CALL TO ACTION

Recommendations from the Technology Leadership and Strategy Initiative
U.S. Council on Competitiveness
December 2023

The Council on Competitiveness Technology Leadership and Strategy Initiative (TLSI) is a 14-year collaboration among corporate Chief Technology Officers, and leaders of U.S. research universities, national laboratories, and other organizations that advance U.S. science and technology. They explore the frontiers of technology, and the economic, competitive, national security, and societal implications of the multiple technology revolutions unfolding and scaling today. Over the past year, these experts considered the unprecedented speed and scale of today's technological change and the effects on the U.S. innovation system.

This Call to Act reflects their findings and recommendations on what the United States must do to ensure its continued national and economic security, and future prosperity for its people.

Building a New Agile and Adaptive Defense Industrial Base for the 21st Century

Introduction

On June 29, 2023, the Council convened its Summer and 27th TLSI Dialogue, hosted by Lockheed Martin at its Advanced Technology Center in Palo Alto, California. About 35 leaders from technology-intensive industry sectors, universities, national laboratories, and the Federal government came together to explore forces, challenges, and opportunities reshaping the U.S. defense industrial base. Discussions centered around five themes:

- Developing an adaptive and agile industrial base to meet U.S. economic, national security, energy, and sustainability needs;
- Optimizing the growing defense reliance on new knowledge and technology developed in the commercial sector and universities;
- Lowering Department of Defense cultural barriers to increased use of commercial technologies, and reforming acquisition to speed insertion of cutting-edge technology;
- An emerging parallel system for defense innovation; and
- Deploying technology statecraft with strategic allies.

The following are findings and recommendations from the dialogue.

Our inability to transition new technologies into defense systems and to the warfighter quickly is one of the largest strategic threats to the United States today. Rapidly advancing technology is disrupting defense and the defense industrial base. U.S. defense capabilities are being reshaped by emerging technologies and game-changing technology-enabled concepts such as artificial intelligence, machine learning, autonomy, crewed/uncrewed teaming, next-generation communications, spectrum technologies, space, biotech, and digital technologies that weave defense platforms together for different mission applications and changing battlefield conditions. We are

innovating amazing technology across the whole U.S. ecosystem, but it can take years for it to have its intended impact for national security.

In addition, many companies in the commercial sector are benefitting from advanced technologies originally developed to meet defense and space missions. Yet, traditionally, these sectors have been treated as distinct, even as emerging technologies are increasingly dual use, and flow back and forth across the defense and commercial sectors blurring their boundaries. The United States needs to overcome these traditional separations and boundaries to accelerate toward a more competitive, innovative, and integrated industrial base.

The models for defense R&D, acquiring defense technologies, and partnerships with the defense industrial base that worked well in the last century cannot ensure the Nation's national security because conditions have changed. The models must be different.

Recommendation:

- **The defense community and other stakeholders should develop and implement an education and communications campaign to explain to policymakers and decision-makers in national security, science, and technology why the rules, expectations, and metrics surrounding defense technology must change.**

Leadership in many emerging technologies is in commercial firms, high-tech start-ups, universities, and national laboratories. The commercial sector is moving so fast, and the investments are so big, the defense industry cannot keep up. The Department of Defense and defense primes must reach into innovating commercial firms, small businesses, and start-ups to bring advanced technologies to military systems.

China's Military-Civil Fusion national strategy reflects this new reality, and seeks to eliminate the barriers between China's civilian research and commercial sectors, and its military and defense sectors. It is working to systematically reorganize the Chinese science and technology enterprise to ensure that new innovations simultaneously advance economic and military development.

New U.S. models are emerging in an effort to accelerate the fielding and scaling of new technologies in defense. For example, DARPA is experimenting with harvesting new technology and capabilities coming out of long-running programs, operationalizing and transitioning them; demonstrating new technologies in operational military units and commands, and leaving a residual capacity; and embedding seasoned entrepreneurs with R&D project performers that have met technical goals and have something of high interest to national security. Emerging models could be tapped for increased speed in the technology areas where we cannot afford to fail.

Recommendations:

- **The Department of Defense should open competition to more players, including commercial firms of all sizes and non-profits, which can produce creative solutions, lower costs, and speed**

development. For national security, we must integrate and apply the different capabilities and skill sets of commercial firms—including start-ups and small businesses—defense primes, universities, and the venture capital community, enabling each to do what they do best.

- **The Department of Defense could encourage the use of commercial providers by requiring a waiver if there is a desire to exclude non-traditional providers in favor of a supplier that already has a contract in place.**

- **The United States needs to leverage organizations that touch both the defense and commercial worlds. For example, a commercial company may not want to work with the government or the Department of Defense, but may be willing to work with a defense prime that is set up to work with government.**

- **The Department of Defense needs to use the authorities it has and emerging models to drive partnerships that can create agility and speed. This includes broader application of Other Transaction Authority, partnership intermediaries, consortia, defense venture funds, and the use of non-profit foundations.**

- **Instead of waiting for technology on the shelf from commercial firms, defense serving organizations should take key problems to commercial firms, and let them consider if solving the defense problem is worth their investment in building the infrastructure or manufacturing capability that would be needed. When there is both a defense and commercial market potential, commercial-government partnership can be successful.**

- **To expand competition beyond firms working at high levels of system integration, the Department of Defense could reduce the level of integration for more competition at a lower level in the technology stack.**

- **For Department of Defense programs of record with defined roadmaps, an analysis of alternatives every five years should be built into the acquisition process to assess the potential for new options and capabilities presented by new technology advancements.**

- **Emerging models for accelerating the fielding of new technology in defense systems should be examined for their potential for broader use.**

The Federal acquisition, contracting, and program management culture creates a bias that inhibits risk taking, use of new partnership approaches with the commercial sector, and acquiring technologies outside of the Department of Defense, its traditional contractor base, and the United States. The culture has arisen from a complex of rules and regulations, policies, practices, controls, and metrics—focused on cost savings, risk avoidance, and technically acceptable solutions—and a low tolerance for failure. Embedded in the organizational DNA, the culture impacts decision-making about innovative approaches to partnership with commercial companies. If freed of this culture, contracting officers could apply their mastery of the rules as an enabler, rather than as a barrier.

Recommendation:

- **To encourage new models and partnerships in defense programs, develop program manager training and certification that provide greater authority and flexibility in negotiations, decision-making, and program implementation**.

The Department of Defense has made significant efforts to open the aperture to innovating small businesses and start-ups through initiatives such as DIU, AFWERX, SpaceWerx, NavalX, and SOFWERX. However, friction all around doing business with the Federal government creates barriers that inhibit the ability of small businesses, start-ups, and non-profits to engage with the department. These include export controls, getting clearances, DFAR compliance, accounting rules, lack of access to key classified data, cost sharing requirements, and caps on salaries, pay raises, and overhead.

Government is not an attractive market for many small business. Delays in the acquisition process, and uncertainties about steady funding and future government purchases raise the market risk for small businesses and start-ups that lack the large markets and deeper pockets of defense primes. For small businesses that might engage in defense research and technology projects, there is no support for longer-term transitions, for example, moving to Technology Readiness Level-5 (TRL) and above, and transitioning to a service or program of record.

Recommendations:

- **Defense primes and other large companies should work with small businesses to show them the pathways for longer-term transitions, how to engage the services, and how to insert innovations into defense research, development, and engineering programs of record**.

- **Defense primes and other large companies could serve as strategic partners and corporate investors in small business ventures. The corporate partner could provide resources and capital, and allow the entrepreneurial culture to flourish in the small business venture.**

- **The Department of Defense should articulate pathways and provide support for small businesses moving their innovations to TRL-5 and above, and transitioning them to a service or program of record**.

- **For small businesses, the Department of Defense should make greater use of contract types that do not require cost analysis and compliance with DFAR overhead requirements**.

Many small business working with the Department of Defense will fail, few will scale, and their technologies could be lost. In FY 2021, small businesses accounted for more than three-quarters of the research and development companies doing business with the Department of Defense, many working on promising technologies.[1] This risks a fragile and less resilient defense industrial base.

[1] Small Business Strategy, U.S. Department of Defense, January 2023.

Recommendations:

- **The Department of Defense should make greater use of knowledge in the rich community of experience in the venture capital world to better understand the capabilities and sustainability of small high-tech businesses in which it may wish to engage.**

Gaps remain in financing for the development and scale-up of technology needed in defense. Different segments of the community that fund technology development and commercialization—venture capitalists, private equity, companies that want to license technology, and companies that want to take a product to market—look for different types of opportunities.

For example, venture capital plays a limited role because most technology opportunities in national security are not big enough to attract venture capitalists, and will not generate an adequate return on investment. Very few university spin-outs receive venture capital funding, and there is a high spin-out failure rate. A dual-use opportunity for both a commercial and defense market may generate venture capital interest. However, timescales matter—developing technologies for defense often takes a long time, while venture capitalists look for technologies that can be monetized and scaled quickly.

The Nation lacks tax structures and financial incentives that encourage investment in certain critical technology areas. And, typically, the Federal government can fund only a small number of the proposals it receives in response to a research or technology-related RFP. But, in a constrained budget environment, the United States cannot shotgun spread investments in all technologies.

In addition, universities and Federal labs often file for a U.S. patent only with no protect rights outside of the United States. This limited intellectual property protection is a disincentive for private investment.

Recommendations:

- **The Federal government should map these funders scope of operation, identify the gaps, and develop options to fill them.**

- **Making more information available about small businesses that respond to Federal government RFPs but do not receive a grant or contract could potentially draw investments from private venture funding.**

- **Industry, academia, and government need to identify which technologies are a priority for national security and future competitiveness, and direct tax incentives toward their advancement and scale-up.**

- **To attract private investment in innovations with high commercial and national security potential, universities and Federal laboratories should file for patent protection outside the United States, in addition to U.S. patents.**

Universities could play a larger role in national security, defense technology, and industrial base strength, but are not geared toward research translation and technology commercialization. Universities create a lot of intellectual property, some of which can be applied to military systems. However, the academic research culture does not prioritize patenting, translation, technology transfer, or commercialization. Faculty incentives, such as promotion and tenure criteria, are around publication, winning grants, and peer recognition.

Recommendations:

- **Universities should rethink promotion and tenure criteria to place greater emphasis on translation and commercialization of research.**

- **To drive a shift in the university research culture, marquee Federal research sponsors could place greater emphasis on working with industry, technology translation, and commercialization in their R&D grant programs. In addition, universities should undertake efforts to demonstrate to faculty how their research can be put to use by society through commercialization.**

- **The Department of Defense and defense primes are reaching into universities in new ways, for example, through the University Consortium for Applied Hypersonics and Acquisition Innovation Research Center focused on data science. These models should be considered for more widespread use.**

- **Universities should consider developing patent portfolios around technologies that reflect their strengths, align faculty clusters to those strengths, and make those known to industry and companies in sectors that could potentially benefit from that expertise and technology. It would also demonstrate global leadership in the field, attract collaborators from industry increasing translation and commercialization opportunities, and augment the university's competitiveness in winning research grants.**

- **The Department of Defense should establish a program to enable university faculty to go to an operational military base to experience first-hand how things get done. Faculty can then bring that knowledge back to their research groups and graduate students to help them understand the real world in which their potential innovations could contribute.**

- **Faculty members should spend time at a start-up to better understand how research and technology is used, the market, and entrepreneurial pathways. They can then bring that start-up experience into view for their research groups and graduate students.**

- **Universities should make it easier for faculty intellectual property creators to advance, translate, and commercialize technology.**

- **The Federal government should consider incentivizing university technology transfer offices.**

- **Community colleges should develop training programming to develop U.S. citizen quantum computer programmers.**

Commercial firms and universities serving defense need greater access to restricted defense data to train AI systems and perform data analytics projects. China is a highly instrumented society, and the government has close relationships with industry through which they share data sets and sources for AI training. In contrast, the United States is disadvantaged in our current structure, which could have an impact on future U.S. competitiveness, both economically and militarily.

Recommendations:

- **The Department of Defense should experiment with new models, including: providing limited data access for proving concepts or value; using a consortium model in which U.S. citizen participants are provided access to public and restricted government data; democratizing enough data and providing incentives to the broader industry to prove what is possible, but then allow companies paying the burden DFAR compliance, such as defense primes, to use that data and create their own intellectual property.**

- **To the extent feasible, the Department of Defense should provide classified networks needed to enable the defense industrial base and defense primes to work on defense projects with each other and within their own companies.**

- **The Department of Defense should establish a data ombudsman to adjudicate and lower barriers to access to government data.**

The strategic geopolitical landscape has changed. The United States should cooperate with its allies to build strategic capabilities, strengthen our readiness and capacity against threat, and to address critical supply chain issues, not just in defense but on a national scale. In many key technologies, government does not own the technical edge and you cannot advance technology for national security in those domains without working with the top researchers and developers in the global scientific community. The United States should collaborate more with its allies in key areas of critical technology, especially in the game-changers for defense and where allies have capabilities that exceed U.S. capability.

Recommendations:

- **For technologies that are most important for national security and future competitiveness, the Federal government should partner with allied governments for bilateral exchanges of knowledge and technologies to strengthen both countries national defense capabilities, and learn what is successful in other countries. The government could consider forming international technology hubs in partnership with strategic allies. Congress should authorize and appropriate funds to support these research collaborations.**

- **Companies in the defense industrial base should engage other countries to identify promising ideas that could contribute to U.S. national security.**

Reshaping the U.S. Innovation Ecosystem for an Era of Rapid Technological Change

Introduction

On September 21, 2023, the Council on Competitiveness convened its Fall and 28th Technology Leadership and Strategy Initiative (TLSI) Dialogue, hosted by the U.S. Department of Energy's Lawrence Livermore National Laboratory in Livermore, California. About 20 leaders from technology companies, universities, and national laboratories gathered to explore the issues, challenges, and opportunities shaping the U.S. innovation ecosystem. Discussions were centered around three key themes:

- Changing the Culture of Research and Innovation Ecosystems
- Enhancing the Innovation Workforce in Critical Technologies and Industries
- Building Innovation Ecosystems through National Domestic Strategies

The following are findings and recommendations from the dialogue.

The siloed roles of government, industry, and universities in the U.S. innovation system may be antiquated for a broadening view of national interest. Universities are viewed as fundamental research drivers, the commercial sector is focused on winning markets, and the government is generally confined to mission and national security related research and technology development.

Each sector can contribute to advancing technology at different points in its development, maturation, commercialization, and deployment, but collaboration between these contributors can ease and accelerate the process. In addition, research can go from fundamental to commercially applicable very quickly. As the research or technology is deployed, additional research, problem solving, and troubleshooting may be needed.

Recommendations:

- **University faculty performing foundational research should be open to pre-competitive conversations about their research with potential users, especially those developing technologies and solutions for national security.**

- **The Federal government should anticipate some research investment may be needed at the deployment stage, providing flexibility to solve problems that may arise.**

Many current technology investments and projects are "push" rather than "pull"—prioritizing basic research, developing technologies, and determining use cases and the market landscape afterwards. This approach extends the time it takes to deploy new technology as additional work and

investment are needed to translate research or emerging technology for application to a specific need, problem, or market opportunity.

Recommendations:

- **The Federal government, and its partners in research and technology, should define pressing problems or needs, mobilize a community of people to solve it, and align R&D and program investment. This could help identify the potential for a robust market for the private sector as well as address significant government missions, and national economic and security needs.**

- **The United States should identify specific areas of science and technology in which collaboration with allies would bring critical knowledge, expertise, and investment to the table.**

- **A use-inspired approach does not exclude performing further foundational research. Basic research is critical for creating the new knowledge needed in the long run to solve problems and meet future national needs, but should be connected to the innovation ecosystem to maximize its impact.**

While the Federal government is increasingly engaged in pilot and demonstration projects to de-risk technologies, projects often do not move toward adoption and scale quickly, lacking the speed of commercialization and returns on investment needed to attract private investment. De-risking is crucial for securing private investment to bring new technologies to market, and the national environment is increasingly focused on deployment at scale. Pilots and demonstrations help establish an emerging technology's technical feasibility, capability, and the economics needed to justify further investment. However, after a Federally-supported pilot or demonstration, the private sector or venture capitalists may not see a technology that can be commercialized fast enough to generate an adequate return on the investment needed to bring the technology to market and scale.

Recommendation:

- **The Federal government should seek buy-in from the beginning of pilots and demonstrations through partnerships between government, researchers, industry, and other non-governmental partners. Early engagement can help researchers better understand industry problems and needs, identify potential applications and industry uses early, provide mechanisms for cost-sharing the de-risking of precompetitive technologies, while industry partners can plan for commercialization and deployment.**

Although technology development and translation are vital to national and economic security, this narrative is not prevalent in the national conversation.

Recommendation:

- **Government, universities, and the private sector must all play a role in articulating the need for these investments, emphasizing their value for security and global competitiveness.**

The culture at many U.S. research institutions is not well aligned with research translation, technology transfer, or collaboration with business for commercialization. Typically, research university culture favors basic exploratory research, and faculty incentives—such as decision criteria for promotion and tenure—focus on research grants received, peer recognition, and publication, rather than rapid translation of research to practical application, useful technology, and innovation. Moreover, industry is changing so rapidly, universities often cannot keep pace because the timescale at which they change is much slower.

Recommendations:

- **The culture at U.S. research institutions needs to shift toward more use-inspired research and prioritize speed of technology development and deployment. The promotion and tenure process should incentivize different kinds of activity, including translation and commercialization.**

- **Federal research funders can play a pivotal role in changing university culture by promoting translation as a priority for gaining grant awards and other support. Several Federal programs are starting this process, including the National Science Foundation TIP Directorate, DARPA, ARPA-H, and others.**

- **Matchmaking systems could pair researchers interested in translating and commercializing their research with MBAs and business professionals.**

- **The university should provide opportunities for faculty to learn start-up skills and the basics of business and markets.**

Translating research into technology, solutions to problems, and impact does not necessarily need to come in the form of traditional commercialization. Non-commercial, community pathways can also be a valuable way to translate and deploy research and new technology, and bring problems and opportunities to the research community. Cooperative extensions are a proven model providing both commercial and non-commercial pathways to move new knowledge and technology into the broader innovation ecosystem and community of users. They have long been key for translation in sectors such as agriculture, and could be considered for other sectors and problems such as climate resilience.

Recommendations:

- **Reframing the translation narrative to a broader concept and changing incentive structures could encourage faculty to engage in more translational activities.**

- **Cooperative extensions should be expanded across other industry sectors and potential user communities. They can help connect faculty members to local businesses, community organizations, interest groups, and citizens, disseminating new knowledge and technology,**

providing practical education, and translating research results into language appropriate for targeted audiences. Research faculty can hear from businesses and the community of potential users about how to improve research and future research priorities, enhancing researchers understanding of the needs of local industries and other communities. Community organizations, industry partners, and local government agencies can identify where infrastructure investments as well as education and skill building efforts are needed.

Many communities and regions in the United States are under tapped or not part of the national innovation ecosystem, lowering the U.S. capacity for innovation and leaving large swaths of the country behind. Bringing these communities into the innovation economy presents a massive opportunity for new specializations, increased national capacity, and a more agile national system. A concentration of innovation assets—talent, research capabilities, educational capacity, and economic opportunities—are crucial for building local innovation ecosystems.

However, capturing this opportunity brings many challenges, including building strong local workforces, sustaining funding for research, and building supporting infrastructure. Obtaining funding is often difficult and resource-intensive, and maintaining the steady stream of funding necessary for innovation ecosystem development is even harder. However, many state and local governments lack a compelling narrative about the value of these investments.

The pandemic has resulted in a greater diffusion of high-skilled and technology workers. In regions that are not participating in the innovation ecosystem or need skilled workers to scale the technologies being developed by Federal laboratories and universities in the region, smaller talent concentrations can become seedlings to create new innovation districts and ecosystems.

Branding can be an issue. Despite its many attractive features, the Midwest has been branded the "Rust Belt" or "flyover country," making it hard to attract people. Pittsburg has struggled with the same image issue, for example, as students consider attending world-class Carnegie-Mellon University, they have a negative perception of Pittsburgh.

Recommendations:

- **Universities should develop a new narrative to bolster support for state and local investment in university research, R&D infrastructure, and programs aimed at translation, deployment, and commercialization.**

- **Communities should consider encouraging the physical co-location of innovation assets, for example, by building innovation districts.**

- **Regions should consider cost-sharing investments to establish large-scale infrastructure shared by universities and their industry partners. This resource-sharing approach could be applied across different sectors and areas of technology.**

- **Regions with nascent high-skilled labor concentrations and rural areas should address infrastructure problems such as broadband connectivity to help grow the high-tech labor pool, access remote workers, and enable new people to join the innovation workforce.**

- **To burnish their images, regions should undertake efforts to share positive stories about what is happening in their communities.**

Growing the workforce required to scale emerging technologies is a challenge, posing a significant barrier to innovation and U.S. leadership in critical and emerging technologies. Ensuring the United States has the workforce it needs to develop and deploy emerging technologies at scale with speed requires strengthening the talent pipeline across the entire education and training continuum. This will require national, regional, and local efforts.

In addition, the population in many U.S. communities and regions is disconnected from the innovation ecosystem. Many people fear and are antagonistic of the potential impacts of new technologies such as artificial intelligence, and the change forces shaping the future, also disconnecting workers who can be trained, retrained, and energized for the future economy. Yet, building a highly skilled workforce can help revitalize physical communities, strengthen the innovation ecosystem, and build new opportunities for workers.

In both the public and private sector, leaders and decision-makers are often unable to keep up with the pace of technological change. Knowledge around the technical aspects and capabilities of new technologies often become separated from the people who are overseeing and making decisions about technology-related programs.

Recommendations:

- **Government leaders and universities in regional communities should engage in a positive reframing of the role of technology in the economy and creating exciting new career opportunities for workers.**

- **Provide current and future workers with a strong baseline of scientific and technical knowledge. STEM education, particularly at the K-12 level, is critically important to provide the foundation of knowledge, and to nurture more engaged students capable of progressing through higher education and their careers.**

- **For incumbent workers and new workforce entrants who do not have a college education, institutions of higher learning should play a role beyond their typical student through community college partnerships, certification programs, or grassroots engagement.**

- **Executive education programs may be needed to arm leadership across government agencies, universities, industry, and other organizations with the information necessary to understand emerging technology-related issues and make good decisions. This is an area where universities**

and their faculty can be invaluable.

- **The National Science Foundation's Established Program to Stimulate Competitive Research (EPSCoR), which aims to enhance research competitiveness of targeted jurisdictions, could be leveraged to catalyze workforce development in critical areas of technology and innovation.**

In the United States, there is a negative public perception about science and engineering, especially among youth. Popular culture often does not portray scientists and engineers as aspirational, rather often as TV characters to laugh at. Young people do not commonly view STEM careers as a positive social status indicator; they want to be social media influencers. Changing the narrative, especially among children, to promote science and engineering will be critical to maintaining a high technology and innovation workforce for the future.

Other nations have used popular culture as an avenue for workforce development; in Korea, there is a nursing shortage, so the media created several television shows centered around positive depictions of nurses; Taiwan launched a similar campaign for manufacturing.

Moreover, at education institutions—from K-12 to post-graduate programs—science and engineering are often taught in a non-enjoyable manner, focusing on technical jargon, mathematics, and complex theories. Few teachers are armed with the skills and experience to teach practical, exciting, and enjoyable science and engineering courses that can inspire and engage students to delve further into the fields.

Recommendations:

- **The Nation needs media images and content that portray scientists and engineers as heroes to inspire children, especially at a young age.**

- **Immigration represent a promising pool for developing a high-tech workforce as many immigrants can change their economic and social status by working in STEM-related careers.**

- **Change the culture around STEM education to emphasize inclusion and arm instructors with the skills to better engage their students to encourage more people to pursue STEM careers.**