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Subcommittee on Emerging Threats and Capabilities

COMMITTEE ON
ARMED SERVICES

UNITED STATES SENATE

HEARING TO RECEIVE TESTIMONY ON
THE DEPARTMENT OF DEFENSE'S POSTURE FOR
SUPPORT AND FOSTERING INNOVATION

Wednesday, April 6, 2022

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Wednesday, April 6, 2022

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

The committee met, pursuant to notice, at 2:30 p.m. in Room SR-222, Russell Senate Office Building, Hon. Mark Kelly, chairman of the subcommittee, presiding.

Committee Members Present: Kelly [presiding], Kaine, Peters, Ernst, Fischer, Scott, and Tuberville.

OPENING STATEMENT OF HON. MARK KELLY, U.S. SENATOR FROM ARIZONA

Senator Kelly: Good afternoon, everyone. The Emerging Threats Subcommittee meets this afternoon to receive testimony today, and I would like to welcome our witnesses, Mr. Michael Brown, Director of the Defense Innovation Unit; Dr. Stefanie Tompkins, Director of DARPA, the Defense Advanced Research Projects Agency; and Ms. Heidi Shyu, the Under Secretary of Defense for Research and Engineering. Thank you all for being here today. I really appreciate you taking the time to do this.

And, you know, we are going to hear today from leaders who are working to support defense and national security innovation, to ensure that the United States retains its technological superiority and maintains its competitive edge over potential adversaries like China in the technological market space.

This is also a good opportunity for our witnesses to discuss how the recently released fiscal year 2023 defense budget request supports investments that advance the innovations needed to make the U.S. military more effective, more lethal, and more capable than those of our potential adversaries.

I would like to welcome again our witnesses who will help shed light on these topics today, and I want to take

this opportunity to again thank you, not only for being here but for your service to our nation. I know all of you share my goal of leveraging innovation to put the most advanced and effective technologies in the hands of our servicemembers and creating a vibrant innovation ecosystem that allows our military to stay more adaptive and more effective than our adversaries.

It is no secret the United States is in a competition with China, who seeks to dominate the national security as well as the commercial technology space. To date, our technological superiority has been enough to maintain our advantage despite the ambitions and methodical progress of China.

While the United States continues to enjoy an advantage in areas like advanced combat aircraft, missiles, nuclear and space technologies, and land and naval power, it is critical that we continue to show the Chinese government and all our competitors that starting a conflict or challenging us is simply not in their best interest. Continuing to advance our technological capability is central to that deterrence, as it removes any doubt about our ability to prevail in any head-to-head conflict, if provoked.

It is also important to remember that our national investments in science and technology research ultimately benefit not just the Department of Defense but also the

broader American public. Technologies funded by the DoD science and technology program over the past century have helped produce the internet, GPS, smartphones, advanced materials, and even medical advances that have improved Americans' prosperity, security, and quality of life. Most recently, DoD investments in medical research have resulted in the vaccines and therapeutics being used to address the COVID pandemic today.

I also want to emphasize that the innovation ecosystems that the Defense Department supports work best when they leverage state, local, and Federal assets and investments holistically, in addition to the broader academic and commercial entities needed to power effective public-private partnerships. My home state of Arizona is leading on this front. Our universities are driving innovation in critical fields, from advanced semiconductors and hypersonics to quantum computing, and applying advanced data analytics to military challenges like managing complex supply chains and improving operational planning. And they are working side-by-side with our military as they do this.

These ties can help us accelerate our defense research programs. We need to foster them, and we need to ensure that we are attracting and retaining the talented personnel and investing in the testing infrastructure, including in Arizona, that makes all this progress possible.

While innovation is something we have historically done better than anyone, we now face an immense threat to our technological superiority. China has been making significant advancements in cutting-edge technologies, like microelectronics and hypersonics, as it seeks to erode our military and economic advantages. They do so through not only dual-use investments but also through corporate coercion, espionage, and their connections between government and industry that would not be conceivable or acceptable in any democratic country.

That is why we must take a strategic approach across all technologies as we are doing now with our plan to boost domestic microchip manufacturing, to bring more of that capability back to America. That will create jobs, it will reduce our reliance on foreign sources, and also mean that we are doing breakthrough research here at home.

So I hope that in this hearing we can examine how DoD, DARPA, and DIU are using the resources and authorities they have been given to help us win the global technological competition against adversaries like China, by making advancements in key emerging technology areas, including artificial intelligence, autonomy, microelectronics, 5G technologies, and hypersonics. And I would also like to ask the witnesses to address any challenges that they are facing in trying to achieve that goal and give us insights and

recommendations on what this subcommittee can do to best support them as they embark on writing our annual defense authorization.

I will now turn to the ranking member, Senator Ernst, for any opening comments that she has.

STATEMENT OF HON. JONI ERNST, U.S. SENATOR FROM IOWA

Senator Ernst: Great. Thank you, Mr. Chair, and good afternoon to everyone. And I want to thank all of our witnesses for being here today.

Every one of us in this room agree that increased innovation to deliver lethal capabilities to the warfighter must be a priority of the Department of Defense. It is not up for debate. The questions and policy choices I am interested in deliberating concern the mechanics of identifying, screening, prototyping, and ultimately delivering technology to the warfighter.

The President's budget promises record levels of investment in research, testing, development, and evaluation. Will the Department translate those dollars into combat capability more quickly, or will projects with bigger price tags continue to die in the valley of death? Barriers like over-classification, continued embrace of exquisite hardware over agile service contracts, and risk aversion to using authorities like the middle tier of acquisition are too high. No budget number can clear them. China is moving quickly and aggressively to adopt emerging technology for their warfighters, and we cannot let the capabilities we provide our soldiers fall behind.

Today I hope you all can help ease my concerns and we can go forward with a commitment to field all necessary

systems more quickly and effectively.

Thank you very much to our witnesses. Thank you, Mr. Chair.

Senator Kelly: Thank you, Senator Ernst. Now I welcome any opening remarks from our witnesses, beginning with Secretary Shyu.

STATEMENT OF THE HON. HEIDI SHYU, UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

Ms. Shyu: Chairman Kelly, Ranking Member Ernst, and Senators of the subcommittee, thank you for inviting us to represent the Department of Defense at this hearing on accelerating innovation for the warfighter. I am honored and proud to be the Under Secretary of Defense for Research and Engineering and the Department's Chief Technology Officer.

I look forward to this testimony as this is the first time I have been to the Senate since my confirmation, and I thank you for your support during that process. It is an honor to be back working at the Department of Defense.

On behalf of the Secretary, the Under Secretary of Defense R&E sets the technology and innovation strategy for the Department. The position oversees the Defense Advanced Research Project Agency, DARPA, the Missile Defense Agency, the Space Development Agency, the Test Resource Management Center, and the Defense Innovation Unit, DIU. I am pleased to testify with the directors of DARPA and DIU by my side today.

As the Under Secretary, my responsibility is to ensure an enduring technological advantage for the United States military. We will accomplish this goal by building and implementing the Department's technology strategy. As

directed by Congress and in alignment with the National Defense Strategy, the forthcoming National Defense Science and Technology Strategy will provide guidance to the Department on near-term challenges and ensure that our nation remains the global leader in technology far into the future. The challenges are vast, from rising nations to rising sea levels.

In my written testimony I describe the specific critical technology areas and how the Department is working faster and more collaboratively across prototyping and experimentation. Today I want to briefly highlight two areas where the Department must work closely with Congress to ensure an enduring advantage, first, building a strong foundation for science, and secondly, updating how the Department does business to better reflect today's world.

Every strong structure needs to stand on a solid foundation. To ensure this country retains our edge and fuels future technologies as capabilities, we must make a commitment to science and technology, particularly in the basic research. We must attract the best people. We must supply the necessary infrastructure for R&D. We must rapidly prototype and perform joint experimentation and collaborate across the technology ecosystem.

If we expect the Department to attract the world's best and brightest to produce state-of-the-art technologies, we

must modernize our laboratory and test ranges. The future of the Department depends on talented people, and we are committed to developing this talent. The Department has invested in a variety of workforce educational and research programs, ranging from K-12 robotic systems to STEM scholarship and social science research. As the strategic competition increases so must our attention to S&T.

I know many of you on this subcommittee feel the same way, and I look forward to working with you to strengthen our S&T, its supporting infrastructure, and the workforce.

In my remaining time I want to discuss how the Department must innovate in pace with the technological change and keeping with the demands of national defense strategy. Historically, the Department has been a leader in R&D. We still are, but the growth of private sector R&D has exploded over the last 50 years.

As seen in Ukraine, novel commercial technologies paired with conventional weapons, can change the nature of conflict. The Department's processes, ranging from programming to experimentation to collaboration should be updated to reflect the dynamic landscape of today and anticipate the needs of tomorrow. Our nation's private sector is our competitive advantage, and we must focus on improving how the government and private sector work together.

I am committed to working with you to ensure the Department can move as quickly as possible as it engages with the private sector and the whole innovation ecosystem to rapidly transition technology through fieldable capability.

Thank you for having us here today. We will all look forward to your questions.

[The prepared statement of Ms. Shyu follows:]

Senator Kelly: Thank you, Secretary Shyu. Dr. Tompkins?

STATEMENT OF DR. STEFANIE TOMPKINS, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Ms. Tompkins: Thank you, Chairman Kelly and members of the subcommittee. I echo Secretary Shyu's thanks for the opportunity to testify today, and I thank you very much for the committee's strong support of DARPA over many years.

It is great to be here with my colleagues. As you know, our organizations work together constantly to advance national security, and we are part of a really extraordinary science and technology ecosystem that extends far beyond just the Department of Defense.

Within that ecosystem, DARPA has a unique role. Our mission is to create technological surprise. We do this by making pivotal investments in technologies that we believe have the potential to completely transform national security. We have been delivering on the mission for over 60 years. We brought to the DoD, and to the nation, game-changers like precision-guided munitions, and Javelin missile, by the way, stealth aircraft, UAVs, the internet, miniaturized GPS receivers, and as you mentioned, Mr. Chairman, most recently, MRNA vaccines.

We are extraordinarily lucky in that we are able to work extremely quickly. We do not just tolerate but we embrace risk, and we constantly seek what we call DARPA-scale impact. One of our program managers once joked, "If

you didn't invent the internet, you only get a B." Now I should add that that program manager was working on MRNA vaccines at the time, so I think in retrospect he probably earned an A.

But that is the past, and so you should ask what we are working on today. Imagine a world where a soldier's basic needs, things like food, water, fuel, or medicine are made right on the spot from waste material, say from plastic, or even just from the air, completely independent of vulnerable supply chains. Imagine a world where both our electronics and our software are completely secure by design and thus unhackable. Imagine a world in which all of our military systems, which today have a lot of trouble interoperating, can seamlessly communicate and work together to provide inherently joint capabilities from military commanders. Those are some of the futures that DARPA seeks to make real.

We are also working to transition technology faster than ever. It is a very dynamic world, and as we have all discussed and observed, quite volatile. So we are creating new ways to do testing, faster than real time and with the assistance of AI, to explore thousands of use cases and missions.

We are transitioning technology not just through programs of record but through new commercialization initiatives, through new partnerships with the COCOMs, or

with organizations such as DIU or other parts of the R&E enterprise, or through rapid DevOp cycles in order to get software directly into the hands of users.

And in addition to the futuristic versions that I shared a minute ago, we also work closely with the military services to de-risk nearer-term technology. For example, as has been very recently reported in the press, DARPA, in partnership with the U.S. Air Force, recently completed a second successful flight test of our Hypersonic-Air breathing Concept, known as HAWC. This test set the U.S. record for scramjet endurance, and we believe it is an inflection point on a path to reclaiming U.S. leadership in hypersonic weapons.

In my written testimony you will see many more examples of DARPA portfolios and programs. I ask you please to remember that some of those will fail. If they do not, it means we are not trying hard enough and we are not taking enough risk. But some of those will succeed, and in doing so may fundamentally transform our nation and strengthen our national security in ways that we can only begin to imagine.

I thank you again for your support to DARPA over many, many years, and I look forward to working with you and others in Congress to ensure the security and resilience of our great nation, and Secretary, as you mentioned, I looking forward to answering your questions.

[The prepared statement of Ms. Tompkins follows:]

Senator Kelly: Thank you, Dr. Tompkins. Mr. Brown.

STATEMENT OF MICHAEL BROWN, DIRECTOR, DEFENSE INNOVATION UNIT

Mr. Brown: Chairman Kelly and members of this subcommittee, thank you for inviting my colleagues and me to speak on behalf of innovation at the Department. Today I would like to speak to one of the most urgent challenges to bolster our nation's defense -- speeding the adoption of commercial technology to our warfighters, which Secretary Shyu talked to.

In an era where the Chinese government has stolen plans for our weapons and studied our way of fighting, advances in commercial technology offer a way to achieve surprise rapidly. Under Secretary Shyu recently released a list of 14 critical technologies for national security. Eleven of the 14, 80 percent, are commercial. Not having an effective approach to adopting commercial technology is a glaring weakness in modernizing DoD.

Since 2015, DIU has transitioned 43 commercial solutions to service partners, 8 in the first half of this fiscal year alone. As one example, DIU successfully prototyped synthetic aperture radar satellites which can see through clouds and at night, and provided the world imagery of Russian forces in and around Ukraine. This enabled us to predict the invasion and prove undeniably what was happening without revealing classified sources. Today, the NRO is

providing this capability as part of security assistance to Ukraine.

These 43 transitions encourage more DoD mission partners to initiate more modernization projects. In the last fiscal year, DIU started a record 37 projects, double our historical average. Additionally, last year companies competing for DIU contracts increased 40 percent and represented 47 states, the District of Columbia, and 17 countries. In total, DIU has introduced 100 new vendors to DoD.

DIU's successes, however, are less than 1 percent of DoD's procurement budget. In part, this is because commercial technologies are different than defense technologies. First, they are supplied in massive unit volumes, sometimes in the millions, often led by consumers. Second, commercial technologies evolve at faster speeds than defense technologies, refreshed in 12- to 18-month cycles. Third, commercial technologies are not service specific, so we often do not know where to buy them. Lastly, we do not control the spread of commercial technologies. Dangerously, they are available through our adversaries as soon as they are available to us. No wonder, then, that we need a different way to assess and buy these commercial technologies.

So DoD must become what I call a faster follower to

gain rapid access to technologies and maintain at least technological parity with adversaries. For this, DoD requires a rethink of the three elements of how we bring capabilities to the Department. Number one, requirements, where commercial technology negates the need for detailed specifications. Number two, acquisition, where DIU's use of non-consortium OTAs in a largely commercial process we invented called Commercial Solutions Opening can be more broadly applied throughout the Department. And number three, budgeting, where new commercial solutions enter the market faster than our 2- to 3-year budget cycle.

Despite acquisition reform there has been almost no reform of the requirements or budgeting processes. Here are my recommendations.

First, establish dedicated organizations or homes for each of the commercial technologies, which can focus our expertise and which are not and do not need to be service-specific. Paired with a stable budget, this becomes a capability of record, not a program of record, where the need for the capability is ongoing. DoD can then assess vendors on a more continuous basis and refresh with a frequency that matches commercial cycles. In doing so, DoD can furnish these capabilities to warfighters in a year rather than in a decade.

Second, eliminate the requirements process for

commercial technologies, replacing it with a rapid validation of needs. We do not need to develop detailed requirements for products the commercial market already builds. In fact, detailed requirements limit the creative problem-solving of companies and limit the number of companies competing.

Third, apply the best practices of commercial procurement that we have learned, more widely apply consortia OTAs and CSOs, thereby maximizing competition while minimizing opportunity costs for vendors to participate. Importantly, if a vendor successfully prototypes a solution there is no required recompete and DoD can scale the solution immediately, eliminating one of the valleys of death caused by waiting for the budget cycle to catch up.

Finally, source commercial technologies from allies, and sell proven solutions to allied militaries, which present excellent export opportunities for U.S. companies. The easiest form of collaboration with allies is with commercial technology, which is unclassified and enables interoperability.

At DoD we continue in a business-as-usual fashion at our peril. We must reform requirements and budgeting while more broadly adopting OTAs to better assess and fuel commercial technologies. I ask Congress to allow for more

flexibility in the appropriations process beyond programs to budget for capabilities like small drones or satellite imagery, which we know we will need for decades to come. Maintaining our military's technological superiority requires us not only to develop defense technologies like hypersonics but of equal importance, fast follow the innovations of our vibrant commercial technology sector. There is a reason the U.S. innovation ecosystem is the envy of the world, and we need to make this the envy of the military.

Senators, thank you very much for your time today, and with my colleagues I look forward to answering your questions.

[The prepared statement of Mr. Brown follows:]

Senator Kelly: Thank you, Mr. Brown, and thank you all for your testimony. I will begin our first 5-minute round of questions, and then we will go in, I think, the order of folks as they arrived. And this question will be for all three of you.

Promoting innovation is a critical task for DoD as we look to outpace countries like China. It is a full contact sport that requires attention and coordination across many offices and activities. It also requires considering not just the technical aspects of innovation like research and development but also a holistic focus on non-technical aspects, like workforce shaping, concept development, and wargaming, that are needed to accept and absorb these technological innovations into the military.

So starting with Secretary Shyu, what work has R&E been doing to invest in key emerging technology areas to address our warfighting needs, and how are those investments being used to shore up risks within the defense industrial base for emerging technology areas like hypersonics and microelectronics?

Ms. Shyu: So a couple of things I would like to talk about. Actually, several things I would like to talk about, and I will talk fast, is you have heard that we have initiated the RDER concept, the Rapid Defense Experimentation Reserve. This is a campaign of joint

experimentation focused on solving the critical joint warfighting capability gaps. This is where we are going out to the services as well as to industry and the smaller companies to understand what prototypes do they have, that they have already developed that they can bring to us, and we can test in a contested, joint environment, to understand the utility of the prototype that they have developed.

And what we want to do is leverage the opportunity to do these sprints, twice per year, to close the capability gaps, and have the Joint Staff as well as the COCOMs and the services to evaluate how well did these prototypes close the capability gaps and prove their utility. We want to be able to rapidly go into rapid fielding, or mid-tier acquisition, or leave behind the capabilities, or doing a design modification to enable different capabilities to be added to it, and come to the next sprint to demonstrate it out.

This could accelerate the capability from innovators all the way to fielding. This is exactly what we are doing, and fiscal year 2023 is our very first sprint.

Senator Kelly: Thank you. Dr. Tompkins?

Ms. Tompkins: I will add on a little bit to this, in the sense that what I will talk about I think dovetails into the RDER program that Secretary Shyu just mentioned. We are developing new ways of doing testing and evaluation, which is not just for testing and evaluating new technologies but

also the concepts themselves. And so when we have the ability to use modeling and simulation in order to go through thousands of potential cases and different combinations of decisions and different combinations of circumstances, but at the same time building in new technological capabilities, it really allows us to figure out how to prioritize our investments, and then we take that, combine it with person-in-the-loop actual evaluation as these technologies are being developed, and live testing, in real time, feeding back and forth with the modeling and simulation. I think we dramatically accelerate our ability to look at specific needs, where the technology gaps might be, and what needs to be developed to fill those.

That overall capability is something that will be transitioned to the Test Resource Management Center under Ms. Shyu's organization, and we anticipate working with RDER funds, for example, in order to test out very specific subsets of these concepts.

Senator Kelly: Sometimes some testing is really, really hard to do, and you can do, through computational fluid dynamics and other methods, get at least the starting points you need of a test program. So it is good to see that you are doubling down on those efforts.

I am going to come back to Mr. Brown here on this question here in the second round, but for now let me defer

to my colleague, Senator Fischer, for 5 minutes of questions.

Senator Fischer: Thank you, Mr. Chairman, and welcome to all of you today. It is good to see you.

Secretary Shyu, you were serving as the Assistant Secretary of the Army for Acquisition, Logistics, and Technology during the Third Offset Strategy, and many believe that the Third Offset was unable to really satisfy Congress' questions about some very basic elements that the strategy had, and also that it delivered few tangible innovations from it.

Could you tell us, what are some of the relevant lessons you learned from that process, and are there challenges you think it revealed about attempting any kind of large-scale change within the Department?

Ms. Shyu: Senator Fischer, the Third Offset really highlighted, in a highly contested environment, what are the things we need to do differently. I can tell you, as an offshoot of that, was born ABII, Assault Breaker II. This is an activity that the Defense Science Board initiated, and DARPA has taken over whole-heartedly. What we need to do is come brief you in a classified setting to let you know of all the things we are doing under that particular activity. I think you would be incredibly impressed. We will be more than happy to follow up and come brief you.

Senator Fischer: Okay. I know that RAND published a study on that last year, I think, and was saying that the Department was alerted to some of the erosion that we were seeing in U.S. technologies with regard to Russia and China. Is that what you are referring to?

Ms. Shyu: Let's see. I am trying to talk unclassified.

Senator Fischer: Okay. Well, we will wait then. We will wait then.

Ms. Shyu: Yes. It basically highlights, in a highly contested environment, how can we conduct the fight. We will be more than happy to brief you at a highly classified level.

Senator Fischer: Okay. Thank you.

Mr. Brown, your organization, the DIU, was one of the few tangible outcomes that saw in Congress from the Third Offset, and I realize that this does predate your time there with the organization. But do you have a view on this?

Mr. Brown: To be more specific, a view on --

Senator Fischer: The Third Strategy and results that you have possibly seen.

Mr. Brown: Well I would just say that as Chairman Kelly remarked, we are in a state where we are losing our technological edge, so I think what we are doing to reinvest everything from basic research, as well as we can do to

stimulate that in the private sector, is exactly the strategy that we need to have to regain that. We may never gain the same level of offset or advantage that our adversaries do not have, but we have to make sure we are investing at the level where at least technological parity in many areas and exceeding what China can do in some.

So while Dr. Tompkins is inventing the future --

Senator Fischer: No, that is good. Thank you.

Mr. Brown: -- we need to rely on the innovation in the commercial sector to bring that capability forward more quickly.

Senator Fischer: Okay. That is good.

Secretary Shyu, Secretary Austin, he has talked about prioritizing hypersonics, and if watch any discussions on this committee, on the Senate Armed Services Committee, or in the Senate itself, you will know that this is an area of interest. I know that you have stressed the importance of making them affordable, and Secretary Kendall has also emphasized the tradeoff between the cost and the capability that is provided on them.

Is there a consensus view within the Department about what role hypersonic weapons will play and what technologies we should be pursuing?

Ms. Shyu: Absolutely. Thank you for bringing this up. This is certainly one of the critical technologies we are

looking at.

I just want to highlight that the Army is going to be fielding hypersonic weapons to integrate next year. The Army and the Navy together develop a common glide body. Navy will be fielding theirs on the Zumwalt, the DDG, fiscal year 2025. Air Force has developed a hypersonics weapon that is flying on B-52 -- they are still in testing -- but they are initiating a program that will go on fighter aircraft. In addition, we are working with the Australians in developing a hypersonic cruise missile. So there are many activities ongoing, in addition to what DARPA is doing, pushing the envelope on the next generation.

And I want to add one more thing. I think it is important to understand that we also have a university consortium of 80 universities working with small companies and large primes in developing the next-generation technology that we will be able to insert into our hypersonics programs. So we are progressing very rapidly.

And the other thing that I think is very important to understand, we are really not in a horse race. You cannot think about this as a horse race. If you have 10, should I have 11? That is really not the right way of looking at this perspective, because we are developing multiple different strategies. And once again I will be more than happy to come and brief you at a higher classification

level.

Senator Fischer: Thank you very much. Thank you, Mr. Chairman.

Senator Kelly: Senator Tuberville.

Senator Tuberville: Thank you, Mr. Chairman. Thanks for being here today in this testimony. Talking about that Dr. Tompkins, I am from Auburn, Alabama. We have a pretty good university there, and we are proud of it.

You know, we do a lot of research on hypersonics and assured position navigation timing, cybersecurity. What stands apart for us is that our Auburn labs are 100 percent U.S. citizens, and that engineering student can conduct classified research for all national security. There does not have to be any hands tied. So we are proud of that.

Do you feel like we are investing enough in academic research at our universities to help with hypersonics and all these other basic researches that we are doing? Are we investing enough in that or are we depending too much on our technology industry?

Ms. Tompkins: The broader question of investment in the ecosystem is something I definitely should defer to Secretary Shyu on. But we work very, very strongly within this entire ecosystem, and we do not look just, for example, at companies or at government labs or at universities. We look at how they are trading off with each other.

I think there are certainly areas in which we could invest not necessarily more in quantity but think more creative about how we can connect students, faculty members and others into these more restricted research ecosystems without penalizing them in terms of their ability to, say, get their degrees quickly or their ability to actually publish on research. There is a lot of opportunity for creativity in that space.

From my perspective, it is less about sort of the volume of the dollars as to how effective we are able to deploy them, and I think there are some definite opportunities to be more creative.

Senator Tuberville: Thank you.

Mr. Brown, I am glad to hear you talk about the commercial technology industry. I do not think we could survive. That is what we have over everybody else in the world. In Alabama, we have over 600 defense contractors. Most of them are on their own. A lot of them are small. I am very concerned about them being able to handle cybersecurity with the little money that they have, compared to the big boys, so to speak. They need to be protected as well as the others.

You can go from working on the hypersonic missile, you can go next door to somebody who working on a new tank, and next door to somebody working on the new lander for NASA.

You can do it all. But a lot of them are small industries. How do we protect those small industries, because a lot of them cannot turn their computers on without China trying to steal everything that they have got? It is a tough road for some of them.

Mr. Brown: Senator, I could not agree more. The industry I came from before being at Defense was cybersecurity, and it is an escalating problem for us, the soft underbelly, or the small businesses that cannot afford to invest there. I think we need some help with some basic tools and hygiene, and I think CISA, at the Department of Homeland Security, has been moving forward at a great pace here.

What I think we have to do is make sure that we can provide some help with the basics for the small businesses, which is often hygiene, about making sure you have patched your software, et cetera. That kind of help, which is available both from an FBI as well as DHS, is what we need to make sure we are doing enough to educate those companies and making sure they are implemented. That is how we help the small businesses, I believe.

Senator Tuberville: Yeah. You know, I do not know how many hundreds of thousands, we are short on cybersecurity. And I will invite all three of you to come to Huntsville. They just started, 2 years ago, a program where they will

take you in the 9th grade, full tuition, come live there, go to school, and by the time you are a 12th-grader, you are far and beyond what is going on in terms of cyber in our universities. And I think that is the thing of the future, bypassing universities and start training these kids in high school. It is an amazing thing that is going on.

Just real quick, the ESOPS, the businesses that are owned by the employees, can you give a rundown, Mr. Brown, of what you know about those and how good they are? And a lot of them, are they making it? Are they able to survive with employee-owned companies?

Mr. Brown: So I do not have a strong point of view about this, because I have not --

Senator Tuberville: Have you dealt with them before?

Mr. Brown: I mean, many companies have implemented that, and I think the idea of having employees have skin in the game through incentive is a good one. It has been used in Silicon Valley, of course, maybe not with an ESOP program but with stock options, for years. So I think that is a good incentive system.

Senator Tuberville: Yeah. I think it is an edge for us in defense, especially.

Thank you very much. Thank you, Mr. Chairman.

Senator Kelly: Senator Scott will be recognized for 5 minutes.

Senator Scott: Thank you, Chairman. Thanks for being here. How many people work in each of your units? How many people work in your area, Secretary Shyu? Do you know?

Ms. Shyu: I do not have that exact number but I can certainly get back to you.

Senator Scott: Do you know, Dr. Tompkins?

Ms. Tompkins: Within DARPA we have just under about 200 government employees, and we certainly have contractor support.

Senator Scott: Mr. Brown?

Mr. Brown: We are 200 in total, which includes 20 active-duty military, about 24 civilians, and the rest are contractors and reservists.

Senator Scott: Okay. How many projects do each of your units work on each year?

Ms. Tompkins: We start about 50 new programs a year, but we also end 50. We end about that many. So it means that we have about 250, approximately, active programs.

Mr. Brown: We started 37 last year and we have 75 underway.

Senator Scott: Okay. Secretary Shyu?

Ms. Shyu: Yeah. I cannot tell you because we cover across the entire DoD. I know just within AI alone there are more than 700 programs.

Senator Scott: Okay. All right. If you will get back

to me and let me know how many people work there.

Mr. Brown, who, that you deal with in the Defense Innovation Unit, is the most friendly to your ideas?

Mr. Brown: In the Department of Defense?

Senator Scott: Yeah.

Mr. Brown: We are finding that there is tremendous receptivity, demand for what we do among the services. Everyone wants to modernize, but I would say the constraints, which are dictated by our historical way of developing capability again start with requirements, a budgeting process that takes 2 or 3 years is the biggest inhibitor, which is why you heard my opening comments, not about technology but what we need to do to change so we can adapt and adopt commercial technology so much more quickly. And we need Congress' help with that, and we need to change some things in the Department, so we can go faster. Speed is a very important competitive dimension in the race with China.

Senator Scott: In my business life we always had a sort of business plan. So what is you all's business plan for each of your units? Like you say, success is tied to what? What would be success be, starting with you? What is success? What do you feel like your purpose is?

Ms. Shyu: Success is going to turn a technology into a military capability and give us an advantage. That is the

success we are looking for. But starting from basic research all the way to the end, it takes time to actually develop that, laser being a perfect example. It has taken decades, but now we are actually demonstrating we can shoot down UASs -- unmanned airborne vehicles -- and we can shoot down cruise missiles. So we are showing extraordinary capabilities, and now we are in the process of fielding those capabilities.

Senator Scott: Dr. Tompkins?

Ms. Tompkins: Our mission is a really unusual one but it is very, very much focused on preventing and creating technological surprise. So what we try to do is we place many, many different bets on technology -- high risk, high payoff. And for us, success is going to be measured at different points in time. So at any moment in time we do look at our entire portfolio of current and recent programs, and we look for transition, through many different paths, into real-world use. But we are also always looking back, and what we are often finding is that something that we invested in one to two decades ago has been truly transformative and completely changed everything about how the military operates. Those are sort of the big bets that we are looking to make, and we are very proud of and we tend to think of as our big successes.

Mr. Brown: So my job is a little easier than my

colleagues in this. We have a crystal-clear focus, and it really builds on what Secretary Shyu said -- getting capability in warfighters' hands. Because it is commercial technology, we often avoid all the classification issues that have come up here already, and we try and get that 1 year if it is software, 2 years if it is hardware.

So we measure, from a project start, when did we get that in warfighters' hands, which means successfully prototyped, it worked technically, production contract in place, and most importantly, budget lined up so it can start to scale. All three have to be met for a transition. We have done 43 transitions since we have been around, and that is a 45 percent transition rate.

Senator Scott: So Communist China has clearly decided to be an adversary. When you think about your jobs, do you say, "I am doing this because it is going to put our military in a better position, and this country in a better position to defend?" and how do you apply that?

Ms. Shyu: One of the things that we do do is we do a net assessment. Namely, we take a look at what is our capability. We also take a look at what is the red capability. That informs us where we need to go. It informs us what we need to invest in to get ahead of the threat. So that is done in step one. So investment in a lot of our technology priority area is informed by where we

need to head, and I think, if I could come in and chat with you at a classified level I can talk about how these pieces are literally stitched together to give us an asymmetric advantage.

Senator Scott: Thank you, Chair.

Senator Kelly: Thank you, Senator Scott.

We will now go into our second round of questions. I want to get back to Mr. Brown for a second. In the beginning of my first question we were talking a little bit about non-technical aspects, like workforce shaping, concept development, and wargaming. And I asked Secretary Shyu and Dr. Tompkins to comment on investing in key emerging technology areas to address their warfighting needs. I think for DIU it is a little bit different with the commercial technology.

But let me ask you this. How often do you see companies out there and you identify things -- like what percentage would you say are actually emerging technologies, and then do you ever get to the point where you realize that some company is so far out in front of maybe our adversaries that have to consider, do we need to classify their intellectual property? Is that ever a consideration as DIU identifies commercial activity?

Mr. Brown: Senator Kelly, the model for DIU is not to set our own priorities. So, you know, the time frame that

Dr. Tompkins has is considerably longer. We are about what can we field quickly.

So our priorities come from mission partners, the services, another part of DoD that says, "We have got an urgent problem," and then we match that with what is available today. So that ends up being different technologies to work on. It is a portfolio -- one in AI, one in energy, cyber.

Senator Kelly: But as you are doing that you must come across things unexpectedly.

Mr. Brown: Yeah. Most of the times I would say we do not see things that need to be classified, and, in fact, in my own personal opinion we overclassify things so it makes it more difficult to work on. I have not encountered one of those in my tenure that I feel like we have got to rush to make this classified.

I think the more innovative it is, it pushes me the opposite way, to feel that we need to go faster, because our adversaries have access to commercial technology as well. So we need to make sure we are including that in warfighting concepts and funding that so that we can bring that to our warfighters.

I think the constraints we talked about earlier that inhibit our ability to get the commercial technology more quickly adopted just put our warfighters behind us, behind

in terms of commercial technology and then certainly versus adversaries.

Senator Kelly: Thank you. I want to follow up on Senator Fischer's question about hypersonics with Secretary Shyu. She was talking a little about cost versus capability, she referenced Secretary Kendall's comments about hypersonics, and am a strong believer that we need to catch up in our hypersonic missile technology. And Secretary Shyu, you talked about putting all the parts, I think, together. But really what we are looking at is increasing our Pk, probability of kill, on a target.

So as you look at hypersonics do you feel that this is the future to increase the probability of destroying a target, or do you sometimes consider existing technology, improving that, that would give us a higher Pk?

Ms. Shyu: That is a great discussion in which we actually have done analysis in. I think we should come back and brief you -- once again, it is unfortunate -- at the classified level. But we can show you the analysis that has been done at a campaign level that looks at conventional weapons as well as hypersonic weapons, to attack against different types of targets. So we have done that analysis. We will be more than happy to come and brief you on that. If you can give us an hour of your time, we will go down to SCF and have a great dialogue.

Senator Kelly: I will take it. And Senator Ernst, if you are ready.

Senator Ernst: Yes. Thank you so much. And for everyone, please, if you identify a technology that is viable for the warfighter, and if all of the departments' existing authorities are employed, how quickly could that innovation be fielded for our warfighters? I would just love to hear from all of you. And Secretary Shyu?

Ms. Shyu: Senator Ernst, I think it depends on the particular type of technology, because there are some technologies, potentially, if it is commercial we can leverage it very quickly. If it is something we need to develop, due to the type of threat that is demanding us to do that, it may take a little longer to develop. But it really depends on the type of technology.

Ms. Tompkins: I have to agree. I can think of examples where we have seen things, for example, with traumatic brain injuries with warfighters, where we were able to very quickly adapt commercial technology. It was not quite what we needed, and so within a year of adaptation we were able to then work with the military to get those deployed out for soldiers.

On the other hand, when it is some type of a munition, when everybody is all in -- so as I think we demonstrated in partnership with the Navy when we were working on the LRASM

missile -- you can do in single-digit numbers of years, but the entire Department has to be working together in order to remove any kinds of normal process-based obstacles.

Senator Ernst: Okay. Thank you.

Mr. Brown: If the technology is commercial and we do not have to go through the development part of that, so our goal, beyond the goal of getting as many things across the line to the warfighter as possible is how fast did we do it. With software, the fastest we have done it, from a concept to actually implemented by warfighters, it was a piece of software for NORTHCOM/NORAD, in under a year. But the gating time on that is the testing time that we want to take, because there are big consequences of making mistakes. So we do not want to compromise on that. So 1 year for software, 2 years for hardware is the target we are currently trying to beat with commercial technology.

To make sure the business process is friendly for commercial companies we try and get them on contract in 90 days. So that is lightning speed for DoD, but it is commercial terms.

Senator Ernst: Right. No, and thank you. I have spoken with a number of leaders in Silicon Valley who have made it clear that they could field technologies and weapons systems ready for experimentation with DIU in the Nevada Test Bed in the next 90 days. So I do believe the

Department of Defense must move toward the pace of private industry, when at all possible, and that any steps we can in that direction are very, very important. However we can move that direction I think we should. I know there is going to be some differences with the different types of systems. But we have to be able to field systems as rapidly as possible, and I am so concerned that sometimes we get so wrapped up in red tape and the budgetary cycles, we need to think about innovation and how we field quickly.

So that is my little rant for this period.

And just in some time that I have remaining, Secretary Shyu, in your assessment, what is Silicon Valley and the defense small business enterprises' capacity to field prototypes for weapons and logistics support equipment if tasked today with, for example, developing missile or ISR prototype, something like that?

Ms. Shyu: I think there is tremendous capability into commercial. I will give you an example in the commercial world. Elroy Aircraft. They are strictly a commercial company but they have developed a cargo UAV that can fly 300 miles and carry 300 pounds of payload. So for logistics, this would be fantastic. And if the government literally can just buy something commercial off the shelf, we do not have to pay for the development. It is paid commercially.

So absolutely, this is exactly where we are teaming up

with DIU, to look for these types of capabilities that literally we can just buy rather than trying to reinvent.

Senator Ernst: Right. And I think, Dr. Tompkins, that was maybe what you were referring to as well, to be able to procure something and make minor modifications, where necessary, right? Yes.

Ms. Tompkins: Yes.

Senator Ernst: Thank you. I yield back. Thank you.

Senator Kelly: Thank you, Senator Ernst. Senator Kaine.

Senator Kaine: Thank you, Chair and Ranking. Important subcommittee. I want to say hi to Mike Brown, who is an old friend, and I would say if you guys ever want to do a really good field trip, when you are in Silicon Valley go by DIU, because you will really see great things. And I had a wonderful visit a few years ago and remember it well.

Secretary Shyu, I want to ask you this question. Now you have been in your position for almost a year. Do you think that the split of AT&L into two divisions had a positive impact on fostering innovation?

Ms. Shyu: There are pros and cons.

Senator Kaine: I am more on the con side myself, I am going to say, but I am not doing it every day. So those who do it every day may have certainly a better-informed view than I do.

Ms. Shyu: I would say on the positive side -- I will give you both perspectives. On the positive side, I can spend more of my time on the research and development on the S&T side. On the con side, namely you have got two people that are going to be sitting in multiple meetings now, and you have to literally link arm-in-arm. There are all the meetings within the Pentagon, I have to be linking the arm with A&S. Otherwise, I am going to create an island of just S&T that never transitions, which is not what I want to do.

Senator Kaine: Can you give me an example? So how do we mitigate the downside of that con? So you do it by linking arms. Can you give me an example of a project or something you are working where you think it is working well, where you have got arms linked and something is being delivered or done that you feel good about?

Ms. Shyu: I am looking forward to Dr. Bill LaPlante's final confirmation so we can actually link arms to work on a number of these projects together. I can guarantee you, I cannot wait until he is on board. There is a whole slew of stuff we want to do together.

Senator Kaine: I guess that would another con of splitting them into two is if you get one confirmed and the other is not, then you have the one function that is ready to go and then you are kind of waiting around to link arms with your colleague on the other function.

Sometimes in this committee we do this, but we probably do it even more when we are thinking about budgets and appropriations. We talk about the defense budget and the non-defense budget. And yet there is so much in the "non-defense" budget, whether it is the nuclear programs in the DOE or whether it is NSD programs, where I feel like the distinction between defense and non-defense budget is somewhat artificial. And particularly when you get into research and science and so many different agencies where to do your work really, really well you have to have arms linked not only with your colleagues in the Pentagon but with the agencies outside the Pentagon.

Talk a little bit, a year in, how good you feel about the stakeholders being at the table together rather than siloed, as we are tackling these emerging threats and issues.

Ms. Shyu: I would say one of the things that we are working very closely in the microelectronics area is with the Department of Commerce, because we have to. I will tell you on a lot of the other things, and hypersonics is an example, we are working very closely with the Department of Energy, because the common glide body was developed by Sandia, and the technology is being transitioned to the services. So we do have close collaboration across the different agencies.

Senator Kaine: That is good, because in this defense versus non-defense budget, like Department of Energy, a citizen might think that is all like, you know, promoting American energy companies. No. Overwhelmingly that is taking care of the basic nuclear labs and other research and other assets that lead to the construction of the reactors in Lynchburg that get put on a train down to Newport News and then put into subs and carriers. So all these non-defense agencies, many of them have very direct ties.

Coast Guard is a non-defense agency in the sense that it comes up through DHS rather than DoD. Many of the law enforcement agencies that are working on drug interdiction in the Americas, they come up through DOJ, not through DoD. But we have to really, really, as you say, link arms if we are going to do a good job.

Those are all the questions that I have for now, but I really appreciate the chance to come and encourage fewer silos and more arm-linking.

Senator Kelly: Thank you, Senator Kaine. That is the end of Round 2. We will go to a third round of questions. I want to maybe start with Dr. Tompkins here, and to follow up on something that Senator Ernst mentioned in her opening remarks, and that is the valley of death for some of these technologies. A recent GAO report highlighted this.

You know, DoD has struggled to transition some early-

stage R&D into real acquisition programs, and if we are going to be competitive with China and Russia on some of these technologies we have got to do a better job of getting across that valley. And it is very frustrating for folks out there that want to work on emerging technologies and get them to DoD, things like artificial intelligence and space systems and all kinds of stuff.

Actually, the question is for anybody. Is this a problem that any of your organizations can actually quantify in any way? Do you have any statistics on it, or some data or anecdotes? Do you know how many of the technologies developed in your organizations, or in the case of Mr. Brown, commercial off-the-shelf just actually do not get to the warfighter?

Ms. Tompkins: Statistics, as you can imagine, are really hard to keep track of, because at any moment in time they might change on you. I think the last numbers I saw, where we tracked transition across, say, eight different avenues, we were tracking about, I think, 23 percent that simply did not go anywhere, in the sense that usually for us that means we failed because we were trying something really crazy and it did not work.

Senator Kelly: Sometimes that could be the case, it is just never going to get there.

Ms. Tompkins: Right. But for everything else things

are moving.

Now, of that, I do not know exactly what percentage directly reached the warfighter, because some of them might be in a program of record and it is not quite there yet, or it might be in another government lab, working through the final maturation stages.

But it is a topic we are very, very concerned about, and one of the reasons that we have spent so much more time focusing on commercial transition support to companies that start up, based on having develop DARPA-funded technologies.

Mr. Brown: I would like to start by building on what Dr. Tompkins said. She has a program, the Embedded Entrepreneurship Initiative, for successful companies that are coming out of DARPA programs. So she is trying to provide some support there, and we are trying to also pull there to make that a premier set of companies that we would look to at DIU.

We have, really, two different arms at DIU. One is an investment arm that Congress authorized in the McCain NDAA, National Security and Innovation Capital, to promote private investment in hardware, because private industry does a great job supporting software, a little bit less for deep tech, and that is a lot of what Dr. Tompkins does. So with that we have some money that we can provide for those vendors. That helps them get across one or two of the

valleys of death, maybe getting a company formed, maybe scaling up manufacturing. We are going to look to the successful DARPA companies as one of the sources there.

And then, of course, there is DIU itself, where we provide revenue for companies who are prototyping or testing with us, and we want to have them see production revenue. So we are looking at what is the ongoing, recurring revenue that stimulates more investment dollars to come in to fund these companies that are supporting national security.

From a percentage standpoint, I would say that 25 to 30 percent of the projects we work on have some problem getting the money in place -- the right color of money -- getting money in the right time frame. This is the link to the budgeting process. Because some of the new technologies come up, or emerging threats come up within a budget cycle, and then, as we know, it is very difficult to move money around. So that is a real problem and it frustrates, I would say, 25 to 30 percent of the efforts we work on, where we get a company that has successfully prototyped but cannot get to the warfighters' hand until the budget matches.

Senator Kelly: Frustrating.

Ms. Shyu: I would like to add onto that, if I may. We have talked about the multitude of different ways to do transition, from technology. One path is transitioning directly into a program of record. Another path is if you

are transitioning to commercial. Another path would be you have transition to a prime contractor who is going to design and develop something that ultimately the DoD will buy. And then there is also a transition path of software that went directly into the hands of the operator.

There is also another different way of transitioning. You can transition to Tier 2, Tier 3, Tier 4 contractor, who may design and develop components that go into a prime that transitions into the DoD. We have no contractual mechanism to track that, ergo, the difficulty in trying to figure out exactly which technology you have funded that transition directly.

The other piece, and I want to give you an example, of technology takes time to transition. One of the DARPA programs that funded is a microwave packaging. It was like a $1.5 million microwave packaging contract. It spawned an idea, to figure out how do I design and develop a very innovative architecture for active electronically scanned array, which is critical for the next-generation radar system. It developed something, you know, a prototype, from internal research and development. From that particular effort, when I came on board, I looked at that technology, and I said, "That is really innovative." It was funded from DARPA, transitioning into array technology. I took that technology, matured it, developed it into a prototype, which

then ultimately helped Raytheon, at the time, to win the F-18E/F contract, which it fielded in production.

So you can see the long time frame. It took a decade to get there. But ultimately the sealing contract that was provided from DARPA spawned off an entire product line which resulted in billions of dollars in terms of profit.

So that is a transition. Nobody probably has a record. I knew it because I was involved in it.

Senator Kelly: Senator Ernst.

Senator Ernst: Oh, I appreciate it. Secretary, we talked yesterday a little bit about the RDER program, as well, which I am fascinated by. Does the program address the speed of fielding technologies for the warfighter? Do they talk about time frames and when they want it fielded? Because with the 32 technologies you selected for demonstration, can we expect any of those technologies to be delivered in 2 years or 5 years? Maybe if you could walk me through that, and how you determine how long until fielding.

Ms. Shyu: So the whole intent of RDER is trying to expedite the capability into the hands of the warfighter as quickly as possible, by closing the joint warfighting capability gaps. So we are looking at technology. We can literally demonstrate, in 2023, 2024, and be able to push it out by 2025. So we are trying to compress the timeline, and not wait a decade to push the technology out.

So one of the aspects of being able to accelerate capabilities into the hands of the warfighter is once we determine, the Joint Staff and the COCOMs determine there is operational utility of having this particular protype, I need to have a mechanism, a funding mechanism to rapidly transition this technology.

One of the things that we are going to ask for is, is there a pot of money that we can ask to transition to mature this so I can help the company who produced this, especially if it is a small company, to ramp up production. Because if they deliver a few prototypes to you, and you saw the powerful utility of this and you want to buy 1,000, they cannot flip a light switch and give you 1,000 tomorrow. But I would love to be able to help them bridge the valley of death and not wait 2 to 3 years for the POM process, the PPBE process, to catch up to buy this. This is exactly why small companies die on the vine.

Senator Ernst: Right. Thank you. I appreciate that very much.

And then, as well, we talked a little bit about special forces as well. We have some authorities that they utilize. Does the Special Operations Forces Support Agency have the capacity to deliver innovation to the warfighter quicker than what we see with general DoD timelines?

Ms. Shyu: Yes because they take mature technology.

They are not trying to take immature technology and develop very basic science. They look at what is the stuff that is out there today, that I can literally rapidly buy and field? So their timeline is very compressed. They are not trying to develop next-generation fighter aircraft. They are looking at, hey, what can I get very quickly? It is more like a DIU model.

Senator Ernst: And one thing that we might want to do, too, is just look at the existing authorities within their programs and see if some of those could be applied, DoD-wide.

Mr. Brown, did you have some thoughts, as well?

Mr. Brown: For me it is less about authorities. As I talked about in my opening statement, a lot of the authority already exists within DoD. We need to change some of our processes. But the authority that does not exist Secretary Shyu just talked about, the flexibility of moving money, to get it where it is needed most. I realize why those things existed historically, but now we are in a serious tech competition with China, and they are not waiting for our democratic time frames. I like our system better than theirs, but we have to figure out how to move more quickly.

Really, from a technology adoption point of view, whether it is commercial technology of inventing the next technology, it is about having the flexibility to move it

where it is needed most, in a simpler fashion than we have today. I think that is the most critical element we need to attack between Congress and the Department to improve our defense.

Senator Ernst: Yeah, thank you, and I think this is a big takeaway for me, and I think for a lot of folks as well, is that maybe not so much about the authorities but maybe more about flexibility, within parameters, of course, because we do have to be good stewards of those dollars. But, of course, greater flexibility so we can keep pace, I think is really great.

Thank you very much. I appreciate the information.

Senator Kelly: I would like to talk a little bit about microelectronics with the three of you here for the next 5 minutes. So secure access to microelectronics is a key enabler for so many of our technologies, not just for DoD but our defense industrial base. Our market share has shrunk in the production of these, from upwards of 40 percent to 12 percent today, and if we do not do something about it, it is going to get below 10, and that is not good. And also the most sophisticated foundries for semiconductor chips are now overseas, and this creates just a dangerous reliance on foreign sources.

That is why I have been part of leading this plan on a $52 billion investment that will support bringing this

manufacturing capability back to the United States, and it also will establish a dedicated microelectronics network within the Department that leverages the expertise in our universities and in industry. I would like to thank Secretary Shyu for working with me on this effort, and I know it will help us overcome current challenges in supply chain security and disruptions and the problems that this creates for the Department of Defense.

So I would like our witnesses to address how the paradigm for trusted microelectronics needs to change so we can better leverage commercial practices and economies of scale. Starting with Secretary Shyu, can you begin with what the Department is doing to break the outdated, dedicated, trusted foundry model that has been used since the early 2000s? You know, we do not do most of the technology work the same way that we did 20 years ago.

Ms. Shyu: First of all, I want to thank Congress for giving us the $52 billion. I think it is absolutely critical for this nation to onshore some of these critical capabilities. As we have seen during the pandemic, we cannot get our hands on the microelectronics. This is a tremendous impact on our industries across the board. So thank you very much.

I would say there are several things that we are doing. The Microelectronics Commons is going to be a critical

enabler. The funding that you have given us is going to fund $400 million per year for 5 years to build a lab-to-fab facility that is regional. That is going to help the university to create the next generation of materials and processing technology, to test it out in a regional fabrication facility, and have the ability to transition this technology to a production facility. It is going to help our entire infrastructure. So that is absolutely critical.

The other piece that we are funding within the Department of Defense is the Rapid Assured Microelectronics Prototype commercial, namely we are focused on providing a leading-edge capability, less than 3 nanometer wafer foundry. That is absolutely the state of the art.

We are building that capability in the U.S., and it is also going to strengthen our domestic industry and establish a sustainable ecosystem, because we are teaming up with fabulous companies as well, who can then design within this commercial foundry. What we are looking at is leveraging the state-of-the-art commercial processes and putting on top of a layer, potentially for classified chips that we may need. But literally, we are absolutely leveraging the commercial state-of-the-art foundry.

Senator Kelly: And I cannot stress how important it is that we finally get this across the finish line. You

mentioned we have given you the $52 billion, but we still have some key steps to go here. We are close. This is incredibly important to our national security. I do not think this can wait months. The United States Senate and the House should figure this out this week, and if not this week, as soon as possible. We run the risk of other countries in Europe making these investments. There have been proposals that they have made that substantially, I would say, are above the proposals we have made here. So time is of the essence on this, and we have to get this across the finish line.

I do have a couple more questions if everybody has a few more minutes. I want to talk quickly about some biotechnology and genetic data. You know, our ability to leverage biotechnology and decode genetic data has grown by orders of magnitude over the past three decades. That is why mine and my twin brother's DNA is available to everybody online, thanks to my former employer. I did allow it -- they did ask -- but it is there.

Much of that ability right now lies in the private sector, and that means competitors like Russia and China can buy these and try to exploit sensitive information.

So maybe we start with Dr. Tompkins here. How concerned are you that nefarious actors or near-peer competitors are using genetic data for bioweapons or

intelligence gathering?

Ms. Tompkins: That kind of question is one of many that tends to keep us up at night, as you can imagine. Obviously, I think the kinds of questions you are asking are also very much more part of the intel community. We use the information from them, however, to think about safety, security, and defense. And so what we tend to do is think about how one might very quickly chase down and erase some type of customized capability like that, as well for accelerating our own innovative capabilities, building security from scratch.

Our program Safe Genes is a good example of that, and we are obviously thinking about other defensive kinds of capabilities that are less easily discussed in this type of an environment.

Senator Kelly: And does our growing capability or ability to decode data offer us any mitigation strategies here against bioweapons or other intelligence exploitation? And this is for anybody, if anybody has a comment on this.

Ms. Tompkins: One thing I can talk about, it is still a way away from being ready for prime time, is specifically looking at the epigenome, so not just at the genetics but at sort of some of the proteins and things that are hanging off of the genetic information. And so we have several programs exploring how you can use information in the epigenome to

tell you whether somebody has been exposed to weapons of mass terror, weapons of mass destruction, precursors, things like that, and also exploring ways in which those things might be triggered to provide advanced protection.

Senator Kelly: Any other ways we can guard against potential threats in this area?

Mr. Brown: I will just add a different dimension to this from the sciences. This is one of the areas of emerging technology where the government can play a role by really assisting commercial companies with developing that technology. What I mean by that is being more forward-leaning in terms of contracts to develop the capability. A capability that exists in our commercial sector right now to sequence all pathogens, and that could be happening globally, but there is no program to make that happen.

We should be experimenting with these capabilities, funding some of these companies, so that the U.S. is on the forefront of this technology. I think that is going to be critical. Just like it was in the space race in the 1960s versus the Soviets, the government was very forward-leaning and developed lots of new technology. This is another area where I think we need to be forward-learning with the industrial base.

Senator Kelly: Thank you. The GAO and others have recently highlighted the challenges that DoD faces in

attracting and retaining a highly skilled technical workforce, and I imagine for all three of you, I mean, that is the whole ball game, you know, having the workforce to do this work. It does not matter if it is artificial intelligence or hypersonics or anything, for that matter.

And I have spent some time getting up to speed on what China is doing here and how we stack up. You know, there is more we need to do. So, Secretary Shyu, can you share, what is DoD doing to acquire and retain the talented people that we need to develop and deploy things like artificial intelligence and other emerging technologies?

Ms. Shyu: You bet. One of the things that the DoD has done is create the Smart Scholarship-for-Service Program. Last year we funded 416 scholars for their undergraduate and graduate degrees, if your field is in one of the 21 STEM areas that we are interested in. So these students, their scholarship is being paid for, and when they graduate they come and work in one of the 101 DoD laboratories.

We had great success stories so far, and I can tell you, out of the 416 SMART scholars, 50 percent of them were women, for which I am thrilled, 20 percent were from underrepresented minorities. I would say nearly half of these 416 SMART scholars are pursuing degrees in computer science, in software, in artificial intelligence, which is fabulous. And we are leveraging those SMART scholarships to

support them in growing our bench strength.

If you look at over the years, in the last 2 years, we have had 561 scholars that transitioned to their employment after they finished their degrees, and 70 percent of the SMART scholars, after they finish their service obligation, decided to stay with the DoD laboratories. That is a huge success story.

The other thing that we are doing, and beyond doing just the scholarship piece, we actually awarded 28 grants, at $82 million, to develop K-20 education. Again, Arizona State University, their curriculum for biotech is targeting minority and rural areas in Arizona. You want to increase your bench strength in the future.

The Department, through the National Defense Education Program, created 10 STEM summer camps. Literally, we took the opportunity to pull in 1,200 junior high school students and gave them a week-long STEM camp. They loved it. It was a highly successful education program that we have done, getting junior high school students interested in science and technology, and we want to grow that next year.

So we are doing a number of things that we can reach down, not just at the university level but lower levels as well, to encourage them to go into STEM.

Senator Kelly: Thank you. Dr. Tompkins or Mr. Brown, any comments? I think is a good question to end on too,

because it is so central to everything all of your organizations do.

Ms. Tompkins: I will offer an example of a type of initiative that DARPA specializes in, because it allows us to continue to sort of fund projects as part of what we do, and that would be the Joint University Microelectronics Program, called JUMP. That is nearing the end of a 5-year program lifecycle, and we have just announced the start of the call for proposals for JUMP 2.0.

But this is a university-government-industry consortium, and it is a model that universities themselves often use on a much smaller scale, where you might have a handful of companies together paying into the support of students and essentially developing the pipeline and research baseline for the workforce development.

And in our case, we are talking about 35 universities, over 1,300 students in the last 3 to 4 years, hundreds of researchers across I think about a dozen or two states, where that pipeline directly connects U.S. university students to U.S. both defense and commercial and sometimes allied nation companies in order to significantly build up that workforce.

And so we are not necessarily targeting government labs specifically but what we are very much doing is trying to target that overall U.S. program.

Senator Kelly: Thank you.

Mr. Brown: I am going to be the skunk at the party on this one. I think what the Department does on fellowships, internships, is fantastic, and we need more STEM talent for the competition with China. We should contrast that with how difficult we make it to bring incredibly qualified people into the Department.

One quick example. At DIU we are very lucky to attract a Rhodes Scholar, PhD in computer science from Stanford, who wanted to work for us at a government salary. Seven months, once we identified that candidate to get him in the door. I do not know what we do with that time, and this predates Secretary Shyu. It is the administrative process that we have at DoD that are -- I cannot even explain why it would take that long, for what, in the private sector, would have taken seven days, we would take seven months to do.

We cannot attract the best people if we do not recruit them and have a better process experience.

Senator Kelly: Could you find out, and go back and find out who we could talk to? Because if we can identify why it takes seven months, Senator Ernst and I, we could probably, with some help, figure out what we need to do to speed that up.

Mr. Brown: We would love to tackle that. I hope Secretary Shyu will share my enthusiasm for that.

Ms. Tompkins: If I may add, as I have mentioned several times how grateful we are at DARPA for the authorities and flexibilities that you have granted to our organizations, we can typically hire within a week, Mike. So the problems are solvable.

Senator Kelly: Okay. We need to go to that office.

Ms. Shyu: Sir, one more final thing. I think it important, because you bring them in at the salary level at which government pays. You are nowhere competitive against the commercial industry, who is going to pay them twice as much or three times as much. So that is a disadvantage that we have.

I can tell you one example. I spoke to an individual with a PhD from Stanford. He had two very high-paying offers. I literally spoke to him, "Look, for the sake of national defense you need to take a job and work with me, at a much lower-level salary that I can pay you. But just think of the perspective in the visibility that you will get working with me."

So, literally, I talk him out of an extremely high-paying job to come work for me, and he is coming on board.

Senator Kelly: Great.

Ms. Shyu: So yeah, it is the authority, the flexibility in pay that we do not have, which makes it very onerous in terms of trying to attract talent.

Senator Kelly: Well I want to thank all of our witnesses for participating in today's hearing but also for leading your agencies and serving our country. I believe, you know, very strongly in the work you are doing, and it is important that we continue to not get our eye off the ball here, to focus. I am convinced, long term, we will out-invent and out-innovate our competitors as long as we remain focused on it and you have the tools you need. So please, let us know what you need.

And I just look forward to continuing to work with you, and this hearing is adjourned. Thank you.

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