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**U.S. House of Representatives Committee on Armed Services
Subcommittee on Intelligence and Emerging Threats and Capabilities**

*Hearing Titled: “Interim Review of the National Security Commission on Artificial Intelligence
Effort and Recommendations”*

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Chairman Langevin, Ranking Member Stefanik, and Members of the Committee, thank you for the opportunity to testify on the initial recommendations of the National Security Commission on Artificial Intelligence, and our continued efforts to develop solutions for the nation’s AI-related national security challenges.

Advancing AI for our national security is a bipartisan topic and priority. AI is no longer a long-term basic research challenge or the domain of our innovative private sector. It is not just critical to our future; it is critical to our present. The United States must get AI right to grow our economy, to protect our security—in the broadest sense—and to benefit humanity. The ethical principles we establish, the federal investments we make, the national security applications we field, the organizations we establish, the partnerships we forge, and most importantly the talent we cultivate will determine our place in a very serious strategic competition with authoritarian great powers.

In our judgment, America needs to lead the world in the development of AI. In that regard, however, we are still not where we need to be as a government, as a partner with the private sector, or as a partner with our allies and like-minded nations in the world. We need a fully funded and fully supported strategy to win the AI competition. And we need to build that strategy as just one component of an even more ambitious strategy for winning a broader technology competition that includes several emerging technologies.

The Commission’s work is as expansive as the task at hand. One quickly becomes entrepreneurial by necessity when examining the intersection of AI and national security. Today, however, we would like to focus on the areas of our work and recommendations that touch directly on this committee, some of which are included in the pending National Defense Authorization Act (NDAA) for Fiscal Year 2021. We also want to highlight some critical talent and workforce issues. We see an opportunity for bold action to build the human capital the government needs to win the emerging technology competition.

Mandate¹

The National Security Commission on Artificial Intelligence (NSCAI) was established by Congress to help define the AI challenge and present recommendations for solutions. We are especially heartened by the bipartisan support that the Commission is receiving from both houses of Congress. That support is reflected in the NSCAI proposals that have been included in the House and Senate versions of the NDAA, and in the broad bipartisan interest in the challenges to be addressed in this hearing. We thank the Members of this Committee, in particular Chairman Langevin and Ranking Member Stefanik, for their leadership in advancing a number of the Commission's recommendations, particularly those focused on developing an AI-ready workforce.

In close collaboration with Congress, the White House and executive departments and agencies, the Commission is working to ensure that the many ongoing U.S. Government efforts in AI are complementary and reinforcing. We have enjoyed equal support from leaders in academia, civil society organizations, and the private sector. They have explained their roles in the AI ecosystem, outlined their concerns, and highlighted opportunities for utilizing AI for national security purposes.

Why AI Now?

Artificial intelligence is a technological reality here and now. The compute power, the data, and algorithms are now available to translate many of the theories of the past into applications today. This explosion in AI capabilities is coming at precisely the right time. We need AI applications to help solve critical issues facing our world including the climate crisis and the COVID-19 pandemic. AI has already proven that it can make our lives and society better in everything from diagnosing disease to improving traffic patterns. The potential is exciting. Nevertheless, we are a national security commission and we are concerned that AI, like all technologies, will create new threats and exacerbate some existing challenges.

The International Landscape

The Commission's work is not occurring in a vacuum. We have a pacing competitor in China with a strategy, resources, and, unfortunately, a determination to develop and field AI for purposes that are inimical to U.S. interests. In this regard, AI is not only an "enabling"

¹ Congress created the NSCAI in the John S. McCain National Defense Authorization Act for Fiscal Year 2019, Pub. L. 115-232, as an independent federal commission to consider ways to advance U.S. development of artificial intelligence, machine learning, and associated technologies to comprehensively address U.S. national security and defense needs.

technology. AI is a strategic enabler in a global competition encompassing military, economic, and ideological arenas. The competition is intensifying. The technological dimensions of the competition have been elevated. AI's centrality to the competition touches on everything from specific military capabilities, to the future of the innovation economy, to the struggle between authoritarian and democratic systems of government.

Using AI Responsibly

We are deeply concerned with the ethical and strategic implications of *who* is employing AI and for what purposes. Looking abroad, we are troubled by how AI is being utilized and has the potential to be weaponized. In this, we are talking beyond the potential biases in AI algorithms and the unknown reliability of AI-enabled systems—vexing technical challenges at the heart of domestic debates about facial recognition, for example. We are instead talking about AI systems that may, in fact, be extremely reliable and work exactly how they are designed to work, but for terrible purposes.

We have to acknowledge the dark sides of this technology and its many potentially harmful applications. We must understand how AI supercharges adversaries' disinformation campaigns, and how it will likely be employed to sharpen cyberattacks. Authoritarian regimes will use AI technologies to try to consolidate power, homogenize thought, and expand control beyond their borders. We must also recognize how the digital infrastructure of the future—especially 5G—could facilitate the spread of these vile uses of AI if it does not include safeguards. We must think about how to defend against such harmful applications and build an international consensus against their use. We must also encourage commercial alternatives that protect core American values—including individual privacy—to provide Americans and the world choices about the technology they will increasingly rely on.

A National Security Imperative

As we address potential threats and harms, we must also capitalize on the promise of AI technologies for our nation's defense and intelligence capabilities. The Commission has found that in important ways, AI will change how we defend the American homeland, how our intelligence agencies make sense of the world, and how our military deters adversaries and fights on future battlefields.

We must grasp the inevitability of AI and apply it to protect the American people and our allies and partners. The utility of the technology is extremely broad. In the context of homeland security, we see promise in applying AI to border protection, cyber defense and critical infrastructure protection, and counterterrorism and counterintelligence investigations. In the

intelligence realm, AI algorithms can sift through vast amounts of data to find patterns and identify correlations, while automating imagery analysis and other labor-intensive tasks. For our military, AI-enabled autonomous systems open up new possibilities for operational concepts and command decision-making that will give us advantages on the battlefield. If employed responsibly, we believe AI-enabled military systems can also help reduce risks to U.S. service members in the field and protect innocent lives in combat.

Guiding Principles

The Commission’s work is guided by seven principles that we believe provide a solid foundation for action.

1. **Global leadership in AI technology is a national security priority.** The U.S. Government retains a core responsibility to steer advancements and make investments in ways that protect the American people and ensure a robust basic research environment. Private sector developments in AI are breathtaking, but federal investment is still necessary to sustain basic research and direct targeted investments for national security purposes.
2. **AI adoption for national security is imperative.** We see no way to protect the American people, U.S. interests, and shape the development of international norms for using AI if the United States is not leading the way in application. The future concepts of operations and capabilities necessary to defend our interests and our allies will be AI-enabled.
3. **Private sector leaders and government officials must build a shared sense of responsibility for the welfare and security of the American people.** The government needs help from industry and academia to maximize the promise of AI and minimize the national security risks posed by AI. Leading private sector developments across the range of applications will have to be “spun into” the government, while the government will have to help private companies—including social media companies—understand the AI threat environment from a national security perspective.
4. **People matter more than ever in the AI competition.** We must cultivate homegrown AI talent and continue to attract the world’s best minds. Talent is the critical variable in the new age of competition. We are competing with strategic rivals and with our partners for the best AI talent. We also need to recognize that building an AI-literate national security workforce is a prerequisite for moving the enterprise into the digital age. As we will discuss below, progress will require some audacious action.

5. Actions taken to protect America's AI leadership from foreign threats must **preserve principles of free inquiry, free enterprise, and the free flow of ideas**. As we have seen recently, the government is taking the counterintelligence threat in technical and academic fields seriously, and it is taking action to protect critical technology advantages in fields like microelectronics. We support calibrated and tailored efforts. At the same time, we must not lose sight of enduring American principles and overly securitize basic research or the private sector.
6. At a basic level we see a convergence of interests and concerns between national security officials and those in the AI development and ethics community. Everyone wants safe, reliable AI systems, and at the same time recognizes today's technical limitations. Disagreements will persist about how to develop and use AI, but we believe there is **common ground that can serve as the basis for productive conversations**.
7. **Any use of AI by the United States must incorporate and promote American values**, including the rule of law.

We do not underestimate the challenge of translating principles into concrete recommendations. Much of the Commission's work is dedicated to analyzing the hard problems and doing the policy engineering to accelerate the government's adoption of AI to protect American interests. That includes designing recommendations to overcome the technical, bureaucratic, and cultural obstacles that prevent private sector best practices and technologies from being used for the national interest.

Commission Progress to Date

The Commission has moved with an urgency that is commensurate with the opportunity and the national security threat presented by AI. AI developments could not wait for a traditional approach to government commission work. We could not retreat for a year before delivering a final report. In coordination with the House and Senate Armed Services Committees, we instead decided to make recommendations over the course of 2020. We saw needs, identified practical solutions, and have made over 80 recommendations so far. Our Interim Report last November articulated a series of initial consensus judgments about the current state of affairs. This year, we began publishing a series of quarterly recommendation memos—and will deliver our third next month. We will deliver our final report to Congress and the President in March 2021. The recommendations cover research and development, national security applications, talent and workforce, promotion and protection of critical technologies, international partnerships, and ethics.

The Commission's View of the FY21 NDAA

We are encouraged to see several NSCAI recommendations reflected in the House and Senate versions of this year's NDAA, and would like to take this opportunity to comment on the importance of legislative action in five key areas. We believe it is crucial for these recommendations to reach the President's desk and become law.

1. Expanding AI Research and Development

Both the House and Senate bills feature encouraging actions on federal government investment in AI research and development, public-private coordination, and establishment of technical standards.² The Commission shares these priorities.

We want to emphasize the importance of creating a National AI Research Resource. There is a growing divide in AI research between “haves” in the private sector and “have nots” in academia. Much of today's AI research depends on access to resource-intensive computation and large, curated data sets. These are held primarily in companies. We fear that this growing gap will degrade research and training at our universities.

We applaud recent investments made by the National Science Foundation (NSF) and its interagency partners to establish seven national AI institutes. This is a significant step toward building a nationwide network that will advance the technology and support the broad application of AI to science and engineering and across critical sectors of society.

A National AI Research Resource would support and complement this effort, democratizing access to AI R&D by removing the high-cost barrier to entry currently presented by large compute resources. It would also fuel research and training within the NSF institutes and more broadly, through access to machine learning-ready data sets, using real-world U.S. Government data. In effect, this would spread AI R&D beyond elite universities and big technology companies, and across many scientific fields. The result would be more distributed R&D infrastructure nationwide—and stronger connections among government, the commercial sector,

² The House version of the NDAA for FY 2021 incorporates the National Artificial Intelligence Initiative Act of 2020 in Division E, which would accelerate federal AI coordination and investment, and stimulate greater public-private partnership and AI standards development. H.R. 6395, The William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, 116th Cong. (2020) [hereinafter H.R. 6395]. The Senate version includes Amendment 2242, which would advance AI research and standards development, grant opportunities, and initiate an AI Scholarship-for-Service program. S. 4049, National Defense Authorization Act for Fiscal Year 2021, 116th Cong. (2020) [hereinafter S. 4049].

and academia. The provision in the House NDAA that would create a task force to plan for such a national capability is a strong step in the right direction.³

2. DoD Organizational Reforms

We have made a number of proposals to ensure the Department of Defense (DoD) is well positioned to excel in the AI era. In particular, we want to emphasize the need for a senior-level Steering Committee on Emerging Technology. This top-down approach would help the Department overcome some of the bureaucratic challenges that are impeding AI adoption. It would also focus concept and capability development on emerging threats, and guide defense investments to ensure strategic advantage against near-peer competitors.

Importantly, we believe this Steering Committee must include the Intelligence Community (IC). A central goal of our recommendation is to create a leadership mechanism that bridges DoD and the IC. This would better integrate intelligence analysis related to emerging technologies with defense capability development. And it would help ensure that DoD and the IC have a shared vision of national security needs and coherent, complementary investment strategies.⁴

We also recommend that the Director of the Joint Artificial Intelligence Center (JAIC) should report directly to the Secretary of Defense—or to the Deputy Secretary, if delegated. As with the senior-level Steering Committee, this top-down approach would ensure that AI applications are prioritized within the Department. Secretary Esper has stated that AI is the most important emerging technology to integrate and employ for advantage over our near-peer competitors.⁵ We believe this reporting structure would drive organizational focus, preserve the Department's initial AI projects, enable their growth, and ensure the Department can develop the capabilities needed to successfully adopt AI applications at scale. The Commission supports the provision in

³ See H.R. 6395, sec. 5107. For our full recommendation, see *First Quarter Recommendations Memo*, National Security Commission on Artificial Intelligence at 12 (Mar. 2020), <https://www.nscai.gov/reports>.

⁴ The House's version of the NDAA for Fiscal Year 2021 would create a Steering Committee, but it would not include Intelligence Community representation. See H.R. 6395, sec. 241. For our full recommendation, see *First Quarter Recommendations Memo*, National Security Commission on Artificial Intelligence at 23 (Mar. 2020), <https://www.nscai.gov/reports>.

⁵ See Deputy Secretary of Defense Memorandum for the Chief Management Officer on the Designation of a Senior Official with Primary Responsibility for Artificial Intelligence (Oct. 2, 2019); Testimony of The Honorable Mark T. Esper, *Confirmation Hearing on the Nomination of Hon. Mark T. Esper to be Secretary of Defense*, U.S. Senate Committee on Armed Services (July 16, 2019), 64, https://www.armed-services.senate.gov/imo/media/doc/19-59_07-16-19.pdf; Remarks by the Honorable Mark T. Esper, NSCAI Conference on Strength Through Innovation (Nov. 5, 2019).

the House NDAA that would make this change.⁶ In addition, we think the JAIC should continue to be led by a three-star general or flag officer with significant operational experience.⁷

3. *Microelectronics*

We believe the United States needs a national strategy for microelectronics. Recent advances in AI have depended heavily on advances in available computing power. To preserve U.S. global leadership in AI, we need to preserve leadership in the underlying microelectronics.

In our initial reports, the Commission has put forward specific recommendations to lay the groundwork for long-term access to resilient, trusted, and assured microelectronics. We propose a portfolio-based approach to take advantage of American strengths and ensure the United States stays ahead of competitors in this field.

These steps should be part of a truly national strategy that would strengthen coordination among government agencies and with industry and academia. The strategy should integrate DoD's requirements and initiatives with actions taken by the Commerce and State Departments, and other agencies. It should promote domestic development of microelectronics, coordination with international allies, and protect against illicit technology transfer to competitors through targeted export controls and investment screening. The strategy would build upon the Defense Advanced Research Projects Agency's Electronics Resurgence Initiative, Department of Energy's (DOE) high-performance computing expertise, and NSF's work at the cutting edge of semiconductor research.

We are encouraged that the House and Senate versions of the NDAA contain a requirement for a microelectronics strategy.⁸ The House's version more closely reflects the Commission's recommendations. It specifically calls for an assessment of the feasibility of a national laboratory focused on microelectronics—a concept the Commission has endorsed. Additionally, the House bill would establish an interagency advisory panel. We believe a strategy led by DoD alone would not be the kind of holistic, national strategy we need.

The United States also faces infrastructure and funding gaps for microelectronics research, development, and commercialization in the public and private sectors—all of which are important for maintaining U.S. leadership in semiconductors. The United States must maintain

⁶ H.R. 6395, sec. 217.

⁷ This recommendation is reflected in the conference report of the Senate Armed Services Committee on the NDAA for Fiscal Year 2021. S. 4049, *National Defense Authorization Act for Fiscal Year 2021 Report*, 116th Cong. at 214-215 (2020), <https://www.congress.gov/116/crpt/srpt236/CRPT-116srpt236.pdf>.

⁸ H.R. 6395, sec. 247; S. 4049, sec. 807.

an innovative domestic microelectronics industry and research base to strengthen the U.S. economy and mitigate the threat posed by Chinese industrial policy and corresponding investments.

This is why the Commission strongly supports the provisions from the CHIPS for America Act (H.R. 7178 / S. 3933) that are included in the House and Senate versions of the NDAA.⁹ These measures would strengthen the U.S. microelectronics manufacturing and research base. Congress should build on this momentum by fully funding these initiatives, and by passing a semiconductor R&D investment tax credit, which the Commission has endorsed.¹⁰

4. Ethical and Responsible Use

Determining how to use AI responsibly is central to the Commission’s work. We recently published a detailed “paradigm” of issues and practices that government agencies should consider in developing and fielding AI. We believe these proposals can help DoD and the IC to operationalize their AI ethics principles.¹¹

Within the government, it is important to develop an understanding of these principles and practices, and an awareness of the risks and limitations associated with AI systems. That is why we recommend that DoD, the IC, Department of Homeland Security (DHS), and Federal Bureau of Investigation (FBI) should conduct self-assessments. These should focus on several issues:

- Whether the department/agency has access to adequate in-house expertise—including ethical, legal, and technical expertise—to assist in the development and fielding of responsible AI systems;
- Whether current procurement processes sufficiently encourage or require such expertise to be utilized in acquiring commercial AI systems; and,

⁹ See H.R. 6395, sec. 1821 and S. 4049, amendment 2244.

¹⁰ For NSCAI recommendation regarding the CHIPS for America Act, see *Second Quarter Recommendations Memo*, National Security Commission on Artificial Intelligence at 67 (July 2020), <https://www.nscai.gov/reports>.

¹¹ See *Key Considerations for Responsible Development and Fielding of Artificial Intelligence*, National Security Commission on Artificial Intelligence at 93 (July 2020), https://drive.google.com/file/d/1_zkNkT3Trz3rtFc8KVrEBNlg2R9MaUpi/view. See also *AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense - Supporting Document*, Defense Innovation Board at 19 (Oct. 2019), https://media.defense.gov/2019/Oct/31/2002204459/-1/-1/0/DIB_AI_PRINCIPLES_SUPPORTING_DOCUMENT.PDF; and *Principles of Professional Ethics for the Intelligence Community*, Office of the Director of National Intelligence, <https://www.dni.gov/index.php/who-we-are/organizations/clpt/clpt-related-menus/clpt-related-links/ic-principles-of-professional-ethics>.

- Whether organizations have the ability and resources to consult outside experts when in-house expertise is insufficient.

If these assessments reveal inadequacies, we hope they lead to further actions to institute reforms. We support the provision in the House NDAA that would require such a self-assessment within DoD, and recommend expanding this provision to include the IC, DHS, and FBI as well.¹²

5. Workforce Reforms

Much of the Commission's early work has focused on building an AI-ready national security workforce. This includes recruiting experts and developers, training end users, identifying talented individuals, and promoting education. If the government cannot improve its recruitment and hiring, or raise the level of AI knowledge in its workforce, we will struggle to achieve any significant AI progress.

In particular, we support several provisions in the current versions of the NDAA. These include:

- Training courses in AI and related topics for human resources practitioners, to improve the government's recruitment of AI talent.¹³
- The creation of unclassified workspaces. This would allow organizations to hire and utilize new employees more quickly, while their security clearances are in process.¹⁴
- A pilot program for the use of electronic portfolios to evaluate applicants for certain technical positions. Because AI and software development are sometimes self-taught fields, experts do not always have resumes that effectively convey their knowledge. The pilot program would pair HR professionals with subject matter experts to better assess candidates' previous work as a tangible demonstration of his or her capabilities.¹⁵
- A program to track and reward the completion of certified AI training and courses. This would help agencies identify and capitalize on AI talent within the ranks.¹⁶

¹² H.R. 6395, sec. 248. For our full recommendation, see *First Quarter Recommendations Memo*, National Security Commission on Artificial Intelligence at 72 (Mar. 2020).

¹³ H.R. 6395, sec. 242.

¹⁴ H.R. 6395, sec. 243.

¹⁵ H.R. 6395, sec. 244.

¹⁶ H.R. 6395, sec. 245.

- A mechanism for hiring university faculty with relevant expertise to serve as part-time researchers in government laboratories. The government would benefit from access to more outside experts. We believe this mechanism should apply not only to DoD but also to DHS, Department of Commerce, DOE, and the IC.¹⁷
- Expanding the use of public-private talent exchange programs in DoD. We recommend expanding both the number of participants in general and the number of exchanges with AI-focused companies in particular. We also recommend creating an office to manage civilian talent exchanges and hold their billets.¹⁸
- An addition to the Armed Services Vocational Aptitude Battery Test to include testing for computational thinking. This would provide the military with a systematic way to identify potential AI talent.¹⁹

Two Bold Workforce Moves

Talent is the centerpiece of any winning AI strategy. The Commission has examined the government's current shortcomings and concluded that we must present a clean sheet approach to building a technology workforce to protect the American people. Existing programs will not bring enough digital talent into public service to meet serious shortages. Scholarship and service programs are limited in scale and will not create a common set of ideas, shared experiences, professional culture, or a common mission to improve the government's digital talent. We must fundamentally re-imagine the way the U.S. Government recruits and builds its digital workforce. In addition to the reforms above, we have made two significant proposals.

1. **Build the U.S. Digital Service Academy:** The U.S. Government should create a United States Digital Service Academy (USDSA) that produces technically educated graduates with a service obligation as civil servants. The USDSA would be an independent entity within the federal government, advised by an interagency board that would be assisted by a federal advisory committee composed of commercial and academic leaders in emerging technology. The academy would be a partnership between the public and private sectors, both working together towards a common goal of developing a modern, digitally proficient workforce.

¹⁷ H.R. 6395, sec. 246 and S. 4049, sec. 216 would apply this mechanism to DoD only.

¹⁸ H.R. 6395, sec. 249 captures our recommendation. For our full recommendation, see *First Quarter Recommendations*, National Security Commission on Artificial Intelligence at 42 (Mar. 2020).

¹⁹ S. 4049, sec. 239 advances a variation of our recommendation. For our full recommendation, see *First Quarter Recommendations*, National Security Commission on Artificial Intelligence at 34 (Mar. 2020).

2. **Establish a National Reserve Digital Corps.** Many of the most talented technologists in the United States are eager to serve their country but are unlikely to become full time government employees or military reservists. The government needs a mechanism to tap this talent reservoir. The government should establish a National Reserve Digital Corps modeled after the military reserves that allows civilians to work for the government 38 days a year as advisors, instructors, and developers. We could incentivize participation with a training and education fund and a scholarship program modeled after Reserve Officer Training Corps or ROTC. While short-term volunteers are not a substitute for full-time employees, they can help improve AI education for both technologists and non-technical leaders, perform data triage and acquisition, help guide projects and frame technical solutions, build bridges between the public and private sector, and other important tasks.

Concluding Thoughts

Winning the AI competition is necessary but not sufficient to win the wider technology competition. AI is the primary enabler of, and the connective tissue in, a constellation of emerging technologies that will shape our future. Congress recognized this when it created NSCAI, wisely giving us the mandate to examine AI and “associated technologies.”

While there is no single, definitive list of which technologies are the most important, a general consensus is emerging in government around AI. The Commission examined five recent lists of emerging technologies critical to U.S. national security offered separately by DoD, the Department of Commerce, the President’s Council of Advisors on Science and Technology, and in the Senate’s Endless Frontier Act (S.3832)—see Figure 1. Each list includes AI as a critical technology, while eight other technologies only appear in a majority of the lists: 1) biotechnology; 2) cybersecurity and data management; 3) quantum computing; 4) semiconductors; 5) robotics; 6) advanced communications; 7) advanced manufacturing; and, 8) hypersonics.

The constellation of technologies and the reality of budget limits presents a complicated equation. We need to consider how each of these emerging technologies will be critical to our long-term national competitiveness and then assess how the government can ensure we lead the way. We will need to place big bets on basic and applied research in several areas. We know calls for a national strategy are easy and frequent. But in this case, we need a comprehensive national technology strategy. AI is a centerpiece in what is really a new era of competition. We will need to understand how developments in one technology will impact others.

It is our mandate to help Congress understand the AI-national security nexus and make recommendations to enhance our security. Our mission is to ensure that the United States retains every advantage in AI so the United States can win the strategic competition. Our commitment is that every recommendation will be made with a deep sense of responsibility for the ethical implications of employing AI. We look forward to working together with Congress, the Executive Branch, the American people, and international partners as we move forward to a Final Report.

Figure 1

Emerging technologies identified in multiple U.S. Government lists of critical technology industries

	<u>2018 National Defense Strategy</u>	<u>DoD List of Critical Emerging Technologies</u>	<u>Commerce ANPRM on Emerging Technologies</u>	<u>PCAST List of Industries of the Future</u>	<u>S.3832 - Endless Frontier Act</u>	TOTAL
Artificial Intelligence / Machine Learning	✓	✓	✓	✓	✓	5
Biotechnology	✓	✓	✓	✓	✓	5
Cybersecurity, Data Storage and Data Management	✓	✓	✓	✓	✓	5
Quantum Computing		✓	✓	✓	✓	4
Semiconductors, Supercomputing, and Advanced Hardware	✓	✓	✓		✓	4
Robotics and Autonomy	✓	✓	✓		✓	4
Advanced Communications Technology / 5G		✓		✓	✓	3
Advanced Manufacturing			✓	✓	✓	3
Hypersonics	✓	✓	✓			3