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Before the

Subcommittee on Emerging Threats and Capabilities

COMMITTEE ON
ARMED SERVICES

UNITED STATES SENATE

HEARING TO RECEIVE TESTIMONY ON ARTIFICIAL
INTELLIGENCE INITIATIVES WITHIN THE DEPARTMENT OF
DEFENSE

Tuesday, March 12, 2019

Washington, D.C.

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7   U.S. Senate

8   Subcommittee on Emerging

9   Threats and Capabilities

10   Committee on Armed Services

11   Washington, D.C.

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13   The subcommittee met, pursuant to notice, at 2:37 p.m.

14   in Room SR-232A, Russell Senate Office Building, Hon. Joni

15   Ernst, chairman of the subcommittee, presiding.

16   Members Present: Senators Ernst [presiding], Shaheen,

17   Heinrich, and Peters.

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1   OPENING STATEMENT OF HON. JONI ERNST, U.S. SENATOR

2   FROM IOWA

3   Senator Ernst: The Subcommittee on Emerging Threats

4   and Capabilities meets today to receive testimony on

5   Department of Defense artificial intelligence initiatives.

6   And I want to thank you, gentlemen, for being here

7   today.

8   I do apologize. We have a vote series going on right

9   now, so, at some point, Senator Peters and I may have to

10 switch on and off. We'll run down and vote accordingly.

11   But, I do want to thank you for being here. I'd love

12 to welcome you. We have a very distinguished panel joining

13 us today, ladies and gentlemen.

14   As highlighted in the NDS Commission Report, the U.S.

15 must stay ahead in several emerging technologies in order to

16 maintain or regain a warfighting advantage. These

17 technologies include hypersonics, directed energy,

18 artificial intelligence, 5G, and quantum computing. Russia

19 and China are aggressively developing these capabilities

20 and, in some cases, have already surpassed, or will soon

21 surpass, our technologies. Without action, the U.S. may

22 find itself at a technological disadvantage in future

23 conflicts.

24   Over the next few months, this subcommittee will focus

25 our efforts to ensure the Department is well positioned to

1   outpace our adversaries and maintain a strategic advantage

2   in these key technologies. Today, we will focus on one

3   technology of particular importance, which is artificial

4   intelligence.

5   The recently released Department of Defense Artificial

6   Intelligence Strategy makes clear AI is poised to transform

7   every industry and is expected to impact every corner of the

8   Department, spanning operations, training, sustainment,

9   force protection, recruiting, healthcare, and many others.

10   AI has the ability to provide powerful new capabilities to

11   our warfighters that we are only beginning to imagine. When

12   applied to back-office functions and operations within the

13   Department, AI will be critical in boosting efficiency and

14   increasing the effectiveness of limited resources. With

15   such broad potential impacts, it is important that the

16   Department move quickly to adopt these capabilities so that

17   we don't lose the technological edge.

18   Our adversaries understand the critical importance of

19   AI. Last year, the Chinese government released a strategy

20   detailing its plan to take the lead in AI by 2030. Less

21   than 2 months later, Vladimir Putin publicly announced

22   Russia's intent to pursue AI technologies, stating, "Whoever

23   becomes the leader in this field will rule the world." Both

24   of these countries are investing heavily in military

25   applications of AI to achieve a warfighting advantage.

1   The United States is also investing heavily in AI

       2   applications. Over the last year, the Department has

       3   initiated several important efforts to accelerate the

       4   adoption of AI, including the establishment of the Joint AI

       5   Center, or JAIC, the development of a DARPA AI Next

       6   Campaign, and the release of the DOD AI Strategy. These

       7   efforts demonstrate the extent of the AI transformation

       8   already underway within the Department of Defense and the

       9   priority that is being placed on growing these capabilities.

      10   However, with these important efforts comes the challenge

      11   of coordinating hundreds of disparate AI efforts across

      12   multiple offices and organizations. I look to our witnesses

      13   to help the committee better understand how AI can be

      14   adopted more rapidly, how coordinating the initiatives

      15   already underway within the Department can help us harness

      16   this powerful technology, and where we must invest in future

      17   research to ensure we maintain a long-term advantage.

      18   And again, I thank our witnesses for being with us

      19   today. I look forward to their testimony.

      20   And I would turn to my Ranking Member, Mr. Peters.

      21   Senator Peters, thank you. New Ranking Member joining us.

      22   This is our first subcommittee hearing of the Congress.

      23   Senator Peters, I welcome you onboard. Thank you very much.

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1   STATEMENT OF HON. GARY C. PETERS, U.S SENATOR FROM

2   MICHIGAN

3   Senator Peters: Well, Madam Chairwoman, thank you.

4   It's an honor to be with you. I've enjoyed working with you

5   over the years, and we'll continue to do that in the next 2

6   years in this Congress.

7   And also, I'd like to thank the gentlemen for you being

8   here today, for your testimony.

9   You know, artificial intelligence is already impacting

10   our daily lives through commercial products and services,

11   from applications as simple as Alexa to very complex

12   systems, like self-driving automobiles. AI has huge

13   implications for our national security, as well. For

14   example, it'll enable new capabilities in intelligence

15   analysis, autonomous systems, as well as cybersecurity. At

16   the same time, AI can create new threats in these and other

17   areas that can be exploited by our adversaries. I hope, in

18   this hearing, that we can hear from our witnesses on the

19   Pentagon's efforts to position itself in the rapidly

20   changing world of AI, from the more near-term activities of

21   the Joint AI Center to the long-term, high-risk, high-payoff

22   research efforts of DARPA and the Defense Innovation Unit.

23   The current AI systems that exist today only exist

24   because of decades of research in computer science, control

25   systems, microelectronics, and other fields. There are many

amazing commercial capabilities available today, yet AI is
still relatively primitive to what we all think it can be.
We need to continue to invest in fields like computer
science and electronics, but also research in areas such as
our understanding of how machines and people learn and can
work together to make sure that that promise becomes a
reality.

I would like to understand how the DOD is working to
move AI capabilities quickly into fielded systems, as well
as how the Pentagon is developing a long-range strategy on
R&D of new capabilities.

I hope we can discuss how we are engaging with the best
minds in defense and the commercial industry, Silicon
Valley, government labs, and universities to address many of
these challenges.

I would also like to learn about efforts to ensure that
the DOD and the Nation has the expert workforce that we will
need within government to stay at the leading edge of this
technology.

And finally, I'd like to recognize -- General Shanahan
is a distinguished graduate of the University of Michigan,
earning his commission there through the ROTC. The
University of Michigan is one of many academic institutions
in Michigan that prioritizes artificial intelligence
research, particularly for the development and testing of

1 autonomous vehicle systems.

2   General Shanahan, I know that U of M would love to host

3 you back on campus to see the work that they're doing on AI

4 and on autonomy and its relevance to your work. And I hope

5 that you and -- as well as our other members of the panel,

6 are able to take a trip to Michigan sometime soon.

7   So, I thank the Chair again for holding this hearing.

8 And I certainly look forward to our discussion.

9   Senator Ernst: Yes. Thank you very much, Senator

10 Peters.

11   And we will start with Dr. Peter T. Highnam. And Dr.

12 Highnam became the Deputy Director of the Defense Advanced

13 Research Projects Agency, what we know of as DARPA, in

14 February of 2018. Prior to coming to DARPA, Dr. Highnam was

15 the Director of Research at the National Geospatial-

16 Intelligence Agency, on assignment from the Office of the

17 Director of National Intelligence. And prior to that

18 assignment, he also served 6 years at ODNI's Intelligence

19 Advanced Research Projects Activity, initially as an Office

20 Director and then as Director.

21   Dr. Highnam, we welcome you. And you may start your

22 opening remarks. Thank you very much.

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1   STATEMENT OF PETER T. HIGHNAM, DEPUTY DIRECTOR,

2   DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

3   Dr. Highnam: Thank you, Chairwoman Ernst, Ranking

4   Member Peters.   I'm pleased to be here to represent the

5   Defense Advanced Research Projects Agency and share with the

6   subcommittee DARPA's work to advance AI technologies.

7   I'm going to begin with a little bit about DARPA's

8   history in this field.   In 1960, shortly after DARPA was

9   created, ARPA was created.   One of the first information

10   technology offices that we had gave this quote, "It seems

11   reasonable to envision bringing computing machines

12   effectively into processes of thinking that must go on in

13   realtime, time that moves too fast to permit using computers

14   in conventional ways.   To think in interaction with a

15   computer in the same way that you think with a colleague

16   whose competence supplements your own will require much

17   tighter coupling between man and machine than is possible

18   today."

19   So, back then, when computers were large, were room-

20   size, when they were being used for computing missile

21   trajectories and so on, this man saw what was possible, saw

22   the insights that were becoming available, and saw the push

23   that we're still working on, which is changing computers

24   from tools to partners.   And that actually is the history of

25   AI investments by DARPA for the last 60 years.

1   So, that is also quintessential DARPA. This man had,

2   you know, one foot in defense, seeing the mission and seeing

3   what was needed, and one foot in the technology side, and

4   framed the problem using use cases, knew what had to be

5   done, and started driving. It's unlikely that he realized

6   -- that he thought that there would be six decades of

7   investments and hard work that followed that to get to where

8   we are today.

9   I'd like to say that, after 60 years of pushing, AI is

10 an overnight success.

11   [Laughter.]

12   Dr. Highnam: Really, within the last 10 years, when

13 you think about the kind of technologies. A lot of

14 transitions and successes over the decades, much

15 accomplished, and much still to do.

16   DARPA describes the investments in AI using a waves

17 construct. The first wave at the beginning, for the first

18 20 years or so, are normally known as describe. So, this is

19 where knowledge was encoded in rules, "If A, then B." And

20 so, if you look inside the tax -- if you do personal taxes

21 today, there's a rule-based system inside there that was

22 what, 40 years ago, would have been called AI technologies,

23 now is just computer science, or IT. That's the price of

24 success. It's no longer AI. It's just commonplace.

25   And then, in the last -- beginning in the mid-'70s, the

1   technology -- science had put in place to begin what became

2   machine learning. The theory was put down, but it -- only

3   in the last 10-15 years, we now have the compute cycles, we

4   have the data availability. And that's when the current

5   wave, the second wave, of machine learning really took place

6   and really came into being.

7   And now we're looking past that, at DARPA, into what

8   comes next. So, we have two waves of technology. One was

9   descriptive, one was recognizing situations, classifying,

10   and so on. And now we have to be able to explain, to really

11   build the trust between these systems and the people who are

12   using them and working with them in realtime, in difficult,

13   stressful situations, but building the trust so that they

14   really can become partners. And this is the role of

15   explanation.

16   It's a great time to be at DARPA, because we're now on

17   the brink of a lot of really exciting things. And that's

18   the genesis of the current initiative, the $2 billion

19   investment that we've said we're now making in AI

20   technologies.

21   That said, there's a brittleness to the current

22   technologies. And the tools are immature, still. We don't

23   have an engineering discipline behind AI technologies. And

24   there is issues, that I'm sure everyone will talk to you

25   about, about missing data volume, missing data quality,

1   provenance, and so on, the training, second-wave systems.

2   And these systems tend to have unexpected failure modes.

3   So, in front of you, there's -- there should be an

4   example of the brittleness of AI. These are drawn for the

5   -- from the academia mixture. You may have seen these

6   before. In the first picture, on the left, there's a panda,

7   which you and I look at with all the history that we have of

8   looking at these critters. And on the right is also a

9   picture that looks like a panda, as well, to us. The

10 difference is that, in the digital representation, a certain

11 amount of "noise" represented by the middle picture was laid

12 on top of it, and a highly trained second-wave

13 classification system, machine-learning system, went from

14 classifying that picture as a panda to now as a gibbon, with

15 high certainty. The fragility of these methods -- these are

16 very literal methods. There is no semantics, there is no

17 intelligence.

18   The second example is of -- perhaps of more concern.

19 And this represents -- this shows a stop sign in a physical

20 situation. So, think autonomous vehicles. And, to you and

21 I, again, it's a stop sign. It has a certain shape. To a

22 trained system, to a highly trained system, it's no longer

23 -- when you put that little white sticker -- or that yellow

24 sticker onto the stop sign, it's now classified as a speed

25 limit sign. This is a -- you can think in terms of

1   autonomous vehicles, the brittleness and fragility of the

2   systems. You can also think in terms of adversarial

3   endeavors. It takes camouflage and deception to a whole new

4   level.

5   So, I wanted to -- very important to point those things

6   out.

7   Now -- so, today we have autonomy. We have a lot of

8   work successes in cyber, from first- and second-wave

9   technologies. We have novel hardware, high-performance

10 hardware, low-energy hardware coming into place. And yes,

11 then we have a lot of tools, and hundreds of thousands of

12 people are being trained and really wanting to use machine

13 learning. We have to go to the next step, this commonsense

14 reasoning, being able to explain where this inference came

15 from. We have to get there. Otherwise, trust won't be --

16 won't come into place.

17   So, what we've done is to talk about, in our new

18 initiative, robust AI, dealing with adversarial AI, both

19 unintentional and intentional, high-performance, in terms of

20 compute cycles and minimizing energy, and delivering

21 radically new capabilities. This is the genesis of the AI

22 Next Campaign, creating systems capable of reasoning,

23 regenerative, contextual, and explanatory models. We

24 already have over 20 programs running in AI, new programs --

25 research programs started. We have over 80 programs in the

1   agency. About one-third of the programs in the entire

2   agency now are either creating AI technologies or aggressive

3   users of those technologies.

4   And last, the -- we really need to -- to your point

5   about workforce, we really had to get more people engaged.

6   So, typically, we put out a call for proposals -- research

7   proposals, people apply, and, 6 to 9 months later, if

8   selected, they're on contract. We have something called AI

9   Exploration, by which we are driving the research community

10   to explore this -- the space of the third wave aggressively.

11   We post a topic, and we award contracts within 90 days of

12   posting the topic. We've now done this six times. We've

13   invested, so far, on the order of $45 million in this. And

14   there's tremendous uptake from the research community, these

15   opportunities. All unclassified, all fundamental work.

16   So, from 60 years ago to now, I don't think Mr.

17   Licklider, at the time, would have anticipated that the

18   Department of Defense would have an AI strategy, such a huge

19   success in recognition, and that the President would sign an

20   AI executive order. Who would have thought?

21   So, game-changing capabilities for the Defense

22   Department and the world, from 60 years of investment, much

23   accomplished, and much to do.

24   Thank you.

25   [The prepared statement of Dr. Highnam follows:]

1   Senator Ernst: Very good. Thank you so much.

         2   Mr. Michael Brown is the Director of the Defense

         3   Innovation Unit, DIU, at the U.S. Department of Defense.

         4   DIU fields leading-edge capability to the military, using

         5   commercial technologies faster and more cost-effectively

         6   than traditional acquisition methods. Prior to that, Mr.

         7   Brown served as a White House Presidential Innovation Fellow

         8   at the Defense Department. He has also worked as CEO of

         9   Semantec Corporation and as CEO of Quantum Corporation.

        10   So, thank you, Mr. Brown, for joining us today. It's

        11   good to have you here again. If you would, please go ahead

        12   with your opening statements.

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1   STATEMENT OF MICHAEL A. BROWN, DIRECTOR, DEFENSE

2   INNOVATION UNIT

3   Mr. Brown: Thank you, Chairman Ernst, Ranking Member

4   Peters, and members of the subcommittee.   Thank you for

5   inviting me here today to discuss DIU's efforts in AI.

6   As you said, about 6 months ago, I joined DIU as the

7   Director, and, having led a number of technology companies,

8   most recently Semantec, I've witnessed how new technology

9   like AI can fundamentally redefine how we live and work, and

10 how we fight wars.

11   Before joining DIU as the Director, as you mentioned, I

12 worked as a Fellow, responding to the Secretary of Defense's

13 request of -- understand China's investments in early-stage

14 technology firms, many of which were AI-focused, and its

15 technology transfer implications for national security.

16   As you mentioned in opening remarks, China and Russia

17 have already recognized the enormous commercial and military

18 potential of AI, and are investing heavily, with aims to

19 become dominant.   By 2025, China aims to achieve major

20 breakthroughs in AI and increase its domestic market to

21 reach $60 billion.   To achieve this target, the Chinese

22 government leverages civil-military fusion, where, by law,

23 every commercial AI innovation is immediately transferred to

24 the Chinese military.   China also leverages U.S. talent and

25 resources by establishing research institutes in the U.S.,

1   investing in AI-related startups in the U.S., recruiting

2   talent in the U.S., and building academic partnerships.

3   Russia, as you mentioned, with Vladimir Putin's

4   comments, is similarly focused on building its AI capacity,

5   but is behind the U.S. and China, in terms of overall

6   investment, research, and startups.

7   In the face of great-power competition, DIU is working

8   alongside -- with the rest of DOD to maintain our

9   technological edge, not only in AI, but other dual-use

10 technologies, as well. Accessing mature AI-driven

11 technologies from the commercial sector is an essential

12 component of the Defense Department's Artificial

13 Intelligence Strategy and a paradigm shift from an --

14 defense industrial base to a national security innovation

15 base prescribed by the National Defense Strategy.

16   DIU's AI portfolio focuses on understanding, tracking,

17 and vetting commercial companies' abilities to solve high-

18 impact problems identified by our military leadership. AI

19 projects today include work with the Air Force, Army, Navy,

20 and components, as well as Joint Chiefs of Staff.

21   As a foundational technology, the DIU AI portfolio

22 specifically prioritizes projects that address three major

23 impact areas where AI has proven to excel commercially.

24 Here are three examples:

25   First, computer vision. Adding automation to object

1 recognition and infrastructure assessment, DIU is

2 prototyping computer-vision algorithms in humanitarian

3 assistance and disaster recovery use cases.

4   Second, large dataset analytics and predictions, making

5 sense of massive datasets and patterns more efficiently and

6 cost-effectively than human analysts. For example, DIU is

7 prototyping predictive maintenance applications for Air

8 Force and Army platforms, with the potential to save the

9 Department billions of dollars.

10   And third, strategic reasoning, mapping probabilistic

11 chains of events and developing alternative strategies to

12 inform top-down planning in environments characterized by

13 uncertainty, missing information, and speculation. DIU is

14 prototyping an application that leverages AI to provide

15 insights to high-level strategic questions.

16   With these projects, DIU engages across the Department

17 on AI and makes its commercial knowledge and relationships

18 with potential vendors available to any of the services,

19 service labs, and components. We already have in place a

20 strategic partnership with JAIC, which we've agreed upon

21 with General Shanahan. Simply stated, DIU will prototype

22 commercially successful AI applications and measure their

23 relevance to mission imperatives. And, if successful, we

24 transition those to JAIC so they can be scaled and

25 integrated into their national mission initiatives. We look

1   forward to working closely together with JAIC.

2   DIU also works with the Defense Innovation Board and

3   will work with the newly established Congressional National

4   Security Commission on AI to leverage the best practices and

5   learnings from the commercial software industry executives

6   who participate on that board.

7   Cultural divides and ethical differences are often

8   blamed for the lack of closer cooperation between DOD and

9   Silicon Valley, but, more often than not, the true deterrent

10   is misaligned economics. Enabling DOD to be a better

11   customer for early-stage companies will not only help DOD

12   acquire the best commercial technology faster and cheaper,

13   but will also provide access to the ideas of sought-after AI

14   talent that DOD may not be able to attract. And the more we

15   collaborate with the private sector on mutually-beneficial

16   projects, the more opportunities we'll have to engage in an

17   open dialogue about the applications and principles for the

18   use of AI.

19   DIU plans to continue its focus on AI as a key

20   technology portfolio, solving DOD problems with commercial

21   AI solutions to bring the Department new capabilities and

22   encourage nontraditional technology firms to work with DOD

23   as part of the national security innovation base, will be a

24   priority.

25   Thank you.

1   [The prepared statement of Mr. Brown follows:]

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1   Senator Ernst: Thank you very much, Mr. Brown.

2   And last, certainly not least, we have Lieutenant

3   General John N.T. "Jack" Shanahan.   And, General Shanahan is

4   the Director, Joint Artificial Intelligence Center, Office

5   of the Department of Defense Chief Information Officer at

6   the Pentagon.   General Shanahan is responsible for

7   accelerating the delivery of AI-enabled capabilities,

8   scaling the departmentwide impact of AI, and synchronizing

9   AI activities to expand joint force advantages.

10   General, please go ahead.

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1   STATEMENT LIEUTENANT GENERAL JOHN N.T. SHANAHAN, USAF,

2   DIRECTOR, JOINT ARTIFICIAL INTELLIGENCE CENTER, OFFICE OF

3   THE DEPARTMENT OF DEFENSE CHIEF INFORMATION OFFICER

4   General Shanahan: Good afternoon, Madam Chairwoman,

5   Ranking Member, distinguished members of the subcommittee.

6   Thank you for the opportunity to testify before the

7   subcommittee today on the Department's artificial

8   intelligence committees.

9   I'm honored to serve as the first Director of DOD's

10   Joint AI Center, or the JAIC. I've been in this position

11   for just over 2 months. Previously, I served in the Under

12   Secretary of Defense for Intelligence, where, for 2 years, I

13   was the Director of the Algorithmic Warfare Cross-functional

14   Team, also known as Project Maven.

15   Artificial intelligence, or AI, is rapidly changing an

16   ever-expanding range of businesses and industries. It

17   offers the opportunity to transform every corner of the

18   Department from multidomain operations at the edge to back-

19   office business functions. As described in the 2019

20   National Defense Strategy, or NDS, it is also poised to

21   change the character of warfare. Thoughtful, responsible,

22   and human-centered adoption of AI in the DOD will strengthen

23   our national security and transform the speed and agility of

24   our operations.

25   Last June, then-Deputy Secretary of Defense Shanahan

1   directed the DOD Chief Information Officer, Mr. Dana Deasy,

2   to establish the Joint AI Center to accelerate the delivery

3   and adoption of AI-enabled capabilities, scale the

4   departmentwide impact of AI, and synchronize the

5   Department's AI activities. In parallel, DOD submitted its

6   first AI Strategy to the Congress as an annex to the NDS.

7   Last month, the Department released an unclassified summary

8   of DOD's AI Strategy, doing so on the heels of the

9   President's signature of the executive order on AI. The

10 JAIC's missions and functions nest well under the principles

11 and objectives outlined in the AI executive order.

12   JAIC's formation also dovetails Section 238 of the

13 fiscal year '19 NDAA. Additionally, JAIC will benefit from,

14 and help bring to fruition, recommendations of the new

15 National Security Commission on AI. I was privileged to

16 talk with the members of the Commission yesterday, when they

17 met for the first time. I know Senator Heinrich was also

18 there.

19   The JAIC is the focal point of the DOD AI Strategy and

20 was established to provide a common vision, mission, and

21 focus to drive departmentwide AI capability delivery. I

22 want to highlight three primary themes for our approach:

23   First, delivering AI-enabled capabilities at speed.

24 JAIC is collaborating with teams across DOD to identify,

25 prioritize, and select mission needs, and then execute a

1   series of cross-functional use cases to demonstrate value

2   and spur momentum. We need early demonstrable wins to show

3   practical results and the art of the possible, followed by

4   scaling across the enterprise. Projects fall into two main

5   categories: national mission initiatives, or NMIs, and

6   component mission initiatives, or CMIs. NMIs are driven and

7   executed by the JAIC as broad, joint, crosscutting AI

8   challenges; whereas, CMIs are component-led, but are able to

9   make use of JAIC's common tools, libraries, best practices,

10 and more.

11   Our emphasis on rapid, iterative delivery of AI

12 complements the Department's ongoing work at the other end

13 of the AI spectrum, in fundamental research and development,

14 as you heard from Dr. Highnam. Our first two NMIs are

15 predictive maintenance with the Special Operations Command

16 and U.S. Army H-60 helicopter use case and humanitarian

17 assistance and disaster relief, in which we will field AI

18 capabilities in support of natural events, such as wildfires

19 and hurricanes. We are also getting a headstart on a

20 planned fiscal year '20 cyberspace NMI designed to use AI-

21 enabled capabilities to improve event detection, network

22 mapping, and compromised-account identification.

23   At the same time, we are now in the early problem-

24 framing stage for another proposed NMI in fiscal year '20

25 that will be more oriented on the NDS, National Defense

1   Strategy, in operations against peer competitors. And we

2   are also in initial discussions with the military services,

3   components, and combatant commands on the applicability of

4   AI to help with solutions in areas as diverse as talent

5   management, suicide prevention, preventive medicine, and

6   information operations, among others.

7   The second theme is scale. As I know firsthand from

8   Project Maven, scaling AI across the enterprise is hard, but

9   it's also the only way we will realize the full benefits of

10   AI in the Department. JAIC's early projects serve a dual

11   purpose, to deliver new capabilities to end users as well as

12   to incrementally develop the common foundation that is

13   essential for scaling AI's impact across DOD. We will put

14   this foundation in a -- in place in a way that aligns with

15   DOD enterprise cloud adoption.

16   And the third theme is talent. We built the initial

17   JAIC team with representatives detailed from across each of

18   the services and other components. Today, we have 30

19   people, growing to over 50 within the next 5 months. We do

20   not receive our permanent manpower until fiscal year '20.

21   For the JAIC to succeed, we must attract and cultivate

22   a select group of mission-driven, world-class AI talent, to

23   include enticing experts from the tech industry to serve

24   with us. The success of human-centered AI and human-machine

25   teaming within DOD requires growing and sustaining an AI-

1 ready force, one that is conversant in the language of AI,

2 willing and able to operate with a new kind of speed and

3 agility.

4   In closing, the JAIC is now up and running, and we're

5 open for business. Thank you for your strong support in

6 driving momentum in this critical area. I look forward to

7 continuing to work with Congress as we advance the adoption

8 of AI across the Department and use the JAIC to accelerate

9 our progress.

10   Thank you for the opportunity to testify this

11 afternoon. I look forward to your questions.

12   [The prepared statement of General Shanahan follows:]

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1   Senator Ernst: Absolutely.

 2   And again, thank you, to our witnesses, for being here

 3   today.

 4   And I'll go ahead and start with the questioning here,

 5   and then, when Senator Peters -- oh, here he comes -- when

 6   he returns -- I'll go ahead and start with my questions, and

 7   then, Senator, I'll turn it over to you.

 8   Again, thank you very much. This is a very interesting

 9   topic, and I think we can learn a lot from the discussion

10   today.

11   To all of our witnesses here, if you could share, how

12   are the AI efforts in R&D coordinated among DARPA, JAIC, and

13   the services? And, General Shanahan, you had mentioned the

14   synchronization of AI activities, and you had mentioned R&D.

15   If you could all share, How do you synchronize that

16   information? How do you share that information? What are

17   the best techniques in doing that?

18   And, Dr. Highnam, if we could start with you, please.

19   Dr. Highnam: So, the -- whenever DARPA starts a

20   program, a research program, there's a development of use

21   cases. We always -- we seek to understand: If we succeed

22   in that program, who cares, who benefits? So, that means

23   that our program managers are out, talking inside the

24   services all the time; in fact, across the national defense

25   establishment, writ large. So, there's the natural inbuilt

1 connection before we even start, before we even agree to

2 start a high-risk activity. And that's true whether it's

3 hypersonics or quantum or AI. This is normal business.

4   Now, in fields like AI technologies, which are software

5 tools with a lot of tail to them -- sustainment, deployment

6 tails -- I personally, as an R&D guy, am really happy to now

7 have the JAIC sent up as a partner to take on that 6-4 and

8 on, that engineering, deployment, sustainment tail, because

9 it's going to make -- I expect it will make transitions into

10 practice a lot -- not simpler, but more straightforward. I

11 fully recognize just how much hard work General Shanahan and

12 his team are going to have to do to make that end of the

13 business happen.

14   Senator Ernst: Absolutely. Thank you.

15   Mr. Brown: So, Senator Ernst, the most important area

16 for us to collaborate with is JAIC. So, as I'm sure you

17 recognize, DARPA has a different timeframe in mind that we

18 all benefit from, being longer term. DIU's timeframe is 24

19 months or less, so we aim to get commercial companies on

20 contract within 60 days, and then a prototype fielded within

21 2 years. And, in software, we're trying to go faster than

22 that, a year to 18 months.

23   So, in coordinating projects, our strategy with JAIC,

24 which I'm very pleased to be in partnership with General

25 Shanahan, is, we'll go out and look at what's successful

1   commercially, including vendors, and then, if we prototype

2   something successfully, we're the trial, and we want to

3   scale it. Then we start working with JAIC for what's the

4   infrastructure we need and how would we make that available

5   to all of the services. For example, we're working together

6   now to get a vendor that we have worked with on prototype to

7   get a production contract that will be with JAIC so any of

8   the services can take advantage of that.

9   For our project-base work, we also coordinate with the

10   Vice Chairman of the Joint Chiefs. We have a quarterly

11   meeting with General Selva, not just on AI, but our other

12   projects, to make sure we're doing things that make sense to

13   joint forces. And then we have monthly meetings with each

14   of the Assistant Secretaries for Acquisition -- so Army,

15   Navy, Air Force, Dr. Jette, Dr. Roper, Hondo Geurts -- to

16   make sure that what we're working on makes sense with their

17   priorities. The last thing we want to be doing is a lot of

18   independent projects that don't have leverage --

19   Senator Ernst: Right.

20   Mr. Brown: -- across the --

21   Senator Ernst: Correct.

22   Mr. Brown: -- Department.

23   Senator Ernst: Correct. Thank you.

24   General Shanahan: Senator, while the number may vary

25   depending on who wrote it, I think, in fiscal year '18, the

1 number was 511 projects that had AI as their primary focus

2 across the Department. And the question is, Are all those

3 511 projects towards a common end, in support of the

4 National Defense Strategy? This question of synchronization

5 is essential to where we're going in the JAIC, and it comes

6 down to governance and oversight. In Section 238 of the NDA

7 actually directs governance and oversight, for this very

8 reason.

9   We have a lot of work to do in this area. I would like

10 to start by just getting our arms around all of the projects

11 that will come out in fiscal year '20, to understand the

12 amount of funding, what the projects are for, not to

13 threaten somebody's budget. That is not the intent of the

14 JAIC. But, we owe it to the Department and to the Hill and

15 to the public to be able to account for all of those

16 projects and the money that's being spent.

17   So, I take that very seriously. We're still in the

18 building phase right now for the JAIC, but we are in early

19 discussions about what governance looks like for the JAIC

20 and, How do we bring all of us together to understand what

21 are the projects going towards? A $200,000 research project

22 at University of Michigan may be exactly what we need for a

23 long-term insight into a particular part of autonomous

24 vehicles. The question is, Do we know about it at a central

25 level so that the Secretary and the Deputy Secretary of

1 Defense are comfortable about what the Department is doing

2 in artificial intelligence?

3   So, we take this very seriously. And, as Dr. Highnam

4 said, we're also in discussions, just between DARPA and us,

5 on, Where is that transition from DARPA, ready to field,

6 over to the JAIC? And we are in early conversations of

7 that. We don't have programs identified yet.

8   Senator Ernst: Very good. Well, I appreciate that.

9   Going back to what Dr. Highnam said is, of course, Who

10 cares and who benefits? I think, bottom line, that is a

11 great way to put it. And, if you're not sharing information

12 and going through that synchronization, who cares and who

13 benefits? We don't really know. So, I appreciate that very

14 much.

15   Thank you. I will step out. And Ranking Member will

16 take over the meeting.

17   Thank you.

18   Dr. Highnam: If I may, one go-back on that. So, in

19 all of our research programs, we also seek transition of the

20 technologies that come out. We don't just do the research.

21 This is Defense. We're pushing it. And we seek transition

22 agreements with the end users, wherever they may be, in the

23 services or in the IC.

24   Senator Ernst: Thank you.

25   Senator Peters [presiding]: Thank you, Madam

1 Chairwoman.

 2   I think I want to -- I'd like to pick up a little bit,

 3 Mr. Brown, on -- you were discussing the commercial sector

 4 and how we're reaching out to the commercial sector to be

 5 bringing in a lot of this technology. And certainly, that's

 6 what we're seeing -- probably some of the most exciting

 7 advances are happening outside of the DOD, in the commercial

 8 space, and, because of all the applications from the

 9 financial industry, to banking to insurance to automobiles

10 -- I mean, all of that is going to be transformed in

11 significant ways from artificial intelligence.

12   But, it's important for the DOD to be able to bring

13 that in and use it effectively. And there are a number of

14 factors that usually, I think, stand in the way of that

15 happening, from our very cumbersome procurement process, to

16 say the least, that we have, that scares companies away from

17 being involved with the Federal Government, to a slow and

18 often late budget process that we have here. There are

19 enhanced security reviews. I mean, there's a long list of

20 challenges. And that's what I'd like you to elaborate on,

21 as to, What challenges do you envision, as we try to adapt

22 some of these commercial applications into military use?

23 And then, General Shanahan, if you'd follow up on Mr.

24 Brown's comments. And Dr. Highnam, too.

25   Mr. Brown: So, Senator Peters, you're exactly right.

1   And I am benefiting from the wisdom of folks who came before

2   me in setting up the Defense Innovation Unit, because they

3   -- we largely address, by how we were formed, some of those

4   constraints that you talked about.

5   So, first, procurement process. So, we have set up a

6   special solicitation process. It's open -- anyone can

7   respond -- where we do not start with a list of detailed

8   requirements assuming we know how industry should solve a

9   problem we might have in DOD. But, we start with something

10 very simple -- sentence or paragraph, saying, "This is the

11 problem we're trying to solve. What can you offer us that

12 will help address that?" So, that gets us away from, again,

13 very detailed requirements to seeing, What does the

14 commercial sector offer?

15   Then we try and move at commercial speed and commercial

16 terms, meaning we don't have onerous requirements for IP,

17 and we don't take companies through something that is

18 unfamiliar to them. We'd like them to view DOD and

19 government as just another vertical as they look at other

20 commercial segments they want to pursue. So, again,

21 commercial terms and speed are important for us there.

22 Because our mission is, How do we expand the national

23 security innovation base? How do we get more vendors

24 working with us?

25   Then, as it relates to the budget process, that's

1 something that we are looking at now. How do we ensure that

2 there's a transition if we successfully prototype a use

3 case? How can we move quickly to get that fielded? So, we

4 have to use a variety of techniques. Some of them you've

5 helped establish, like the Rapid Innovation Fund.

6 Fortunately, in the AI sector, that's made much more easy

7 with the partnership with JAIC, because now we've got

8 infrastructure, folks who can help make this available to

9 the rest of the services. We've talked about the contract

10 that we're working right now, production contract being one

11 we'll be able to draw from.

12   And, as it relates to security, we try and move away

13 from classified use cases and translate those to a

14 commercial problem. So, we try and work almost exclusively

15 in an unclassified realm. So, we're conscious of those

16 constraints, and we have ways to make it easier for

17 commercial vendors to work with us.

18   I think another benefit is being able to work and

19 access the talent, the ideas that come from the folks in the

20 commercial sector, because we may not be able to track all

21 the talent -- it's likely we will not be able to -- in the

22 AI fields within the Department of Defense.

23   Senator Peters: All right. Thank you.

24   General?

25   General Shanahan: Senator, the legislation is clear:

commerciality, first and foremost. And for the 2 years that

I worked in Project Maven, we took that approach. Now,

there are always going to be some unique problem sets within

the Department that require some in-house developments and

in-house solutions, but we went with commerciality every

time. And I would say I was fortunate, fortunate in the

form of a Marine Corps colonel who was an operator, an

intelligence professional, but also a level-3 certified

acquisition pro, and he was able to work within the confine

of the DFAR. And people are surprised that we use the DFAR

to that effect. There are additional authorities we've been

granted. I haven't had to use them yet in the JAIC because

we're so new in the standup of the process. But, there are

ways to work the system, thanks to -- as Michael Brown just

said, the existing solutions are already out there in

commercial industry. And, as I get further into standing up

the JAIC, what I'm looking for, as many arrows as possible

in the quiver of acquisition and contracting, to -- able to

pull for a different situation on any given day, whether

it's an other transaction authority, commercial service, or

just using straight-up DFAR. But, it's not easy to do it,

but there are ways to work within the system, and we do put

commerciality at the beginning of every project.

Senator Peters: So, you say that it's not easy, but

there are ways. So, you're -- you believe that you have the

1   authorities that you need, at least at this moment? Or is

2   there more that this committee --

3   General Shanahan: I do believe, at this moment, we

4   have the authorities we need.

5   Senator Peters: Okay.

6   General Shanahan: And I reserve the right, 1 year into

7   this, to come back and make a different case.

8   [Laughter.]

9   Senator Peters: Yeah. Duly noted, General.

10   Dr. Highnam, did you have anything to add?

11   Dr. Highnam: Yes. From the research aspect, looking

12   at our investments in FY18, about 50 percent of our AI

13   research investments were industry, about 14 percent were

14   small business. So, we have a very large coverage of

15   picking up and driving the development of the best ideas.

16   About one-third went to universities. So, those are the

17   sources.

18   And, for us, as we look ahead to technologies coming

19   onboard, maturing them, and, to the examples they gave

20   earlier, reducing the brittleness and just catering towards

21   the engineering front needed for large-scale military

22   deployments, we're addressing rigor, making sure they work,

23   robustness. Second-wave technology is applied aggressively

24   to defense applications. And then creating and proving out

25   the third wave of technologies -- of AI technologies --

1   again, creating them from -- not from whole cloth, but from

2   working with the companies and working with the schools to

3   do that.

4   Senator Peters: Great.

5   Thank you.

6   Senator Shaheen.

7   Senator Shaheen: Thank you all very much. I'm sorry I

8   missed your testimony earlier.

9   In 2017, China laid out plans to become the leader in

10 AI by 2030. What's our strategy to make sure, (a) that

11 doesn't happen, and (b) that we are the leader, as opposed

12 to China?

13   Mr. Brown: I'll take a crack at that. This is

14 obviously much broader than a Department of Defense

15 strategy. And I think we know well how to win a tech race,

16 because we did it quite effectively the last time we were

17 involved in one with the Soviets in the Cold War and

18 afterwards. And it starts with, What are doing to invest in

19 ourselves? All the breakthroughs that Silicon Valley is

20 benefiting from, even today in our economy, as we look at

21 some of these software IPOs -- Uber, Lyft, AirBNB -- have

22 come from federally funded research. So, I credit DARPA and

23 the other parts of the Federal Government that create those

24 breakthroughs -- Internet, GPS, miniaturized electronics, et

25 cetera. So, I think it starts with what we do in federally

1 funded research, education. So, what we did to focus on

2 engineering and science after Sputnik, need to do that

3 again. And then the national purpose. So, what we have now

4 with the executive order, how do we build on that to create

5 a common purpose about this being important? My concern

6 would be that -- How many Americans know about the national

7 order of -- on artificial intelligence, and how many young

8 people are we reaching to inspire that this needs to be

9 their mission? Because this technology race, especially on

10 AI, is going to be multigenerational. It's not going to be

11 lasting one administration, or two. So, we've got to get

12 the national purpose behind this to support, then, what we

13 can do to leverage that in the Defense Department.

14   Senator Shaheen: Well, so that raises the next

15 question, which is, Are we doing that?

16   Mr. Brown: Well, I think you could always say we could

17 be doing more.

18   Senator Shaheen: Okay. What more should --

19   Mr. Brown: There's no --

20   Senator Shaheen: -- we be doing?

21   Mr. Brown: There's no time to waste in this race with

22 China. They have --

23   Senator Shaheen: So, what --

24   Mr. Brown: -- some advantages, in terms of, today,

25 probably more patents that they've -- there's more startup

1 activity, in terms of dollars invested. But, the U.S. still

2 has a lot of critical advantages, in terms of our education

3 system, what we're doing to actually pioneer things, in

4 terms of hardware technology to advance AI, the tensor

5 processing units, et cetera, the activities like DARPA is

6 working on, with very long-term research in mind. I feel

7 like the U.S. still has a lead there. We've just got to

8 take more advantage of that. What makes us special in this

9 race?

10   Senator Shaheen: And how concerned are we that, not

11 only is China making this commitment, but that they're

12 stealing our intellectual property, which includes AI, and

13 that we have not figured out how to adequately respond to

14 that, I would say? You all may not agree with that, but

15 that's certainly my view. I don't know who -- who would

16 like to answer that? General Shanahan?

17   General Shanahan: It -- yes, Senator. And to just

18 carry on to what Mr. Brown was talking about earlier, it --

19 this is not just a DOD question -- whole of DOD -- it's not

20 just whole of government, it's whole of society, it's

21 multigeneration to be able to build. If I look at bringing

22 in talent -- AI talent into the JAIC, I can ask the services

23 to, "Give me your best AI talent." There's just not enough

24 to go around. It will take decades to build this. So, this

25 is, one, for the executive order on AI. It's a start, but

1 there has to be an implementation plan, which I know is

 2 coming. But, also, the National Security Commission on AI

 3 will lay out some of these very factors about, How do we

 4 this as a society, everything from grade-school education to

 5 military courses bringing in concepts of coding all the way

 6 from the very beginning?

 7   Now, to your other point, Senator, about intellectual

 8 property theft, every one of us has a concern about that.

 9 It's been taking on -- taken that much more seriously in the

10 past 2 years than I would have said 5 years ago, beginning

11 to understand the scope of the problem. Just using Huawei

12 as an example, having a whole-of-government approach to

13 convince people not to use that technology, because it has

14 an entry point into places in China. This is something

15 we're working very hard at protecting our own systems,

16 protecting our data. Without getting into any details in

17 the project I worked on the Under Secretary of Defense for

18 Intelligence Project Maven, but also as we stand up the

19 JAIC, is protecting our data, doing everything we can to

20 make sure somebody doesn't understand what that data is, how

21 we built our algorithms. There is so much more than this.

22 But, I believe the sounding board of what China is doing,

23 just within the past 2 years, is now making a difference.

24 Much more to do, but it -- we are taking a different

25 approach that we were in the past.

1   Senator Shaheen: Well, thank you. I appreciate that.

2   I would argue that, as we look at the education system,

3   that one of the things we should recognize is the importance

4   of immigration to that, and that, as we look back over the

5   last 30 or 40 years, that one of the things that has been so

6   important to our system of higher education are those people

7   from around the world, the best and the brightest. And when

8   we have a system that says, "We don't want you to come here

9   to college, and we want you to go home as soon as you're

10   done," that's not in our interest. So, I would argue that

11   that needs to be part of our strategy, as well.

12   Thank you.

13   Senator Ernst [presiding]: Thank you, Senator Shaheen.

14   Senator Heinrich.

15   Senator Heinrich: I want to start by thanking our

16   Chair and Ranking Member for hosting this hearing. This is

17   an incredibly important topic, and one which we all need to

18   be, sort of, educating our peers about, because, as our

19   guests today know, this is going to be a bigger and bigger

20   piece of what we focus on in the next few years.

21   And I'm really pleased to announce that this week we

22   are officially launching the Artificial Intelligence Caucus

23   in the U.S. Senate. So, along with Senators Portman and

24   Schatz, Gardner, and our Chair and Ranking Member, we're

25   looking forward to trying to work together to strike that

1   right balance in developing the technology and the policy so

2   that academia or labs, private industry, and Federal

3   entities like the ones we have testifying here today, can

4   harness this to the benefit of the American people.

5   AI is, as you said, really going to impact every sector

6   of our economy, our society, not just the Department of

7   Defense. And I want to start with Lieutenant General

8   Shanahan and thank you for your participation yesterday with

9   the AI Commission. It's my understanding that the services

10 and other components in the Pentagon right now have been

11 directed to coordinate with the JAIC, with the Joint

12 Artificial Intelligence Center, regarding any AI initiatives

13 that cost more than 15 million annually. Is that

14 coordination happening?

15   General Shanahan: Senator, it's not fully in place

16 yet. It is --

17   Senator Heinrich: Okay.

18   General Shanahan: -- my intent, through governance and

19 oversight within the JAIC, to put that structure in place,

20 for that -- for the very reason that you said. We have to

21 know what they're spending it on.

22   Senator Heinrich: So, it all starts with knowing what

23 we're doing --

24   General Shanahan: Yes.

25   Senator Heinrich: -- and then building off of that.

1   Do you have the authorities that you need to be able to do

2   this part of your job effectively?

3   General Shanahan: I'd say Section 238 will grant those

4   authorities. And if I feel like we need any other

5   authorities, we'll go back through the Department. But, I

6   believe I have those authorities right now.

7   Senator Heinrich: So, as we look at this over the

8   course of the next couple budget years, what should we be

9   measuring the JAIC against, in terms of metrics, and by what

10   -- what timeline?

11   General Shanahan: When we talk about the JAIC, in

12   capability delivery, I'll divide it up into product delivery

13   and then the rest of the JAIC. Product delivery is, Are we

14   delivering on the national mission initiatives and component

15   mission initiatives? On the national mission initiatives,

16   have we put results in place that are making a difference,

17   with a return on investment? That won't be an instantaneous

18   measure, even with Project Maven, which has been going for

19   almost 2 full years right now. The return on investment

20   takes a while to measure in AI. As we talked about

21   yesterday at the National Security Commission, this is

22   transformational. And when you feel the first sprint 1

23   algorithms, they are not game-changing, they're designed for

24   the operator to say, "They're not good enough. Here's what

25   I need to do and get to sprint 2, and we'll get to

1   transformation." But, we need to show that we are

2   delivering capabilities.

3   For the component initiatives, I need to give an

4   incentive for the services and components to come to the

5   JAIC. How do I do that? One, funding. Two, joint common

6   foundation, or a JAIC common foundation. "I have data for

7   you to use. I have tools. I have frameworks. I have some

8   cloud and edge services. I have a -- I'm a place that --

9   one-stop shopping," which is a really -- does -- that term

10 doesn't always work as well as it sounds on paper. But, I

11 need to give people an incentive to come in to the JAIC, to

12 help them accelerate their own AI initiatives.

13   Yes, sir.

14   Senator Heinrich: Talk to me a little bit about --

15 yesterday at the AI Commission meeting, I thought it was

16 really helpful, what you said about the cultural nature of

17 this, and the multigenerational aspect of this. So, talk

18 about how we manage that. Because the people who manage it,

19 yourself included, we're not going to have the same

20 intuitive access to this world that the people getting out

21 of coding schools right now are -- have today. So, how, as

22 the Pentagon, do you manage this cultural transition within

23 such a large organization?

24   General Shanahan: Well, I would put culture and talent

25 management at the top two of my priorities in trying to

1   change the Department with -- in bringing artificial

2   intelligence into it. And, as I said yesterday, there is a

3   combination of top-down pressure and bottom-up innovation.

4   For the most part, I believe the bottom-up innovation

5   exists. We have to give it a -- an outlet, a vehicle to

6   give people room to go out and try things new and different,

7   allow them to fail, and just show that they have a different

8   way of doing business, that we can listen to them. And

9   there are now new programs in some of the departments, like

10 Kessel Run with the Air Force. There is more and more of a

11 culture change beginning to happen, but it's not part of the

12 institution yet. What we have to do is institutionalize it.

13 So, we have to give the top cover, in forms of resources,

14 authorities, and policies, as well as going out and giving

15 capabilities to people in the field.

16   One of the things I say is that, absent somebody

17 getting to play with AI, it's science fiction. They need --

18   Senator Heinrich: Right,

19   General Shanahan: -- to see it, to smell it, to touch

20 it and really see what it can and cannot do. And part of

21 that is experimentation. We have to -- it's almost like a

22 war period between World War I and World War II, where we

23 can go out and actually experiment with these capabilities.

24   But, to do that, we have to develop the capabilities. It's

25 a little bit of a vicious cycle. We have to get

1 capabilities in the hand of operators and analysts, try them

2 out, wargame with them, try new operating concepts, and then

3 figuring out what works and doesn't work. That cycle is a

4 little slow in get going right now. So, when you ask about

5 timeframe, I would say a year, in some respects, in terms of

6 delivering capabilities; 2 years to begin to say, "Are we

7 changing the Department?" As you heard from Colonel Cukor

8 yesterday, we're 2 years into this, and I would say not

9 everybody accepts the change --

10   Senator Heinrich: Yeah.

11   General Shanahan: -- that's coming.

12   Senator Heinrich: Great. Thank you, General.

13 Appreciate it.

14   Senator Ernst: Thank you, Senator Heinrich.

15   I think we'll go ahead and do a second round of

16 questions. And I will reserve my questions until the end so

17 we can make sure that the rest of our Senators have an

18 opportunity.

19   So, Senator Peters, please go ahead.

20   Senator Peters: Thank you, Madam Chair.

21   General Shanahan, there is a concern out there by many

22 that the -- a -- the possibility that AI-enabled systems and

23 autonomous systems will cross some ethical lines, especially

24 in a -- in operational settings. And I know that the DOD AI

25 Strategy includes efforts to think about AI ethics and

1 safety issues are you're developing the systems. And, as

2 you just said, you've got to get them out in the field,

3 you've got to work them, but it probably makes sense to be

4 thinking about this on the front end, as well, as we go

5 forward.

6   So, if you've -- for the panel, here, if you could

7 highlight for us what your biggest ethics-related concerns

8 are for the possible use of AI systems by the military, and

9 how you're working to address them.

10   General Shanahan: Yes, Senator. Every technology

11 introduced in the Department comes with a question of the

12 lawful, safe, and ethical use of that technology. AI is not

13 different in that respect. It has some differences, in

14 terms of what you would call "explainable AI." Is an AI

15 making decisions based on data now instead of algorithms --

16 rules-based algorithms that have been programmed into it?

17 We are thinking about this from the very beginning.

18   Based on my work in Project Maven, I can tell you the

19 algorithms -- were fielded are light years away from SKYNET

20 and full autonomous weapon systems. But, we know we have to

21 start thinking about the policy implications of that. If

22 you were to ask what the -- what -- where the highest

23 temperature is outside the Department, it's on the question

24 of lethal autonomous weapons. Autonomy in weapon systems is

25 governed by DOD policy today, and we are partnered, and the

1   JAIC is partnered, with the Defense Innovation Board, who

 2   has a year-long project underway about AI principles for

 3   defense, doing open hearings, being able to hear from

 4   anybody that wants to come in and talk about their concerns

 5   about the ethical, safe, and lawful use of artificial

 6   intelligence in DOD. I will tell you, it's something we

 7   take extremely seriously. We will go at this, as we have

 8   done with other technologies, through a very rigorous and

 9   disciplined test and evaluation, validation, and

10   verification process. We have not fielded an algorithm in

11   Project Maven without having gone through that rigorous and

12   disciplined process. As early as we are, and as brittle as

13   those algorithms are, we put them through that process. If

14   we start talking about full autonomous systems, that level

15   of rigor and discipline will only continue to increase.

16   But, in terms of what we are most concerned about is

17   its performance of algorithms. As Dr. Highnam said earlier,

18   some of the algorithms have failure modes that we have to

19   take into account. And that DOD policy that -- or directive

20   that I referred to, has several sections on what we have to

21   go through in the Department to be ready to test and field

22   technology that involves autonomy.

23   But, autonomous -- fully autonomous weapon systems with

24   artificial and general intelligence is what people seem to

25   think is the worst case. I think of artificial narrow
                                47

1   intelligence. Anything we field will be fielded in

2   accordance with the Law of War, international humanitarian

3   law, rules of engagement, and commanders' judgment. I mean,

4   these are things that we take into account for every

5   technology, even more so because people don't know all about

6   the implications of artificial intelligence in a weapon

7   system.

8   Senator Peters: Yeah. And, as you go through that

9   process, you know, it -- certainly, that's encouraging, that

10   that thought process is occurring within your organization,

11   but I think we have to also realize that some of our

12   adversaries may not be constrained by some of the same kinds

13   of processes that we go through, and could present a --

14   unacceptable risk to us, from a national security

15   perspective, as well as the men and women who go in harm's

16   way facing autonomous systems that operate under a

17   completely -- set of rules than what we would think is

18   appropriate here in the United States.

19   So, I think that leads to my last point, and that's

20   thinking of some of the -- these higher-level concerns and

21   policy concerns of what we should be thinking about

22   globally, in terms of these technologies. And I know, when

23   we were talking about AI, we often turn to technical experts

24   and engineers. And often technical experts and engineers

25   make comments about ethics. But, I have found that's a

somewhat narrow approach, and we've made those kinds of

mistakes in the past. And so, my sense is -- are you and

Dr. Highnam -- are you also working with philosophers and

ethicists and folks who think deeply about some of the moral

questions associated with these technologies? Or should we

be doing more?

Dr. Highnam: One, there's always more to do. We had

an AI colloquium last week, a DARPA colloquium. About 700

people there. And one of the most interesting panels that

we had was on ethics, led by Richard Danzig, who used to be

the Secretary of the Navy. Fascinating discussion. So,

it's very much a part of the technical discussions that are

going on. We are looking at that.

Now, within -- wearing a slightly more technical hat,

there are some issues, at the moment, that we are very

concerned about, from a -- with a technical solution. One

is the implicit bias. The field of data science and machine

learning or machine training have significant overlap. And

there's a tendency among people who are human, as they build

these systems, to pick datasets, to cull datasets, to

unintentionally put leads or, again, bias into how they're

doing things, which means a system could preferentially

recognize Joe or Jane, based on -- just because of the way

it was trained. And that's a piece of the puzzle. And we

have research programs going directly against that. A large

1   one underway now is understanding group biases. But, again,

2   this is common to data science and machine training.

3   The second area is about -- to do with deployment of

4   technology when we -- if we don't fully understand its

5   failure modes, back to the point I made earlier. One of our

6   programs, short autonomy, has a very interesting premise, an

7   important one. So, we have an autonomous vehicle, a flight

8   vehicle, a ground vehicle. You can make it a lot more

9   flexible in how it deals with unexpected conditions by

10 adding some second-wave AI technologies to the puzzle. So,

11 a condition shows up, it adapts and makes changes. But,

12 it's -- again, if you don't really understand the failure

13 modes, if you don't have that assurance and sense, almost,

14 of a cyber assurance that this is going to behave itself and

15 operate within safe limits, then you put something on the

16 street or in the air that's -- you really have to take a

17 little -- you have to think hard about before you do that.

18 So, a lot of our research, again, is going into making

19 technologies robust in that sense, as well. We have

20 multiple programs -- research programs addressing different

21 aspects of this problem. It's a very important problem.

22   Senator Peters: Great. Thank you.

23   Senator Ernst: Senator Shaheen.

24   Senator Shaheen: Thank you.

25   Dr. Highnam, did I understand you correctly when you

1 said: As we look at where AI is currently being developed

 2 in this country, about 50 percent of it is in large

 3 businesses; 14 percent, small businesses; and a third from

 4 universities? Was that --

 5   Dr. Highnam: It's 50 percent in business, of which 14

 6 -- so, 14 percent, overall --

 7   Senator Shaheen: Ah. Okay.

 8   Dr. Highnam: -- then 36 percent, larger businesses; 34

 9 percent universities; and the rest in service labs, energy

10 labs, and so on.

11   Senator Shaheen: So, the rest is from the public

12 sector --

13   Dr. Highnam: Yes.

14   Senator Shaheen: -- then.

15   Dr. Highnam: Yeah.

16   Senator Shaheen: So, if you think about past

17 circumstances in our history, whether it was the Manhattan

18 Project or putting a man on the Moon, can we analyze the

19 sectors that provided that technological innovation, and

20 figure out whether this is the right breakdown, in terms of

21 where AI is coming from?

22   Dr. Highnam: So, the answer is certainly yes. It's

23 not something I've done. But, to comment on that, if I may,

24 the -- this is the research phase. So, we're finding --

25 these investments are not on systems that are in any sense

1   deployable.

2   Senator Shaheen: Sure.

3   Dr. Highnam: But, these are people -- I'm finding them

4   in industry, with really good ideas, who propose to our

5   research programs. And then, as much of this technology

6   evolves, they publish some, they don't publish some,

7   depending on --

8   Senator Shaheen: Right.

9   Dr. Highnam: -- classification, and so on. But, a lot

10 of the time, we want industry to make these technologies, as

11 they are proven to work, to be commercial, to be

12 incorporated into --

13   Senator Shaheen: Right.

14   Dr. Highnam: -- other products that then the

15 Department can buy back. I think that the days are gone

16 when we can think about corralling hundreds of thousands or

17 very large numbers of experts in such a hot technology area.

18 So, we -- this is normal -- DARPA's normal business mode,

19 but I'm certainly going to take your question back for a

20 look.

21   Senator Shaheen: Well, I was just thinking about, How

22 do we encourage more experimentation, more research? And

23 thinking about small businesses. So, if we look at -- small

24 businesses create 16 times more patents than large

25 businesses.

1   Dr. Highnam: Yep.

2   Senator Shaheen: You know, two out of every three jobs

3 are created from small business. So, are there ways we can

4 incentivize small business to do more of that research and

5 innovation that we're looking at to provide the AI that we

6 need? And I would argue that one program that is there that

7 helps do that is the SBIR program --

8   Dr. Highnam: Yeah.

9   Senator Shaheen: -- Small Business Innovation Research

10 program.

11   Dr. Highnam: So, two answers. One -- I'm sorry, it

12 was part of my preamble -- one of the things we've done in

13 our AI campaign is to set up something called AI

14 Exploration. So, in that, we post a topic of interest.

15 Anybody is given 30 days to respond. And it's typically

16 schools and small businesses who do that. And then we award

17 within 60 days after that. So, 90 days from posting to

18 award, up to a million dollars per award, up to about 18

19 months in duration. And we've invested about 45 million so

20 far, since September, in this activity. Because, you're

21 right, this is a lot of the innovation, and this is us

22 exploring in a space and giving them the grounds to do that.

23 We've also recently revamped our small business approach to

24 align it directly with our research programs. We're also

25 encouraging moving directly to phase two. And we also have

1 an innovation accelerator, as well, to advise small

2 businesses on how to take things commercial after they

3 discover it, not just in AI, but across the board.

4   Senator Shaheen: So, are there other policy changes

5 that we should be thinking about to promote -- should be --

6 we be encouraging more set-aside for SBIR programs? Are

7 there other ways in which we can promote AI that we're not

8 currently doing?

9   For any of you?

10   Dr. Highnam: And we're seeing an awful lot of smart

11 small businesses come forward, teaming with schools, teaming

12 with big companies sometimes. So, certainly those in the

13 DARPA -- the larger DARPA ecosystem understand how to work

14 us.

15   Mr. Brown: I think this just emphasizes what you've

16 heard from all of us, the need to work with commercial

17 innovators in –

18   Senator Shaheen: Right.

19   Mr. Brown: -- AI. I saw an interesting statistic that

20 came from Congressional Research Service recently, that, in

21 the 1960s, a third of the global R&D was U.S. defense-

22 related, and now that number is 3.7 percent. So, it just

23 speaks to the need to look outside. And I think what you've

24 heard from all of us -- DIU, that's our mission, so of

25 course you'd expect me to say that, but we heard it from Dr.

1 Highnam, General Shanahan, that we want to work with these

 2 successful innovators outside, and bring that technology in,

 3 because, unlike the Manhattan Project working on one

 4 specific goal, AI is a horizontal technology that is infused

 5 in everything, or will be. And so, that really speaks to

 6 the beauty of the U.S. capitalistic free-market system so

 7 that we can benefit from all that innovation happening

 8 across. And I think our challenge is, Where do we pull that

 9 in, from a talent perspective, technology perspective, and

10 proven use cases? And how do those apply to the Defense

11 Department?

12   General Shanahan: And, Senator, I -- if we -- it's

13 about messaging that -- as been said, AI, unlike any other

14 technology in the past, is been -- the equation has been

15 completely turned around as commercial and not government.

16 The message of -- the United States Government, not just the

17 Department of Defense, has an interest in promoting AI from

18 the smallest company up to the biggest company. And with

19 Project Maven, we had no favorites. Everybody was a player,

20 smallest startup all to the biggest companies in the United

21 States. But, getting the message that we want the business,

22 and if they have their intellectual property to work with

23 the government on, we want to take that.

24   What I don't want to see is some of the best companies

25 in the United States, some of the best intellectual talent

1 we have out there being funded with VC money from places

2 like China. But, if they have to go somewhere, and we're

3 not giving them an opportunity, that's what's going to

4 happen.

5   So, we have a role, I think. It's a very serious role,

6 is to communicate that we're serious about artificial

7 intelligence, we need the capabilities you bring to the

8 table, and the three of us represented here from AI now to

9 AI next, and Mr. Brown in between, sort of going out and

10 doing the pilots and finding the right companies out there,

11 that is a message we need to communicate. And I think part

12 of that, through the executive order on AI, but also the

13 National Security Commission on AI that will come out with,

14 I expect, some very weighty recommendations about a societal

15 change in how we're looking at artificial intelligence.

16   Senator Shaheen: Well, thank you. I appreciate all of

17 those responses.

18   If we're going to continue to be competitive in the

19 rest of the world, then this needs to be part of our

20 strategy. And, you know, if you're correct, Mr. Brown, that

21 -- you know, in our system that unleashes all of this

22 innovation in the private sector, then we should be able to

23 win that competition. But, I think that there are policies

24 that we need to put in place to encourage that, and we ought

25 to think about which ones make sense to get where we want to

1   go.

2   Thank you all very much.

3   Thank you, Madam Chair.

4   Senator Ernst: Thank you. Absolutely.

5   I will wrap up with just a couple questions. And I do

6   want to thank you for the discussion. We've covered a lot

7   of territory, a lot of very interesting territory. I

8   appreciate the discussion on ethics, as well, with lethal

9   autonomous weapons. I think that's something that we need

10 to fully vet and explore even more.

11   But, what I'd like to do is turn back to the more

12 mundane, everyday uses of AI, if we can. And, General

13 Shanahan, you had -- I think, had mentioned some of those

14 uses. Of course, we have companies, like Amazon and UPS and

15 Walmart, and they do use AI for those back-office types of

16 tasks that you had mentioned earlier. Can you walk us

17 through some of those tasks and where we might be able to

18 utilize AI? And not big, sexy topics, but certainly if we

19 can streamline the way we do business within the DOD, I

20 think this would be helpful.

21   General Shanahan: Yes, Senator. It's -- it -- when

22 you talk about smart automation, or, in the vernacular of

23 the industry, "robotic process automation," it's not

24 headline-grabbing, in terms of big AI projects, but it may

25 be where some of the most efficiencies can be found. That's

the case in -- if you read the dailies in industry, whether

it's in medicine or in finance. This is where early gains

are being realized in AI. Some of the other projects we

take on in the Department are probably years in the making

of return on investment. These other areas, I think, will

be much shorter-term return on investment.

What we're trying to do in the JAIC -- when I looked at

this just a couple of months ago, we weren't even

concentrating on this smart automation. I'm now trying to

figure out how I stand up a small office just focused on

that. I don't see us leading that, but it's leading others

to find out how to incorporate these technologies into their

back-office functions.

And I've already met with the Chief Management Officer

of the Department, as well as the Chief Data Officer of the

Department, to have these early discussions. I -- I'm

convinced there will be lots of opportunities in back-office

functions, finance being, I'd say, the first one to take on,

to help augment people. I think people get very concerned,

right off the bat, about being replaced. There's not enough

people to go around, for the most part, so this is about

augmenting people and being able to do much more work than

they were able to do with the tools, which, in some cases,

are far too old, manual, laborious. These are about how to

-- if you see the demonstrations of a bot versus a human

1 doing the same sort of manual task, there's no question who

2 gets to the finish line first.

3   Senator Ernst: Absolutely.

4   General Shanahan: So, we're early in this process

5 right now. But, that's one I'm very interested in taking.

6   Senator Ernst: No, I think that's really important.

7 One of the big discussions that we've had, just in the last

8 year, was the DOD audit, and how do we arrive at a clean

9 audit through such a large -- what I describe as a large,

10 you know, animal. And is it practical to look at an

11 application like that? Would it be helpful to guide us

12 towards a clean audit?

13   General Shanahan: I'd say the answer to that is yes.

14 Scoping it will be the challenge, is finding out how big

15 this is to go after the audit. But, I know the Chief Data

16 Officer, Michael Conlin, is looking at applications like

17 this. There are big decisions made in the Department with

18 data done in a very manually intensive way. If those

19 decisions can be made faster and better, that, of course, is

20 something that the leadership of the Department is

21 interested in.

22   So, the answer to your question is yes. It's a

23 question of understanding the scope and the scale of doing

24 it.

25   Senator Ernst: Very good.

1   And, of course, the inventory purposes, acquisition,

2   program spending, you name it, I think that AI can help in

3   those areas. It has been mentioned, maintenance, as well --

4   predictive maintenance on equipment and aircraft, so forth,

5   would be very helpful, as well.

6   General Shanahan: And, Senator, if I may just add on

7   to the point. Whether it's smart automation or predictive

8   maintenance -- as we're finding very early, the problems

9   themselves are not massive, but the lessons learned are what

10   we're really catching on to.

11   Just one use case of a helicopter, seemingly simple.

12   But, everything we're learning about data management, which

13   would be no surprise to anybody in industry who's dealing

14   with artificial intelligence and machine learning. But,

15   those are what we're trying to collate and bring up to a

16   higher level for the Department about understanding what

17   different standards, policies, authorities need to be in

18   place to make this happen against all the different aircraft

19   in the Department of Defense.

20   And, to your other point about -- I call it a flywheel

21   effect. Once a few people begin to understand what smart

22   automation does, it will catch on. But, nobody believes it

23   yet, because they haven't the benefit of actually seeing it

24   work.

25   Senator Ernst: Absolutely.

1   General Shanahan: But, that's what we have to do, is

2   -- we have to show -- it's the show-me piece. It's -- we

3   have to have people believe it's real, and not just science

4   fiction.

5   Senator Ernst: Absolutely.

6   And with that, I will go ahead and wrap up this hearing

7   today. I do want to thank the members of our panel for

8   being here. And the flywheel effect, it starts here, as

9   well, in Congress, and making sure that we are educating

10   others on artificial intelligence and the applications for

11   our DOD.

12   So, thank you, again, to the witnesses for being here

13   and for educating us on what your jobs entail and how we can

14   better use artificial intelligence. Thank you, gentlemen,

15   very much.

16   This concludes the hearing of Emerging Threats and

17   Capabilities.

18   [Whereupon, at 3:53 p.m., the hearing was adjourned.]

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