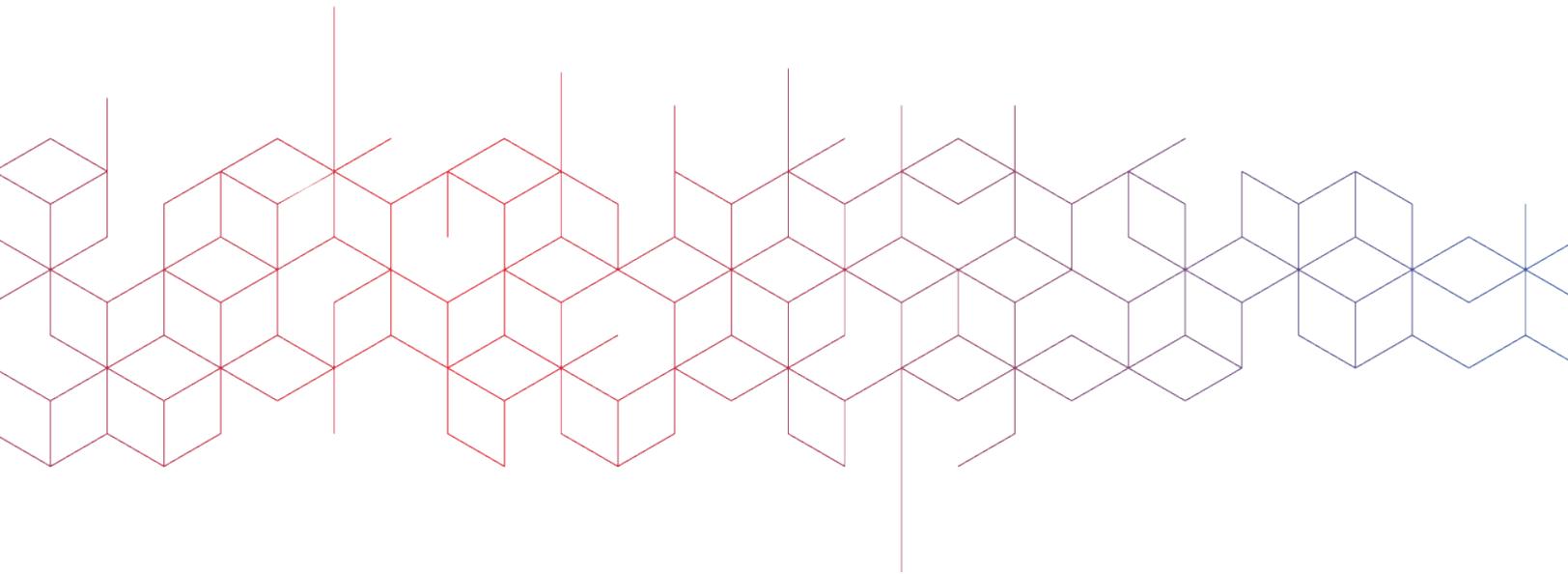


# NATIONAL DEFENSE SCIENCE & TECHNOLOGY STRATEGY 2023

UNITED STATES DEPARTMENT OF DEFENSE



# 2023 National Defense Science and Technology Strategy

SHARPENING OUR COMPETITIVE EDGE

## Introduction

As the 2022 National Security Strategy and National Defense Strategy (NDS) make clear, the United States is in the midst of a decisive decade where the terms of geopolitical competition between the world's major powers will be set. The Department of Defense (DoD) will advance its priorities in three interlocking ways – through integrated deterrence, campaigning, and by building enduring advantages. Accelerated technology advancement and innovation are key elements to achieving DoD priorities through these strategic ways, and to ensure our national security over the long term. U.S. and allied leadership in technology and innovation has long been part of our military advantage. We must take steps to preserve our leadership and counter our competitors who have taken direct aim at this advantage. To respond to this challenge, the NDS calls for “broad and deep change in how we produce and manage military capability...to construct an enduring foundation for our military advantage.”

In accordance with the NDS, our defense science and technology enterprise must “leverage asymmetric American advantages: our entrepreneurial spirit and our diversity and pluralistic system of ideas and technology generation that drive unparalleled creativity, innovation, and adaptation.” Through these asymmetric advantages we will create, analyze, test, acquire, and protect the knowledge and tools needed to meet the three strategic ways of the NDS.

“BUILDING THE FUTURE JOINT FORCE THAT WE NEED TO ADVANCE THE GOALS OF THIS STRATEGY REQUIRES BROAD AND DEEP CHANGE IN HOW WE PRODUCE AND MANAGE MILITARY CAPABILITY. U.S. COMPETITORS INCREASINGLY HOLD AT RISK OUR DEFENSE ECOSYSTEM – THE DEPARTMENT, THE DEFENSE INDUSTRIAL BASE, AND THE LANDSCAPE OF PRIVATE SECTOR AND ACADEMIC ENTERPRISES THAT INNOVATE AND SUPPORT THE SYSTEMS ON WHICH THE JOINT FORCE DEPENDS.”

— 2022 National Defense Strategy

In this Science and Technology Strategy, we establish the ways to sharpen our competitive edge. We will focus on the Joint Mission, create and field capabilities at speed and scale, and ensure the foundations for research and development.

## The Defense Science and Technology Challenge

In the past, the Department's leadership in science and technology provided the United States and our allies and partners with unmatched capabilities. However, advanced science and technology are now available worldwide. Infused with private investment, companies around the world conduct research and development with dual-use commercial and defense applications. These changes in commercial markets have altered the dynamics for who creates cutting-edge knowledge and tools for the military and how countries access them. The DoD must be more proactive with its engagements with the private sector to make the right investments to capitalize on emerging technologies, as well as to preempt adversary attempts to do the same by protecting critical and emerging technologies early in the development cycle.

We must also solve increasingly complex security challenges that involve science and technology. These challenges range from countering cyber-attacks to securing our supply chains, from defending against advanced offensive technologies, to addressing

biological threats. Responding to these complex challenges requires the DoD to not only strengthen its connections to our nation's strong foundation in science and technology, but to also change its internal processes to identify technologies and see them progress through acquisition into fielded capabilities. As highlighted by the NDS, the DoD needs to "overhaul its approach to force development, design, and business management practices," by transitioning to an approach that "incentivize(s) the design of open systems that can rapidly incorporate cutting-edge technologies," and "rewards rapid experimentation, acquisition, and fielding."

Our competitive edge in defense science and technology is built on our global leadership in these fields. This competitive edge is derived from our nation's values, our relentless exploration of the endless frontier of scientific knowledge, our ingenious invention of new technologies, and our industrial application of science and technology to strengthen national security while promoting peace and prosperity.

We will make the necessary adjustments to our internal processes, our engagement with the technological innovation base, and our industrial posture to address the emerging dynamics of this era of strategic competition. Our strategy aligns new mechanisms for supporting research and development with more effective pathways for acquisition and sustainment. At the same time, we will divest from outdated legacy systems and leave behind risk-averse processes. Making these changes will require the enterprise working together to execute on three strategic lines of effort:

- I. **Focus on the Joint Mission:** Invest in information systems and establish processes for rigorous, threat informed analysis that will better enable the Department to make informed choices in its science and technology investments.
- II. **Create and field capabilities at speed and scale:** Foster a more vibrant defense innovation ecosystem, accelerate the transition of new technology into the field, and communicate effectively inside and outside the Department.
- III. **Ensure the foundations for research and development:** Recruit, retain, and cultivate talent; revitalize our physical infrastructure; upgrade our digital infrastructure; and nurture stronger collaboration across all stakeholders.

In every line of effort, we will follow these guiding principles:

**The Purpose of Defense Science and Technology is to Enhance National Security and Influence.** While related to broader work on science and technology, defense science and technology builds enduring military advantages in direct support of national security. Our research and development will always support this core purpose.

**A Joint Mission is a Collaborative Mission.** Any future fight will be a joint fight. The defense science and technology enterprise must collaborate with Office of the Secretary of Defense (OSD) Components, the Joint Staff, the Combatant Commands, the Defense Agencies, and the Military Services to accelerate development of joint warfighting capabilities that address the key challenges described in the NDS. The Chief Technology Officer of the Department of Defense is uniquely positioned to draw together communities across the Department to focus on research and engineering challenges.

**International Allies and Industry Partners are Integral to American Research and Development.** We will expand opportunities to co-research and co-develop with our allies and partners. We will also leverage our broad innovation ecosystem across academia, Federally-funded research and development centers (FFRDCs), university affiliated research centers (UARCs), DoD laboratories, national laboratories, non-profit entities, commercial industry, and other Government departments and agencies.

## Effective Technology Protection is Tailored to Support Military Innovation.

Technology protection is vital to achieving an enduring advantage. While we must accept some degree of risk to catalyze innovation, we must also protect sensitive technologies and military programs from theft, diversion, and exploitation by our strategic competitors. We will build our technological edge using carefully targeted controls and by working closely with our allies and partners to jointly and effectively protect our collective research, development, and innovation efforts, including warfighting concepts and capabilities during joint experimentation.

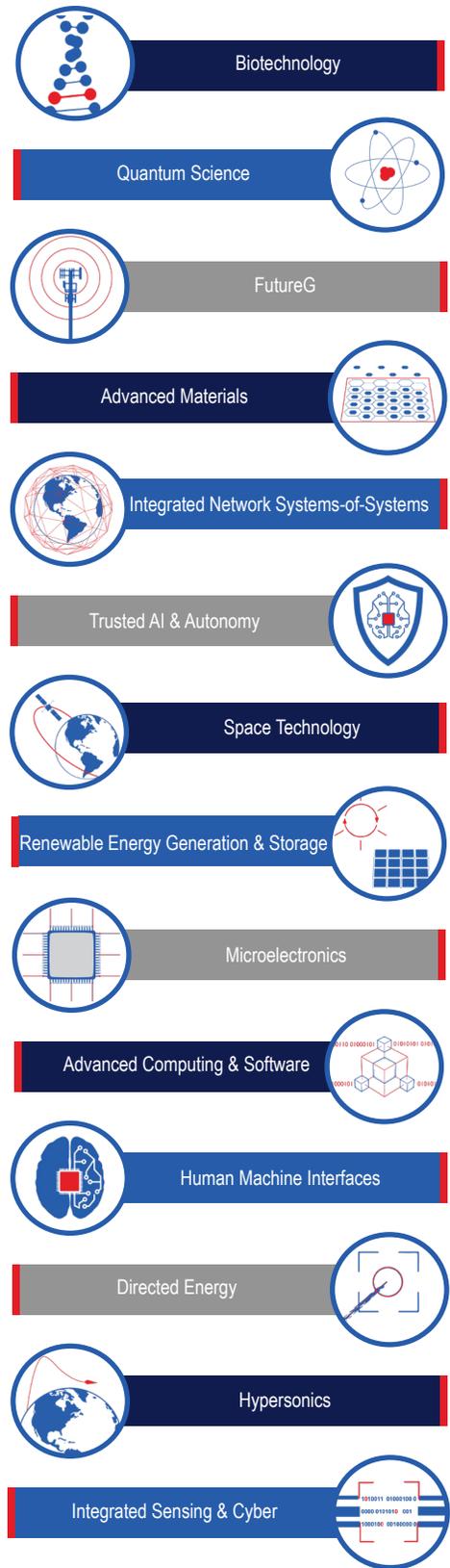
## I. Focus on the Joint Mission

The NDS requires us to “make the right technology investments.” That means making carefully crafted decisions that bolster our comparative advantages rather than engaging in wasteful technology races. Whenever possible, we will place emphasis on developing asymmetric capabilities for the Joint Force. To achieve the objectives of the NDS we must leverage critical emerging technologies.

The Under Secretary of Defense for Research and Engineering’s *Technology Vision for an Era of Competition* and the Department’s *Critical Programs and Technologies List* identify critical technologies to guide and protect investments for the Joint Force. In 2022 the Department designated these Critical Technology Areas to address the key national security challenges the nation faces, including the Department’s pacing challenge, the People’s Republic of China. These Technology Areas are grouped in three categories that represent the broad approaches required to advance technologies crucial to the Department: (1) seed areas of emerging opportunity, including biotechnology, quantum science, future-generation wireless, and advanced materials; (2) effective adoption areas where there is vibrant existing commercial activity, including trusted artificial intelligence and autonomy, integrated networked systems-of-systems, microelectronics, renewable energy generation and storage, advanced computing and software; and human-machine interfaces; and (3) defense-specific areas, including directed energy, hypersonics, and integrated sensing and cyber. By focusing efforts and investments in these Critical Technology Areas the Department will accelerate the transition of key capabilities to the Military Services and the Combatant Commands.

No single critical technology is a stand-alone capability, nor should any recommendation be treated as static. Instead, continuous and rigorous assessment is needed to ensure the Department updates its scientific and technological priorities based on the best available data and analytic capabilities. This will ensure the DoD is focused on the right technologies for strategic competition.

## CRITICAL TECHNOLOGY AREAS



## RIGOROUS ANALYSIS

To build enduring advantages for the Joint Force in a resource-constrained environment, we must establish a methodological process to identify and prioritize investments in capabilities with the greatest potential to meet current and future warfighting needs. Making the right technology investments will require the DoD to harness the analytic power of modeling and simulation to inform our assessments of emerging technologies that have greater operational value. Developing highly accurate campaign-level system-of-systems models and simulations will help us identify capabilities and determine the mission contributions of specific technologies. Integrating physics-based models into campaign-level system-of-systems models will improve the accuracy of our assessments. These robust models and simulations will be coupled with comprehensive technology watch and horizon scanning efforts to inform future critical technology investments.

## JOINT EXPERIMENTATION

Analysis alone cannot improve our ability to fight and win. The DoD will amplify and accelerate its capacity to convert joint warfighting concepts to capabilities through continuous and iterative joint experimentation to advance the NDS goals. The DoD research and engineering enterprise will leverage the best and brightest from the Military Services, the Combatant Commands, the Joint Staff, the OSD Components, and industry to identify promising joint solutions and technologies that are ready to be prototyped and experimented with in the field. These efforts will place particular emphasis on prototyping and experimenting with capabilities necessary to achieve the vision laid out in the NDS.



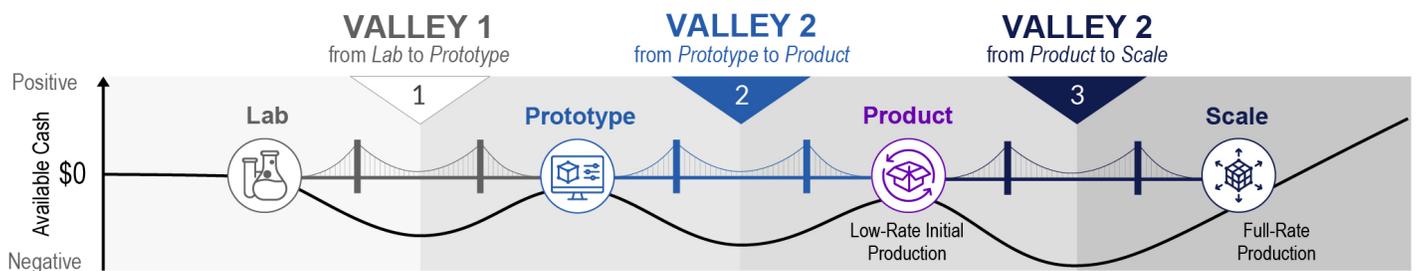
*S.S. Katherine Johnson deployed a U.S. Army Space & Missile Defense Command assured Position, Navigation, and Timing joint capability technology demonstration satellite (NASA)*

# II. Create and Field Capabilities at Speed and Scale

The DoD cannot afford for useful research to languish in the laboratory, for bureaucratic processes to prevent engagement with innovative private companies, or to allow old paradigms to prevent collaboration with some of our most trusted partners. Instead, the DoD will make the changes necessary to foster a more vibrant ecosystem that brings in new partners to grow our research and collaboration base. We will also recalibrate our technology protection paradigms to bring in our most trusted allies and partners, while enhancing protective measures for our critical technologies that contribute to our military advantage. To increase the vibrancy of the ecosystem and enhance the effectiveness of research efforts, we will continuously communicate with our allies and partners to generate more opportunities to collaborate.

We cannot endlessly quest for exquisite capabilities at the expense of pragmatic solutions. The DoD will accelerate the process of turning ideas into capabilities by creating new pathways to rapidly experiment with asymmetric capabilities and deliver new technologies at scale. Doing so requires that we bridge the valley of death between prototypes and full-scale production. We will bridge the valley of death by improving the alignment of research and engineering processes with

# Valleys of Death in Defense Innovation Acquisition



This visual conveys a simplified conceptualization, illustrating key areas where innovative technologies often struggle to reach subsequent stages. Defense innovation is a nonlinear process, with diverging paths for different sources and types of innovation.

acquisition and sustainment processes. This requires closer alignment between research and engineering scientists and engineers and acquisition and sustainment contracting officers and program executive offices, as well as alignment with industry and warfighters throughout. The DoD must foster a more vibrant innovation ecosystem by leveraging teamwork, which includes our allies and partners, research networks, and industry. Bringing our processes and systems into sync will enable the DoD to continuously transition joint solutions to procurement.

## FOSTER A MORE VIBRANT ECOSYSTEM

In keeping with our guiding principles, the DoD will not research and develop military capabilities alone but will instead continue to build upon our vast network of allies and partners to strengthen the competitive advantage our innovation ecosystem provides to the United States. A vibrant innovation ecosystem depends upon clear communication to ensure partners have accurate information and can build complementary processes to enable effective collaboration. True innovation requires novel approaches to challenging problems that often emerge in unexpected circumstances. Fostering a vibrant ecosystem that includes numerous partners and encourages cross-collaboration will create more opportunities for insights to emerge. We will increase partnerships with both traditional and non-traditional members of the defense innovation ecosystem. These partnerships include: academia, FFRDCs, UARCs, national laboratories, the Military Services' Innovation Centers, non-profit entities, commercial industry, other Government departments and agencies, and our international allies and partners. At the same time, we recognize that increasing the number of participants in the innovation ecosystem will increase the associated risk of unauthorized technology transfers, requiring the DoD to take steps to ensure that sufficient technology protections are in place and that partners have demonstrated the ability and intent to protect sensitive and critical technologies.

## STRENGTHENING COLLABORATION WITH INTERNATIONAL ALLIES AND PARTNERS

We know that U.S. strategic advantage in achieving our national security goals and maintaining our technological edge lies in our relationships with allies and partners. We will further strengthen our science and technology defense cooperation with allies and partners through both bilateral and multilateral initiatives, including our North Atlantic Treaty Organization (NATO) allies in the NATO Science and Technology Organization (STO), the Australia – United Kingdom (UK) – United States (AUKUS) partnership, the longstanding “Five Eyes” (Australia, Canada, New Zealand, the UK, and the United States), The Technical Cooperation Program (TTCP) alliance, the Quadrilateral Security Dialogue (QSD) with Australia, India, Japan, and the United States, and new initiatives such as the NATO Defence Innovation Accelerator for the North Atlantic (DIANA).

The DoD will look to expand on these bilateral and multilateral engagements to create new science and technology partnerships with countries that share our values, that innovate to create new technologies, and that are committed to protecting technologies from competitors who seek to erode our advantages. In so doing, we will continue to share our respective priorities and identify opportunities for information and technical exchanges as well as seek opportunities for collaborative prototyping, experimentation, and co-development. Defense science and technology cooperation with our allies and partners will help create more capabilities, increase shared production capacity, and reinforce our shared commitment to, and therefore the credibility of, integrated deterrence.

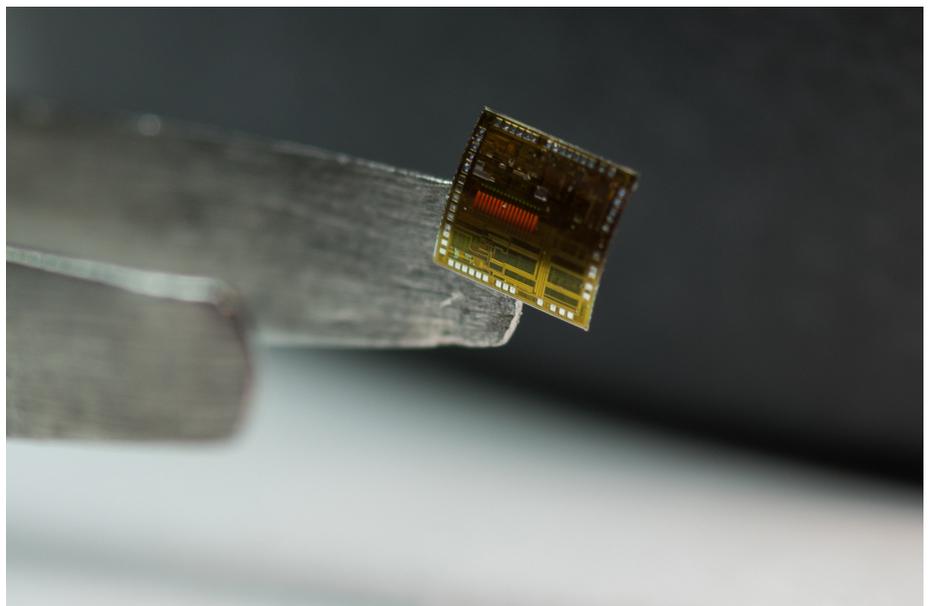
### NON-TRADITIONAL PARTNERSHIPS

We must establish new pathways to apply dual-use technologies that solve national security problems. The Defense Innovation Unit (DIU), the U.S. Air Force's AFWERX, the U.S. Navy's NavalX, the U.S. Army's Rapid Capabilities and Critical Technologies Office (RCCTO), U.S. Army's XTECH, the U.S. Special Operations Command's SOFWERX, the U.S. Space Force's SpaceWERX, and others in the Department all actively engage commercial companies to identify opportunities to leverage their dual-use technologies for military applications. To advance joint solutions, the DoD will develop new processes, procedures, and forums to more closely connect members of this innovation ecosystem to each other. Moreover, the DoD will tap into the innovation potential of our nation's small businesses by expanding engagements with and investments into this community to support their ability to prototype and scale their products into production.

U.S. innovation in some critical technologies, particularly those that have unique military applications, may be underinvested in by private capital markets. Potential market failures make it difficult for the DoD to form partnerships to fund the prototyping of technologies critical to national security. To create the necessary innovation environments for these technologies, the DoD must forge new investment pathways to increase U.S. access to developing defense capabilities. The Department will identify and prioritize technology gaps that are underinvested, up and down the supply chain. The DoD will then partner DoD strategic capital with private capital markets to fill those gaps, increase DoD access to critical technologies, and protect critical industries from predatory foreign investment.

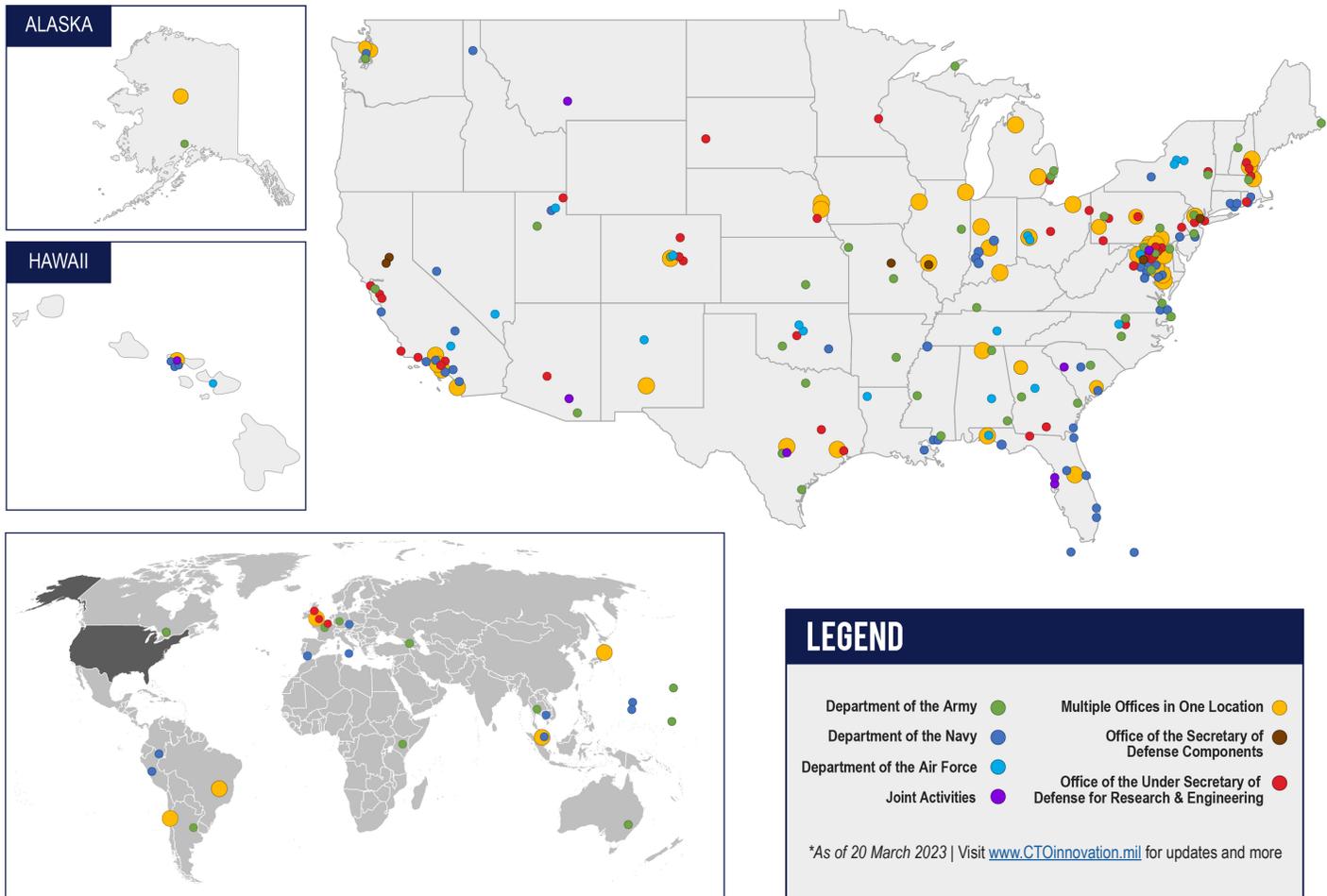
### INNOVATION IN INDUSTRIAL PROCESSES

Building enduring advantages requires not only enhancements to end products but also innovations in industrial production. To improve industrial processes for defense while meeting the current and future needs of the Joint Force, the DoD has established nine Manufacturing Innovation Institutes (MII) as public-private partnerships. These DoD MIIs are focused on advancing manufacturing technologies and processes, building strong supporting ecosystems, and providing advanced



*A flexible silicon-on-polymer chip with over 7,000 times the memory capability of any flexible integrated circuit on the market today (U.S. Air Force Research Laboratory)*

# Defense Innovation Ecosystem



manufacturing education and workforce development. We must build on these efforts to reduce the timelines for producing critical items and significantly increase our ability to manufacture new technologies at speed and scale.

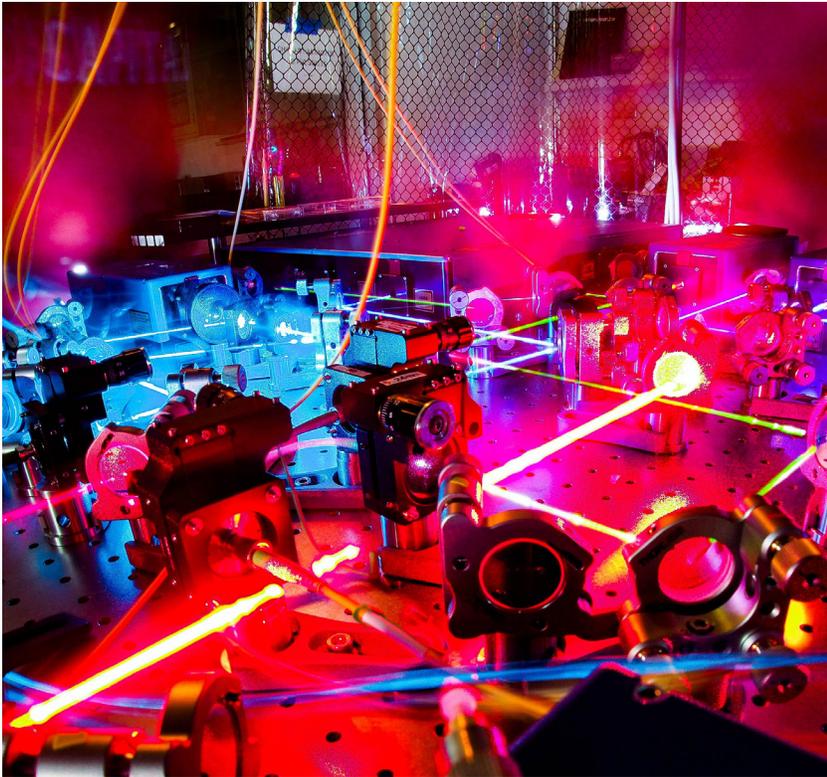
## CONTINUOUSLY TRANSITIONING CAPABILITIES

Transitioning capabilities from research and development into production requires continuous campaigns of prototyping and experimentation to identify capabilities early that provide operational benefit. Rapid innovation is a continuous cycle that demands the DoD evolve its approach to be more engaged throughout the technology transition process. As we experiment with emerging technology prototypes, we will use feedback from end users early and often to find and fix problems and make early decisions to reprioritize resources should a prototype prove non-beneficial. Leveraging this feedback to our advantage, we will accelerate the transition of the technologies that have the most operational value from prototypes into products and prepare for production and acquisition early on.

To fast track this effort, the Office of the Under Secretary of Defense for Research and Engineering will collaborate with the Under Secretary of Defense Acquisition and Sustainment to develop new processes, procedures, and forums to drive close collaboration with the Military Services' and OSD acquisition and sustainment communities to spearhead rapid fielding of capabilities at speed and scale.

## COMMUNICATING CLEARLY

We have multiple audiences to speak with and hear from across the Department, Congress, U.S. Government departments and agencies, industry, academia, allies and partners, and, above all, the American public. Effective



*Quantum computing research in Adelphi, Maryland (U.S. Army Research Laboratory)*

communication is vital to ensuring the vast network that makes up our innovation ecosystem can contribute effectively and collaboratively on the most pressing challenges the warfighter faces and will face in the years to come. Furthermore, communication ensures the DoD receives useful feedback that improves the Department's decision-making on the capabilities it aims to create and field and process improvements to ensure effective partnerships. Clear communication also informs investment decisions by industry and our international partners, enhances technology protection, and increases credible deterrence.

To enhance communication inside the Department we will leverage the convening power of cross-organizational committees such as the Innovation Steering Group (ISG). The ISG was established by the Deputy Secretary of Defense to provide

a forum to elevate discussion of research and engineering issues across the Military Services, the Joint Staff, and the Combatant Commands. The Department will continue to leverage the ISG to drive change through the research and engineering enterprise to better posture the DoD for strategic competition.

Outside the Department we will enhance communication with industry and academia, not only by communicating more, but also by increasing transparency about our core operational problems. The DoD will actively seek to engage with the press, trade associations, academic conferences, and discussions with executives at small, medium, and large technology companies. We will also strengthen our communication with other Government organizations, such as the Department of Energy, the Department of State, and the Department of Commerce, to advocate for DoD equities that enable our objectives of integrated deterrence, campaigning, and enduring advantage to be achieved. We will identify areas of mutual concern as we each tackle shared challenges. The Department will continue to use external advisory groups, such as the Defense Science Board and Defense Innovation Board, to perform independent assessments and provide outside recommendations.

Consistent with our overarching national security interests and this Strategy's guiding principles, we are prepared to accept more risk to share more information with allies and partners who share with us and protect sensitive information. The DoD is actively engaged in efforts to address over-classification with the objective to protect classified information while expanding collaboration with allies and partners.

Finally, signaling to our adversaries is important when it comes to military capabilities. We will continue to use uncertainty to our advantage, complicating our competitors' military preparations. We will also make deliberate decisions about what to conceal and reveal and when to do so, leveraging science and technology to both reassure our allies and deter potential adversaries.

### PROTECTING CRITICAL TECHNOLOGIES

Our competitors are equally aware of the strength of our innovation ecosystem and are actively attempting to acquire technologies from the United States through licit and illicit means. Maintaining our technology advantage requires the DoD to ensure we are taking the appropriate safeguards to protect sensitive technologies and military programs against intellectual property theft and technology diversion and exploitation.

Neither the DoD nor the rest of the U.S. Government can protect technology alone. We must work in close coordination with partners and allies in Government, industry, and academia, at home and abroad. We are confident that America and our unparalleled network of allies and partners can out-compete and out-innovate strategic competitors by taking full advantage of open science, collaborative research, and free enterprise, while at the same time taking steps to ensure our technological advances and innovations do not benefit the militaries of our strategic competitors.



*A student conducts research during a 10-week internship in Washington D.C., part of a summer program administered by the U.S. Navy's Historically Black Colleges & Universities and Minority Institution program (Naval Research Laboratory)*

## III. Ensuring the Foundations for Research and Development

We cannot create 21st century capabilities using 20th century equipment, education, and employment policies. Building enduring advantage requires that we invest in infrastructure and reinvigorate our workforce. To execute Joint Missions in highly contested environments we must test our technology in realistically challenging circumstances. We need to collect and analyze data using modern digital infrastructure. In addition, we need to recruit, retain, and engage the most talented people in the world—both those in our workforce today and in the workforce of the future.

### ENHANCING LABORATORY AND TEST INFRASTRUCTURE

We must make foundational investments in the equipment and facilities required to discover and test new capabilities. Our infrastructure needs to be modernized to enable tests that model the Joint Force's ability to fight through network degradation. We need to have the capability and capacity to accommodate new concepts and new ways of testing that emerging technologies will require. Not only will these investments introduce new capabilities to our infrastructure, they will also help attract and retain the most sought-after talent.

Allies and partners, as well as industry, are integral to our laboratory and testing infrastructure. We aim to provide our most trusted allies and partners broader access to our laboratory and testing infrastructure than ever before, sharing and protecting together rather than cannibalizing scarce resources and talent among ourselves. Working together, we will expand opportunities for facility clearances, increase visibility into our supply chains, fix the weakest links, and ensure the integrity and security of research, development, and manufacturing infrastructure in government, industry, and academia.

### UPGRADING DIGITAL INFRASTRUCTURE

We will continue to modernize our digital infrastructure to improve information sharing and knowledge management. Cloud computing and data sharing will be the norm, in alignment with the Department's *Digital Modernization Strategy*, *Digital Engineering Strategy*, *Data Strategy*, and *Cyber Security Strategy*. Whenever appropriate, we will consult with allies and partners to build shared platforms that advance collaborative research and development.

Technology standards and protocols are core to our digital infrastructure, national security, and economic prosperity. As we upgrade our digital infrastructure, we will reengage in the standards bodies that set technical specifications. We will also encourage industry, academia, and allies and partners to participate in standard-setting more actively. Working with our allies and partners we will continue to shape the international rules of the road.

### CULTIVATE THE CURRENT WORKFORCE

Our people are essential for defense and science technology. The talent and expertise we need are globally distributed, mobile, and highly sought after. To compete, the Department must invest broadly in this workforce and develop technically minded and proficient leaders who understand how to identify talent.

We will also empower our scientists and engineers to grow their knowledge and skills. We will increase collaborative efforts with the private sector, such as the Defense Ventures Fellowship. We will also align more closely with FFRDCs and UARCs, as well as with industry, through programs like the Engineer and Scientist Exchange Program (ESEP). We will modernize training to address technical skills our people need for successful careers in the 21st century. By taking greater advantage of learning throughout the innovation ecosystem, we can more than keep pace with rapid changes in science and technology.

"WE WILL INCREASE THE AVAILABILITY OF FELLOWSHIPS, INTERNSHIPS, AND ROTATIONAL ASSIGNMENTS – INCLUDING IN PRIVATE SECTOR – TO GROW THE SKILLS OF OUR WORKFORCE, PROVIDE A BROAD RANGE OF EXPERIENCES, CREATE COLLABORATION OPPORTUNITIES, AND CARRY BEST PRACTICES BACK TO THE DEPARTMENT."

— 2022 National Defense Strategy

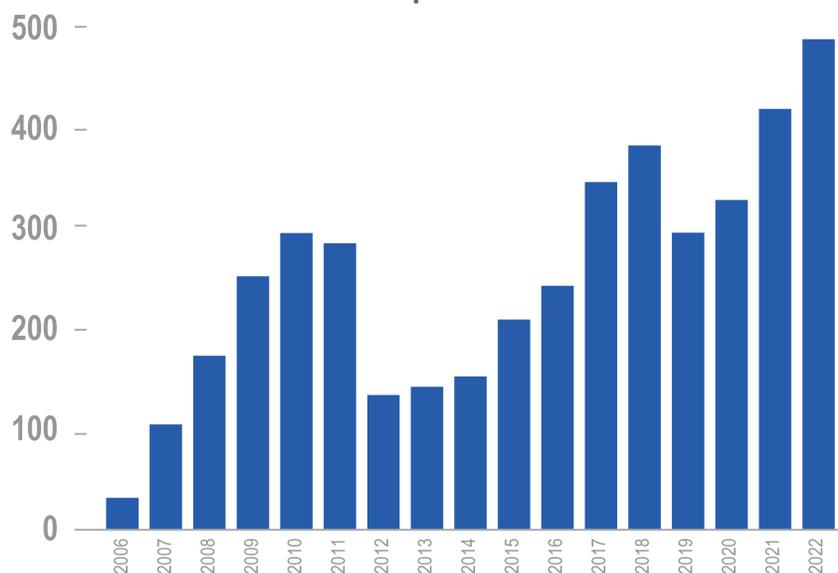
### INVESTMENTS IN THE WORKFORCE OF TOMORROW

Education is another cornerstone for building enduring advantage. We will invest in tomorrow's workforce at every level of education. Building skills at an early age through competition is critical to excite and encourage students to be interested in pursuing careers in science, technology, engineering, and mathematics (STEM). Under programs like the Defense STEM Education Consortium (DSEC), the National Defense Education Program (NDEP), and the Science, Mathematics and Research for Transformation (SMART) Program, we will further invest in our STEM workforce pipeline that is critical to our national security.

## SMART Scholarship PROGRAM SPOTLIGHT

The SMART Scholarship-for Service program aims to bring more highly-skilled STEM professionals into the DoD civilian workforce. This competitive scholarship sponsors students in one of 24 national security-critical STEM fields. Selected students are matched with a relevant DoD facility and awarded a full-tuition scholarship. Each summer, they intern at that DoD facility, learning and building relationships. Upon graduation, they go work at this installation for a period commensurate to their scholarship: One year of scholarship is one year of paid service.

### SMART Scholarships Awarded Per Year



- Over 90% of SMART scholars successfully complete their sponsored degree and service requirement.
- Over 70% have remained in DoD employment after their service requirement ended.
- Over the next 5 years, SMART projects to award ~2,500 scholarships.

## Conclusion

The challenges we face modernizing our defense science and technology enterprise have been decades in the making. Moreover, we now face in the People's Republic of China a strategic competitor with access to cutting-edge research and development and the will to mount a sustained challenge to a stable and open international system. This represents a clear challenge to the DoD's technological edge. Wherever the Joint Force operates in the future, we should expect that the environment will be contested. The need for change is real and urgent. We cannot rest on our laurels or delay.

We will focus on the NDS when identifying and investing in critical technology areas for the future. Working with our allies and partners, as well as industry, we will align research and engineering with acquisition to rapidly field new capabilities at speed and scale. We will also ensure the foundation for future research and development by investing in our people and the infrastructure they need.

Together we will be far stronger.

The Department will act urgently to address the diverse and complex challenges that our country faces to protect the security of the American people, to expand economic prosperity and opportunity, and to realize and defend the values at the heart of the American way of life.