, accurate diagnosis of brain injuries. This contributes to readiness of the Force, and helps minimize long-term brain damage resulting from improperly diagnosed injuries. Infrascanners – are now part of the Marine Hospital Corpsman diagnostic toolkits for operational use.

Transitioning Technology to the Fleet

The Navy continues to advance the latest technology to the Fleet and Force. Sea Hunter, the largest unmanned surface vehicle, completed the first ever autonomous surface vessel open ocean transit from San Diego to Pearl Harbor in concert with a major battle group exercise in the Fall of 2018. Sea Hunter is just one part of providing autonomous technology to the Fleet in all domains. The DON recently installed a next generation network hardware and software demonstrator on one ARLEIGH BURKE Class destroyer, with plans for a second by the end of the year. This at-sea network architecture is the first step to enabling a more agile, lethal force with distributed and coordinated hard kill and soft kill capabilities. This summer the Department will install SSL-TM aboard USS *Portland* (LPD 27). Already tested at over 100 kilowatts, it will be the most powerful laser ever demonstrated on a Navy ship. The SSL-TM deployment will provide warfighter feedback which will inform the HELIOS program planned for installation on board our destroyers and integrated with AEGIS combat system. Moving technology rapidly from the lab and industry to the warfighter provides us with the needed

feedback to enhance the technology development. As the Department looks for avenues to accelerate the technology development process, the feedback from these technology demonstrations will ensure continued improvements to the warfighter.

Partnerships

To solidify our Joint competitive advantage, the Navy partners across the DoD to discover and develop disruptive technologies with multi-domain applications. This fall, the Department will establish a DoD Railgun facility at White Sands Missile Range to demonstrate Hyper Velocity Projectiles at full energy and multiple repetition firing rate. Using the DARPA-developed Sea Hunter, we are conducting early operational testing and evaluation. Finally, to address systems that operate at hypersonic speeds, we are working a joint DARPA/Air Force effort that enables future air-launched, tactical-range hypersonic boost glide systems.

Congressional Authorities

The DON continues to make good use of congressional authorities like 10 USC § 2363 (aka Section 219). The Department has implemented this authority for Naval Innovative Science and Engineering (NISE) investments that provide the NR&DE with mechanisms to fund four crucial efforts. These include innovative basic and applied research in support of military missions, development of programs that support the transition of technologies developed by the defense laboratories into operational use, workforce development activities to recruit and retain personnel with needed scientific and engineering expertise and supporting efforts to revitalize and recapitalize the laboratories. NISE funding has allowed the DON to maintain its lead over all other US Government agencies in the number of patents it receives annually. Last year we received over 330 utility patents for new inventions.

As a result of this year's NISE-funded projects, the Department was able to demonstrate new technology at the Advanced Naval Technology Exercise (ANTX) Coastal Trident program at the Naval Surface Warfare Center Port Hueneme Division. Successful ANTX demonstrations resulted in a number of new partnership arrangements, including three Cooperative Research and Development Agreements, one Partnership Intermediary Agreement, and one strategic Educational Partnership Agreement. These partnerships will speed transition of technology to

the Fleet and optimize resources. In addition, numerous NISE-funded projects were able to further the testing and experimentation, and one project will transition into a Combat Systems demonstration next year. Another technology success is the new capability to 3D print custom molded earplugs at Navy sites. This effort, grew out of several years of basic and applied research, addresses the need to provide more effective and easier to use hearing protection to warfighters in extreme noise environments.

Our ability to recruit, compensate and retain the nation's best minds is due in large part to long-standing congressional advocacy for the laboratory personnel demonstration program, first established through the FY 1995 National Defense Authorization Act (NDAA). Successive improvements to the lab demo's contribution-based compensation system have established, and then greatly extended, direct-hire authorities, providing laboratory directors with extremely effective manpower management tools. Our laboratory leaders greatly appreciated the many FY 2016 NDAA enhancements that brought additional flexibilities through student direct-hire conversions, flexible term appointments, reemployed annuitants, Voluntary Early Retirement Authority and Voluntary Separation Incentive Payments.

Furthermore, congressional authorities, originally granted via Section 233 of the FY 2017 NDAA, have expanded NR&DE activity flexibilities in many areas including contracting, purchasing, IT procurement, facilities management, and laboratory revitalization. In FY 2018 the DON implemented twelve management initiatives using this authority, that, in a short time, have led to great improvements in project delivery, support, experimentation and prototyping; strengthening the workforce at the labs and warfare centers to meet technical capability demands of the Navy. The second phase of implementation will focus on business operations, personnel management policies and practices and facilities management construction and repair. This will allow us to address important issues such as the age and condition of the unique RDT&E facilities and test ranges that are essential to ensure the technological superiority of our forces against potential threats. I look forward to continued collaboration with this Committee to refine and expand upon these authorities to ensure continued vitality, effectiveness and competitiveness across the NR&DE ecosystem.

Conclusion

Thank you for the opportunity to testify on the naval science and technology program for FY 2020. The Department of the Navy maintains its commitment to science and technology to further our advantages to the Fleet and Force. The naval research enterprise continues to search for new technology around the world, to search for new ways to partner with non-traditional innovators, and to search for new ways to buy research smarter and faster. This enterprise cannot succeed without the strong congressional support you continue to provide.

James F. Geurts
Assistant Secretary of the Navy
(Research, Development and Acquisition)
12/5/2017 - Present

On Dec. 5, 2017, Mr. James F. Geurts was sworn in as Assistant Secretary of the Navy for Research, Development & Acquisition (ASN (RD&A)), following his confirmation by the Senate November 2017. As the Navy's acquisition executive, Mr. Geurts has oversight of an annual budget in excess of $60 billion and is responsible for equipping and supporting the finest Sailors and Marines in the world with the best platforms, systems and technology as they operate around the globe in defense of the Nation.

Mr. Geurts previously served as the Acquisition Executive, U.S.. Special Operations Command (USSOCOM), at MacDill Air Force Base (AFB), Florida, where he was responsible for all special operations forces acquisition, technology and logistics. In this position his innovative leadership and technological ingenuity provided rapid and affordable acquisition that positively impacted the USSOCOM acquisition work force and the special operations forces capability on the battlefield. These contributions were recognized by both private and public institutions during his tenure to include earning the Presidential Rank Award, USSOCOM Medal, William Perry Award and Federal Times Vanguard Award for Executive of the Year.

Prior to Senior Executive Service, Mr. Geurts began his career as an Air Force officer where he served as an acquisition program manager with engineering and program management leadership positions in numerous weapon systems including intercontinental ballistic missiles, surveillance platforms, tactical fighter aircraft, advanced avionics systems, stealth cruise missiles, training systems and manned and unmanned special operations aircraft.

He has over 30 years of extensive joint acquisition experience and served in all levels of acquisition leadership positions including Acquisition Executive, Program Executive Officer and Program Manager of Major Defense Acquisition Programs.

Mr. Geurts is a distinguished 1987 ROTC graduate from Lehigh University where he received a Bachelor of Science in Electrical Engineering. He holds a Master of Science in Electrical Engineering from Air Force Institute of Technology, Wright-Patterson AFB and in National Security Resourcing from Industrial College of the Armed Forces, National Defense University, Washington, D.C. Mr. Geurts also attended executive leadership and international studies programs at Harvard Kennedy School and George Washington Elliot School.

Updated: 19 December 2017

SUBCOMMITTEE ON INTELLIGENCE
AND EMERGING THREATS AND
CAPABILITIES
U.S. HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON INTELLIGENCE AND EMERGING
THREATS AND CAPABILITIES

U.S. HOUSE OF REPRESENTATIVES

HEARING DATE/TIME: March 28 2019, 10:00 A.M.

SUBJECT: Fiscal Year 2020 Air Force Science and Technology

STATEMENT OF: Dr. William B. Roper, Jr.
Assistant Secretary of the Air Force for Acquisition, Technology and Logistics

NOT FOR PUBLICATION UNTIL RELEASED BY
HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON INTELLIGENCE AND EMERGING THREATS AND CAPABILITIES
U.S. HOUSE OF REPRESENTATIVES

Introduction

Chairman, Members of the Subcommittee and Staff, I am pleased to have the opportunity to provide testimony on the Fiscal Year 2020 Air Force (AF) Science and Technology (S&T) Program and our efforts to innovatively and affordably respond to warfighter needs now, while simultaneously creating the force of the future.

Globalization and the proliferation of technology mean we face threats and competition across all domains. America's potential adversaries are rapidly fielding capabilities that approach our own. We must retain our technological edge and equip Airmen so they decisively prevail in combat across the full range of military operations. We are pushing the boundaries in new business practices and reshaping our approaches to deliver new, innovative technologies to the warfighter faster and smarter.

Global competition has changed the speed at which the world around us operates. We must be able to rapidly integrate new technology into our systems whether the development is internal to the Air Force or other parts of DoD, industry, or academia. The adversary and technology will constantly evolve, adapt and change. Today, the pace of change is accelerating; and we must adapt our processes and policies to move more rapidly ensuring our Airmen always have the advantage.

As the Air Force budget request highlights, we are committed to science and technology and driving innovation across the enterprise. The Air Force Fiscal Year 2020 President's Budget request for S&T is approximately $2.8 billion. This is an increase of $160 million, a 6.0% increase, from the Fiscal Year 2019 President's Budget request.

In addition to balanced S&T funding, the Air Force Fiscal Year 2020 President's Budget request also includes approximately $1.6B in prototyping and experimentation funding focused on moving S&T out of laboratory and into the hands of warfighters to build capability at the speed of innovation (i.e. Advanced Engine Transition Program, hypersonics prototyping, directed energy

prototyping, and other smaller developmental prototyping activities).

The Air Force Fiscal Year 2020 President's Budget request for S&T, prototyping and experimentation sets us on a path to be responsive to emerging S&T worldwide, apply new scientific breakthroughs to Air Force problems, embrace agility in focusing limited resources into areas of highest potential impact and rapidly translate technical breakthroughs into fielded Air Force capabilities.

Organizing to Address the National Defense Strategy

The National Defense Strategy describes the projected security environment and the key military missions we need to provide. The common strategic characteristic is speed, which means that the Air Force's ability to adapt and respond faster than our potential adversaries is the greatest challenge we face over the next 30 years. Meeting that challenge requires the Air Force to pursue a path toward institutional agility and a commitment to change those things that stand between us and our ability to rapidly adapt. We have undertaken multiple efforts to start addressing the speed challenge.

The Air Force created the Air Force Warfighter Integration Capability (AFWIC) to develop an integrated future force design across all Air Force mission areas. The Air Force also created the Capability Development Council for governance of the future force capability development decisions, allowing us to resource technology transition decisions faster. The Capability Development Council is a governing body chaired by the Vice Chief of Staff of the Air Force (VCSAF) that provides strategic direction and integration of operational Air Force capability development activities across the Air Force enterprise. We have also reformed the Small Business Innovation Research award processes, continued our commitment to prototyping and experimentation, refocused efforts on technology transition, added Technology discussions into recurring Major Command, Headquarters, and Program Executive Officer meetings, and undertaken a 2030 S&T Review. I am certain we will need to

continue additional efforts to go faster but we are moving out.

Air Force Fiscal Year 2020 Science and Technology Program and Associated Efforts

The Air Force's science and technology (S&T) investment hedges against the unpredictable future and provides pathways to a flexible, precise and lethal force. Air Force innovations arising from technology breakthroughs create new, previously unimagined capabilities that stand to re-shape future military operations.

As the Air Force budget request highlights, we are committed to science and technology and driving innovation across the enterprise. The Air Force Fiscal Year 2020 President's Budget request for S&T is approximately $2.8 billion. This is an increase of $160 million, a 6.0% increase, from the Fiscal Year 2019 President's Budget request. While this budget request is balanced across the building blocks of S&T, the majority of the increase in S&T funding in the FY20PB is in basic and applied research.

In addition to balanced S&T funding, the Air Force Fiscal Year 2020 President's Budget request also includes approximately $1.6B in prototyping and experimentation funding focused on moving S&T out of laboratory and into the hands of warfighters to build capability at the speed of innovation (i.e. Advanced Engine Transition Program, hypersonics prototyping, directed energy prototyping, and other smaller developmental prototyping activities).

In 1944, Theodore von Karman envisioned a new Air Force through his study, *Toward New Horizons*. The technologies imagined more than 70 years ago are the reality that keeps America safe today; however, in alignment with our National Defense Strategy, we knew our strategic mindset must change. We embarked on a year-long journey to develop the Air Force S&T 2030 Strategy to move the Air Force from a current force challenged by increasingly sophisticated adversaries to a force that dominates time, space and complexity in future conflict. As the Secretary of the Air Force Dr. Heather Wilson recently stated at the Air Warfare Symposium, "Instead of looking at where potential

adversaries are heading, or coming up with the same list of technologies that we've come up with to research over the last 20 years, the Air Force S&T strategy will seek to predict where adversaries cannot easily go and ensure that the Air Force gets there first." The new Air Force S&T 2030 Strategy also helps reform the way S&T is led and managed, ensuring we employ business practices that increase our S&T enterprise's inventiveness, productivity, and responsiveness to Air Force needs. We know that culture change takes time and we can't afford to get it wrong, so we are being deliberate in our changes and implementation.

The new Strategy drives advancements that will deliver transformational strategic capabilities to the joint warfighter. We are advancing technology solutions along five strategic capabilities:

- **Global Persistent Awareness** – continuous and timely knowledge of our adversaries through the operating environment;
- **Resilient Information Sharing** – assured and resilient communications and precise position, navigation, and timing across all Joint Force assets;
- **Rapid, Effective Decision-Making** – use of automation and artificial intelligence to accelerate battlespace knowledge and decision-making faster than our adversary;
- **Complexity, Unpredictability, and Mass** – overwhelming adversaries with complexity, unpredictability, and numbers; and
- **Speed and Reach of Disruption and Lethality** – exploiting new methods to rapidly attack, disrupt and neutralize dynamic and mobile targets with speed and global reach.

The Air Force Fiscal Year 2020 President's Budget request for S&T, prototyping and experimentation sets us on a path to be responsive to emerging S&T worldwide, apply new scientific breakthroughs to Air Force problems, embrace agility in focusing limited resources into areas of highest potential impact and rapidly translate technical breakthroughs into fielded Air Force capabilities.

Global Persistent Awareness and Resilient Information Sharing

Many technologies will contribute toward improved capabilities for Global Persistent Awareness and Resilient Information Sharing, but I will highlight our focus on quantum, cyber, and space technologies.

Quantum and Advanced Communications

The Air Force focuses investment in quantum information science (QIS) in three specific areas: quantum sensing (sensors and clocks used for navigation, detection, and force orchestration), quantum communications (advanced, secure, tamper-evident communications and networking enabled by fundamental quantum effects), and quantum computing (storage devices, specialized circuits, and algorithms operating on data maintained in superposition). While the current Air Force S&T goals in advanced quantum communications and quantum computing are more far-term, all three QIS areas (sensing, communications and computing) are expected to have long-term, large scale impacts. For example, QIS will modernize our nuclear forces, improve Command Control Communications, Computers, Intelligence, Surveillance, Reconnaissance (C4ISR) as well as resilient and agile logistics. This commitment will also lead to better joint lethality, especially in contested environments, improved materials performance from fuels to avionics to airframes, and finally, to more advanced autonomous systems.

Cyber and Big Data Analytics

Every day, Airmen encounter sophisticated and persistent adversaries in cyberspace, some of whom are now peer competitors in this domain. The Air Force S&T cyber investment touches many areas. We use cyber to assure communications across physical and security domains, to protect our legacy and future avionics systems, to counter global threats to mission performance (spectrum congestion and jamming), to increase air-to-air capacity over longer range with military-grade security, and to expand available bandwidth through dynamic

spectrum access. The Air Force is enhancing cyber resiliency through an effective mix of redundancy, diversity, and distributed functionality that leverages advances in virtualization and cloud technologies. Efforts such as the Cyber Grand Challenge, executed in collaboration with DARPA, have informed Air Force investments in counter cyber operations such as defensive autonomic response. The Air Force boosts mission assurance with S&T efforts that pursue survivability and freedom of action in contested and denied environments through enhanced cyber situational awareness for air, space, and cyber commanders.

This past year, the Air Force in partnership with DARPA participated in the planning, commitment, and creation of a technology repository for a U.S.-based Center of Excellence supporting a hardened microkernel that protects critical assets, enhances mission assurance, and eliminates some classes of cyber-attack. The kick-off Summit with industry and academia in November 2018 committed itself to the goals of removing barriers to adoption.

Additionally, the Air Force is leveraging Big Data technology, to provide analytic capabilities across multiple modes of intelligence, including virtualization distributed computing and machine learning to achieve operational agility through superior decision speed. We are developing prototypes of expandable cloud processing analytic capability that combine signals intelligence and Moving Target Indicator radar data, and can incorporate other data sources. The prototypes enable instant look-back for analysts through fast processing of large amounts of fused data.

Space

Our adversaries have recognized the advantages we gain from operating in space, and are developing capabilities to deny us the use of space in crisis or war. While we all would prefer the space domain remain free of conflict, our adversaries are not operating in a manner aligned with that

preference. We will deter and defeat these threats in order to secure the satellite constellations that power our military forces and civilian infrastructure.

The Air Force's S&T portfolio aligned to space is broad in scope, creating a very agile portfolio spanning basic research published in world renowned scientific journals to in-house satellite operations conducted on satellites assembled by laboratory Airmen. The Air Force Space S&T portfolio covers the breadth of Air Force interests by investing in foundational research and space experiments, as well as emphasizing the five specific disciplines of Space Environment, Nuclear Deterrence Operations, Space Situational Awareness, Communication/Position, Navigation and Timing, and Intelligence, Surveillance, and Reconnaissance/Missile Warning.

The Air Force seeks to explore and mature a number of space resilience technologies in a relevant environment through on-orbit space experimentation. The Evolved Expendable Launch Vehicle (EELV) Secondary Payload Adapter (ESPA) Augmented GEO Laboratory Experiment (EAGLE) project, launched on 14 April, is currently demonstrating enhanced capabilities in space system anomaly resolution and the capability to supplement ground based space situational awareness assets from a geosynchronous platform. Through this experimentation, Air Force Space Command operators are learning new operational tactics and techniques that will inform future requirements for delivering space systems to the warfighter.

The Air Force also continues development of the Navigation Technology Satellite-3 (NTS-3), which aims to demonstrate a range of technologies for potential inclusion in future GPS satellites or potential augmentation of GPS, such as hosted Satellite Navigation (SatNav) payloads on other DoD, commercial, or international spacecraft. Launch of NTS-3 is currently projected for 2022 with a planned one-year, on-orbit experiment period.

Rapid, Effective Decision-Making and Complexity, Unpredictability, and Mass

Autonomy, Artificial Intelligence, and Robotics

The Air Force held an Artificial Intelligence Summit and identified three key investment areas: condition based maintenance; supporting the intelligence community; and autonomous air combat operations. Advances in these areas provide significant improvements to decision-making speed and mission agility, posing new challenges to the adversary at a pace they cannot match.

The Air Force is focused on operationalizing autonomy on two fronts; autonomy at rest and autonomy in motion. Autonomy at rest provides tools to move inside the adversary decision cycle by accelerating the intelligence process and providing predictive logistics and maintenance. The focus of the autonomy in motion thrust is the reduction of operator burden and increased performance striving to overwhelm our adversaries with complexity and speed.

The advent of Unmanned Air Systems (UAS) introduced a new class of air platforms and enabled an unrivaled ability to provide ISR on the battlefield. The Air Force is poised to take UAS to the next level with digital engineering and low-cost manufacturing, providing a flexible, adaptable, and cost-imposing capability to the warfighter. On March 5, 2019, the Low Cost Attritable Strike Demonstration effort (XQ-58A) completed a successful first flight test on 5 Mar 19 in Yuma, CA. The launch and recovery systems worked as expected and the vehicle flew for 72 min. For this test, the remote pilot controlled the aircraft in semiautonomous manner by providing inputs but allowing the aircraft to self-manage stability and control. This was the first step of our Skyborg effort, which advances research in aircraft piloted by artificial intelligence. We are now ready for the second step toward unmanned tactical aircraft where we need to think of the aircraft not as just an air platform but also as a software platform, which could allow a future of flying with an artificially intelligent wingman. These aircraft could be used in a more dangerous role or react more quickly to a threat faster than our current exquisite manned aircraft. These attritable aircraft can

be used to impose high-cost responses from our adversaries and extend mission range. There are some tough challenges ahead but we need be the first to develop this technology or we run the risk of falling behind. We need to accelerate ahead of the pack.

The future aerospace manufacturing environment will feature flexible and reconfigurable robotic systems that work in close proximity with the human workforce. The Air Force successfully demonstrated the Advanced Automation for Agile Aerospace Applications (A5) Robotic System. Typically, robotic arms are bolted into place and perform repetitive actions as a platform moves down a production line. The A5 robot is mounted on a mobile platform that allows it to move about an aircraft. The 22,000 pound A5 robotic system is the first multi-purpose robot designed for use on an aerospace factory floor. By capitalizing on advancements in man-machine interfacing technologies, the A5 robot is anticipated to cut depot maintenance times for aircraft coating removal up to 50 percent, saving time and money over the lifecycle of a platform.

Disruption and Lethality

Hypersonics

We are assessing our technology investments to ensure our future warfighters can be more disruptive and lethal. Capitalizing on recent years of increased investment, the Air Force is deliberately accelerating the pace of research and development across the breadth of hypersonic regimes and systems and directed energy efforts.

The Air Force, in partnership with the DARPA, is maturing two S&T flight demonstration programs. The Hypersonic Air-breathing Weapon Concept (HAWC) activity matures and integrates critical technologies and attributes of an effective air-launched, scramjet-powered hypersonic cruise missile capability. Similarly, the Tactical Boost Glide (TBG) effort develops and demonstrates technologies to support air-launched, deep-strike hypersonic boost-glide systems. In addition, the Air Force maintains a comprehensive and wide-reaching investment portfolio associated

with hypersonic technology, including propulsion, advanced materials, manufacturing technology, sensors and algorithms, and aero-structures.

The Air Force is pushing to field air-launched hypersonic strike capability as soon as possible. Thanks to the Middle Tier Acquisition authority granted to the Air Force by this Congress (Section 804 of the FY16 National Defense Authorization Act), we have been able to race down the path to this capability even faster through two prototyping efforts. The AGM-183A Air Launched Rapid Response Weapon (ARRW, "Arrow") will operationalize the technical concepts established by the Air Force Research Laboratory and DARPA partnership in hypersonics S&T. Likewise, the Hypersonic Conventional Strike Weapon (HCSW, "Hacksaw") is integrating separate, more mature technologies into a new configuration for air-launched prompt strike. The Services have signed a Memorandum of Agreement so all of the Department's hypersonics technologies can be leveraged to move as fast as possible to capability. Stripping a total of 10 years from these programs, we expect to demonstrate the Department's first operational flight test in 2020 and achieve early operational capability in 2021.

Directed Energy

Exploiting directed energy technology, high energy laser (HEL) and high-powered microwave (HPM), allows us to fundamentally alter operational concepts and maintain parity with peer competitors, especially as we face operating in increasingly contested environments. Directed energy weapons offer transformational capabilities to enable Airmen to effectively, affordably, and rapidly defeat massed attacks from an adversary and to strike critical targets at the speed of light. These same weapons can provide the ability to disruptively engage targets of interest with little to no collateral impacts or detectable disturbance and provide protection to Air Force assets that must operate in harm's way.

The Air Force has a long history of science and technology investments in directed energy to

the point that we are now positioned to provide the airman distinctive and revolutionary capabilities for several Air Force and joint mission areas. The Air Force Directed Energy Weapons Flight Plan identified three use cases for directed energy weapons: base defense, precision engagement, and aircraft protection.

We see the most near-term application and potential transition of directed energy weapons for the base defense mission area. In October 2018, the Air Force held a successful experimentation event at White Sands Missile Range, NM. The experiment focused on understanding the capabilities and limitations offered by existing off-the-shelf directed energy HPM and HEL systems against unmanned aerial systems (UAS). Building on the success of this counter-UAS directed energy experiment, the Air Force plans to conduct further experiments with directed energy technologies for base defense. Through directed energy prototyping and experimentation the Air Force expects to learn operational tactics and techniques over the next 18 months that will inform future requirements for delivering directed energy systems to the warfighter.

The Air Force is continuing S&T efforts for the precision engagement and aircraft protection use cases to enable future prototyping and experimentation in these mission areas.

Biotechnology

Biotechnology research is also part of the S&T portfolio. For example, we are continuing to develop bio- and nature-inspired designs to improve the functionality and efficiency of weapon seeker and sensor concepts, developing multi-faceted wide-field-of-view seekers for use in next-generation weapon concepts such as the Miniature Self Defense Munition. Additionally, biotechnology research on biomarkers recently transitioned to the Air Logistics Center at Warner Robbins AFB that detects stress and exhaustion for workers in confined space areas. The Air Force also conducts directed energy bioeffects research at Joint Base San Antonio, TX. Our research focuses on the interaction of

lasers and radio frequency energy with the body to understand harm, protect the Airman, and exploit vulnerabilities for directed energy weapons.

Initiatives to Field Tomorrow's Air Force Faster and Smarter

Innovation Outreach

Technology is evolving ever more rapidly, and is being driven primarily by the private sector. Air Force leadership understands the importance of connecting innovators of disruptive technologies with our warfighters for capability development. The Air Force is developing an ecosystem which serves as a catalyst for innovation and agile engagement across industry, academia and non-traditional contributors.

The Air Force Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR) Program provided undiluted capital as a means of leveling the playing field for small business involved in research, development, testing and evaluation of cutting-edge technologies and systems. We implemented several experimental processes designed to reduce the time to contract, increase exposure of the opportunity for technology relevance and to reduce time of technology transition.

Air Force Pitch Day completed a successful event on 6-7 March 2019 in New York City. Our team of "venture ninjas" awarded 51 contracts to startups and small businesses on-site, with initial payments made in less than 15 minutes. The fastest was done in three! Solicitation timeline was cut from 180 days to less than a week, and 242 contracts, worth $75M, were awarded that week. We saw a wide array of ideas: companies building downlink hotspot satellites in space, others applying AI to imagery to find targets of interest, others turning that imagery into 3D maps with all sorts of applications. With game-changing ideas being generated in commercial startups at an increasingly accelerating pace, we can ill afford the next generation of tech companies to grow up disconnected to our mission. Expect more Pitch Days in future.

A large part of Pitch Day's success was AFWERX, an innovation outreach program with the goal of improving Air Force capabilities by connecting innovators, simplifying technology transfer, accelerating results and fostering a culture of innovation in Airmen. AFWERX has several tools at their disposal to connect Airmen ideation with cutting edge companies by using accelerators, public challenge events, and access to capital through the SBIR program. Additionally, they have created a virtual collaboration tool for enterprise-wide use, including for use with this year's Squadron Innovation Fund campaign. To further facilitate the transformation of ideas-into-solutions, AFWERX has opened 3 innovation hubs in Las Vegas, Crystal City and Austin. These centers work together to provide tech scanning, industry analysis, light prototyping with basic manufacturing tools, and lean start up designing. The hubs also connect the Air Force with high-tech entrepreneurs and spare-time garage tinkerers, who use the AFWERX processes as a way to pitch their ideas to the Service.

Ensuring success of startups, who are developing technologies of importance to the warfighter, is also an important part of the Air Force innovation outreach efforts. In 2018, the Air Force partnered with Techstars, a company that assists with the acceleration of innovative startup companies, to launch The Air Force Accelerator Powered by Techstars. The tech accelerator focused on increasing the engagement with early stage innovative startups to tackle Service needs. It signaled the Air Force was open for business and in a way that resonated with the entrepreneurial community. The initial program was successful, resulting in all 10 cutting-edge companies winning DoD contracts or private investment. This is another example of how the Air Force is creatively adapting existing business enterprise tools to connect with non-traditional partners.

Sustainment Research and Development

The 2018 National Defense Strategy called for the application of modern technology to reduce sustainment costs while improving aircraft availability. In response, the Secretary of the Air Force, established the Rapid Sustainment Office (RSO) to identify, apply, and scale game-changing technology to decrease sustainment costs and increase readiness across the enterprise.

The Air Force continues to experience product support challenges with its aging aircraft fleet due to the rising number of Diminishing Manufacturing Sources and Material Shortages (DMSMS) for parts and support equipment. To address this problem, the RSO is strategically poised to accelerate implementation of agile technology capabilities, such as Additive Manufacturing (AM), Condition-Based Maintenance and Automation/Laser technologies to address the Service's part supply challenges.

Advanced Manufacturing

The Air Force's Manufacturing Technology program is a key enabler of Executive Order 13806 (Jul 2017) mandating the United States strengthen the manufacturing capacity of the defense industrial base, and increase the resiliency of supply chains critical to national security. The Air Force is focused on developing and deploying agile aerospace manufacturing and sustainment technologies in accordance with the SECAF's vision of Fielding Tomorrow's Air Force Faster and Smarter. Through engagement with the other Services and industry, the Air Force's Manufacturing Technology program is advancing the state-of-the-art in aerospace manufacturing in critical areas such as hypersonic strike, networked command, control and communication (C3) systems, attritable and low-cost aircraft and space systems, while developing new efforts aimed at bolstering the nascent industrial base in directed energy weapons and quantum devices. The agile manufacturing vision is premised on implementing advanced digital manufacturing capabilities within the industrial base through three strategic thrusts: 1) implementing the factory of the future to

drive greater efficiencies through human-machine teaming, Industrial Internet of Things (IIoT) systems, and augmented/virtual reality tools; 2) creating a digital engineering and design environment to deliver comprehensive life cycle data management as well as advanced cost and supply chain management tools; and 3) enabling greater implementation of additive manufacturing technology for both next generation capabilities as well as the rapid fabrication of parts and tooling for sustainment operations.

A recent success in this effort is the Air Force-trademarked AgilePod®. It is a multi-sensor capable and flight-line reconfigurable pod that enables operators in the intelligence, surveillance and reconnaissance (ISR) and Air Force Special Operations communities to rapidly configure the pod to accommodate mission requirements. Additionally, the pod is platform agnostic and enables the rapid integration of new capabilities.

Digital Engineering

The Air Force engineering enterprise has been exceptionally capable at providing the technical foundation to deliver advanced weapon systems. Acquirers must be more agile and innovative to rapidly adopt decisive technologies and deliver on shorter acquisition cycle times. The Air Force strongly supports the Digital Enterprise Environment (DEE) as a critical modernization initiative that benefits the warfighter by reducing engineering decision making timelines for fielded systems, thus increasing weapon system availability, and allowing more robust decision making during system design. The modern, integrated, model-based DEE will enable the Air Force to convert its acquisition processes from traditional industrial age ways of doing business to a new streamlined approach that rapidly develops, fields and sustains new capabilities.

Recently, a few Air Force programs implemented a portion of this capability and have seen dramatic reductions in decision-making timelines. For example, A-10 engineers used digital models to develop the repair process following a bird strike to the wing. The model was constructed to fit over

the damaged area to create a part that would fit the wing area. This method allowed the engineers and machinists to inspect the damaged structure and the proposed repair digitally before beginning fabrication. These Airmen produced a repair part so precise that squadron aircraft mechanics mounted the part without any additional adjustments.

Supporting Innovation – People, Infrastructure and Authorities

We recognize the technological superiority of the Air Force depends on the talent and innovative spirit of our workforce. The ability to recruit, retain and develop the Air Force science, technology, engineering and mathematics (STEM) workforce has been greatly supported and enabled by Congress. The National Defense Authorization Acts of the past several years have provided additional personnel authorities to the S&T community. In order to stay competitive, we have utilized the direct hire authorities to gain approximately 150 personnel from Academia and Industry. The authority also allows us the ability to attract the right talent for the right positions, which is vital to our innovation ecosystem. We recognize that we are in competition for the right talent, and we must develop processes and policies to recruit, hire, and retain top talent as our people are our foundation. By using the competition smartly, we can set the requirements high to attract quality talent. We are continuing our efforts to fully implement all of the personnel authorities provided by the Congress.

Infrastructure focused on S&T is an important component to support innovation and force modernization. While our researchers routinely partner with academia and industry, a significant portion of military-focused research is done in Air Force facilities. We continuously assess laboratory infrastructure to determine how best to support technology needs of the future. With the latest release of the National Defense Strategy, we implemented a multidisciplinary/cross-organizational team to confirm and validate alignment of a 5-year infrastructure and facility plan. Results are expected later this summer.

Conclusion

The Air Force's Science and Technology Portfolio is shaped to deliver, with speed, capabilities that are lethal, persistent, resilient and unpredictable and cost-imposing for our adversaries. While the technologies the Air Force invests in are critically important, the pace at which the Air Force innovates and responds is even more significant. We are pushing the envelope on getting technology to the warfighter faster and smarter by transforming our innovative culture, creating new industry, academia and international partners, and utilizing new business and hiring processes, and improving the way we develop and transition technology.

William B. Roper, Jr.

Dr. Will Roper is the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics. As the Air Force's Service Acquisition Executive, Dr. Roper is responsible for and oversees Air Force research, development, and acquisition activities totaling an annual budget of over $40 billion for over 465 acquisition programs. In this position, Dr. Roper serves as the principal advisor to the Secretary and Chief of Staff of the Air Force for research and development, test, production, and modernization efforts within the Air Force. In addition to his Air Force responsibilities, Dr. Roper is the Service Acquisition Executive for the Joint Strike Fighter. Dr. Roper also serves on the DoD's Cloud Executive Steering Group.

Before assuming his current position, Dr. Roper was the founding Director of the Pentagon's Strategic Capabilities Office (SCO). Established in 2012, the SCO imagines new—often unexpected and game- changing—uses of existing government and commercial systems: extending their shelf-life and restoring surprise to the military's playbook. Since 2012, SCO has grown from $50M/year to the current $1.5B/year request in President's 2018 budget with projects spanning new concepts such as hypervelocity artillery, multi-purpose missiles, autonomous fast-boats, smartphone-navigating weapons, big-data-enabled sensing, 3D-printed systems, standoff arsenal planes, fighter avatars, and fighter-dispersed swarming micro-drones which formed the world's then-largest swarm of 103 systems. During his tenure as SCO Director, Dr. Roper served on the Department's 2018 National Defense Strategy Steering Group and Defense Modernization Team.

Previously, Dr. Roper served as the Acting Chief Architect at the Missile Defense Agency (MDA) where he developed 11 new systems, including the current European Defense architecture, advanced drones, and classified programs. Before this, he worked at MIT Lincoln Laboratory and served as a missile defense advisor to the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD/AT&L).

EDUCATION

2001 Bachelor of Science in Physics, Georgia Institute of Technology
2002 Master of Science in Physics, Georgia Institute of Technology
2010 Doctorate in Mathematics, Oxford University

CAREER CHRONOLOGY

1. January 2006 – June 2010, Missile Defense Advisor, MIT Lincoln Laboratory, Washington, D.C.
2. August 2010 – August 2011, Member, Missile Defense Advisory Committee, Missile Defense Agency, Washington D.C.
3. June 2010 – August 2012, Acting Chief Architect, Missile Defense Agency, Washington D.C.
4. August 2012 – February 2018, Director, Strategic Capabilities Office, Office of the Secretary of Defense, Washington, D.C.
5. February 2018 – present, Assistant Secretary of the Air Force for Acquisitions, Technology and Logistics, Headquarters U.S. Air Force, Washington, D.C.

MAJOR AWARDS AND HONORS

Department of Defense Medal for Distinguished Public Service
Secretary of Defense's Award for Excellence
USD/AT&L Award for Innovation
MDA's Contractor of the Year
MDA's Innovation and Technology Awards
Rhodes Scholar

(Current as of February 2018)

WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING

MARCH 28, 2019

RESPONSES TO QUESTIONS SUBMITTED BY MR. LANGEVIN

Secretary GRIFFIN. First, I would like to thank this body for the authorities granted which have been extremely useful for the Defense Laboratories. These authorities have been implemented extensively across the Services, particularly those affecting Personnel, Infrastructure, and Technology Transfer. In the FY17 NDAA, Section 233 provides an opportunity for the Services to consider and approve alternative and innovative methods which would provide eligible centers more flexibility to manage and operate research and development activities; facility management, construction and repair; business operations; personnel management policies and practices; and intramural and public outreach; as well as enable more rapid deployment of warfighter capabilities. To date, 18 methods were approved by Assistant Secretaries concerned (12 were approved for the Navy and 6 were approved for the Air Force). The Army is currently proposing one method for approval. The Military Departments expect to submit more initiatives for approval as they continue to work on streamlining internal departmental processes. The wider adoption of this authority and others is not a case where incentives are lacking, but rather a case where higher commands are prohibiting the use of the available authorities. Section 211 of the FY17 NDAA formally established the Laboratory Quality Enhancement Program (LQEP) which has facilitated the use of the authorities to convening quarterly to review policies and practices affecting the Science and Technology Reinvention Laboratories (STRLs). The panels for Personnel, Infrastructure, and Tech Transfer created as a result are charged with reviewing and reinterpreting existing statute and implementing regulations with emphasis on component policies that present barriers to innovation. Military Departments have used several authorities to fund minor MILCON projects that have greatly impacted the laboratories. Over the last three fiscal years, the Army has spent $211.2M; the Navy has spent $70.3M and the Air Force has spent $78.2M on minor MILCON. Funding for these projects was authorized by section 2363 (Mechanisms to Provide Funds for Defense Labs for Research and Development of Technologies for Military Missions) and section 2805d (Unspecified Minor MILCON). These authorities are vital to maintaining and modernizing the laboratories and warfare centers. [See page 30.]

Secretary JETTE. The Army sees tremendous value in the pilot program under the Fiscal Year 2017 National Defense Authorization Act Section 233. In June 2017, ASA(ALT) established a policy that enables rapid adjudication of waivers submitted for the Section 233 program, and provided a mechanism for all Army labs to implement the waiver under the auspices of their command structure. Such an innovative program has taken some time to instill in the organization. But we have a significant number of pending waivers that are currently being considered. [See page 30.]

Secretary GEURTS. The Navy has implemented Section 233 of the FY 2017 NDAA in the following Navy Science and Technology Reinvention Laboratories (STRLs) as part of the pilot: Naval Sea Systems Warfare Centers; Naval Research Laboratory; Naval Air Warfare Center, Aircraft Division; Naval Air Warfare Center, Weapons Division; Naval Information Warfare Center, Atlantic; Naval Information Warfare Center, Pacific; and Naval Facilities Engineering and Expeditionary Warfare Center. The Navy's implementation approach has been in phases so as to best evaluate the impact. The first phase implemented 12 business operations, contracting and facility management initiatives on November 16, 2017. The second phase has been comprised of initiatives in the following focus areas: business operations, personnel management policies and practices, and facility management construction and repair.

The vetting of the initiatives with stakeholders is ongoing and will be incrementally implemented in three sprints.

- Sprint I approved 12 contracting and facility management initiatives on March 5, 2019.
- Sprint II will approve 10 Information Technology Purchase Request and Authority to Operate and business process initiatives in April 2019.
- Sprint III to provide additional business process relief is targeted for approval later in CY 2019.

The Navy has been looking at pilots in five focus areas: business operations, contracting, personnel management policies and practices, IT policies, and facility management construction and repair with benefits resulting in a 30 percent decrease in contract processing time, equivalent to 354,000 processing days saved. The Navy recommends extending the sunset clause beyond FY 2022 to at least FY 2025. This extension will allow time to incorporate lessons learned and to investigate new opportunities. [See page 30.]

Secretary ROPER. I greatly appreciate the authorities that Congress has provided our Service laboratories over the last few years. The Section 233 authority is a powerful tool for our laboratory commander to remove barriers to innovation. I'm confident that we've worked through our internal challenges and have developed the level of advocacy we need to get proposals through the approval process. This will definitely enable the Air Force Research Laboratory to take full advantage of this authority. A new call for proposals recently went out by the Air Force Research Laboratory. After a review by the Commander of the Air Force Materiel Command, I look forward to seeing and approving the proposals when they reach my desk and hope to do so this year. [See page 30.]

RESPONSE TO QUESTION SUBMITTED BY MR. BROWN

Secretary GRIFFIN. From RPP: The Rapid Prototyping Program (RPP) began in 2017 and is DDR&E(AC)'s only enduring prototyping program with 6.4 funds. Over these three years, 96% of RPP funding is associated with Service/Agency programs. Additional details here:

FY 2017–2019 Total execution value $234.4M (FY17: $100M; FY18: $45M; FY19: $89.4M)

Associated with Programs of Record: $223.9M/93% (FY17: $91.7M; FY18 $42.8M; FY19: $89.4M)

Not directly linked to a Program of Record: $10.5M/7% (FY17: $8.3 FY18: 2.2M; FY19: 0)

From RIF: 100% of the RIF program ($250M annually) is outside of a Program of Record (POR). The purpose of RIF is to insert emerging innovative technologies that DIRECTLY SUPPORT the National Defense Strategy (NDS), Modernization Priorities, and Component goals into DOD Programs of Record (POR). RIF leverages innovations from Phase II Small Business Innovative Research (SBIR), defense laboratories and other sources to enable PORs to insert new technology with minimal program disruption." Since 2011 RIF has invested $1.8B in over 800 projects, transitioning over 60% of successful projects into PORs, program requirement documents, or other Agency programs.

From SCO: All of SCO's 6.4 work is similarly outside of PORs. SCO's mission is to identify, analyze, and prototype new and disruptive applications of existing and emerging systems, as well as near-term technologies, to create operational strategic effects, specifically: deterrence, power projection, cost imposition, surprise, and overmatch. The resulting prototyping projects—motivated primarily by INDOPACOM and EUCOM operational challenges—either transition to enhance existing PORs (e.g., buy down risk, prove out new missions/capabilities) or establish new PORs. [See page 26.]

RESPONSES TO QUESTIONS SUBMITTED BY MS. HOULAHAN

Secretary GRIFFIN. AI Efforts: The Department is moving across a broad front to engage and align the numerous efforts of our laboratories and agencies to increase our outreach to Universities for their key contributions. Basic research investments in applied mathematics will allow us to push the envelope on AI technology to enable capabilities that do not currently exist. First, new applied math methods might allow the Department to work with data sets that are not well curated. In essence, new methods are required to take optimal advantage of sparse data sets that are incomplete and noisy. Second, better understanding of cognitive neuroscience and biological neural nets may allow us to develop the next generation of AI that mimics the human or animal brain. Finally, both of the above activities will allow for the Department to generate AI that is more understandable to humans for optimal human-machine teaming. In the months leading up to the publication of our AI strategy in June 2018, the Department's research laboratories and agencies such as DARPA, as well as the intelligence community collaborated to forge a strategy. We have continued to develop and strengthen our engagement by using our Communities of Interest to host focused workshops on the impact of machine learning and AI to areas including: autonomy; Command, Control, Communications, Computers

and Intelligence (C4I); and cyber. We have also reached out to our Allies including the UK, Australia, Canada, New Zealand, Japan, and Korea and found them ready to engage and align efforts in this key area. Through our Basic Research Offices, we continue to reach out with the Services and DARPA as part of the AI next campaign. We are also engaging with some Universities through FFRDCs including the Software Engineering Institute at Carnegie-Mellon and MIT Lincoln Laboratory where we are ramping up efforts. We are discussing with Universities the key role they can play in strengthening discipline of "AI Engineering", increasing the production of talented AI graduates, and contributing new ideas that greatly improve our ability to trust and understand AI systems. The Department is increasing scholarship offerings for those pursuing AI studies. And the Services are reaching out to Universities to establish new AI institutes.

Additive Manufacturing: DOD's research and development community has multiple investments in advanced manufacturing under the Manufacturing Technology (ManTech) Program. ManTech is authorized by Section 2521 of Title 10, United States Code and is part of the USD(R&E) portfolio. ManTech, as an investment program, began in 1956 and continues to this day with funding across USD(R&E), Army, Navy, Air Force, Defense Logistics Agency (DLA), and Missile Defense Agency (MDA). The other two funded investment programs in manufacturing are the Defense Production Act Title III, and the Industrial Base Analysis and Sustainment (IBAS) efforts, both managed by the Industrial Policy Office in the Office of the Under Secretary of Defense, Acquisition & Sustainment. DOD uses these accounts to address issues with the capability and capacity of our manufacturing industrial base. Within USD R&E DOD ManTech programs invest in individual manufacturing projects focused on bringing new manufacturing and production processes and systems to acquisition program managers, thus helping to bridge the gap between discovery and implementation of new capabilities for the warfighter. Sample projects funded out of the USD(R&E) Program Element include:

- Cold Spray Additive Repair
- High Temperature Engine Components (HighTEC)
- Micro Electro-Mechanical Systems (MEMS) Inertial Navigation System
- Manufacturing of Carbon-Carbon Composites for Hypersonic Applications (MOC3HA), and
- Vertical Cavity Surface Emitting Lasers

The USD(R&E) ManTech investment uniquely supports the eight DOD manufacturing innovation institutes. DOD established the Manufacturing Innovation Institutes (MIIs) as public-private partnerships to address critical manufacturing risks, boost manufacturing innovation for the DOD, encourage re-development of US manufacturing capabilities, and provide an integrated whole-of-sector approach in each of eight technology-focused areas. To date, the DOD has invested over $600M to establish MIIs for additive manufacturing; lightweight and modern metals; digital manufacturing, design, and cybersecurity; integrated photonics; flexible hybrid electronics; revolutionary fibers and textiles; regenerative tissue manufacturing; and advanced robotics. DOD funding for the MIIs has engendered more than $1.6B in additional state, industry, and academic cost-share contributions that substantially improve the DOD return on investment.

Since 2011, the DOD has invested $113.5 Million in research and development projects for Additive Manufacturing, sometimes also referred to as 3D Printing, in a public-private partnership with America Makes, the national AM innovation institute to advance the technology for DOD and the nation. Similar to 3DP, Additive Manufacturing (AM) is an emerging technology based on building up material using computer-controlled equipment to make sophisticated parts and assemblies. AM technology is used in sustainment to manufacture noncritical replacement parts in the field and support activities resulting in increased readiness and reduced operational problems on the front lines. AM enables the manufacturing of parts that weigh less and perform their functions better than those made with traditional subtractive techniques. DOD also established the Joint AM Steering and Working Group to work to foster coordination and collaboration between the Services and Defense Agencies. These groups seek to maximize the application of additive manufacturing in support of the warfighter and sustainers and promote AM-based designs where beneficial. These groups are tasked to: develop a DOD AM vision; disseminate information on DOD AM efforts throughout the Services and Components; provide recommendations for a joint AM investment strategy; identify and share AM best practices; and encourage joint approaches to accelerate AM qualification and certification. [See page 25.]

Secretary GRIFFIN. Since 2011, the DOD has invested $113.5 million in research and development projects for Additive Manufacturing (AM), sometimes also referred to as 3D Printing, in a public-private partnership with America Makes, the national

AM innovation institute to advance the technology for DOD and the nation. Similar to 3DP, AM is an emerging technology based on building up material using computer-controlled equipment to make sophisticated parts and assemblies. AM technology is used in sustainment to manufacture non-critical replacement parts in the field and support activities resulting in increased readiness and reduced operational problems on the front lines. AM enables the manufacturing of parts that weigh less and perform their functions better than those made with traditional subtractive techniques. As a result of the America Makes partnership, the DOD developed a strategic roadmap for AM across the Department. Within the strategic roadmap, each Service maintains an AM implementation plan, which details specific actions and milestones to incorporate AM technologies through investments in AM research, development and deployment projects.

The Services are also experimenting with the application of AM to mission critical parts. A full Report to Congress detailing these activities was provided in 2017 to the House and Senate Armed Services Committee. DOD is working to more effectively engage the universities and R&E labs in AM in a number of ways. Universities currently participate in AM as members or hosts of the Manufacturing Innovation Institutes and through ManTech funded projects. Universities such as Massachusetts Institute of Technology, SUNY Polytechnic Institute, Carnegie Mellon University, and University of Michigan are closely coupled with the non-profit organizations that operate the MIIs. They bring access to existing resources to support the federal investment in the MIIs. Other university members are engaged in the development of advanced manufacturing technology projects and the support of education and workforce development training and programs accessible to both the public and private sectors. [See page 26.]

RESPONSE TO QUESTION SUBMITTED BY MR. BANKS

Secretary GRIFFIN. Huawei has a strong market position, but the 5G ecosystem extends far beyond Huawei's market penetration. This 5G ecosystem has many parts and a specific claim about market penetration in any of these aspects is problematic. DOD's perspective is to provide for national security to create an environment where U.S. companies are free and empowered to do what they do best: innovate and globally collaborate to bring transformational products and services to the market. [See page 20.]

RESPONSES TO QUESTIONS SUBMITTED BY MR. WALTZ

Secretary GRIFFIN. We, in USD(R&E), are collectively taking best practices across the research and engineering enterprise such as SCO, DIU, the labs, and others and institutionalizing their missions while also utilizing pilot programs such as the Army Open Campus initiatives that leverage regional expertise and facilities to accelerate the discovery, innovation, and transition of science and technology in places like Boston MA, Chicago IL, Austin TX, and Playa Vista CA. Another example is the Navy innovation hub formed around NSWC Crane as an anchor technology driver that is in partnership with major regional universities (Indiana University, Purdue University, University of Southern Indiana, Notre Dame) and industry (defense, commercial, and non-profit).

1) Bringing the Missions of Core DIU, NSIN, and NSIC Together

In February 2019, OUSD(R&E) directed DIU to assume operational management of two entities: (1) NSIN, formerly known as MD5–National Security Technology Accelerator, and (2) NSIC, a new entity authorized in the John S. McCain NDAA for FY 2019. To avoid confusion as DIU assumes responsibility for three organizations, DIU uses the term "Core DIU" to refer to the DIU activities focused on prototyping existing commercial solutions for DOD customers. Together, Core DIU, NSIN, and NSIC encompass the full range of technology readiness levels and create new opportunities for National Security Innovation Base (NSIB) participants to solve national security challenges. Consolidating these activities under DIU—and more broadly under OUSD(R&E)—will streamline operations, improve coordination, and foster growth in the NSIB. The graphic below depicts how core DIU, NSIN and NSIC will operate across the technology maturity spectrum and with different elements of the NSIB ecosystem. [The graphic referred to was not available at the time of printing.]

2) Overview of DOD Innovation

In February 2018, the DOD re-established the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)). This reorganization consolidated a number of organizations tasked with specialized yet complementary missions under OUSD(R&E) leadership to advance research and increase the speed of

delivery and return on investment of new technologies and discoveries for the services and DOD.

- DOD laboratories: Conduct basic and applied research on service-specific challenges.
- DIU: Prototypes existing commercial solutions for DOD customers. It is also a member of a working group with the Defense Innovation Board (DIB) and NSIN to develop frameworks and paths for enhanced collaboration across the NSIB.
- Strategic Capabilities Office (SCO): Creates near term strategic operational effects to support U.S. Indo-Pacific and European Command, using existing and emerging government and commercial systems.

These three organizations are an example of the broader R&D ecosystem that the Department relies upon to provide superior technological capabilities to the warfighter, now and in the future. [See page 23.]

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

MARCH 28, 2019

QUESTIONS SUBMITTED BY MR. CONAWAY

Mr. CONAWAY. Thank you for taking the time to appear before the committee. With regards to the Citizens Broadband Radio Service and ensuring the most effective spectrum management, I have a few questions.

a) Does DOD foresee any issues with the CBRS Spectrum Access System (SAS) [the SAS is tasked with protecting the higher tier users from harmful interference and assures efficient use of the 3.5 GHz band for everyone] and Environmental Sensing Capability (ESC) certification that could be a hurdle to a quick approval process?

b) Has the DOD and FCC finalized the approval process for CBRS certification reports?

c) The NTIA, DOD, and other Federal agencies have identified the 3450–3550 MHz band for potential repurposing to spur commercial wireless innovation. What is the timeline for the DOD submitting a proposal under the Spectrum Pipeline Act of 2015 to study the potential for introducing advanced wireless services in this band without harming or interference with critical government operations?

d) Is the NTIA or FCC considering the 3.1–3.45 GHz band for sharing with commercial operations as well? Are there dynamic techniques that can be used for more efficient spectrum sharing?

Secretary GRIFFIN. a) The Department has been proactively engaged in working with industry and the national regulators (i.e., FCC, NTIA) on this innovative sharing framework and see no hurdles to approval at this time. In general, the SAS/ESC construct is designed to not only protect DOD systems, but will enable mid-band 5G spectrum. Our work with WinnForum is a good example of the value of partnerships with industry and how trusted engineering can be used to assess the feasibility of a new sharing concept between federal and non-federal applications. We would defer any questions on the approval process regarding certifications to the national regulators (i.e., FCC).

b) The approval process for CBRS certification reports has been established and we have a way forward. DOD looks forward to continuing to work in partnership with NTIA and FCC to conduct a comprehensive review of each ESC and SAS certification report to ensure each company's technical solution satisfies DOD requirements.

c) DOD is engaging with other key stakeholders, including NTIA, FCC, and interested commercial entities, to define the scope of funding required for DOD under the Pipeline Act for specific activities that would potentially increase commercial access to the band on a shared basis.

d) This sub-band is part of the 3100–3550 MHz range, for which the MOBILE NOW Act requires NTIA, in coordination with FCC, to submit a report to Congress, which is currently in development. DOD is supporting NTIA studies to determine the feasibility of sharing the band with a commercial system. We defer any specific questions on this effort to NTIA and FCC.

Mr. CONAWAY. Thank you for taking the time to appear before the committee. With regards to the Citizens Broadband Radio Service and ensuring the most effective spectrum management, I have a few questions.

a) Does DOD foresee any issues with the CBRS Spectrum Access System (SAS) [the SAS is tasked with protecting the higher tier users from harmful interference and assures efficient use of the 3.5 GHz band for everyone] and Environmental Sensing Capability (ESC) certification that could be a hurdle to a quick approval process?

b) Has the DOD and FCC finalized the approval process for CBRS certification reports?

c) The NTIA, DOD, and other Federal agencies have identified the 3450–3550 MHz band for potential repurposing to spur commercial wireless innovation. What is the timeline for the DOD submitting a proposal under the Spectrum Pipeline Act of 2015 to study the potential for introducing advanced wireless services in this band without harming or interference with critical government operations?

d) Is the NTIA or FCC considering the 3.1–3.45 GHz band for sharing with commercial operations as well? Are there dynamic techniques that can be used for more efficient spectrum sharing?

Secretary GEURTS. a) The Navy has expressed concerns about the potential risks and vulnerabilities related to the interoperability of the SAS platform. The Navy participated in multiple Service, joint and interagency working groups with DOD, FCC and NTIA to identify the risks that are most relevant to maritime operations. The Navy has provided input at all levels to shape the guidelines related to the ESC and SAS certifications.

b) We defer to DOD and FCC on this question.

c) We defer to DOD on this question. The Navy has participated in the planning of this effort and has submitted multiple proposals for feasibility studies, which are now informing the efforts of the lead organization for this project, NTIA. The Navy has and will continue to provide a member to the NTIA-led working group to advise on Navy equities and concerns.

d) We defer to NTIA on this question. While the Navy is not currently included in NTIA's efforts for this study, the Navy stands ready and looks forward to the opportunity to collaborate with NTIA on a more strategic way forward that prioritizes projects as band-width allows.

QUESTIONS SUBMITTED BY MR. SCOTT

Mr. SCOTT. Dr. Griffin, I appreciate the letter you sent to me on March 8, 2019. expressing support to Hacking for Defense, where you stated that programs like this "provide clear value to the warfighter" and "stimulates the National Security Innovation Base." I was happy to see that your support of this program is reflected in the President's Fiscal Year 2020 budget request. Programs like this are key innovation programs within the Department of Defense because they not only work on real-world DOD problems but help produce real-world solutions for the Department.

a. Given the success of Hacking for Defense, what other applications are available to support the DOD?

b. Have we incorporated successful practices into other facets of the Department?

Thank you for your attention to the subject.

Secretary GRIFFIN. From DIU: Hacking for Defense has been successfully delivered at more than 21 universities throughout the country, but it is only one of myriad programs offered by the DOD sponsor for Hacking for Defense, the National Security Innovation Network (NSIN; formerly MD5). In addition to Hacking for Defense, NSIN also manages and executes 13 other programs designed to combine DOD end users with students and faculty from top research universities and early stage ventures from commercial innovation hubs throughout the country. Among these are NSIN's "Hacks" program, which delivers 48-hour hackathons focused on a DOD capability gap and includes transition funding to develop rapid prototypes of the Minimum Viable Products (MVPs) developed at the hackathon. Additionally, NSIN sponsors the Washington, DC-based "Fed Tech" program, which is designed to identify extant DOD Lab Technology that could answer a current DOD end user pain point, build an entrepreneurial team around it, and then launch a dual-use venture that can be added into the National Security Innovation Base (NSIB) and improve the technology transfer and transition (T3) rates of the DOD Labs. NSIN also leverages a network of more than 30 universities throughout the country to engage students and faculty in applied problem-solving to help enable the Department's modernization priorities by focusing on areas such as AI/ML, quantum computing, edge processing, advanced materials, and counter-drone measures. Applying the Hacking for Defense methodology to other areas of the Department is certainly worthy of further study; the most direct applications to other areas of the Department are probably in areas like advanced manufacturing and supply-chain management issues, both of which fall under the purview of the Office of the Under Secretary of Defense for Acquisition and Sustainment.

Mr. SCOTT. In January 2018, the U.S. Army renewed a 10-year, $2.3 billion dollar contract with Georgia Tech to assist the Department of Defense (DOD) with research and development and provide increased responsiveness to the nation's warfighters. I appreciate the addition of some of the nation's brightest STEM professionals in solving our toughest research problems.

a. How effective have DOD partnerships with universities been to lighten the load of DOD research?

b. Can you give a few specific examples of how our investments in universities have made impacts to today's warfighters?

Secretary JETTE. a. Army scientists and engineers work closely with academia to extend our core competencies across a number of disciplines, bringing together cutting-edge academic research with Army research staff who keep the collaboration oriented towards solving Army-relevant problems. This approach lightens the load of DOD research not only by leveraging academia's intellectual capital, but also their world-class facilities, instrumentation, and other infrastructure investments as well.

b. The Army's investments in universities through Army Single Investigator Grants, University Affiliated Research Centers (UARCs), and other extramural programs have resulted in knowledge products that have impacted Army investments. For example, the Army's support of Nobel Prize winning research into groundbreaking methods to produce new enzymes directly led to commercial, cost-effective synthesis of biofuels for aviation platforms. Army support to universities has also resulted in the development of extended range munitions; informed development of next generation weapons; improved computer network defense; and resulted in advancements in vehicle armor.