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# 21<sup>ST</sup> CENTURY INDUSTRIAL BASE

## FOR NATIONAL DEFENSE

### Final Report



DEFENSE SCIENCE BOARD

February 2025

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This report is a product of the Defense Science Board (DSB). The DSB is a Federal Advisory Committee established to provide independent advice to the Secretary of Defense. Statements, opinions, conclusions, and recommendations in this report do not necessarily represent the official position of the Department of Defense.

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DEFENSE SCIENCE  
BOARD

OFFICE OF THE SECRETARY OF DEFENSE  
3140 DEFENSE PENTAGON  
WASHINGTON, DC 20301-3140

## MEMORANDUM FOR UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING

SUBJECT: Defense Science Board Report on 21<sup>st</sup> Century Industrial Base for National Defense

I am pleased to forward the final report of the Defense Science Board (DSB) study on *21<sup>st</sup> Century Industrial Base for National Defense*. This report examines the current defense industrial base (DIB), considering current economic and security pressures, as well as events from recent history, to understand whether it can meet both foreseen and unforeseen needs in future conflicts.

The Russian invasion of Ukraine and subsequent fighting offers a reminder that prolonged warfare at scale applies unique pressure to industrial bases that has not been experienced within the United States since World War II. By tracking the development of industry since the last full-scale industrial mobilization, this report demonstrates that economic and structural trends demand a different approach to evaluating capacity for military research, development, and production. The Department and the nation as a whole would be better served by adopting the concept of a National Security Industrial Base that encompasses the broader commercial sector's capacity in addition to traditional defense contractors (as well as those in allied and partner nations).

Demonstrating the full capacity of the National Security Industrial Base will be key to deterring major conflict going forward. As long as potential adversaries understand that the United States is prepared to turn the whole of its economy toward wartime production, if necessary, they will be far less motivated to take courses of action that demand it.

The observations, findings, and recommendations within were approved by the full DSB after thorough discussion and deliberation. I fully endorse all the study's recommendations and urge their careful consideration and adoption.

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Dr. Eric D. Evans  
Chair, Defense Science Board

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DEFENSE SCIENCE  
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**MEMORANDUM FOR THE CHAIR, DEFENSE SCIENCE BOARD**

SUBJECT: Report of the Defense Science Board (DSB) 21<sup>st</sup> Century Industrial Base for National Defense

The final report of the *21<sup>st</sup> Century Industrial Base for National Defense* study was approved by the Defense Science Board. It adopts a historical approach to the topic, covering World War I, the interwar period, World War II, and Cold War conflicts to better understand how the U.S. industrial base has developed over time. Most central to this story is the end of the Cold War, in which “the Last Supper” saw a winnowing and consolidation of major defense firms, bringing about what is now understood as the defense industrial base.

In the decades since, many companies that previously engaged with both the defense and commercial sectors in a meaningful fashion were no longer able to compete with defense-oriented prime contractors. This state of affairs has impeded innovative companies from engaging with the DoD, which, among other issues, obscures the true capacity of industry that must be mobilized during major conflict. As the United States has not been forced to make such a decision since World War II, it is imperative that the government maintain a comprehensive understanding of what resources can be employed for national defense if needed. This includes commercial and academic institutions conducting key research, and necessarily considers the capabilities, capacity, resources, and information flow from allies and partners.

We describe this broader body of industrial and research capacity as the National Security Industrial Base. We describe its development, identify the elements necessary for the NSIB, and describe steps needed to accomplish its formation.

A handwritten signature in black ink, appearing to read "William Schneider".

Dr. William Schneider  
Study Co-chair

A handwritten signature in black ink, appearing to read "B. Lambert".

Mr. Brett B. Lambert  
Study Co-chair

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# DSB Study on 21st Century Industrial Base for National Defense

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## DSB Study on 21st Century Industrial Base for National Defense

### Executive Summary

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The industrial base of the United States and its allies and partners underwrites collective capacity to deter or, if necessary, defeat an adversary's coercive threat or use of military power. The industrial capacity of the United States and its allies proved decisive in creating winning outcomes in World War II and during the Cold War—it remains crucial today. However, there was a period following the end of the Cold War where some doubted its importance.

The argument was this: There was great promise for the evolution of a peaceful world order and a global era of economic development and prosperity. The pace of technological advances during the Cold War, including the military applications of technologies of information and weapon delivery accuracy, independent of range, made the prospect of future non-nuclear conflict self-detering, as such conflict was likely to be extraordinarily lethal, discriminate, and brief. A diplomatic system of arms control arrangements between the major nuclear powers sustained incentives for reciprocal nuclear deterrence and a shared interest in preventing the proliferation of weapons of mass destruction. These expectations seemed to be affirmed in the 1991 Gulf War, which was brought to a successful conclusion in less than 100 hours.

However, as time has passed, none of the assumptions that shaped post-Cold War diplomacy, military modernization, and the United States defense industrial base (DIB) have been sustained. The People's Republic of China (PRC) abandoned half a century of its minimum deterrence nuclear posture in favor of a vast and furious increase in its nuclear forces. Russia abandoned compliance with most of the significant bilateral arms control agreements, causing the United States to also withdraw. Russia embarked on the development, production, and fielding of seven new types of intercontinental nuclear delivery systems. The Democratic People's Republic of Korea (DPRK) conducted six successful nuclear tests and demonstrated a modern intercontinental ballistic missile, and Iran is well on its way to producing sufficient nuclear material for a nuclear weapon.

Russia's second invasion of Ukraine in 2022 has also confirmed the United States cannot expect post-Cold War stability. Russia's indiscriminate application of military power—including overt and covert collaboration with its allies—lethal to both combatants and non-combatants—is in flagrant violation of international law. Moreover, Russia has magnified the consequences of its refusal to comply with its bilateral nuclear arms control commitments by commingling threats of nuclear use in a non-nuclear conflict with a non-nuclear state.

Perhaps most disturbing is that China, Russia, Iran, and North Korea, have created a network of treaties and diplomatic commitments for mutual military and economic support. The combination of the growing, interlinked capabilities, the rekindling of geopolitical, strategic rivalries, and technological advancements that upend the foundations of many U.S. military strategies may pose a threat to the U.S. homeland and to those of U.S. allies. The capabilities within this emerging alliance have profoundly changed the international security environment and shaped requirements for the industrial base that supports national defense within the United States, its alliance members, and its security partners. Future conflicts involving peer powers could likely become prolonged affairs facing China, Russia, Iran, and North Korea's combined capabilities. These conflicts could extend over a period of years as challenges increase to pre-deployed clandestine cyber and kinetic capabilities able to disrupt both commercial and national security

infrastructure.<sup>1</sup> The threat to the United States and its allies should not be underestimated and it returns us to a world where the United States and its allies must have the industrial capability to support sustained military action.

A cursory analysis of the U.S. industrial base might at first reduce concerns. After all, the United States boasts the biggest economy in the world, as measured by its approximately \$28 trillion gross domestic product (GDP) and capital markets with more than \$55 trillion in assets, not to mention controlling the reserve currency that settles over 70% of global transactions and spending \$1 trillion a year on national security.

However, a deeper analysis shows that, adjusted for purchasing power parity, the Chinese economy is 25% larger than that of the United States and is growing faster.<sup>2</sup> Manufacturing contributes at least twice as much to the Chinese GDP as it does to that of the United States. This means the United States must think of China as having more than 2.5 times the manufacturing economy of the United States.<sup>3</sup>

Moreover, the PRC uses its largest industrial and scientific enterprises to accelerate the application of advanced technology for military applications through military-civil fusion, enabling China's defense establishment to promptly benefit from advanced technology. Five Chinese dual-use companies have 45% higher total revenue than the six U.S. prime contractors (without adjustment for the purchasing power differences, which would make the ratio even higher). Unlike the United States, its practices enable China to maintain supply chain integrity without relying on foreign sources for its vast critical material and electronics requirements. In stark contrast to this Chinese supply chain independence, DoD acquires products and services from more than 40,000 Chinese suppliers.<sup>4</sup> Consequently, U.S. companies are competing directly against this Chinese controlled-capitalist framework in which public resources are allocated to enable private victories in pursuit of government objectives.

The United States is thus in an economic and defense competition with the PRC, which is a near-peer in some areas, a full-fledged peer in others, and a "super-peer" in many mission-critical areas, enabled by its robust industrial base and assured global supply chains. Furthermore, the PRC pursues a whole-of-government, integrated, global industrial strategy focused on securing access to and controlling aspects of world markets for critical materials, energy, and food.

To be clear, the Chinese economy faces significant risks ("3 Ds"—debt, demographics, and deflation). However, the United States also has challenges. Its debt is concerning, particularly considering unfunded social security and Medicare obligations. It also has nearly the same fertility index as China at around 1.6 (it takes 2.2 to sustain an indigenous population). The United States is still dealing with an inflation problem. Finally, the median age of the U.S. population is 38, implying that a majority of the American public

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<sup>1</sup> Michael Marrow, *The Homeland is no longer a 'sanctuary' warns new TRANSCOM boss*, *Breaking Defense*, October 9, 2024, <https://breakingdefense.com/2024/10/the-homeland-is-no-longer-a-sanctuary-warns-new-transcom-boss/>; G. Lubold et al, *Mystery Drones Swarmed a U.S. Military Base for 17 Days. The Pentagon Is Stumped*; *Wall Street Journal*, October 12, 2024, [https://www.wsj.com/politics/national-security/drones-military-pentagon-defense-331871f4?st=XW7nV3&reflink=article\\_email\\_share](https://www.wsj.com/politics/national-security/drones-military-pentagon-defense-331871f4?st=XW7nV3&reflink=article_email_share).

<sup>2</sup> CIA World Factbook (real China GDP - PPP = \$31.227T in 2023 growing at 3.58% U.S. \$24.668T and growing at 2.54%) <https://www.cia.gov/the-world-factbook/countries/china/#economy> and <https://www.cia.gov/the-world-factbook/countries/united-states/#economy>).

<sup>3</sup> <https://www.statista.com/chart/20858/top-10-countries-by-share-of-global-manufacturing-output/#:~:text=According%20to%20data%20published%20by.the%20country's%20gross%20domestic%20product.>

<sup>4</sup> source NOTE: Golvini during their briefing - update

cannot personally recall the Cold War and its economic costs. Thus, the United States should not assume that China’s problems will eliminate its risks.

The growth in geopolitical risk, and the growth in the PRC’s industrial capability thus require a revisiting of assumptions about how the industrial base of the United States and its allies can be reshaped to meet the security challenges of the 21<sup>st</sup> century. The World War II metaphor of the United States as the “arsenal of democracy,” coined by President Franklin Roosevelt in December 1940 in his *Fireside Chat*, was built on the fact that the United States had— by far—the world’s largest manufacturing base. This no longer reflects 21<sup>st</sup> century reality. Thus, what we consider to be the “defense industrial base,” which is a small percent of the total U.S. industrial base, can no longer be thought of as a powerhouse without peers for supporting needed fielded capabilities as well as the development of new ones. Additionally, the traditional industrial base cannot readily be “surged” to meet modern wartime contingencies of a protracted conflict with multiple adversaries. The invasion of Ukraine by Russia has taught us hard lessons—neither the United States nor its allies are prepared to engage in and win a protracted engagement with a peer adversary.

To address this problem, this report proposes a new paradigm that enables the United States and its allies to create, employ, and sustain a “National Security Industrial Base (NSIB)” that utilizes a greatly increased portion of their industrial capabilities.<sup>5</sup> This new paradigm incorporates the industrial capacity of the United States and its allies—civil and military—that can be brought to bear to offset China’s vast manufacturing base and to meet extreme future contingencies involving protracted conflict with multiple adversaries in multiple theaters of operations.



More specifically, this report makes recommendations in three topic areas:

1. **Creating Greater Commercial Sector Participation in the National Security Industrial Base.** The United States and its allies and partners have significant capabilities beyond the traditional industrial base, and we must change DoD processes (e.g., in requirements definition, acquisition, and financing) to benefit from the broader industrial base.
2. **Leveraging Allies and Partners in the National Security Industrial Base.** The combined economic activity of the United States and major allies and partners provides the ability to counter the industrial might of China and its allies.
3. **Planning for Extreme Contingencies—National Security Industrial Base Mobilization.** We need to plan in advance what we would need to do to mobilize more of our productive capacity, in order to deter or counter aggression. The DoD needs to establish a regularly exercised national security industrial mobilization office accountable for creating and sustaining a plan that incorporates both U.S. and allied defense and civil, and commercial scientific and industrial capabilities.

This report’s strategic view of the needed industrial base of the United States and its allies aims at both enhancing the U.S. deterrent and its capacity for response in a world at its most dangerous place since the

<sup>5</sup> Such a national security industrial base would align the DOTMLPF-P (Doctrine, Organization, Training, Materiel, Leadership and education, Personnel, Facilities – Policy) and would be the framework for developing the design of defense products. See Appendix D for further discussion and information.

end of the Cold War. It also makes a number of practical suggestions for action in line with the above recommendations.

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**The threat to the U.S. homeland is real, as it is real for U.S. allies.**

**The United States faces a determined and credible threat not from one but four nation-states that now aid each other in substantive ways.**

**The United States must advance the structure of its own industrial base, and lead cooperation with our allies to harness more capabilities from the collective alliance of democratic nations to meet a clear and present danger.**

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## DSB Study on 21st Century Industrial Base for National Defense

### I. Introduction

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The existence of a dedicated military industrial base that can provide sufficient products and services for the U.S. military to deter, and if necessary, win a peer-to-peer sustained fight is a myth. This has not been true for decades, but the belief remains widespread because the lack of a peer adversary since the end of the Cold War has meant the United States has not had to confront its implications.

We do now. The People's Republic of China (PRC) continues to be a pacing threat in some areas, but increasingly, as this report illustrates, U.S. capabilities are falling behind the PRC in an increasing number of areas. This trend must be reversed to ensure U.S. interests are protected in the future.

For at least the last 20 years, the United States has been focused on countering near-term tactical threats. To a large degree, the Military Services, the Office of the Secretary of Defense, Congress, and the defense industry upon which the United States has traditionally relied, have not pursued the capabilities required to deter, and if necessary, prevail in a prolonged peer-to-peer conflict.

The defense industrial base (DIB) upon which the U.S. military now relies is more global, more commercial, and more financially complex than its past iterations, and these conditions will only intensify. This has significant implications as U.S. systems become more complex and rely increasingly upon global supply chains which, in many areas, are not processed or produced by allies or partners. Current practices, processes, and dependence with relation to the current DIB are simply insufficient to meet current and emerging threats.

The U.S. Government (USG) and the independent research and development (IR&D) it provides the DIB are now just a small fraction of the research and development (R&D) occurring within U.S. commercial markets overall—and represents an even smaller percentage of investments being made by close allies and their own commercial enterprises. Yet, the USG in general and DoD specifically continue to struggle to tap into this vein of innovation and production on a meaningful scale.

The traditional DIB is now the tail, not the dog of spending, innovation, mass production, and effective mobilization that wags it. The DIB is perfectly right-sized for peace, though with supply chain risk from potential adversarial suppliers, but cannot be expected to provide the overwhelming capacity the United States and its allies will need for a protracted conflict with either peer or near-peer competitors.

The fundamental question of this study is not how to make the current DIB better, but what type of National Security Industrial Base (NSIB) does the United States need and what must be done to make this transition? The current DIB will certainly continue to play a vital role, but policymakers must open their minds to greater ingestion of U.S. commercial capabilities, as well as those of allies, to form a collective NSIB that is credible enough to deter, and if that fails, win a protracted conflict with peer actors. To that end, this study focused on re-thinking, adapting, and overcoming the structural issues created since the end of the Cold War to ensure U.S. warfighters, as well as those of allies and partners, never enter a fair fight let alone a disadvantaged one and can sustain a protracted conflict for as long as it takes to prevail. The alternative is exponentially more costly.

This report lays out overarching recommendations which, if implemented, would improve the health of the current DIB and begin the transition to the NSIB, ensuring U.S. interests are protected going forward.

1. Creating Greater Commercial Sector Participation in the National Security Industrial Base .
2. Leveraging Allies and Partners in the National Security Industrial Base .
3. Planning for Extreme Contingencies—National Security Industrial Base Mobilization.

The study specifically addresses four key overarching needs:

1. What DoD actions should be taken to embrace the industrial base challenges it now faces.
2. How the Department must leverage and exploit the tremendous, and largely untapped, commercial capacity, financial resources, and innovation thriving in the United States.
3. How to structurally engage and ingest the capabilities and technologies of allies along with their commercial industries to, in part, de-risk supply chains.
4. How to exercise this new industrial base paradigm to ensure its result is more than just words in a vast sea of industrial base studies.

All these goals culminate in a more holistic creation of a NSIB collectively shared with our allies—no longer a U.S. arsenal of democracy, but a collective democracy of our collective arsenal.

## II. Recommendations

### Recommendation 1:

#### Creating Greater Commercial Sector Participation in the National Security Industrial Base



In 1945 national security spending accounted for roughly 44% of U.S. gross domestic product (GDP). Today that figure is roughly 3.5%. At the same time real GDP growth rose from \$2.5 trillion in 1945 to \$21 trillion in 2022 (FY17 dollars). Not only has the defense budget declined in relationship to GDP over this long period, but the innovation of the U.S. commercial engine continues to drive U.S. economic growth, now leveraging over \$50 trillion in equity capital market assets. The U.S. commercial industry is the major driver of overall U.S. GDP, yet the Department too often relies on a highly consolidated DIB born from the post-Cold War for a vast majority of its spending.

While the Department has increasingly attempted to tap into the U.S. engine of innovation and commercial investment, a vast majority of these efforts have not been coordinated across Military Services, departments, or agencies, reducing the overall potential impact to address warfighter needs. These disparate efforts have led to many false starts, loss of credibility, and doubt in the Department's commitment to ingest the most advanced technology and services the commercial industry has to offer.

The traditional DIB is no longer capable of meeting all the needs of an emerging threat environment presented by strategic competitors. The current structure is unlikely to deter, let alone prevail, over the threats the U.S. must consider for the foreseeable future. It also has significant supply chain risk from potential adversarial suppliers, which are too frequently single-sourced.

The PRC alone has more than 2.5 times the manufacturing base, even when not adjusting for purchasing power, and through their policy of civil-military fusion this base will only grow in size and capability. The standard approach to incrementally improving the current DIB as a deterrent is not a tenable or reasonable strategy.

Despite a significant budget, DoD does not actually build much. It primarily relies on the DIB to develop, build, and ultimately maintain the goods and services upon which warfighters' lives depend, as well as the lives of the citizens they defend. This reliance on the DIB is made clear by examining the reported DoD derived revenue of just the top 10 DIB contractors, which is roughly \$111 billion dollars in awards and roughly 35% of the total DoD procurement and R&D budget.<sup>6</sup> Moreover, the large prime contractors within

<sup>6</sup> *Top 100 for 2024, Top 100 | Defense News*, <https://people.defensenews.com/top-100/>.

the DIB benefit from roughly 70% of program procurement spending which is mainly programs of record, including aviation, shipbuilding, ground vehicles, missile defense, and missiles and munitions.<sup>7</sup>

Even the largest players in the DIB increasingly rely upon suppliers that operate within a highly diverse and globalized commercial industrial base. The Department must engage directly with the commercial base to both ensure suppliers will be there to support the DIB and to better understand where DoD might be more advantaged by dealing with commercial entities directly—particularly for services, software and sustainment. The advantages that have historically enabled American preeminence in defense technology are not a birthright. Key elements of the commercial supply chain necessary to ensure U.S. dominance on future battlefields are not necessarily assured as they once were.

Over the years the DIB itself has become more global, commercial, and financially complex. Yet, for the most part, the procurement systems the United States maintains have not adjusted to this reality. Outdated constructs of a static industrial base, where DoD simply asks the same DIB to do more, faster, and cheaper must give way to the facts on the ground that the true industrial base is no longer a monolithic entity, but rather is composed of a complex and dynamic commercial supply base. Any future industrial base policy must consider these facts in developing a more sophisticated and nuanced view of the base.

The goods and services the Department increasingly relies upon reach far deeper into the overall U.S. and global economy than most in the Department appreciate, with a few notable exceptions. While there are unique items produced solely for the Department, these items themselves often rely upon a complex and integrated supply chain of product providers which if restricted at the 2<sup>nd</sup>, 3<sup>rd</sup>, or even below the 4<sup>th</sup> tier would jeopardize even the seemingly pure DIB players' abilities to support the warfighter.

Given the current threat environment, a comprehensive effort must be made to: 1) incentivize the traditional DIB to ingest more commercial products and services into their own offerings; 2) enhance and accelerate direct interaction with the U.S. commercial industry; 3) accelerate participation of mid-tier and emerging defense-oriented companies which seek to provide a bulk of their products and service to address national security needs; and 4) expand the comparative advantage the United States has to leverage financial vehicles to incentivize, finance, and accelerate investment to meet DoD's long-term needs.

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**What Must Be Done:** Incentivize the traditional DIB to ingest more commercial products and services into their own offerings.

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As has been discussed, the traditional DIB market is largely serviced by a few prime conglomerates born out of the 1993 “Last Supper.”

The customers they serve have been largely comfortable with their capabilities and structure, while the prime contractors have built internal institutions over the years which reflect the customers' bureaucratic processes. These processes, coupled with the dearth of experience many system buyers have with commercial practices, have led to unneeded delays, cost growth, and systems that are often a generation or two behind the capabilities being pursued in the commercial sector. Moreover, once delivered they are often unserviceable unless the services come from the prime DIB contractor which often controls the intellectual property (IP).

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<sup>7</sup> Doug Berenson and Ian van Son, *Not Much Has Changed among the Top 100 Defense Market Leaders*, *Defense News*, August 7, 2024, <https://www.defensenews.com/opinion/2024/08/06/not-much-has-changed-among-the-top-100-defense-market-leaders/>.

The restructuring of the defense industry after the 1993 *Last Supper* led to a steep decline in the number of commercial firms serving the DoD and other markets (**Figure 1**). In turn, the shrinkage in the number of commercial participants in the supply chain led to fewer competitors and higher costs to the DoD.

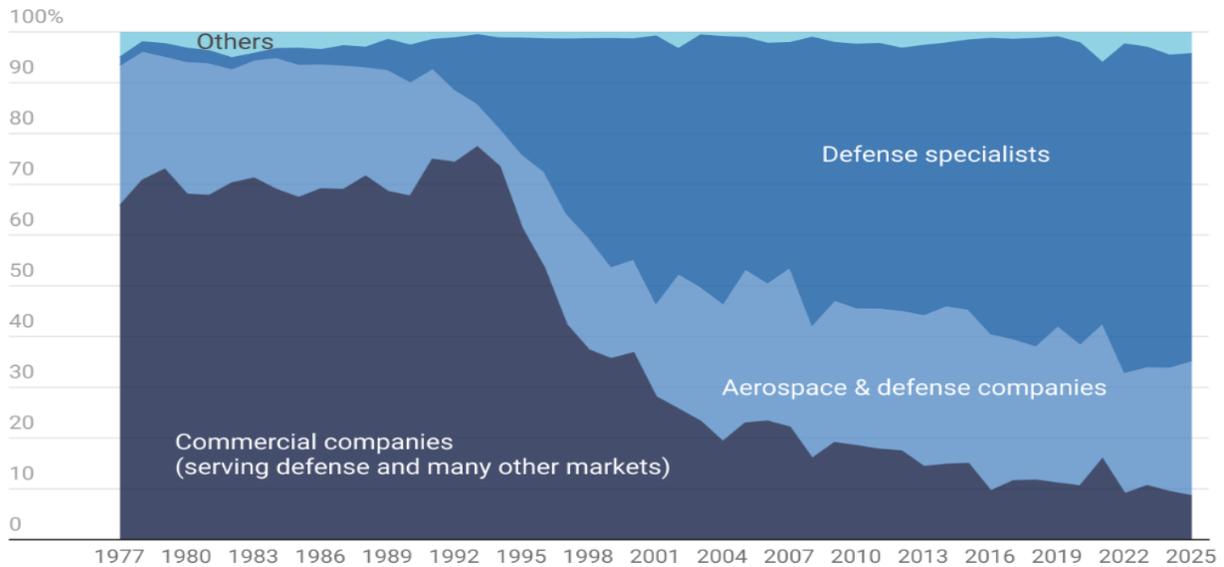


Figure 1. Major Weapon Systems Acquisition Budget: Share By Industrial Base Category

[Source: [https://csis-website-prod.s3.amazonaws.com/s3fs-public/2024-08/240821\\_Defense\\_Isolation\\_Fig1.png?VersionId=nSOcFfc09ou7m1mVwajLciwsTVsHC88h](https://csis-website-prod.s3.amazonaws.com/s3fs-public/2024-08/240821_Defense_Isolation_Fig1.png?VersionId=nSOcFfc09ou7m1mVwajLciwsTVsHC88h)]

While the DIB remains a relevant source for many exquisite advanced systems unique to DoD needs, for the DIB to remain relevant in global protracted engagements requiring mass production, DoD must increase focus on leveraging commercial technologies and production at scale. It must strengthen efforts to partner and exploit the great advances in commercial innovation, speed to market, and rapid manufacturing. In some cases, this will also require open architectures to advance capabilities and numbers of U.S. assets **at the speed of war over the speed of contracting**.

There has been no shortage of contract vehicles, such as other transaction agreements (OTAs), that allow for the more rapid introduction of capabilities from both DIB and non-DIB companies alike. To a significant degree the slowness of the Department and the DIB to adopt more commercial systems is no longer an issue of regulation, it is increasingly an issue of culture—both from DoD and the DIB.

Often the current DIB has significant offerings which can be technically superior to the commercial companies. However, the DIB also benefits from a detailed understanding of how to operate within the often-byzantine procurement systems of rules, regulations, and compliance which too often creates insurmountable barriers to entry for many pure-play commercial companies which could offer competitive solutions.

The relationship between the DoD and the DIB since the *Last Supper* has created an often-perverse disincentive for the primes to embrace commercial technologies and offer them as part of a comprehensive solution. That said, some primes are getting better and have assigned individuals in leadership to seek out and collaborate with commercial innovative companies. Several major DIB players have also created corporate venture capital (CVC) funds focused on discovering, investing in, and benefiting from innovative firms. These efforts are to be applauded but must scale up if the DIB wishes to meet changing DoD needs

when faced with a peer competitor which has both greater capacity for mass production and the integrated policy of military-civil fusion.

The DIB should be encouraged by DoD leadership to expand their partnerships with the U.S. commercial sector. It would be beneficial to DoD for the larger DIB companies to review with DoD science and technology (S&T) and acquisition and sustainment (A&S) leadership, their progress in leveraging commercial suppliers.

On the Department side, there exist tools and resources to better understand commercial alternatives to many procurement awards. Notable is the requirement under the Federal Acquisition Streamlining Act (FASA) of 1994 (S.1587) for programs to perform a “market survey” of alternative sources prior to award. These efforts are uneven in their application of research and analysis. A vast majority of program offices do not conform to the intent of FASA. Often market surveys do not play a strategic role in decision making and are performed with more of a “box-checking” compliance mentality. This often can lead to “vendor lock” and limits the Department’s flexibility, often leading to warfighter needs that can be only sustained by the primes.

The Department should consider strengthening these reviews to be more comprehensive across commercial capabilities. The reviews should be a critical decision-making milestone, not a compliance form. Toward that end, the professionals responsible for these surveys should have a forum to discuss best practices and experiences, perhaps hosted by the Defense Acquisition University (DAU), on a regular basis. Program executive officers (PEOs) and program managers (PMs) should elevate the importance of these efforts in their decision making.

One example of a significant resource for both the DIB and the Department to better understand priorities and challenges, which the commercial sector is addressing, is in the Manufacturing USA institutes, formerly known as the National Network for Manufacturing Innovation. Begun by the Department in 2012, this innovative effort to bring industry, academia, and the U.S. Government (USG) together around specific areas of core research to enhance manufacturing in the United States has proven to be a wise investment.<sup>8</sup>

DoD currently partners with nine of the institutes, Department of Energy (DOE) with seven, and Department of Commerce (DOC) with two for a total of 18 public-private partnerships, each working both independently and often collaboratively. These Institutes, each with at least a 1:1 matching investment by industry, support U.S. manufacturing workforce development, innovation, and solving the most challenging manufacturing needs of departments which work with them. For DoD, the average five-year investments are between \$70 to \$120 million.

The latest awarded, led by DoC is the SMART USA Institute for digital twin and another to be awarded this year will be the AI institute for Resilient Manufacturing.

To date DoD has committed roughly \$1B resulting in ~\$2B in non-federal cost sharing and produced nearly \$1.2B in federal project work. As of mid-2024 over 2,000 companies, universities, and non-profits have engaged the institutes with most historically being directly non-DoD suppliers.

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<sup>8</sup> National Academies of Sciences, ***Securing Advanced Manufacturing in the United States: The Role of Manufacturing USA: Proceedings of a Workshop***, The National Academies Press, October 13, 2017, <https://nap.nationalacademies.org/catalog/24875/securing-advanced-manufacturing-in-the=united-states-the-role-of>.

For the defense institutes, highlighted in **Figure 2**, the Manufacturing Technology Program (ManTech) office under the Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E)) has been a consistent and powerful partner guiding DoD needs and ensuring the innovation developed in the institutes is applied across Department requirements.

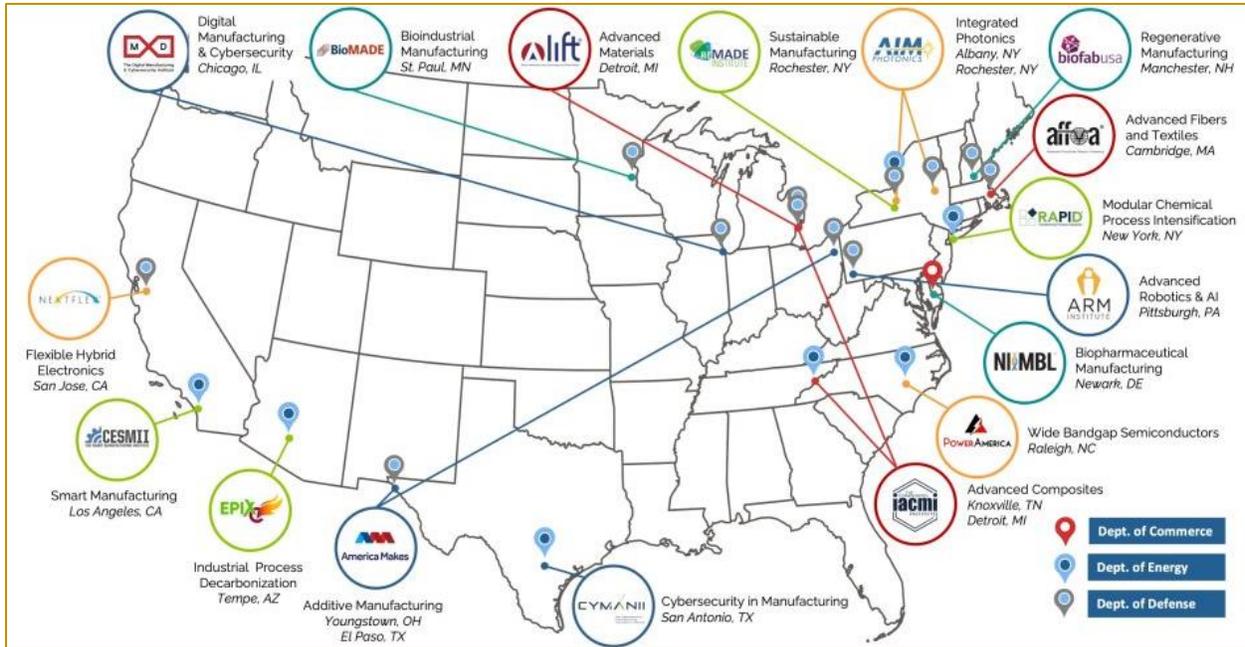


Figure 2. Manufacturing USA Network  
 [Source: <https://www.manufacturingusa.com/pages/manufacturing-usa-brand>]

While some companies within the DIB participate in the institutes, most members come from academia and commercial industry. These institutes allow both DoD and DIB to access efforts underway to meet the manufacturing and workforce challenges facing the commercial sector, which can then be applied to DoD needs.

For the Department to leverage its matching investment over 12 years it should review how to get more from the institutes and continue to examine new areas of manufacturing, with hard problems to solve, that may be addressed in the further expansion of this effort.

Also, as the Defense Innovation Board identified in their 2024 report *Optimizing Innovation Cooperation with Allies and Partners*, these operational institutes could serve as vehicles to explore greater cooperative manufacturing innovation efforts with allies and partners, although to date they have been limited to U.S. industry and academic institutions.

**What Must Be Done:** Enhance and accelerate direct interaction with the U.S. commercial sector.

With the U.S. commercial sector driving the vast majority of R&D and production investment, DoD must do a better job of understanding and directly engaging industry to address the many shortfalls DoD is experiencing in order to adequately address an emerging peer threat.

To reiterate, the DIB itself has become much more reliant on commercial products manufactured many layers down in the supply chain. Many of these products are not developed or produced in the United States

or by its closest allies. This is a strategic risk that has increasingly been recognized, but not yet successfully mitigated.

The Department, as well as the DIB, have made some significant strides over the last decade to better understand the risks within the supply base. The COVID-19 pandemic demonstrated how much further these efforts must go.

The DoD has devoted significant resources through programs such as the *Defense Production Act (DPA) Title III* and the Manufacturing Capability Expansion and Investment Prioritization (MCEIP) programs to address these risks by increasingly direct engagement with the U.S. commercial base.

The Title III office is unique among Federal Government entities. While it is housed within the Department, and indeed called the *Defense Production Act*, it focuses on sustaining critical production, commercializing research and development investments, and scaling emerging technologies for the entire USG. This office has also led the DoD effort to respond to EO 14017, *America's Supply Chains* allocating nearly \$600 million last year and addressing key challenges to the supply chain. Title III is truly an all of government vehicle that allocates resources primarily to commercial entities in support of urgent USG needs, such as critical minerals.<sup>9</sup>

In January 2024 another major milestone was achieved when the Department created the Defense Industrial Base Consortium (DIBC) using OTA. This allows the office to reduce the contractual burdens and provide a vehicle to “rapidly research, prototype, and manufacture commercial solutions for defense requirements and innovations from private industry, academia, and firms not traditionally part of the defense contracting systems.”<sup>10</sup> This milestone should be applauded but must scale to meet emerging demands.

The office traditionally also had the capability to offer purchase-commitment projects, which allowed a steady demand signal to industry of a long-term commitment. Unfortunately, the important capability of “no-year, no-color” money has been eliminated over the past three years by Congress which has determined that Title III money must conform to typical appropriation limitations of expiration after two years. The office’s ability to provide an assured long-term commitment and partnerships with commercial vendors, often with unique capabilities to meet identified needs within the industrial base, has diminished with this change. This decision should be reversed and return to allowing the office to ensure a consistent and credible demand commitment to vital commercial suppliers.

In terms of U.S. allies, recent changes to the *National Defense Authorization Act (NDAA)* have allowed DoD to open Title III funds in support of its Canadian, British, and Australian partners. This is a significant step forward and should be examined carefully as the U.S. explores how to further utilize Title III with a larger group of key allies.

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<sup>9</sup> While the DPA was first passed in 1950 and was vital in the early years of the Korean conflict, it has also been used by every president since to address urgent national needs across all USG departments. Funding has vastly fluctuated over the years, reaching nearly \$1.4 billion in FY22. Most Americans came to know the DPA Title III office as the government vehicle through which urgent requirements were met by commercial industry that resulted from the COVID-19 pandemic.

<sup>10</sup> Laura Taylor-Kale, **The Reauthorization of the Defense Production Act: DoD’s Perspective**, Opening statement for Dr. Laura Taylor-Kale Assistant Secretary for Industrial Base Policy, U.S. Department of Defense to the House Financial Services Committee Hearing Subcommittee on National Security, Illicit Finance, and International Financial Institutions, www.congress.gov, May 8, 2024, <https://www.congress.gov/118/meeting/house/116636/witnesses/HHRG-118-BA10-Wstate-SmithA-20231212.pdf>.

The DIBC, with its unique resources and expertise, could also be utilized to inform a broader spectrum of commercial companies of the near- and longer-term needs of the Department through an aggressive outreach program to the commercial sector. The office already has a significant outreach program, but it is focused primarily on urgent requirements. With additional resources the office could serve as an excellent focal point of outreach to a broader commercial audience sharing needs, while also learning more of the vast capabilities from a commercial industry that in 2022 invested nearly \$692 billion on R&D.<sup>11</sup>

The Department itself could better utilize MCEIP and Title III. PMs and PEOs should prioritize and leverage these to provide better outreach and engagement with the commercial industry. This could also be a resource for those responsible for “market surveys.”

The Department must also do a better job of overseeing and coordinating disparate DoD entities created over the years termed the “innovation ecosystem.” Many have been created to allow for direct engagement with the commercial sector, which is to be applauded, but the Department must ensure there is minimal duplication of effort or competing signals being sent to the private sector.

While some within this group are represented by well-established entities such as the federally funded research and development centers (FFRDCs) and the Office of the Secretary of Defense (OSD) Defense Innovation Unit (DIU), many offices have been created over the last two years to meet unique Service requirements. These interactions with the commercial sector may have value across the Department but are largely stove-piped in individual innovation ecosystem offices.

As the charts in **Figure 3a and 3b** (on following pages) show, there is no shortage within the DoD innovation ecosystem of efforts underway. These efforts are rarely coordinated across the Military Services or the OSD. The number of offices has doubled in just the last two years.

This, and other commercial outreach efforts, may lead to the exploration of the creation of a Chief Commercial Officer within the OSD that would harmonize the disparate efforts across the Department to directly engage the commercial industry.

With the correct structure, such an office may also become the champion of addressing other systemic challenges larger commercial companies face when attempting to support DoD efforts. Specific examples may be speeding up commercial spare and repair parts certification in a timely manner to generate more competition and capacity within the sustainment and support functions or opening more 6.1 basic research, 6.2 applied research, and 6.3 advanced technology development to qualified commercial firms through targeted engagements.

In looking forward toward identifying and partnering with emerging commercial technology firms, there is no better standard set than what has been accomplished by the DIU.

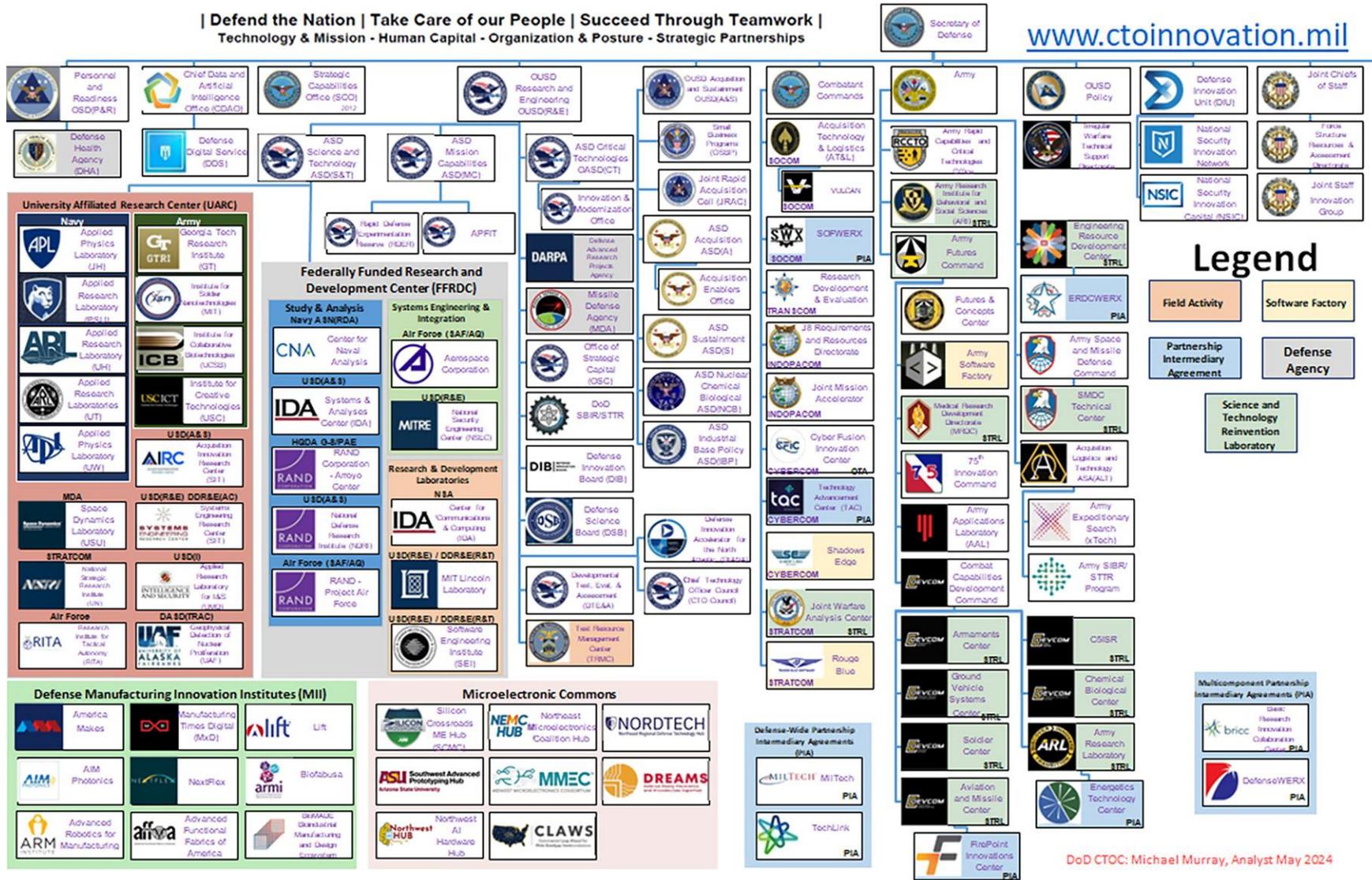
Secretary of Defense Dr. Ashton Carter was the father of the Defense Innovation Unit Experimental (DIUx), an organization designed to ingest the best commercial technology the United States had to offer and rapidly meet warfighters’ urgent needs. Since its founding in 2015, DIU (which dropped the “experimental” x in 2018), has been the Department’s leading organization to identify, fund, and work with emerging U.S. commercial technology companies across a wide span of technology challenges.

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<sup>11</sup> A. Hughes, *Business R&D Performance in the United States Nears \$700 Billion in 2022*, National Center for Science and Engineering Statistics (NCSES), NSF 24-334, 2024, <https://nces.nsf.gov/pubs/nsf24334>.

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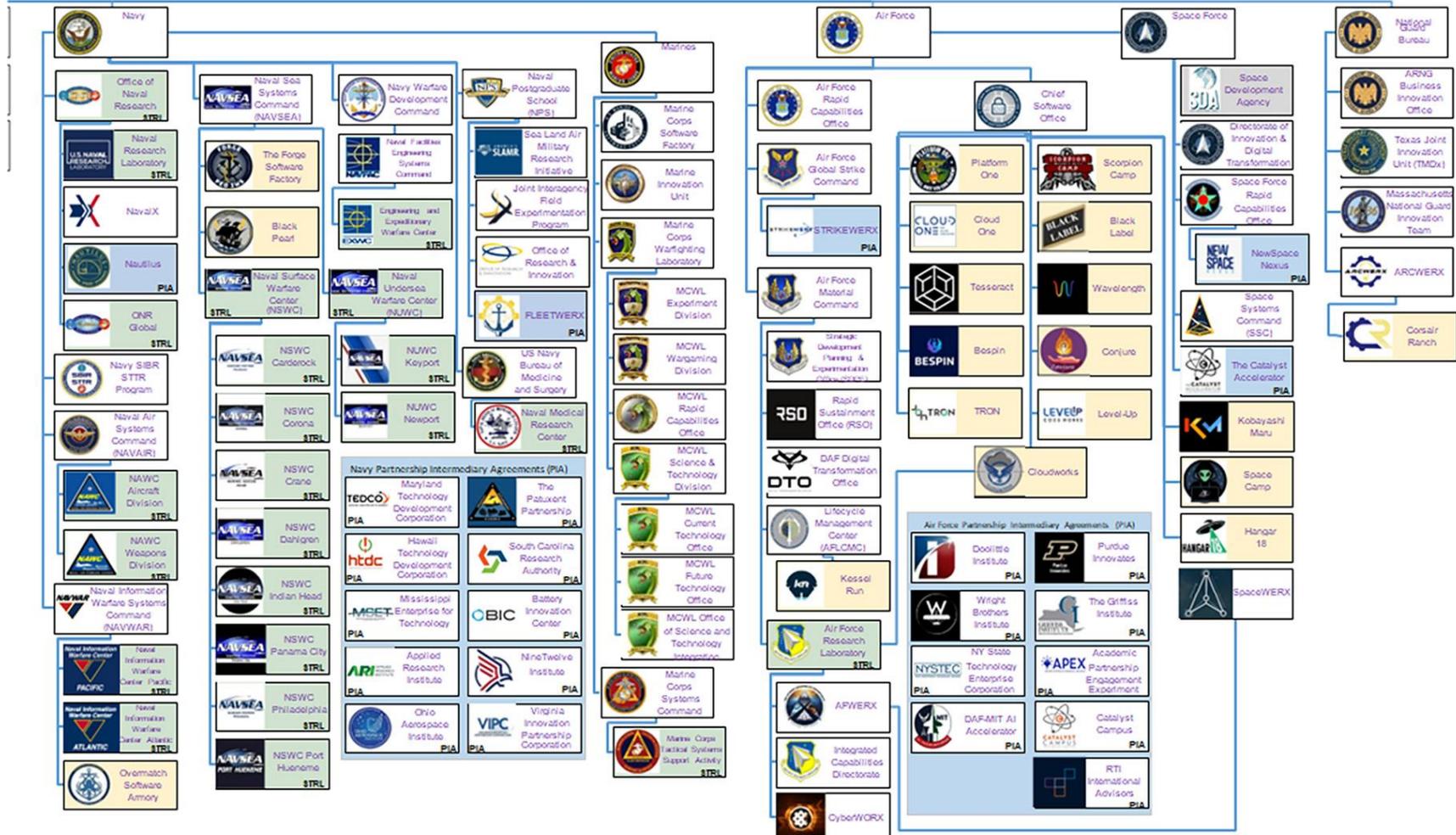
Figure 3a. DoD Innovation Ecosystem (Part 1)  
 [Source: www.ctoinnovation.mil]



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Figure 3b. DoD Innovation Ecosystem (Part 2)  
 [Source: [www.ctinnovation.mil](http://www.ctinnovation.mil)]

Innovation Ecosystem 2024



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Since its inception, DIU has invested more than \$1.7 billion, in over 100 companies and 451 awards, across all 50 states. It has also worked with 27 companies from 10 allied nations and now has offices in Silicon Valley (HQ), Boston, Austin, Chicago, and the Pentagon. Thirty-eight percent of awardees are first time DoD contractors, 87% are non-traditional providers, and 80% qualify as small commercial businesses—a record no single program office would be capable of achieving.

There is a compelling case that DIU, given its experience, track record, and close cooperation with the U.S. investment community, should continue to be the key interface between advanced emerging commercial technology and warfighter needs from an overall Department perspective.

Over the last decade, DIU has also earned the trust of the investment community, which often brings additional non-USG investment to many of the companies with innovative technologies and capabilities. The companies which DIU identifies are continuing to strive to solve unique defense challenges but doing so with a commercial operational mindset.

For the last fiscal year of the recent annual report, DIU invested more than \$500 million, primarily focused around six technology areas: artificial intelligence and machine learning (AI/ML), autonomy, cyber and telecommunications, energy, human systems, and space.

In addition to scouting the best commercial solutions the United States has to offer, DIU has also taken on more foundational work, such as Project Blue, which qualifies unmanned aerial vehicle (UAV) companies to sell to the Department—somewhat like a Good Housekeeping seal of approval. Rather than each department or program office individually vetting companies, DIU took on the role of vetting companies for the entire Department thus streamlining acquisitions and saving countless taxpayer dollars all while getting product to the warfighters in a much more efficient and timely manner.

Likewise, DIU has taken on leading the Immersive Commercial Acquisition Program (ICAP). This program selects acquisition executives for a one-year deep dive to better understand the commercial marketplace and demystify issues that have too often prevented the Department from engaging with commercial firms.<sup>12</sup>

Even with all the success of DIU, the organization continues to struggle with transitioning identified capabilities and products to the warfighter at scale. DIU is clearly capable of identifying commercial technology that would benefit the warfighter. The primary issue is transitioning those identified and vetted capabilities to the warfighters.

An example is the DIU identification and vetting of Saildrone, an autonomous above water unmanned system. Despite identifying and vetting the technology capabilities, it took far too long to transition the technology to the Navy. Institutional barriers and the drumbeat of “not invented here” mentality that far too often permeates the acquisition establishment were the primary barriers to adoption—not the technology.

It is unfortunate that DIU often is more an advocate for the best U.S. technology can offer the warfighter but challenged in transitioning capability to that warfighter as they must work with the Military Services to inject advanced capabilities outside the established procurement system.

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<sup>12</sup> Immersive Commercial Acquisition Program (ICAP), *Defense Innovation Unit*, <https://www.diu.mil/work-with-us/immersive-commercial-acquisition-program-icap>.

The Department should consider assigning a single point of contact from each service acquisition executive (SAE) office to be the conduit through which DIU could engage and present the opportunities it identifies as well as work with the SAEs to ensure an effective transition.

Although it is a high-level organization reporting directly to the Secretary of Defense in order to leverage the skills and investment of the organization, DIU needs an institutional footing inside the Military Services and the most appropriate place would be within the SAE offices.

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**What Must Be Done:** Accelerate participation of mid-tier and emerging defense-oriented companies which seek to provide a majority of their products and services to address national security needs.

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Over the last decade, a significant amount of private equity has flowed into small and medium-sized firms who have prioritized the U.S. national security market as their primary sales channel and rationale for significant internal R&D.

While many of these firms also pursue commercial markets, their orientation is primarily to develop products and services for DoD and other national security agencies. They are differentiated from the DIB in that they primarily rely on commercial solutions and processes to meet complex DoD needs, which both produces greater competition and often at much greater speed to market. Many in the mid-tier have been hurt by supply chain disruptions and many have been acquired by the large system integrators that serve as prime contractors, with others struggling once they graduate the Department's small business preferences.

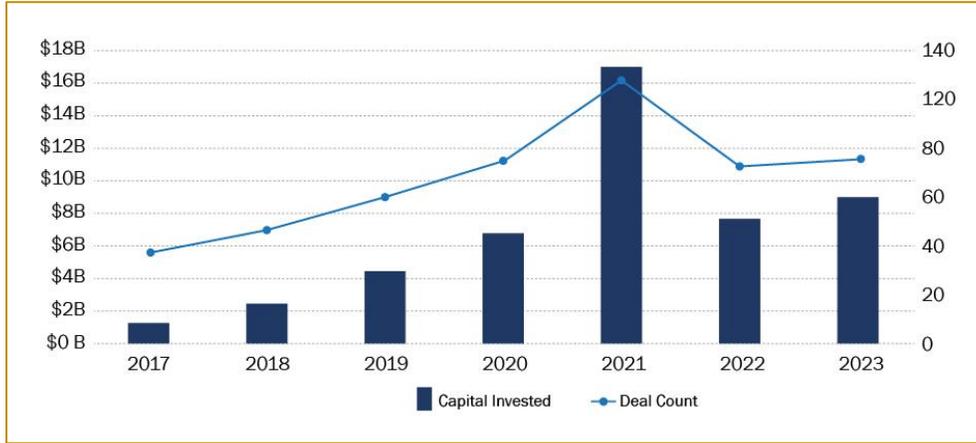
The Department far too often has bar-belled supply chains with large original equipment manufacturers (OEMs) and many small businesses with little in between. With Department contracting objectives often including over 25% small business content, there is no room for midsize companies to become top tier 1 or tier 2 suppliers as is often found in commercial marketplaces. Unfortunately, due to the limited size of their balance sheets, small businesses often bring risk to combat system programs because they lack the capital to invest in expanding and sustaining production equipment, are unable to invest in advancing technology, lack deep supply chain relationships, offer labor force compensation plans that are lower than market averages (thereby increasing employee churn), and do not implement industry-leading cyber security practices. The Department should analyze these contracting structures and develop approaches to attract best-in-class dual-use, midsize companies to its industrial base.

The Silicon Valley Defense Group maintains a list of the top 100 firms (NATSEC 100) of leading venture-funded, national security-focused, and dual-use companies. The amount of private investment in the firms on their list is significant, with cumulative investment over \$52 billion as of June 2024, a 20% increase from the same group in 2023.<sup>13</sup> The recent investment peak can be seen in **Figure 4**.

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<sup>13</sup> *SVDG NATSEC100 2024 Report*, Silicon Valley Defense Group, <https://natsec100.org/>.

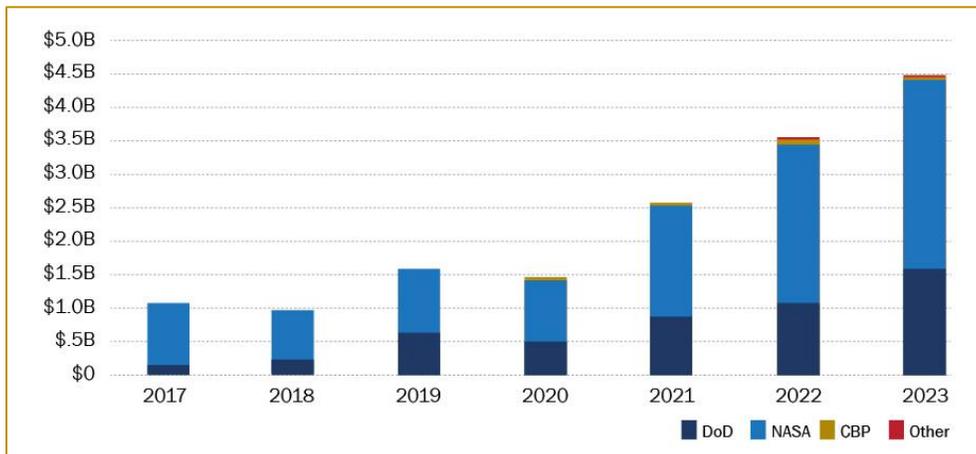
## DEFENSE SCIENCE BOARD



*Figure 4. 2024 NATSEC 100 Deal Count and Capital Invested By Year*

*[Adapted from: NATSEC 2024 Report, <https://sdvg-serving.s3.us-east-2.amazonaws.com/SVDG+NATSEC100+2024+Report.pdf>]*

During the same period, the top 100 within the NATSEC 100 firms were awarded \$22 billion in USG funding but only \$6 billion came from DoD. Even this number is skewed as 81% of the total awarded by the USG and 65% of DoD awards went to a single company on the list, SpaceX. The distribution of this funding can be seen in **Figure 5**.



*Figure 5. Federal Government Awards to All NATSEC 100 Companies*

*[Adapted from: NATSEC 2024 Report, <https://sdvg-serving.s3.us-east-2.amazonaws.com/SVDG+NATSEC100+2024+Report.pdf>]*

The success of companies such as Palantir and Anduril have undoubtedly increased the attractiveness of less-established players who make up the bulk of the NATSEC 100 to private equity investors. The DoD should leverage these investments and encourage acquisition professionals in both R&E and A&S to actively explore where these types of firms may offer a competitive advantage over the traditional DIB.

A relatively new possible model of DoD reaching into mid-tier and emerging suppliers is the Space Development Agency (SDA) formed in 2019 and transferred to the U.S. Space Force in 2022.

Over the last several years the SDA has found success by encouraging teaming between the traditional DIB and both mid-tier and smaller entrepreneurial companies attempting to enter the defense market. Success may also be attributed to a preference toward issuing firm-fixed contracts versus cost-plus awards. The SDA has demonstrated, for their needs, that this approach encouraged the DIB to work closely with their smaller

partners to accelerate development, production, and delivery of products. Recent agreements have Lockheed Martin working with Terran Orbital and SpaceX working with York Space Systems.<sup>14</sup>

In some cases, the Military Services have also broken with the traditional DIB, such as the Air Force's April 2024 decision to award work on the Collaborative Combat Aircraft (CCA) to Anduril and General Atomics over Boeing, Lockheed Martin, and Northrop Grumman. In May 2024, the Army awarded Palantir a \$178 million contract for tactical intelligence targeting access node over RTX.<sup>15</sup>

There are other examples within the Department that have yet to mature but offer promise in both acquisition approach and a shift toward mass production, most notably the Replicator Initiative. Rolled out formally in August 2023 this effort is led by DIU with a goal to field thousands of uncrewed systems by August 2025. Replicator 1 focuses on fielding ADDA2 systems, while Replicator 2 will concentrate on countering small uncrewed aerial systems (C-sUAS).

The program was initiated from Russia's second invasion of Ukraine in 2022. It is estimated the Ukrainians may be utilizing up to 10,000 attritable UAV systems per month in theater, which has added significant tactical advantages.

DoD has confirmed an award to AeroVironment for its Switchblade 600, Anduril's Altius-6600 and Ghost-X UAS and Performance Drone Works C-100 UAS. It is also reported that Anduril's Dive LD will provide uncrewed undersea vehicles. In addition, seven firms have been selected to provide software support for Replicator's autonomy and command and control systems. Significant resources are being devoted to this effort including a reprogramming request for \$300 million in FY23, with another request for reprogramming in FY24 and a further \$500 million in FY25.

While the program has yet to publicly demonstrate the ability to scale while controlling individual system costs, the effort has already demonstrated a significant new approach to acquisitions. Lessons learned from this high-priority DoD initiative will be an important guide for future programs that focus on sustained mass production within short timelines.<sup>16</sup>

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**What Must Be Done:** Expand the comparative advantage the United States must leverage in financial vehicles to both incentivize, finance, and accelerate investment to meet the long-term needs of the DoD.

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A key highlight of this report is that the United States is losing relative capability advantage vis-a-vis the PRC from the perspective of both economic security and defense security. To regain that position of strength, the United States must leverage its unambiguous sources of global competitive advantage, including the depth, breadth, sophistication, agility, and maturity of its capital markets. At \$56 trillion, U.S. equity capital markets are nearly three times the size of the U.S. economy. This vast pool of capital—\$46 trillion in public capitalization and another \$10 trillion in private money—dwarfs that of the Chinese economy. The New York Stock Exchange alone is four times the size of China's Shanghai stock exchange.

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<sup>14</sup> Sandra Erwin, *Space Development Agency Aims High for 2024 after Strong 2023 Start*, SpaceNews, December 7, 2023, <https://spacenews.com/space-development-agency-aims-high-for-2024-after-strong-2023-start/>.

<sup>15</sup> Colin Demarest, *Tech Race Spurs U.S. Investment in New Defense Suppliers*, Axios, July 17, 2023, <https://www.axios.com/2024/07/17/military-defense-contractors-tech-ai-disrupters>.

<sup>16</sup> *DOD Replicator Initiative: Background and Issues for Congress*, Congressional Research Service (CRS) - In Focus, December 2, 2024, <https://crsreports.congress.gov/product/pdf/IF/IF12611>.

American capital markets represent a critical yet underutilized strategic advantage for the Department's ability to field new capabilities and should be tapped for national security requirements.

U.S. capital markets can be accessed through equity investment, lending, or credit guarantees, among other tools, to speed dynamic funding at scale across the spectrum of companies to accelerate technology development for innovation, scale procurement for rapid fielding of capability, and address readiness and infrastructure shortfalls to expand combat capacity. The DoD tends to view legal, regulatory, and logistical hurdles in the Pentagon's rigid process of annual appropriations, extended budget cycles, endless continuing resolutions, and complex procurement procedures as rendering access to the public and private markets nearly impossible. Yet, as other departments such as Energy and Commerce have shown, the primary barrier is neither legal nor technical, but adherence to an overly risk-averse culture wedded to precedent procedures. DoD has already shown an ability to be nimble in response to national emergencies, as seen in the use of OTAs and Title III to address COVID-19 requirements for vaccines and therapeutics. It also has broad precedent for accessing equity through its own venture capital programs, while other Departments like Energy (through its Loan Program Office) or Commerce (through its CHIPS program office) have demonstrated success with credit and credit guarantees. The USG even established the Federal Ship Financing Program in 1936, which provided a full faith and credit guarantee to promote the growth and modernization of the U.S. merchant marine and U.S. shipyards. The DoD obligates hundreds of billions of dollars each year in procurement and R&D contracts that could also support credit guarantees, which would significantly lower interest rates on borrowed capital for companies developing technology or increasing capacity, for example, thereby decreasing costs for DoD.

The Department has developed a range of successful approaches to influence early-stage technology development, including the DIU as well as several "innovation-hub" service efforts, such as AFWERX, SOFWERX, NavalX, Army Futures Command, and the Chief Digital and Artificial Intelligence Office. Most of these efforts leverage some combination of small business innovation research funding, OTAs, broad agency announcements, and as a result, serve as a catalyst for attracting private venture capital at leverage approaching 18-to-1 in the case of In-Q-Tel, a nonprofit acquisition arm of the intelligence community.

Capital markets have repeatedly demonstrated the ability to deploy large amounts of equity and credit at lower expected rates of return when provided lower risk profiles due to government commitments, as seen in many infrastructure projects, effectively reducing the cost of capital. The Title III program already allows DoD to address areas where critical industrial capacity needs improvement with grants, purchase commitments, loans, or loan guarantees. More recently, Congress authorized nearly \$53 billion under the bipartisan CHIPS and Science Act to catalyze U.S. chip manufacturing and another \$65 billion in broadband expansion to underserved areas. DOE has also implemented a broad range of grant, loan, tax credit, and guarantee programs such as the \$161 billion in tax credits for deployment of zero-carbon energy sources and \$116 billion in grants for clean energy R&D and is attracting private capital by lowering risk and cost for technology development and for a future transition to production capacity. These DOC and DOE programs will unlock much more in private and public capital, providing much greater flexibility, speed, and scale than funding through the routine congressional appropriation process.

Accessing private capital also reduces risk and cost because those funds can be made dynamically available in adequate amounts at scale to support program needs with agility. Consequently, the benefits of multi-year procurement can be gained and the holding period on drawn capital can be efficiently minimized, with perhaps 5 to 10 percent or more in savings, while lowering schedule risk, like the experience with multi-year procurements. The capital markets can also provide funds to address critical

readiness issues, such as the significant challenge in Navy ship repair, with approximately 40% of submarines sidelined for maintenance, due in large part to dysfunctional World War II-era drydocks.

The United States has the luxury of being able to integrate the extraordinary equity and debt funding capabilities of its capital markets into the build-up of a future defense industrial network via means no other country in the world can match. The rise of a peer competitor in Asia and ubiquitously available conventional weapons (enabled by commercial technology) that are available to U.S. adversaries leaves the United States with no choice but to take full advantage of its capital markets if it is to regain a position of superiority. Senior leaders within the DoD and U.S. capital markets need to begin a dialog on applying financial tools (which essentially already exist) to provide the market with investment opportunities reflecting reduced risk and reduced return expectations. Through these mechanisms, technology development can be accelerated and transitioned, production increased, and decayed infrastructure that impacts readiness revitalized.

As a use case for leveraging the capital markets, the supply chain challenges in U.S. combat system programs relating to critical materials sourced from Chinese companies could be mitigated through the application of public and private capital. For example, a risk mitigation approach could be to establish a U.S. specialized security zone in the large federal lands across the southwest or at existing arsenals, where world-class manufacturing and processing plants could be permitted for operation through federal regulatory processes, with facilities constructed and operated using public and private capital. This approach would enable the United States to quickly develop the IP for processing critical minerals, and some permitted processing capacity, to ensure small quantities are made as a means to “De-China” weapon system supply chains with trusted U.S. sources. The Department could then develop plans to rapidly scale production in anticipation of war or supply disruption, which could also be financed through the capital markets, perhaps via credit guarantees from a new National Security Infrastructure Bank modeled off Export-Import Bank processes. This zone could be operated much like an oil rig in the Gulf of Mexico or the remote nuclear testing facilities at Idaho National Labs, bringing in specialist operators for specific work engagements. A complementary approach is to leverage the U.S. global comparative advantage in capital markets with tools (e.g., funded contracts and credit guarantees) that lower the cost of capital so U.S. companies can produce the material needed for tomorrow’s battlefields (e.g., Solugen Solutions which received a roughly \$215 million, 18-year loan guarantee from DOE Loan Program Office for its CL-20 energetic material).

This investment approach could be extended to establish a parallel organization that finances or subsidizes U.S. companies to compete strategic investments from adversarial countries in critical assets and infrastructure across international markets (e.g., the PRC’s COSCO Shipping purchase of the Port of Hamburg, PRC’s development of the huge deep-water port in Chancay, Peru, and the sale of nickel and lithium mines to PRC-owned enterprise). U.S. companies are often competing against a whole-of-nation-backed Chinese entity that is subsidized by the PRC to pay a premium price and win a strategic deal. Simply put, U.S. companies cannot compete in these markets without the USG to level the playing field with foreign entities.

## Importance of DoD’s Defense Industrial Infrastructure

Integrating modern technology into the Joint Force requires a large and complex infrastructure for development, testing, manufacturing, and sustainment. As a dimension of DoD’s 1993 decision to reduce the size and cost of the U.S. defense industry, the infrastructure supporting the post-Cold War force structure was also drawn down. Three decades later, following the \$2 trillion, 20-year long engagement in

post-9/11 counterterrorism, the United States and its allies face an even more demanding set of adversaries.<sup>17</sup>

The emergence of a diplomatically aligned and geographically connected Eurasian security coalition composed of China, Russia, Iran, and North Korea. Three of the four have significant and growing nuclear delivery capabilities, while the fourth, Iran, is a rapidly emerging nuclear aspirant. The Office of the Secretary of Defense for Space Policy described the circumstances now faced by the United States and its allies.

We now find ourselves in nothing short of a new nuclear age—an unprecedented mix of multiple revisionist nuclear challengers who are uninterested in arms control or risk reduction efforts, each rapidly modernizing and expanding their nuclear arsenals, and openly threatening to employ nuclear weapons to achieve their aims.<sup>18</sup>

The cooperation of these nations has significantly altered the scope and scale of the potential threat posed to U.S. and allied interests as well as the industrial base needed to deter or defeat this coalition of adversaries. The legacy DoD defense-industrial infrastructure was sized against a security environment which no longer exists.

However, the cycle of rebuilding and expanding industrial infrastructure financed via annual appropriation is not synchronized with U.S. security needs. The Navy’s shipbuilding modernization plan is a 20-year long program at cost of \$21 billion, a figure that is likely to be significantly underestimated.<sup>19</sup> Diminished industrial infrastructure capabilities supporting the U.S. Air Force and U.S. Army are similarly in urgent need of modernization and replacement. The U.S. Air Force infrastructure (including industrial components) can be described as being on “life support,” which is likely to drive a long-term and costly program to rebuild the Air Force and Space Force defense industrial capacity. As a point of comparison, the U.S. Army’s program to modernize its defense industrial infrastructure will require 15-years and \$18 billion to complete.<sup>20</sup>

Current efforts to rebuild defense industrial infrastructure are financed through the annual appropriation cycle, which causes the completion of the projects to lag one to two decades behind need. One path toward

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<sup>17</sup> President Joseph Biden, *Remarks by President Biden on the End of the War in Afghanistan*, August 31, 2021, <https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/08/31/remarks-by-president-biden-on-the-end-of-the-war-in-afghanistan/>.

<sup>18</sup> Deputy Assistant Secretary of Defense for Space, Vipin Narang, *Nuclear Threats and the Role of Allies Remarks by Acting Assistant Secretary of Defense for Space Policy*, August 1, 2024, <https://www.defense.gov/News/Speeches/Speech/Article/3858311/nuclear-threats-and-the-role-of-allies-remarks-by-acting-assistant-secretary-of->; B. Ravid, *Scoop: Biden discussed plans to strike Iran nuclear sites if Tehran speeds toward bomb*, January 2, 2025, *Axios*, [https://www.axios.com/2025/01/02/iran-nuclear-weapon-biden-white-house?utm\\_source=newsletter&utm\\_medium=email&utm\\_campaign=newsletter\\_axiospm&stream=top](https://www.axios.com/2025/01/02/iran-nuclear-weapon-biden-white-house?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiospm&stream=top).

<sup>19</sup> J. Gould and D. B. Larter, *The US Navy’s shaky plan to save its shipyards is getting overhauled*, March 19, 2021, *Defense News*, <https://www.defensenews.com/naval/2021/03/19/the-us-navys-shaky-plan-to-save-its-shipyards-is-getting-overhauled/>; Congressional Research Service, *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*, 05-21-2024, <https://crsreports.congress.gov/product/pdf/RL/RL32665/408>.

<sup>20</sup> D. Roza, Air Force *Infrastructure is on Life Support. A new Plan Aims to Fix it*, December 11, 2024, *Air and Space Forces Magazine*, <https://www.airandspaceforces.com/air-force-installation-infrastructure-plan/#:~:text=A%20New%20Plan%20Aims%20to%20Fix%20it&text=The%20Department%20of%20the%20Air.and%20other%20critical%20base%20facilities>; M. Kelly, US Army Materiel Command, *Army Tests OIB (Organic Industrial Base) Modernization on Capitol Hill*, June 27, 2024, <https://www.dvidshub.net/news/477226/army-shares-oib-modernization-plan-capitol-hill#:~:text=The%20Army%27s%20holistic%20OIB%20modernization.facilities%2C%20processes%20and%20the%20workforce>.

mitigating this risk to U.S. security interests is to use alternative paths to the financing of the defense industrial base through the U.S. capital markets.

## Financing to Accelerate the Introduction of Innovative Technology to the United States and Allied Armed Forces

DoD's encouragement of non-traditional suppliers has facilitated the emergence of a wide range of innovative technologies. However, the U.S. combined arms approach to military power needs to integrate new technologies with legacy platforms, train users in the employment of new technologies, and develop an infrastructure to sustain these capabilities over time. This deliberate approach to developing and absorbing innovative technologies is not well-linked to the time horizon of investors, especially small and agile (but undercapitalized) firms. As a result, many technologies that are very relevant to current and future defense needs are not able to be fully developed to meet DoD requirements before funding expires. Even when development is completed, there are sometimes gaps between the research program managers, who provided parts of that development funding, and the acquisition program managers, who must certify the resulting product or service and contract for its delivery. This "Valley of Death" for promising technologies (as depicted in **Figure 6**) is a well-known limitation on the ability of DoD to rapidly acquire, absorb, and field advanced technologies.

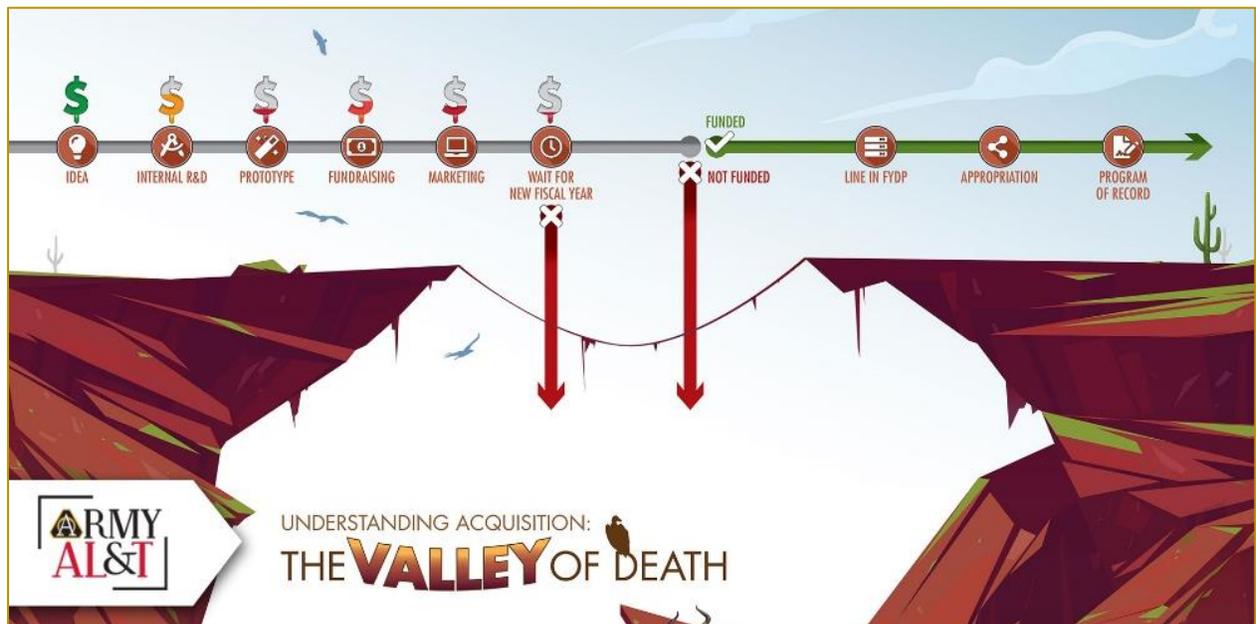


Figure 6. Understanding Acquisition: The Valley of Death

[Source: <https://asc.army.mil/web/news-understanding-acquisition-the-valley-of-death/>]

In 2022, DoD established the Office of Strategic Capital (OSC). The purpose of this organization is to finance the later-stage development of promising technologies aligned with DoD needs. The OSC's 2025 investment plan has recently been published.<sup>21</sup> The OSC approach uses federal loan guarantees (a financing approach widely used for financing allied purchases of U.S. defense equipment) to finance

<sup>21</sup> OSC, *Office of Strategic Capital Announces Release of Fiscal Year 2025 Investment Strategy*, January 2, 2025, <https://www.defense.gov/News/Releases/Release/Article/4020461/office-of-strategic-capital-announces-release-of-fiscal-year-2025-investment-st/> and *OSC's Mission*, Office of Strategic Capital, [https://www.cto.mil/wp-content/uploads/2024/10/OSC-Credit-Program-FAQs\\_Publication-Version.pdf](https://www.cto.mil/wp-content/uploads/2024/10/OSC-Credit-Program-FAQs_Publication-Version.pdf).

development and application of advanced technology to meet DoD needs.<sup>22</sup> Federal loan guarantees are also used elsewhere in the Federal Government, including by the DOE, which has used more than \$40 billion in Federal loan guarantees to finance its clean energy projects.<sup>23</sup>

Since U.S. capital markets are the world’s largest, most robust, and efficient—\$120 trillion, nearly five times the size of the U.S. GDP and dwarfing China’s capital markets<sup>24</sup>—using them to fund defense-related infrastructure is a good match for the interests of both the DoD customer and the U.S. capital markets since long-term investment is needed by both parties. A useful illustration of this approach is the successful financing in September 2024 of a private shipyard in Alabama, the *Mobile Naval Shipyard* for submarine maintenance and support for the Navy’s Military Sealift Command.<sup>25</sup>

The ability of the DoD and Military Departments to access long-term financing from U.S. capital markets is critically dependent on terms that render the risk-adjusted return on the investment attractive to investors. In the Mobile Naval Shipyard case, the Navy made contractual commitments relating to work at the site that reduced risk to investors and attracted funds due to the resulting lower required risk-adjusted return. Each of these transactions for various parts of the DoD defense-industrial infrastructure are likely to have unique characteristics that need to be considered to attract capital market investors. The adaptation of DoD acquisition practices to well-understood and widely used commercial financing practices in the capital markets can address mitigating one of the most prominent risk-items in the ability to reconstitute the defense industrial infrastructure to address the threat.

## Creating Greater Commercial Sector Participation in the National Security Industrial Base

### Recommendation 1 – Specific Recommendations

- **USD(A&S) and SAEs** as DoD financial management leadership take action to reduce capital risk, both availability and pricing, through risk sharing, co-investment, and a broader set of demand signals that capital markets value.
- **USD(A&S) and SAEs** task DoD procurement officials to emphasize and enhance mandatory “market surveys” to identify and quality additional vendors to provide enhanced hardware or software—those innovating who traditionally have not done business directly with DoD.
- **SAEs, program managers (PMs), and program executive officers (PEOs)** prioritize and leverage vehicles such as the DPA, MCEIP, etc. to focus efforts on commercial vendors.

<sup>22</sup> Defense Security Cooperation Agency, *C.9, Financial Policies and Procedures*, <https://samm.dsca.mil/chapter/chapter-9#C9.1>.

<sup>23</sup> Department of Energy, *Financing Programs*, <https://www.energy.gov/lpo/financing-programs>

<sup>24</sup> Gary Gensler, *A Feature, Not a Bug: The Important Role of Capital Markets in the U.S.*, October, 2024, U.S. Securities and Exchange Commission, <https://www.sec.gov/newsroom/speeches-statements/gensler-remarks-bloomberg-global-regulatory-forum-102224#:~:text=First%2C%20the%20U.S.%20economy%20and%20banking%20and%20credit%20union%20sector>; J. Votel, Francis A. Finelli, and S. Cole, *Leveraging US Capital Markets to Support the Future Industrial Network*, *War on the Rocks*, January 11, 2023, <https://warontherocks.com/2023/01/leveraging-u-s-capital-markets-to-support-the-future-industrial-network/>.

<sup>25</sup> *Private Equity Fund Buys Alabama Shipyard for Austal USA's Sub Program*, September 23, 2024, <https://maritime-executive.com/article/private-equity-fund-buys-assets-of-alabama-shipyard-for-austal-s-use>.

## Recommendation 2: Leveraging Allies and Partners in the National Security Industrial Base



*“The farther backward you can look, the farther forward you can see”  
Sir Winston Churchill*

**What Must Be Done:** Make institutional and policy changes that will enable more extensive and effective collaboration with U.S. allies and partners.

To implement the new paradigm for a NSIB, DoD needs to make institutional and policy changes that will enable more extensive and effective collaboration with U.S. allies and partners. U.S. allies and partners have extensive industrial infrastructure with a broad range of advanced capabilities that will contribute to the ability of the alliance to deter or defeat adversaries.

DoD and the Department of State (DOS) have taken advantage of the close defense collaboration in the Indo-Pacific region institutionalized in the Australia-UK-U.S. (AUKUS) agreement of 2021. To enable defense-industrial collaboration within the three-nation alliance, the DOS has sharply reduced the number and types of transactions that require a U.S. government munitions license. The new regulation eliminates a licensing requirement for 80% of the defense trade transactions among the three nations.<sup>26</sup>

This approach holds promise for liberalizing the defense trade environment with other allies and partners as each nation harmonizes their export control enforcement capabilities to deflect the adversary effort to acquire U.S. and allied technology.<sup>27</sup> Some discussions have already begun about broadening the scope of export control reform to Japan, Canada, and New Zealand.<sup>28</sup> Strengthening the capacity of alliance partners to protect technology from adversary compromise could be accomplished by leveraging the existing General Security of Military Information Agreements (GSOMIA) with more than 70 allied and partner nations.

In addition, the United States has entered 28 Reciprocal Defense Procurement (RDP) agreements which most would agree have not been fully exploited as a tool of allied cooperation and production. These

<sup>26</sup> *International Traffic in Arms Regulations: Exemption for Defense Trade and Cooperation Among Australia, the United Kingdom, and the United States*, Department of State, 89 Fed. Reg. 67270 (Aug. 20, 2024), <https://www.federalregister.gov/documents/2024/08/20/2024-18043/international-traffic-in-arms-regulations-exemption-for-defense-trade-and-cooperation-among>.

<sup>27</sup> Zach Dorfman, *Moscow’s Spies Were Stealing US Tech — Until the FBI Started a Sabotage Campaign*, *Politico*, August 4, 2024, <https://www.politico.com/news/magazine/2024/08/04/us-spies-soviet-technology-00164126>; A. Imbrie and R. Fedasiuk, *Untangling the web: Why the US needs allies to defend against Chinese Technology Transfer*, Brookings, 2020, [https://www.brookings.edu/wp-content/uploads/2020/04/FP\\_20200427\\_chinese\\_technology\\_transfer\\_imbrie\\_fedasiuk.pdf](https://www.brookings.edu/wp-content/uploads/2020/04/FP_20200427_chinese_technology_transfer_imbrie_fedasiuk.pdf).

<sup>28</sup> B. Westcott, *Aukus to Consult on Tech Partnerships With Japan, Canada and NZ*, September 17, 2024, <https://www.bloomberg.com/news/articles/2024-09-18/aukus-to-consult-on-tech-partnerships-with-japan-canada-and-nz?sref=boE5Wq9G>.

agreements, when implemented properly, allow the partner nations to open cross border opportunities and waive “buy national” laws. A timeline of these agreements is depicted in **Figure 7**.

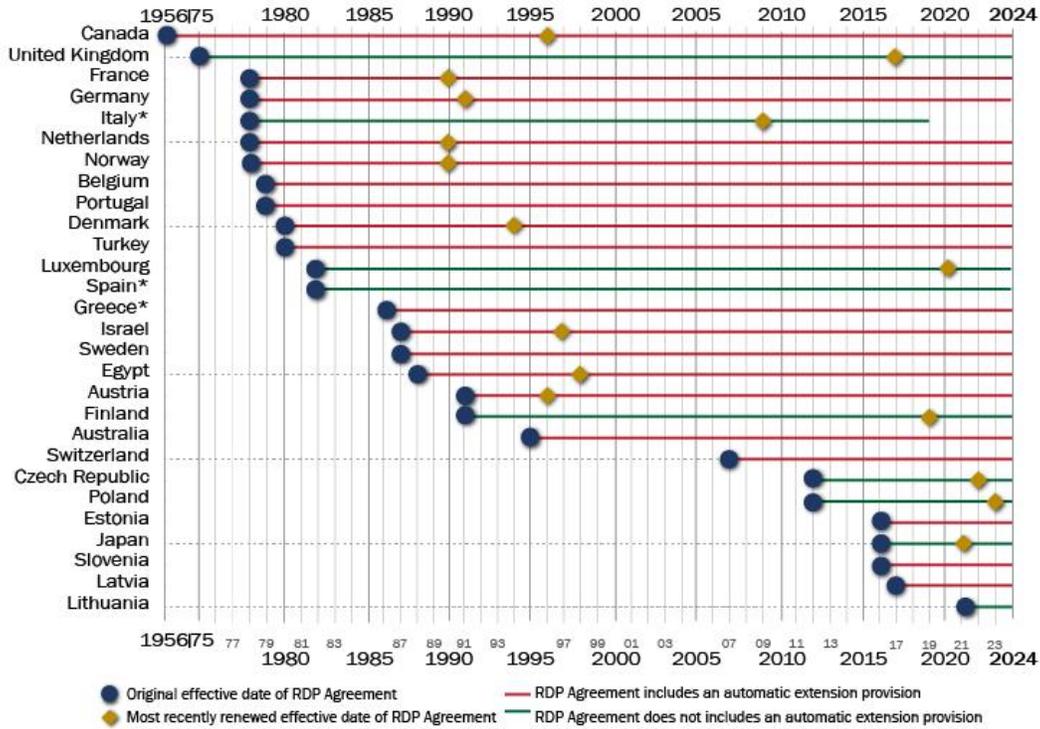


Figure 7. Reciprocal Defense Procurement (RDP) Agreements by Original and Most Recently Renewed Effective Dates and Inclusion of Automatic Extension Provisions

[Adapted from: GAO report 25-106936, December 2024, <https://www.gao.gov/assets/gao-25-106936.pdf>]

To better leverage the full spectrum of multiple partnership agreements, a pilot program to post an attaché from the Defense Counterintelligence and Security Agency (DCSA) at U.S. embassies abroad should be considered. This effort would also support the recently established Defense Security Cooperation Service. The representatives could support the understanding of U.S. policies and best practices DCSA currently performs for U.S. industry. Doing so would also improve prospects for harmonizing technology security practices that could facilitate greater information sharing within the alliance as well.

**What Must be Done:** Leverage Allied scientific and industrial capabilities.

Distant memories of the U.S. World War II experience in industrial mobilization for national defense has caused some observers to overstate the degree to which the United States could be autarkic with respect to meeting national defense needs in a crisis. Over the past three decades, that capability has eroded and disappeared. The United States is no longer the world’s dominant producer of manufactured products; China’s manufacturing base is three times the size of the U.S. manufacturing base (civil and military) and twice its size in terms of value-added. Moreover, the PRC’s practice of “military-civil fusion” enables its

largest firms to be producers of both civil and military products.<sup>29</sup> These circumstances accelerate the transfer of new technology to military applications.

The need to access the defense and civil industrial base of U.S. allies and security partners in a global conflict is no longer optional—it is essential. **Figure 8** summarizes the scale of the manufacturing capabilities of U.S. allies and security partners.

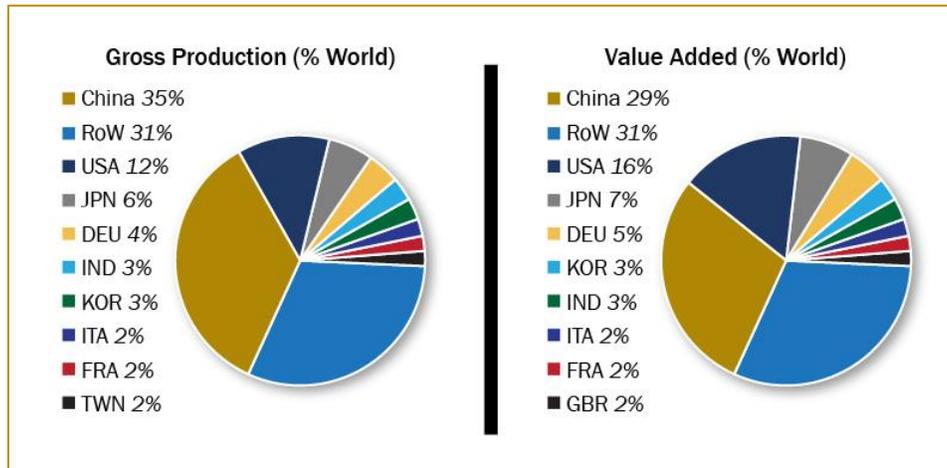


Figure 8. World's Biggest Manufacturing Economies

[Adapted from: <https://cepr.org/voxeu/columns/china-worlds-sole-manufacturing-superpower-line-sketch-rise>; data derived from OECD TIVA database, 2023 update]

U.S. allies have a diverse legacy defense industrial base that is parallel to many capabilities within the United States. Cross-border collaboration between the national industries European nations of the North Atlantic Treaty Organization (NATO) often takes place to develop major platforms, but otherwise there is little cross-border defense industrial consolidation. The focus typically placed on individual nations' capabilities is challenged by the need for U.S. NATO allies to achieve economies of scale through common standards and to limit redundant defense R&D and industrial investment that will enable the alliance to provide effective support to deter or defeat future threats.

The 2023 and 2024 NATO Summit meetings produced alliance-wide defense industrial commitments, a summary of which are displayed in **Figure 9**. Taken together, these commitments reflect a far-reaching agreement within the alliance to make significant changes in how members approach defense-industrial preparedness. The alliance has committed to ending the long recession in alliance military capability between the end of the Cold War and Russia's invasion of Ukraine.

Unfortunately, the United States often overestimates the power and commitment of its allies and partners, witness former Prime Minister of Italy and European Central Bank (ECB) Chair Mario Draghi's September 2024 report, *The Future of European Union Competitiveness*. This report chastises Europe for its declining industrial capability and calls for €750-800B/year in new investment to reconstitute manufacturing

<sup>29</sup> U.S. Department of State, *The Chinese Communist Party's Military Civil Fusion Policy*, <https://2017-2021.state.gov/military-civil-fusion/>; N. L. Chu, *China's Military-Civil Fusion (MCF) Strategy: How Threats and the Government Led the Drive for Technological Innovation*, Naval Postgraduate School, September 22, 2022, <https://apps.dtic.mil/sti/trecms/pdf/AD1200420.pdf>; A. Stone and P. Wood, *China's Military Civil Fusion Strategy*, China Aerospace Studies Institute, USAF, [https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Other-Topics/2020-06-15%20CASI China Military Civil Fusion Strategy.pdf](https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Other-Topics/2020-06-15%20CASI%20China%20Military%20Civil%20Fusion%20Strategy.pdf).

capability, among other initiatives. Who would have believed that Russian GDP would grow 9x faster than the European Union (EU) in 2023 (+3.6% vs +0.4% y/y according to the IMF), despite all the U.S. and G7 sanctions? There is no doubt that growth in Russia’s economy was tremendously enabled by the PRC’s replacing the U.S.\$ as Russia’s reserve currency with its Renminbi (RMB). This replacement enabled Russian banks and companies to access global markets through Chinese and other international banks, further facilitating transactions denominated in Chinese currency with India, of all places, becoming the largest purchaser of Russian oil—much of which was refined and sold back to Europe as diesel or other fuels.

NATO Defense Production Action Plan: Vilnius Summit, 2023	NATO Industrial Capacity Expansion Pledge July 2024
<ul style="list-style-type: none"> <li>  Adopting or updating their national defence strategies and passing the necessary legislation to improve defence industrial cooperation and government-to-industry relationships.</li> <li>  Reviewing national defence procurement processes to identify how and where to compress timelines for acquisition and support more collaboration with allies.</li> <li>  Making targeted investments in industrial defence production, focusing on reactivating or opening new production lines for ammunition and explosives.</li> <li>  Placing major, long-term contracts to bolster their defence capabilities, with significant investments in capabilities such as fighter aircraft, helicopters, uncrewed aerial systems, main battle tanks, infantry fighting vehicles, battle decisive munitions, and air and missile defence systems.</li> <li>  Boosting participation in joint procurement initiatives, bilateral defence cooperation agreements, and joint capability development initiatives.</li> </ul>	<ul style="list-style-type: none"> <li>  Enhance defence industry across the Alliance by fostering cooperation, openness, clear demand signals and contracting, in line with NATO’s strategic military requirements.</li> <li>  Take a more systemic approach to defence industrial development. Allies will develop and share National Plans to enhance industrial capability, capacity and responsiveness.</li> <li>  Urgently deliver critical capabilities required for NATO’s defence plans, with an initial focus on battle decisive munitions and air and missile defence.</li> <li>  Increase large-scale, multinational procurement. Drive more joint procurement to bolster interoperability and interchangeability and deliver better value for money.</li> <li>  Accelerate adoption of new technologies. Harness the considerable potential of our small and medium-sized enterprises.</li> <li>  Enhance cooperation with Ukraine by fostering and expanding defence cooperation between allies and the Ukrainian defence industrial base to the fullest extent.</li> <li>  Enhance cooperation with partners. Continue to take mutual steps with the EU to strengthen coherence and complementarity of respective efforts and relevant work. Enhance dialogue with partners including Australia, Japan, New Zealand and the Republic of Korea.</li> <li>  Reinforce commitment to NATO standards and enhance interoperability and interchangeability, regularly reviewing progress with our Defence Ministers</li> <li>  Protect defence-critical supply chains. Take action to foster the responsiveness, strength, resilience, and security of supply chains to protect our industries and ensure the Alliance develops military capabilities free from hostile influences.</li> </ul>

Figure 9. NATO Summit Meetings (2023 and 2024)

[Adapted from: [https://www.nato.int/nato\\_static\\_fl2014/assets/pdf/2024/7/pdf/240712-Factsheet-Industrial-Capacity-Exp.pdf](https://www.nato.int/nato_static_fl2014/assets/pdf/2024/7/pdf/240712-Factsheet-Industrial-Capacity-Exp.pdf)]

USG leadership has also stimulated a series of engagements with U.S. treaty allies in East Asia, producing new or expanded defense industrial as well as security commitments including the Republic of Korea (RoK), Japan, and Taiwan.<sup>30</sup> These East Asian allies (apart from the RoK) do not have large defense sectors, but they do enjoy extensive and modernized civil manufacturing sectors alongside advanced science and technology infrastructure. These capabilities can readily support the needs of their indigenous defense sectors including collaborative defense products within an “alliance defense industrial base” such as those proposed by DoD in its recently promulgated Defense Industrial Strategy Implementation Plan.<sup>31</sup>

Apart from NATO’s recognition of its need to enable defense industrial modernization, the need to do so has been more widely recognized within the EU as well.<sup>32</sup>

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**What Must be Done:** The United States and its allies and partners must adjust their respective industrial bases and priorities.

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While there have been many significant and positive efforts over the last two decades by the United States to enhance its industrial relationships with its allies, they have largely been developed tactically not strategically. Each department within the USG has pursued interaction and cooperation with its allies, all of which should be applauded. The Departments of Energy, State, Agriculture, Treasury, Homeland Security, and others have pursued either bilateral or multilateral efforts in the best interest of the American people.

While impressive individually, these agreements are each being pursued from the individual stakeholder perspective and have not been considered more holistically in the overarching interest of the USG—in a more strategic way. Likewise, each organization within the DoD has recognized the value of allied cooperation, but from different viewpoints. The clearest lens within DoD are the Military Services where the Combatant Command (CCMD) structure must rely on partners for the execution of missions. The Under Secretaries of Policy, Intelligence, Acquisition and Sustainment, and Research and Engineering and all the Military Services have independently pursued international cooperation aligned with their respective mandates and needs. What is lacking is strategic oversight, framework, and comprehensive exploitation of all the good works that have been pursued and achieved on a tactical basis.

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<sup>30</sup> DoD, *Joint Press Statement for the 25th Korea-U.S. Integrated Defense Dialogue*, September 24, 2024, <https://www.defense.gov/News/Releases/Release/Article/3915402/joint-press-statement-for-the-25th-korea-us-integrated-defense-dialogue/>. Both sides pledged to continue expanding cooperative measures to enhance the defense industrial base and interoperability of both the United States and the ROK; Ken Moriyasu, *U.S. seeks to ‘integrate’ Japan into defense industrial base*, Nikkei Asia, April 3, 2024, <https://asia.nikkei.com/Politics/International-relations/Indo-Pacific/U.S.-seeks-to-integrate-Japan-into-defense-industrial-base>; China (Taiwan) News Agency, *Taiwan urges U.S. to include it in joint weapons production list*, Focus Taiwan, September 22, 2024, <https://focustaiwan.tw/politics/202409240016>.

<sup>31</sup> Assistant Secretary of Defense for Industrial Base Policy, *Defense Industrial Base Industrial Strategy: Enabling a Modernized Defense Industrial Ecosystem*, Department of Defense, October 2024; <https://www.businessdefense.gov/NDIS.html>.

<sup>32</sup> Institute de Relations Internationales et Strategiques, *The Impact of the War in Ukraine on the European Defence Market*, September 2023, [https://www.iris-france.org/wp-content/uploads/2023/09/19\\_ProgEuropeIndusDef\\_JPMaulny.pdf](https://www.iris-france.org/wp-content/uploads/2023/09/19_ProgEuropeIndusDef_JPMaulny.pdf); B. Scheer, *Europe’s defence procurement since 2022: a reassessment*, IISS, October 23, 2024; <https://www.iiss.org/online-analysis/military-balance/2024/10/europes-defence-procurement-since-2022-a-reassessment/> and European Commission, *REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL: Establishing the European Defence Industry Programme and a framework of measures to ensure the timely availability and supply of defence products (‘EDIP’)*, March 2024, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52024PC0150>.

As has been made clear by Russian's second invasion of Ukraine, the USG is ill-prepared to build upon the tactical successes of various bilateral efforts to create a strategic framework that demonstrates both an ability and willingness to reassert collective strength and credible deterrence. The United States must embrace a more comprehensive approach and build upon those individual successes.

The clearest example in the current environment of how likeminded nations cooperate toward a NSIB is large caliber munitions. Russia is awash in large caliber ammunition with their new cooperation agreement with North Korea allowing them to fire 10,000 rounds per day. At the height of the fighting in Donbas, Russia was using more ammunition in two days than the entire British military had in their stock.<sup>33</sup>

Before the Russian second invasion of Ukraine not only was there little focus on the U.S.'s capacity, but the capacities of its allies were further variations of 155mm artillery rounds based upon their own cannons and platforms. Despite being the same caliber, they are uniquely produced across the industrial base to ensure compatibility with various platforms and in fact are not "common standard." Munitions represent a glaring example of how not to plan for a sustained conflict.

This reality on the ground has energized both the United States and its allies to engage cross border cooperation on industrial base policy not imaginable just three years ago. In addition to the U.S. Army's new ammunition plant in Mesquite, Texas, a new ammunition factory is now being built in Queensland, Australia that will be jointly owned by Rheinmetall and Australia's NIOA. This will be the first such facility built in Australia since World War II. The shells will be exported to Rheinmetall in Germany where they will be filled with explosives increasing capacity by 25% to around 55,000 shells per year. This same arrangement between allied nations could produce 100,000 high quality shells per year.

Germany's Rheinmetall is also increasing NATO standard 155mm rounds from roughly 100,000 before February 2022 to 1.1 million rounds by 2027, while Sweden's Saab has doubled to 200,000 155mm rounds in recent years and is on course to reach 400,000 over the next few years.

Raw materials in the supply chain remain an issue, notably the cotton linters which are used to produce nitrocellulose, as well as certain elements in energetic materials that are largely sourced from non-friendly nation suppliers. Rheinmetall has increased their "safety stock" for certain materials such as cotton linters and armored steel to approximately three years of annual production.

Norway has invested nearly \$100M to boost production of critical explosives and rocket motors. They are currently undertaking a joint study with Chemring Nobel, the Norwegian subsidiary of the UK's Chemring for further cooperation in production facilities. The current plan is for a new production facility for Nammo (co-owned by the Norwegian and Finnish governments) to be operational within two years.<sup>34</sup>

These efforts, none of which directly involve the United States, are examples of a collective NSIB. Policymakers must learn the lessons of how the United States and its allies have adjusted the respective industrial base and priorities for a prolonged fight in the future.<sup>35</sup>

While munitions may be clearest example of the need to embrace allies on collective industrial policy, there are also efforts underway to better plan for and engage a policy in support of a NSIB. The significant efforts

<sup>33</sup> Sylvia Pfeifer and Nic Fildes, *Defence Companies Search for Scale in Ammunition Race for Ukraine*, *Financial Times*, October 14, 2024, <https://www.ft.com/content/907848e8-57e0-40c4-97b1-e08b6bf1514f>.

<sup>34</sup> Ibid.

<sup>35</sup> Aabrodski, et al., *Preliminary Lessons in Conventional Warfighting from Russia's Invasion of Ukraine*, pages 2, 55.

underway with AUKUS, particularly Pillar 2, should be commended and set as an example of how to engage with allies from a holistic perspective. As designed, there are two “pillars” to the AUKUS agreement. Pillar 1 involves creation of a sovereign conventionally armed nuclear-powered submarine in Australia. Pillar 2 includes the sharing of information and collaboration in several emerging technology fields including advanced undersea defense capabilities. Pillar 2 carves out many International Traffic in Arms Regulations (ITAR) issues that have historically hamstrung deep cooperation between nations, but the Defense Science Board (DSB) has some concerns regarding the holistic approach of engagement with U.S. allies as it does not currently address the issue of the USG’s excluded technologies list.

While AUKUS offers a good model to sharing critical information with close allies, there remain legacy policy decisions that must be addressed before the United States can truly take advantage of its collective security needs.<sup>36</sup> With closest allies, the United States should help bring about internal standards which would allow necessary ITAR waivers for classified and unclassified programs.

In furthering the collective allied security, the United States should also review the current Security of Supply Arrangement (SoSA) signatories to address specific capability gaps

As previously articulated, the EU has made significant efforts to better rationalize and pursue a collective security industrial framework. Most notable is the *2023 Vilnius Summit* launch relating to the *Defence Production Action Plan (DPAP)*, followed by NATO capacity Expansion Pledge in July 2024. This effort aims to aggregate demand to accelerate joint procurement, increase production capacity, and enhance interoperability. Standard settings are a key feature of DPAP. This agreement also established the first-ever Defence Industrial Production Board which has senior NATO officials seeking to boost industrial capacity and focus on replenishment of NATO stocks resulting from the Russian invasion of Ukraine.

These efforts associated with the United States’ NATO allies should be encouraged and expanded to the extent possible.

There was also the release of the European Defense Industrial Strategy which lays out several ambitious targets. For example, by 2030 EU countries should collaboratively purchase at least 40% of their defense equipment, allocate at least 50% of defense procurement to production in the EU, and trade at least 35% of defense goods from within the EU. Another EU effort came from the *2023 EU Capability Development Priorities* which set strategic guidelines for national and EU-wide defense planning.

All such initiatives are working toward a common goal—but most important is the recognition and urgency to harmonize individual nation’s industrial policies toward a greater good of what we would describe as a NSIB.<sup>37</sup>

While these bilateral and multilateral efforts have made progress around unique cooperative opportunities, the United States must do more to lead cooperative efforts. Perhaps the most direct change DoD could pursue is significant reform in its own rules around Foreign Military Sales (FMS), Foreign Military Financing (FMF), and Direct Commercial Sales (DCS) of U.S. products to its allied nations.

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<sup>36</sup> Issue was outlined by Bill Greewalt and Tom Borben in *The Strategist*.

<sup>37</sup> Audrey Aldisert and Cynthia Cook, *Readying NATO’s Defense Industrial Base for Its 100th Anniversary*, Center for Strategic International Studies (CSIS), July 8, 2024, <https://www.csis.org/analysis/readying-natos-defense-industrial-base-its-100th-anniversary>.

Without forsaking key IP protection, revisions could be made to both speed the process and ensure consistent delivery to allies. These programs collectively signed over \$1 billion in sales last year, but, not unlike DoD’s own production processes, the shipment of hardware often takes far too long.

The entire Department, not just offices such as the Defense Security Cooperation Agency, must accelerate efforts to support these programs, from the PEOs to PMs, to leadership within the Military Services, including the CCMDs. Outside DoD, there must be engagement with other stakeholders throughout the USG—DOC, DHS, DOE, etc.—to ensure the ability to leverage these important tools is seen in the context of promoting allied interoperability and the pursuit of a total NSIB.

### Leveraging Allies and Partners in the National Security Industrial Base

#### Recommendation 2 – Specific Recommendations

- **Secretary of Defense**, within the interagency, continue efforts to advocate for building/replicating AUKUS defense trade regulatory reforms to enhance U.S.-allied defense industrial base as well as S&T collaboration, interoperability, and advanced manufacturing capabilities.
- **USD(A&S) working with Military Service PMs and PEOs** work with DOS, DOC, DOE, and other USG stakeholders to negotiate manufacturing standards, certification of parts, and interoperability of hardware and software to enhance surge production (DoD lead).
- **USD(P) and USD(I&S) with Director, Defense Counterintelligence and Security Agency (DCSA)** working with interagency security reformers, reimagine information sharing with allies to enhance the industrial base as part of deterrence.
- **USD(R&E), USD(A&S), USD(P), and USD(I&S)** collectively prioritize and accelerate current efforts to transition cooperative R&E efforts with United States allies to NSIB production.
- **Secretary of Defense and Military Service Secretaries** lead in the interagency in exploiting the unique U.S. international defense market presence to facilitate creation of a sustainable alliance industrial capability.

### Recommendation 3: Planning for Extreme Contingencies—National Security Industrial Base Mobilization



Prior to World War II, the U.S. naval forces were ported in San Pedro, California. Following the completion of the Navy's exercises operating from Pearl Harbor in April of 1940, President Roosevelt directed the Navy to keep the naval forces in Pearl Harbor rather than return them to their home port in California to increase deterrence against Japan. It was also intended to mitigate the consequences for deterrence of a secret transfer of Navy ships via the Panama Canal to the Atlantic. This reflected the U.S.-UK prewar conference in August 1941 establishing the higher priority in winning in the European theater.<sup>38</sup>

This path the United States took in World War II from its decade-long industrial mobilization planning to the implementation of the national defense and defense industrial mobilization for total global conflict a decade later is no less relevant for the most extreme contingency of the 21<sup>st</sup> century.

#### **What Must be Done:** Prepare industrial mobilization plan for potential sustained conflict.

The Korean War (1950–1953) was an abrupt shock to U.S. defense planning and post-war expectations of the USG. Less than two months before the Democratic People's Republic of Korea (DPRK) invaded South Korea, Congress was debating the size of the defense budget; \$13.2 billion was appropriated. After the DPRK invasion in June 1950, a series of four supplemental appropriations led to a total of \$48.1 billion appropriated for FY51. Two days following the invasion, the *Military Selective Service Act* was extended for two years, and in September 1950, the *Defense Production Act of 1950* was signed into law allowing the President to assign priorities, allocate materials and facilities, requisition property for defense production, regulate consumer credit, make or guarantee defense production loans, negotiate long-term contracts for scarce materials, and to impose wage and price controls.<sup>39</sup> The authorities in the DPA are very similar to the proposals in the 1930 *Industrial Mobilization Plan*.

If there were to be coordinated and integrated diplomatic and defense industrial capacities from China, Russia, Iran, and North Korea, that coalition's global influence and large standing military forces would present significant challenges to the United States, allies, and partners. To address these potential challenges, the inversion of the recent industrial mobilization practices to the conversion of the entire U.S. scientific and industrial infrastructure is necessary to adequately support national defense. Such an approach would rely on a National Security Industrial Base that would confer extraordinary powers on the Federal government to control and allocate resources available to it to national defense.

<sup>38</sup> K. Martin, *Solely a Bluff: Relocating the US Fleet to Pearl Harbor*, *National World War II Museum*, October 20, 2021, <https://www.nationalww2museum.org/war/articles/fdr-bluff-relocating-us-fleet-to-pearl-harbor>.

<sup>39</sup> D. M. Condit., *History of the Office of the Secretary of Defense: The Test of War, 1950-53*, (1988, [https://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries\\_Vol2.pdf](https://history.defense.gov/Portals/70/Documents/secretaryofdefense/OSDSeries_Vol2.pdf)). Congress is now considering legislation to reauthorize and expand the scope of the *Defense Production Act*.

The industrial structure of the United States has changed profoundly since the industrial mobilization planning function largely vanished from the DoD or elsewhere in the Federal government. The size of the industrial base was reduced significantly by the post-Cold War consolidation of DoD prime contractors from > 30 to five (the *Last Supper*).<sup>40</sup> The rapid introduction of the technologies of information throughout the nation’s scientific and industrial economy have profoundly changed the nature of what is more appropriately described as the NSIB than the more customary DIB as summarized in **Figure 10**.

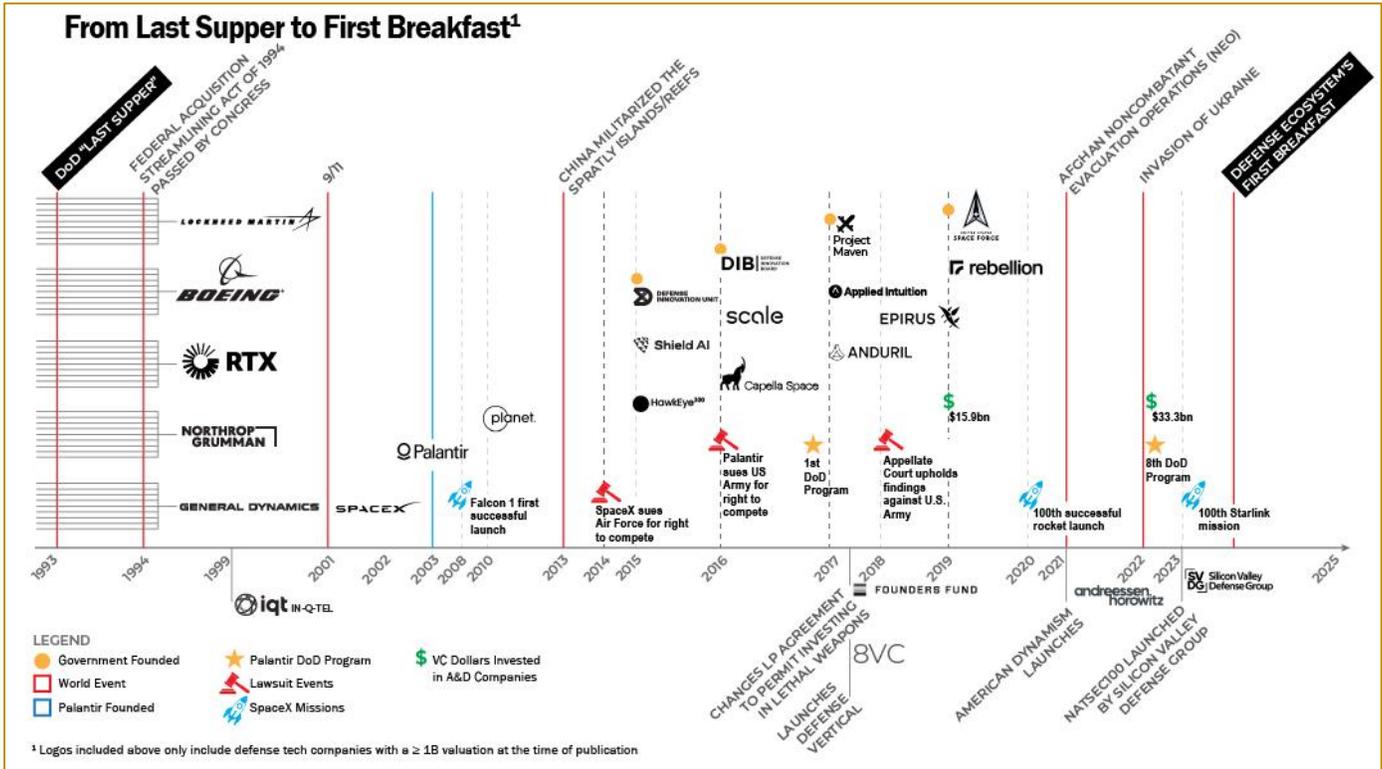


Figure 10. From Last Supper to First Breakfast  
 [Adapted from: <https://blog.palantir.com/from-last-supper-to-first-breakfast-cb971128b0bf>]

Many elements of industrial underpinnings of the firms developing and producing advanced technologies and products created in the decades since the end of the Cold War are providing products and services to the DoD. In some sectors of the national defense ecosystem, particularly space, the civil sector has largely displaced the government sector in the development and application of advanced technologies formerly provided by traditional defense contractors who dominate the DIB. In a scenario of an existential conflict involving a broad coalition of adversaries, the capacity of the United States to respond effectively will depend upon its ability to marshal national scientific and industrial resources on a scale that has only emerged once in our modern history—in World War II. A feasible, legal capacity to create and plan to initiate a “whole-of-nation” response to an existential security threat will be crucial to being able to deter such a risk.

<sup>40</sup> J. Mintz, *How a Dinner Led to a Feeding Frenzy*, July 3, 1997, *Washington Post*, <https://www.washingtonpost.com/archive/business/1997/07/04/how-a-dinner-led-to-a-feeding-frenzy/13961ba2-5908-4992-8335-c3c087cdebc6/>. Less than five years after the “Last Supper” took place, the negative effect on the defense industrial base began to appear. *Whatever Happened to Defense Industrial Preparedness*, *Joint Forces Quarterly*, 1997, <https://ndupress.ndu.edu/portals/68/Documents/jfq/jfq-16.pdf>.

The United States must adjust—plan for a global sustained conflict so it do not have to fight one.

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**What Must Be Done:** Institutional change to enable deterrence through the capacity to mobilize the whole of the U.S. scientific and industrial base.

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Both legal and policy precedent is available to affirm that the USG has the legal and constitutional authority to marshal the Nation’s resources to create an effective defense against an existential threat. Since the World War II and Korean War legislative and policy responses to wartime necessity, additional authorities have been created through the *International Emergency Economic Policy Act* (IEEPA).<sup>41</sup> Along with the *Trading with the Enemy Act of 1917* they constitute the primary authorities for USG action relating to economic transactions including the imposition of economic and financial sanctions on individuals and organizations in adversary states. The IEEPA has been invoked 69 times since the statute was enacted in 1977. The DSB has proposed creating a parallel statute to specifically address national security emergency powers as well in its 2022 Summer Study, *Technology Superiority*.<sup>42</sup>

The authority for defense industrial mobilization is best lodged in the DoD as was the case in the immediate response to the Korean War in 1950 and was in place prior to World War II. Recreating an Office of Defense Mobilization would establish an entity charged with developing detailed plans for defense industrial mobilization on a national scale to address defense and security needs where the United States faces an existential threat. By having national mobilization plans in place, and where possible, to exercise their implementation can enable the U.S. defense industrial capacity to be used to contribute to the ability of the United States to deter the threat or risk of a major conflict.

## A Competitive Assessment of the Defense Industrial Bases of China and the United States

The Center for Strategic and International Studies (CSIS) published the results of a recent industrial base war game, *Conflict in the Western Pacific and the Defense Industrial Base*.<sup>43</sup> The wargame simulation was extensive with wide participation. The simulation scenario was based on a U.S.-China conflict in the Western Pacific region and tested the ability of the defense industrial base to cope with the demands of an intense U.S.-China military conflict. Although the simulation noted other challenging aspects of the international security environment (e.g., DPRK, Iran, and, Russia) they were not direct parties to the conflict in the simulation).

The CSIS simulation affirmed an observation of this DSB industrial base study; the legacy DIB cannot surge development, production, training, and other dimensions of defense-industrial readiness on a timescale that could meet the needs of the immediate conflict. The observations clarify the scope of the threat.

The PRC’s focus on securing access to critical raw materials is clear. In addition to efforts to secure its indigenous capacity in both raw materials and associated processing, its foreign policy aims are also aligned toward gaining access to non-Chinese sources of raw materials. Its interconnected trade and

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<sup>41</sup> Congressional Research Service, *The International Emergency Economic Powers Act: Origins, Evolution, and Use*, January 30, 2024, <https://crsreports.congress.gov/product/pdf/R/R45618/13>.

<sup>42</sup> Defense Science Board 2020 Summer Study, *New Dimensions of Conflict*, [https://dsb.cto.mil/wp-content/uploads/reports/2020s/DSB-SS2020\\_NewDimensionsofConflict\\_Executive%20Summary\\_cleared.pdf](https://dsb.cto.mil/wp-content/uploads/reports/2020s/DSB-SS2020_NewDimensionsofConflict_Executive%20Summary_cleared.pdf).

<sup>43</sup> CSIS, *Conflict in the Western Pacific and the Defense Industrial Base*, November 2024, <https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/CSIS%20Simulation%20Results.pdf>.

investment strategy has focused on countries with whom its diplomatic and security initiatives have been concentrated, especially Australia, Brazil, Democratic Republic of the Congo, South Africa, and Turkey. **Figure 11** shows a sample of these materials and trade relationships.

Mineral Type	China's Strengths	China's Dependencies (Country)
Iron and ferro-alloy metals	<ul style="list-style-type: none"> <li>▪ Vanadium</li> <li>▪ Molybdenum</li> </ul>	<ul style="list-style-type: none"> <li>▪ Niobium (Brazil)</li> <li>▪ Cobalt (Congo)</li> <li>▪ Chromium (South Africa)</li> <li>▪ Tantalum (Congo)</li> </ul>
Nonferrous metals	<ul style="list-style-type: none"> <li>▪ Gallium</li> <li>▪ Germanium</li> <li>▪ Tellurium</li> <li>▪ Rare earth elements</li> <li>▪ Antimony</li> <li>▪ Arsenic</li> </ul>	<ul style="list-style-type: none"> <li>▪ Beryllium (United States)</li> <li>▪ Lithium (Australia)</li> </ul>
Precious metals		<ul style="list-style-type: none"> <li>▪ Rhodium (South Africa)</li> <li>▪ Platinum (South Africa)</li> <li>▪ Palladium (Russia/South Africa)</li> </ul>
Industrial minerals	<ul style="list-style-type: none"> <li>▪ Graphite</li> </ul>	<ul style="list-style-type: none"> <li>▪ Boron (Turkey/United States)</li> <li>▪ Zirconium (Australia)</li> </ul>

Figure 11. Sample of Raw Materials in the Chinese Economy

[Source: <https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/CSIS%20Simulation%20Results.pdf>]

The PRC's instruments for promoting its access to critical raw materials include the Belt-and-Road Initiative, participation in diplomatic and trade blocs such as the BRICS+ organization, the Shanghai Cooperation Organization, and other regional trade organizations. These trade and investment initiatives are supplemented by a very ambitious diplomatic effort to support leadership visits. A subset of total leadership visits by year are listed in **Figure 12** and compared with American leadership visits to the same region.

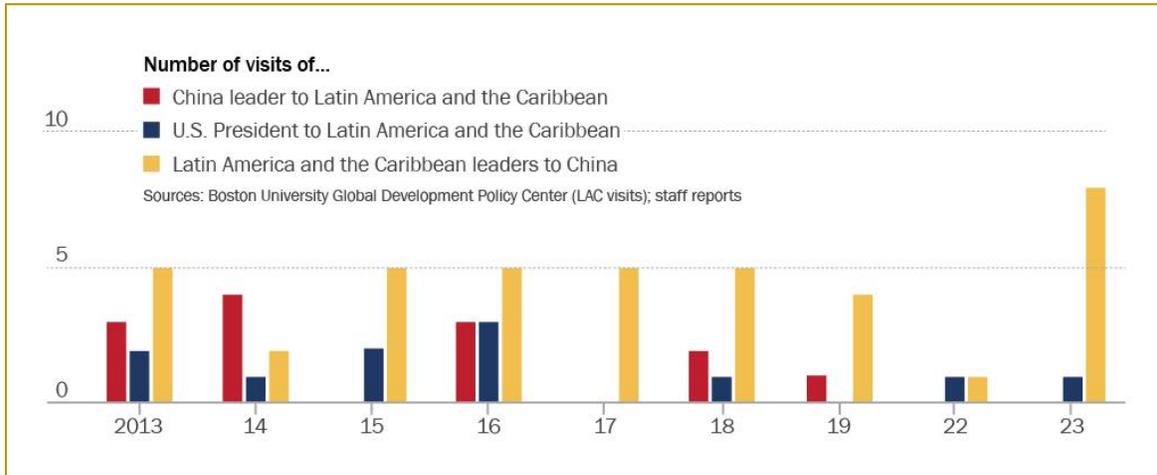


Figure 12. Latin America Leadership Visits

[Adapted from: [https://www.wsj.com/world/china-xi-jinping-latin-america-acf6dbc1?st=YRsoDj&reflink=article\\_email\\_share](https://www.wsj.com/world/china-xi-jinping-latin-america-acf6dbc1?st=YRsoDj&reflink=article_email_share); data derived from Boston University Global Development Policy Center]

U.S. experience in supporting the Ukrainian forces needs for modern munitions in its protracted conflict with Russia is well known. Post-Cold War assumptions about future conflicts being of very limited duration contributed to a reluctance to maintain large stocks of costly modern munitions. Current missile production times are compared in **Figure 13**.

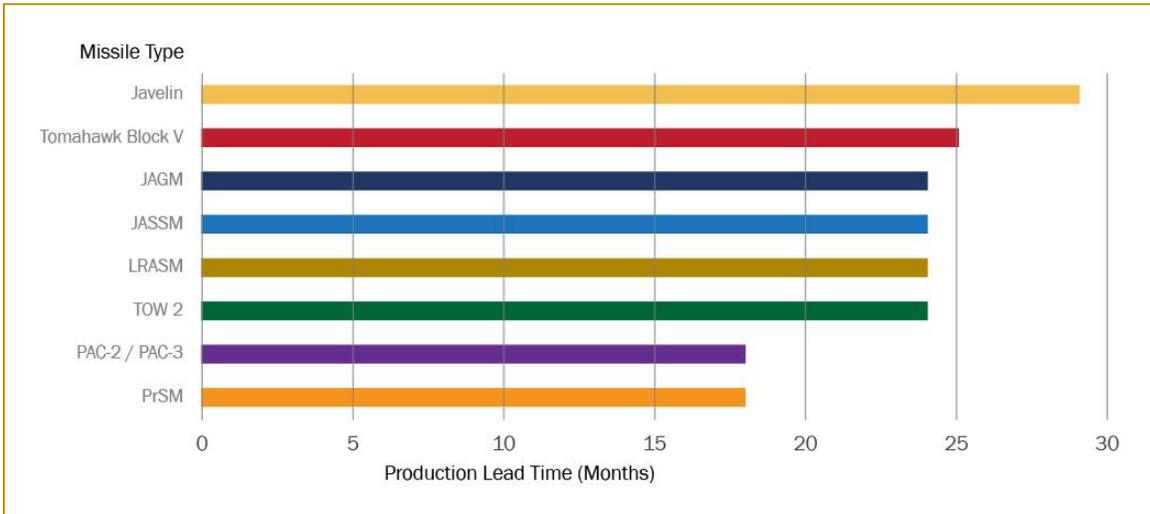


Figure 13. Selected Munitions Production Timelines

[Adapted from: <https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/CSIS%20Simulation%20Results.pdf>]

The protracted timelines to produce modern munitions—two to three years—has made it difficult for both the United States and its allies and partners to respond simultaneously to the extraordinary demands of the protracted conflicts in Israel and Ukraine. The United States has undertaken an approach that could reduce the protracted lead times for munitions production by duplicating industrial facilities for producing the same sorts of munitions across the industrial base of the alliance.

### Labor Force and Administrative Constraints on the Ability to Surge DIB Production

The highly cyclical nature of defense-industrial production has contributed to skill shortages in program-critical systems. The reauthorization of the 1950 DPA in 2024, particularly its Title III provisions (*Expansion of Defense Productive Capacity and Supply*) provide an opportunity to fund the necessary education and training of defense-relevant skills to mitigate shortages (Figure 14).

Workforce	Contracting and Acquisitions
<ul style="list-style-type: none"> <li>▪ Insufficient supply of engineers, electricians, pipefitters, shipfitters, metalworkers, and others.</li> <li>▪ These challenges have caused notable delays with frigates, submarines, destroyers, and other ships.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Insufficient number of appropriated multi-year contracts.</li> <li>▪ Little urgency in acquisitions and contracting, which are currently operating in a peacetime environment.</li> </ul>

Figure 14. Defense-Industrial Production Deficiencies

[Source: <https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/CSIS%20Simulation%20Results.pdf>]

Multi-year contracting limitations reflect the long-standing reluctance of the Congressional appropriations process to commit future appropriations to multi-year procurements unless very specific criteria are met.<sup>44</sup> It is unlikely that in the absence of a general mobilization that these constraints will be diminished unless a broad legislative-executive agreement is made to approve several multi-year procurements *en bloc*.

<sup>44</sup> Defense Acquisition University, *Multiyear Procurement*, <https://www.dau.edu/acquipedia-article/multiyear-procurement#:~:text=Congress%20has%20mandated%20the%20following.of%20a%20proposed%20contract%20award.>

The DoD has a large and flexible contracting workforce with a wide range of authorities to meet service needs as shown in **Figure 15**. In addition, the Army has an experienced expeditionary contracting workforce to support contingency operations abroad.<sup>45</sup>

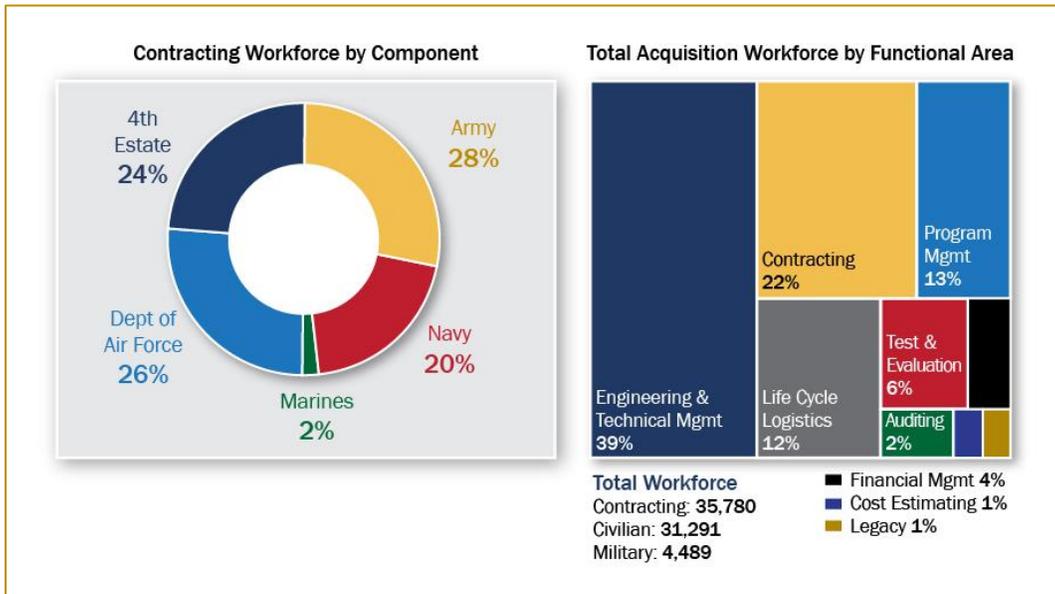


Figure 15. Workforce by Component and Area

[Adapted from: [https://www.acq.osd.mil/asda/dpc/cp/policy/docs/newsletters/2024/Policy\\_Pulse\\_Newsletter\\_\(July\\_2024\).pdf](https://www.acq.osd.mil/asda/dpc/cp/policy/docs/newsletters/2024/Policy_Pulse_Newsletter_(July_2024).pdf)]

**What Must be Done:** Transition of the NSIB from “Normal” to “National Mobilization” operations

The emergence of a Eurasian coalition of four competitors/potential adversaries—China, Russia, Iran, and North Korea—would create a formidable constellation. This constellation would have large inventories of nuclear weapons and associated delivery systems for local, regional, and intercontinental employment, and could build on current diplomatic coordination through a network of bilateral treaties and agreements. They share an aspiration to undermine the coalition of the United States and its allies both in the Eurasian region as well as Africa and Latin America. The four nation states also collaborate in their defense-industrial establishments and conduct military exercises throughout Eurasia and its littoral regions.

While no immediate threat is posed by a conflict with a coordinated campaign by these four potential adversaries, either in a single theater, or in multiple theaters in the region including Europe, the Middle East, and East Asia and the Pacific, planning for such a compelling threat—including industrial mobilization can contribute to both deterrence, and if deterrence fails, to be able to respond to such a powerful threat.

The need for an effective industrial mobilization planning process is compelling. The reserve capacity for the United States to respond as was done in World War II as an “arsenal of democracy” to such an extreme contingency is no longer a realistic alternative.

<sup>45</sup> *US Army Expeditionary Contracting Command*; <https://acc.army.mil/files/ECC.pdf>.

As noted earlier, China has a large advantage in the scale of its manufacturing base—more than three times that of the United States—an advantage that can only be offset by incorporating the manufacturing base of U.S. allies in coordination with the United States.

The Chinese manufacturing base is dominated by large diversified industrial organizations able to contribute to its capacity for defense product development and production while facilitating the technology transfer between civil and defense sectors. This structure suggests that its capacity to mobilize for protracted conflict may be significant and could contribute to the PRC’s ability to field powerful military forces early in a conflict in concert with its allies, possibly in multiple theaters.

The PRC’s ability to do so is enabled by its defense-industrial structure. **Figure 16** illustrates how China’s largest companies create a large defense industrial manufacturing enterprise which augments its ability to integrate advanced technology rapidly through “military-civil fusion” programs.

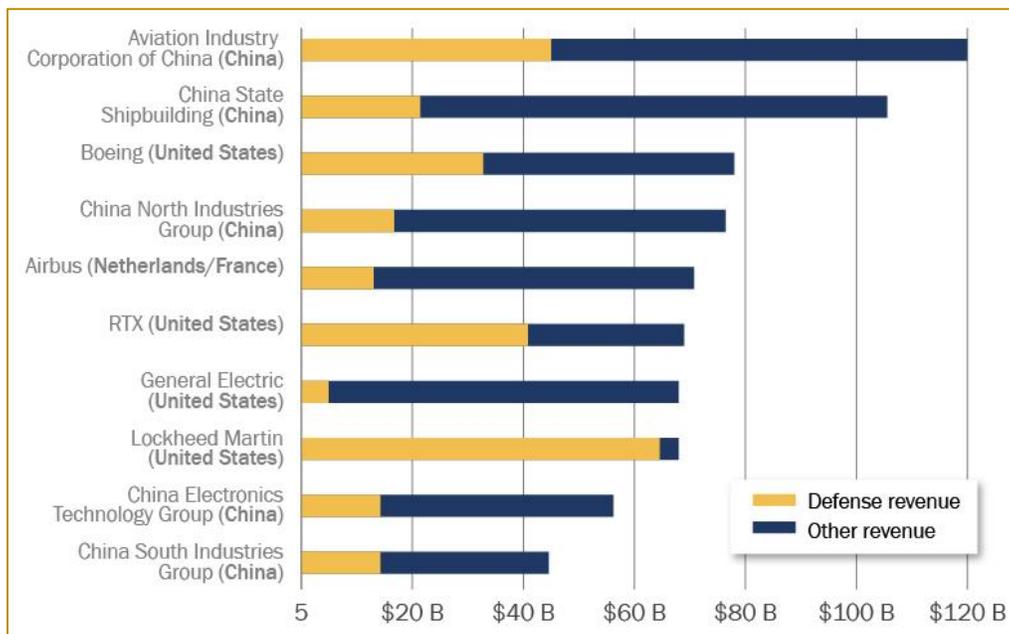


Figure 16. Top 10 Largest Defense Companies Globally by Total Revenue, 2023

[Source: <https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/CSIS%20Simulation%20Results.pdf>]

China’s 10 largest defense firms include a substantial source of revenue from non-defense technology enterprises, while the largest U.S. defense firms (e.g., Lockheed Martin and RTX) tend to be “pure-play” defense enterprises who emerged as the key systems engineering and integrated firms from the “Last Supper” defense industrial reorganization in the United States following the end of the Cold War. To this point, the Defense News Top 100 Global Defense Companies lists six U.S. companies and five Chinese companies in the top 12. Those U.S. companies have twice the defense revenues as the Chinese companies, but those five Chinese companies have nearly 50% more total revenue than the U.S. top companies, demonstrating this dual-use feature of the Chinese industrial base.

The PRC’s diplomatic and defense partners, the DPRK, Iran, and Russia have a much-diminished civil economy, but have significant defense-industrial enterprises. The diplomatic coordination between these nations enabled by their structure of bilateral agreements makes defense industrial and military collaboration in a crisis much more likely than *ad hoc* diplomatic or military collaboration.

The scale of the potential threat posed in an extreme contingency (e.g., simultaneous adversary military operations in Europe, the Middle East, and East Asia) is beyond the capacity of the current industrial base to address. U.S. experience suggests that there is an approach that can deter the emergence of such a threat, and if deterrence fails, to defeat the threat by a concerted U.S. and allied response.

In this respect, U.S. experience in the industrial base mobilization planning is inadequate to describe the scope and scale of the industrial mobilization process needed to support extreme defense mobilization contingencies that require the diversion of national scientific and industrial resources entirely to the cause of national defense. In the pre-World War II case, the U.S. dominance of the excess industrial capacity of the alliance could be the focus of the industrial mobilization effort. Mobilization planners could then focus on the management of the authorities needed to redirect civil and military resources entirely to the service of national defense.<sup>46</sup>

Mobilization of the NSIB among allied countries is a more complex diplomatic and defense-industrial planning process than has heretofore been considered. The United States has been successful at promoting the propagation of alliance industrial standards to produce defense products throughout the alliance, and have advocated (with somewhat less success) a sustained pace of defense investment (two percent of GDP was agreed at the NATO Wales Summit in 2014).<sup>47</sup> U.S. alliance relationships in East Asia are bilateral arrangements and historically have been focused on collaborative military operations to achieve the aims of the underlying bilateral security agreements.

New intra-alliance processes will be needed to create a new dimension to align the scientific and industrial civil and military capabilities of the United States and its allies to meet the needs of collective defense against an unprecedented modern potential adversary coalition of four nuclear-armed states.

These characteristics strongly imply a need for intra-alliance NSIB mobilization planning that will enable the complete civil and military industrial capacity of allied nations be coordinated with those of the United States to create an alliance NSIB.

The requirements associated with a national effort to align the components of U.S. civil scientific and defense industrial capabilities into a process that will produce military capabilities that will deter or if deterrence fails, defeat a potential adversary coalition requires an extraordinary planning effort. We know that the planning effort to enable the United States and its allies to prevail in World War II was a decade-long endeavor.

The planning process that will coordinate, integrate, and synchronize the mobilization planning of the United States and its allies and partners will require a sustained and institutionalized process to implement. To undertake such a process, DoD will need to re-establish an Office of Industrial Mobilization Planning. This office will need to have the authority and capabilities to prepare the Nation and the alliance to mobilize and to address the most extreme contingencies associated with coalition of highly capable adversaries on a global scale.

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<sup>46</sup> Thomas D. Morgan, *Industrial Mobilization of World War II: America Goes to War*, JSTOR, <https://www.jstor.org/stable/26304207?seq=1>.

<sup>47</sup> NATO, *Wales Summit Communiqué (2014)*, [https://www.nato.int/cps/en/natohq/official\\_texts\\_112964.htm](https://www.nato.int/cps/en/natohq/official_texts_112964.htm).

LE Planning for Extreme Contingencies—National Security Industrial Base Mobilization

**Recommendation 3 – Specific Recommendations**

- **USD(A&S)** re-establish the functions originally found in the Office of National Defense Mobilization.
- **USD(A&S) lead, with Joint Staff and Military Services**, in coordination with U.S. allies, develop a threat based, not time-phased, NSIB mobilization plan.
- **USD(A&S) lead, with Joint Staff and Military Services**, conduct an annual full industrial base mobilization exercise to reduce potential national mobilization vulnerabilities in the event of a near-peer conflict.

### III. National Security Industrial Base as an Instrument of Deterrence

Scientific and industrial capacity is a foundational dimension of deterring adversaries from conventional warfare against the United States and its allies, the scope of which extends beyond current definitions of the DIB.<sup>48</sup> A broader concept, the NSIB, captures the entire productive capacity of the United States and its allies to win in a protracted conflict with a peer adversary. While the DIB constitutes all industrial infrastructure (public and private) able to meet DoD needs in peacetime, as well as wartime surges in scientific and industrial output, the NSIB reflects a conversion of the Nation's entire scientific and industrial capacity into a capability able to defeat existential military threats against the homeland.

The NSIB has only been established once in the United States' modern history—during World War II. Civil manufacturers were converted to defense production while many civil-sector products were subject to rationing and other measures aimed at curtailing wartime competition for goods and services pertinent to the armed forces' needs. Although the Japanese raid on Pearl Harbor on December 7<sup>th</sup>, 1941, is often depicted as a “bolt from the blue” strategic surprise attack by the national security apparatus, this perspective of the attack and the beginning of the war omits a crucial dimension that enabled the United States to prevail in World War II—pre-war mobilization planning.

The pervasive political instability in Europe and Japan's invasion of Manchuria in 1931 offered strategic warning of threats to come when the War Department initiated the industrial mobilization process in 1930. The defeat of Japanese forces at Kalkin Gol on September 1, 1939, effectively disconnected Japan from the war in Europe that began on the same day. This development enabled U.S. war planners to adopt its “swing strategy” of prioritizing the conflict in Europe and resolving to shift major forces to the Pacific theater once the European conflict was resolved.<sup>49</sup>

U.S. planners had an opportunity to view industrial production in Nazi Germany during the first 18 months of World War II (September 1939 through June 1941) when the Hitler-Stalin alliance enabled both states to expand the scale and resilience of their defense-industrial structures.<sup>50</sup> The Soviet Union's supply of critical raw materials, especially oil, rubber, manganese, and grain, were decisive enablers for the scale of the Wehrmacht's invasion in June 1941. For the prior decade, planners were able to assess the implications of military modernization within the Axis powers and the evolution of their wartime aims to refine U.S. defense-industrial planning processes. This was our own successful effort at military-civil fusion.

<sup>48</sup> The diplomatic and defense-industrial alignment of the principal adversaries of the U.S., China, the DPRK, Iran, and Russia has been built around their shared antipathy to the U.S. model and a commitment to block, disrupt, or defeat U.S. and allied foreign policy goals. S. Fukutomi, *Russia, China and Iran move closer after President Raisi's death*, May 24, 2024, <https://asia.nikkei.com/Politics/International-relations/Russia-China-and-Iran-move-closer-after-President-Raisi-s-death>; A. Kendall-Taylor, Richard Fontain, *The Axis of Upheaval: How America's Adversaries Are Uniting to Overturn the Global Order*, *Foreign Affairs*, April/May 2024, <https://www.foreignaffairs.com/china/axis-upheaval-russia-iran-north-korea-taylor-fontaine>; Congressional Research Service, *North Korea-Russian Relations: Current Developments*, May 2024, <https://crsreports.congress.gov/product/pdf/IN/IN12355>; M. Glanz and C. Freeman, *Xi and Putin Strengthen Strategic Ties, Spurn U.S. Leadership*, U.S. Institute of Peace, May 2024, <https://www.usip.org/publications/2024/05/xi-and-putin-strengthen-strategic-ties-spurn-us-leadership>; D. Stroul, *Russian-Iranian Cooperation and Threats to U.S. Interests*, April 17, 2024, Washington Institute for Near East Policy, <https://www.washingtoninstitute.org/policy-analysis/russian-iranian-cooperation-and-threats-us-interests>.

<sup>49</sup> Office of the Historian, U.S. Department of State, *Wartime Conferences, 1941-1945*, <https://history.state.gov/milestones/1937-1945/war-time-conferences>.

<sup>50</sup> Edward E. Ericson, *Feeding the German Eagle: Soviet Economic Aid to Nazi Germany, 1933-1941* (Greenwood Publishing Group, 1999).

## Institutional Change is Needed to Enable Deterrence Through the Capacity to Mobilize the Entire U.S. Scientific and Industrial Base

Both legal and policy precedents affirm that the USG is authorized to marshal the Nation's resources to create an effective defense against existential threats. Since World War II and Korean War legislative and policy responses were enacted based on wartime necessity, additional authorities have also been created through the *International Emergency Economic Policy Act* (IEEPA). Along with the *Trading with the Enemy Act of 1917*, these collective policies constitute the primary authorities for USG action relating to economic transactions, including the imposition of economic and financial sanctions on individuals and organizations. The IEEPA has been invoked 69 times since the statute was enacted in 1977, and the DSB proposed creating a parallel statute to specifically address national security emergency powers in its 2022 Summer Study.<sup>51</sup>

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<sup>51</sup> Defense Science Board, *Summer Study on New Dimensions of Conflict*, 2022, [https://dsb.cto.mil/wp-content/uploads/reports/2020s/DSB-SS2020\\_NewDimensionsofConflict\\_Executive%20Summary\\_cleared.pdf](https://dsb.cto.mil/wp-content/uploads/reports/2020s/DSB-SS2020_NewDimensionsofConflict_Executive%20Summary_cleared.pdf).

## IV. Threat Perceptions Impacting U.S. Industrial Base

The global international security involvement of the United States has been a unique property of its post-World War II diplomatic and military experience. Allies in one theater of operations often did not have their national security interests challenged in another, limiting their readiness to participate in “out of area” operations. With the post-Russia invasion of Ukraine and emergence of a security and diplomatic-related potential adversarial coalition, there is a material change in the perception of U.S. allies throughout the world about potential threats to their security interests.

China, Russia, Iran, and North Korea are interlocked through a series of diplomatic, economic, and security agreements with a shared animosity to the United States and its allies.<sup>52</sup> This network of agreements does not correspond to the NATO agreement’s core provision that an attack on one is an attack on all; however, it does permit a wide range of situation-dependent joint actions that can considerably expand the scope of a security threat to the United States and its allies.

The flexibility of these agreements is affirmed by (but not limited to) the scope and scale of defense-industrial collaboration between the four nations in support of Russia’s invasion of Ukraine.

1. The PRC is the largest “contributor to Moscow’s war in Ukraine through its provision of critical components or weaponry” and its success in bypassing U.S. and allied sanctions have encouraged others to do the same.<sup>53</sup>
2. The DPRK provides half of munitions used by Russian forces in Ukraine. The DPRK has also agreed to supply around 12,000 troops including 1,500 Special Operations Forces to fight in Ukraine in support of Russia’s “Special Military Operation.”<sup>54</sup>
3. Iran has broadened its arms supply relationship with Russia significantly to support Russia’s operations in Ukraine including the supply of drones and cruise and ballistic missiles. Iran will soon sign a 20-year bilateral economic and security agreement with Russia as well that will be like a 25-year agreement Iran previously signed with the PRC in 2021. The agreement will reflect the close defense-industrial collaboration in support of Russia’s war in Ukraine.

The coordinated diplomatic and defense industrial cooperation has emerged as a coalition of nuclear-armed adversaries on a super-continental scale. In the past, these four nations posed individual and specific threats tied to local interests and contingencies. Diplomatic opportunities to engage these nations separately were frequently undertaken to mitigate risks and manage tensions.

<sup>52</sup> Paul J. Saunders, *Meet the CRANKs: How China, Russia, Iran and North Korea Align Against America*, *The National Interest*, May 28, 2024, <https://nationalinterest.org/feature/meet-cranks-how-china-russia-iran-and-north-korea%2%A0align-against-america-211186>.

<sup>53</sup> C. Balmer and H. Pamuk, *Blinken says China is Russia's primary military complex supplier*, *Reuters*, April 19, 2024, <https://www.reuters.com/world/blinken-says-china-is-russias-primary-military-complex-supplier-2024-04-19>; V. Dendrinou and A. Nardelli, *India Is Now Russia’s No. 2 Supplier of Restricted Technology*, *Bloomberg*, October 11, 2024, <https://www.bloomberg.com/news/articles/2024-10-11/india-is-now-russia-s-no-2-supplier-of-restricted-technology?srd=undefined&sref=boE5Wq9G>; S. Faragasso, *Chinese Export of Restricted High Priority Battlefield Items to Russia*; ISIS, September 23, 2024, <https://isis-online.org/isis-reports/detail/chinese-export-of-restricted-high-priority-battlefield-items-to-russia>; M. Seldon et al, *Russia has built a Covert Trade Channel with India Leaks Reveal*, *Financial Times*, September 4, 2024, <https://www.ft.com/content/101afcd6-8e6f-4b5f-89b0-98f48cd5d119>.

<sup>54</sup> B. Klinger, *North Korea Sent 8 Million Artillery Shells to Ukraine. Next Up: Troops*, *The National Interest*, October 23, 2024, <https://nationalinterest.org/feature/north-korea-sent-8-million-artillery-shells-ukraine-next-troops-213347>.

This extensive collaboration at scale is creating the risk of what Nicholas Eberstadt has described as a Eurasian “World Island” conflict becoming a step closer.<sup>55</sup> Collaboration between four continental scale adversaries has not taken place since the alliance between the German, Austro-Hungarian, Russian, and Ottoman Empires in 1914–18. Identifying and understanding the specific relationships between Chinese, Russian, Iranian, and North Korean members, their industrial bases, and their military apparatuses will be crucial to balancing against their regional influence.

## The North Korean Threat

The growth in scale and capability of the DPRK’s nuclear capabilities, its introduction of ground forces in the Ukraine conflict, as well as the PRC’s vast increase in nuclear forces are seen as a powerful risk to Europe as well as the Indo-Pacific littoral.<sup>56</sup> The range of recent DPRK intercontinental ballistic missile (ICBM) tests including the flights of its *Hwasong 18* ICBM (tested in 2023) and *Hwasong 19* (tested in 2024) poses a threat to Europe and has become recognized as such.<sup>57</sup> These concerns have been magnified by North Korea’s military presence in Europe through its troops operating there under Russian command, and as an arms supplier to Russia.

The DPRK has also strengthened its bilateral relations with Iran and has been able to leverage its newly established treaty-based relationship with Russia as well as its substantial nuclear weapons and long-range ballistic missile developments. **Figure 17** summarizes the DPRK’s relationships throughout the Middle East, which includes providing nuclear and long-range missile capabilities to two of the region’s nuclear powers, Iran and Pakistan.

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<sup>55</sup> Nicholas Eberstadt, *North Korean troops in Russia bring a ‘World Island’ conflict closer*, *Washington Post*, October 27, 2024, <https://www.washingtonpost.com/opinions/2024/10/27/north-korea-troops-russia-ukraine/>.

<sup>56</sup> Alexander Mattelaer, *China’s Nuclear Shadow Reaches Europe*, *RUSI*, October 8, 2024, <https://www.rusi.org/explore-our-research/publications/commentary/chinas-nuclear-shadow-reaches-europe>; DoD, *Pentagon Says 10K North Korean Troops in Kursk Oblast*, November 4, 2024, <https://www.defense.gov/News/News-Stories/Article/Article/3955757/pentagon-says-10k-north-korean-troops-in-kursk-oblast/>.

<sup>57</sup> *North Korean ICBMs now Threaten Europe*, *European Security and Defense*, June 24, 2023, <https://euro-sd.com/2023/02/news/29830/north-korean-icbms-now-threaten-europe>. The July 12, 2023, test of the DPRK’s *Hwasong 18* missile (with some superficial similarities of Russia’s SS-27 Mod 2) has a 15,000-km range able bringing all of Europe and the United States under threat. Theodore Postal, *The Transfer of a Russian ICBM to North Korea? Beyond Parallel*, August 17, 2023; <https://beyondparallel.csis.org/the-transfer-of-a-russian-icbm-to-north-korea/>; Vann H. Van Diepen, *North Korea Tests New Solid ICBM Probably Intended for MIRVs*, *38 North*, November 5, 2024, <https://www.38north.org/2024/11/north-korea-tests-new-solid-icbm-probably-intended-for-mirvs/>.

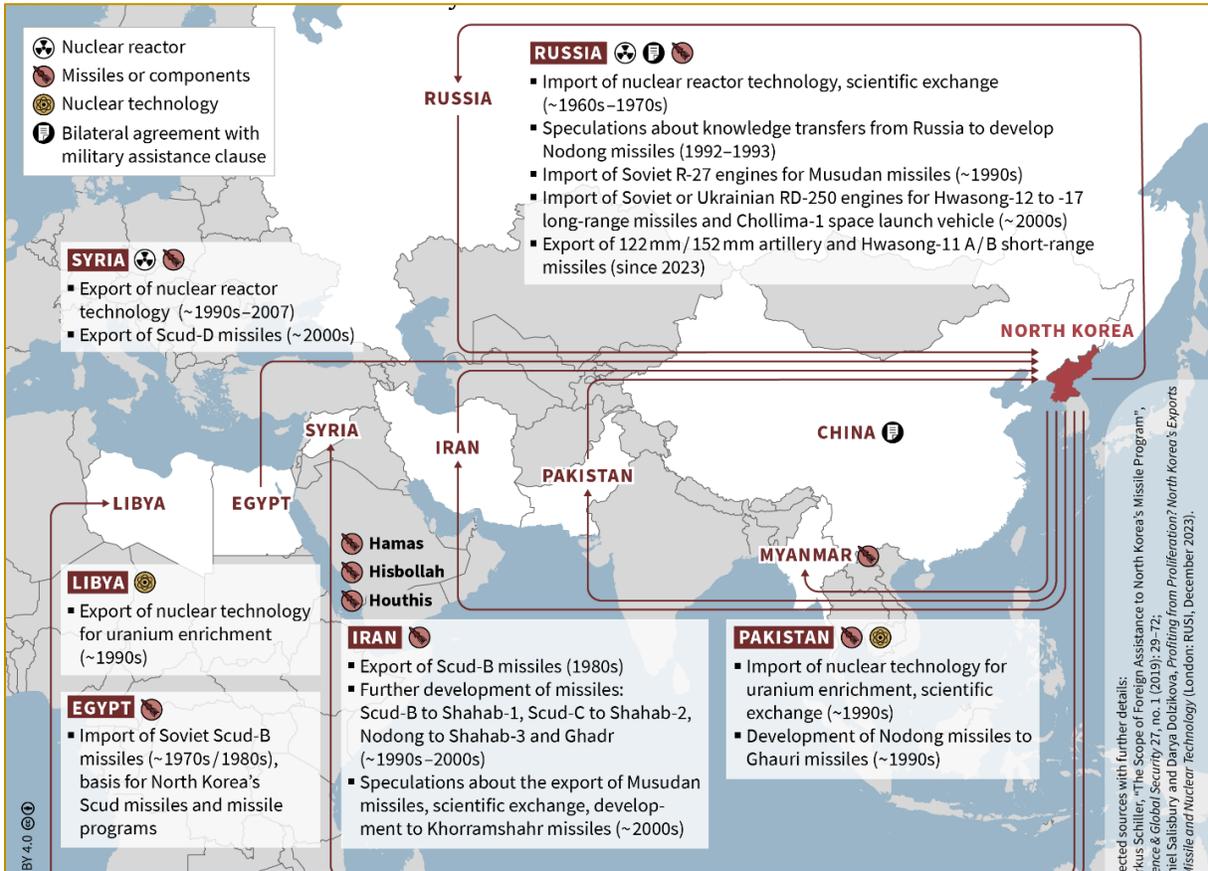


Figure 17. Selected Nuclear and Missile Deals by North Korea

[Source: [https://www.swp-berlin.org/publications/products/comments/2024C49\\_NorthKorea\\_ArmsPolicy.pdf](https://www.swp-berlin.org/publications/products/comments/2024C49_NorthKorea_ArmsPolicy.pdf)]

Russia’s security treaty with the DPRK has significant implications for security elsewhere, particularly in Europe. The DPRK is expected to have 100 nuclear weapons by 2030.<sup>58</sup> The DPRK now provides about half of Russia’s conventional munitions used in Ukraine.<sup>59</sup> In addition, the DPRK is now deploying its regular troops in Ukraine in support of Russian military operations—a development which may also precipitate the ROK entry into the conflict as a weapons supplier to Ukraine.<sup>60</sup>

Differences between North Korea and Russia’s 1961 and 2024 Treaty.

The tailored character of reciprocal relationships between China, Russia, Iran, and North Korea does not offer insights into the commitment—if any—of the parties when the interests of more than one state are involved. However, some insight into the worries and aspirations motivating its creation can be gleaned in the shifts from historical relationships between those partners, as can be seen in recent changes to the

<sup>58</sup> A. Fink et al, *The Nuclear Programs of China, Russia, North Korea, and Iran*, Center for Naval Analysis, January 31, 2024, <https://www.cna.org/reports/2024/01/the-nuclear-programs-of-russia-china-north-korea-and-iran>.

<sup>59</sup> Lara Jakes, *What Weapons Is North Korea Accused of Supplying to Russia?*, *New York Times*, June 17, 2024, <https://www.nytimes.com/2024/06/17/world/europe/russia-north-korea-weapons-ukraine.html>.

<sup>60</sup> Hyung-Jin Kim and Kim Tong-Hyung, *South Korean intelligence says North has sent troops to aid Russia’s war in Ukraine*, October 18, 2024, <https://apnews.com/article/north-korea-russia-ukraine-war-troops-south-spy-9cd563c5570f68e9b314976009682810>.

DPRK-Russia relationship and aid provided to Russian forces through munitions, ballistic missiles, and troops (which differs significantly from provisions in their previous 1961 Treaty).<sup>61</sup>

A key difference between the 1961 agreement (*Treaty of Friendship, Cooperation and Mutual Assistance*) and its 2024 Russia-DPRK replacement (*Treaty on Comprehensive Strategic Partnership*) is the Article 3 security focus of the current agreement, which has shifted language from pledging consultation to cooperation, as well as deepening ties in a number of security- and economic-linked issues including counterterrorism, information security, human trafficking, compatible standards, and labor mobility. A comparison between agreements is displayed in **Figure 18**.

Treaty of Friendship, Cooperation and Mutual Assistance, 1961	Treaty on Comprehensive Strategic Partnership, 2024
Military Assistance and Security guarantees ( <b>Article 1</b> )	Military assistance per Article 51 of the UN Charter and respective countries' laws ( <b>Article 4</b> )
Aims to strengthen bilateral economic and cultural ties ( <b>Article 4</b> )	Shall promote the expansion and development of cooperation in trade and economic, investment, scientific and technological fields ( <b>Article 10</b> )
Shall consult together on all important international questions involving the interests of both states, in an effort to strengthen peace and universal security ( <b>Article 3</b> )	Shall mutually cooperate to ensure solid regional and international peace and security ( <b>Article 3</b> )
Each contracting party undertakes not to enter any alliance or to participate in any coalition directed against the other contracting party ( <b>Article 2</b> )	Each party has an obligation not to conclude agreements with third countries that infringe on the sovereignty, security and territorial integrity of the other party ( <b>Article 5</b> )
Reunification of Korea ( <b>Article 5</b> )	No mention of reunification of Korea
No emphasis on non-traditional issues	Increased emphasis on cooperation in the fields of health, standards, education, and labour mobility ( <b>Article 12 and 14</b> ) Cooperation in the fields of international information security; and countering disinformation ( <b>Article 18 and 20</b> ) Cooperation on international terrorism and extremism and human trafficking, illicit circulation of goods and funds ( <b>Article 17</b> ) Cooperation between legislative, executive, and law enforcement agencies of the countries ( <b>Article 15</b> )

Figure 18. Comparison between North Korea and Russia’s 1961 and 2024 Treaty  
 [Source: <https://www.orfonline.org/expert-speak/russia-north-korea-sign-a-new-treaty>]

## The Iranian Threat

The Iranian threat has primarily been extended through the cadre of proxy forces it supports throughout the Middle East. Iran has armed these forces, and they pose a powerful threat in the region, as well as projecting Iran’s military power as an instrument of international terrorism. Iran’s regional proxies are displayed in **Figure 19**.

<sup>61</sup> Abhishek Sharma, Rajoli Siddharth Jayaprakash, *Russia, North Korea and the East Asian Security Order*, Observer Research Foundation, July 8, 2024, <https://www.orfonline.org/expert-speak/russia-north-korea-sign-a-new-treaty>.

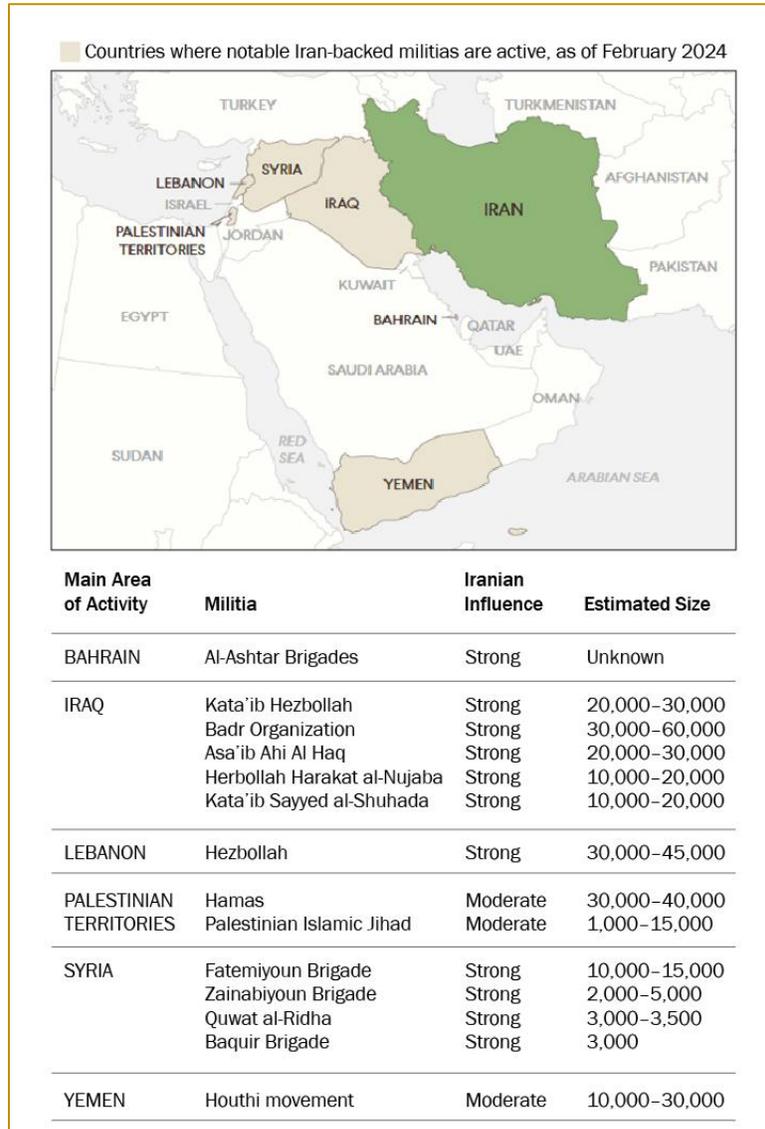


Figure 19. Iran’s Regional Affiliates  
 [Adapted from: <https://www.cfr.org/article/irans-regional-armed-network>]

Iran’s indigenous ballistic missile program has advanced significantly from the medium-range ballistic missiles (MRBMs) it acquired from the DPRK in the 1980s, which now have the capability to strike targets throughout the Middle East as well as Southeast Europe. Iran also has bi-lateral security-related agreements with both China and Russia. These arrangements have matured since Russia invaded Ukraine in 2022.

Iran has become a crucial partner of Russia, both in the supply of advanced weapons (e.g., *Shahed*-series drones and short-range ballistic missiles (SRBMs)) to support its campaign in Ukraine and as a partner in Russia’s clandestine infrastructure to evade Western sanctions. The International North–South Transport Corridor (INSTC) enables the transport of goods to or from Russia via Iran across the Caspian Sea. This infrastructure for sanctions evasion has significantly diminished the effectiveness of Western sanctions, even if it has imposed higher costs on Russia than would have been the case without sanctions. The

increasing integration of the defense industrial bases in Iran and Russia for drones and ballistic missiles has become a significant dimension of their collaboration in supporting Russian forces in Ukraine.<sup>62</sup>

Perhaps the most enduring economic and security relationship between Iran and its Eurasian security partners is with China. As an energy-poor nation, economic and financial arrangements with Iran are of great value to China, which is now the largest buyer of Iranian oil. The relationship was established in 2016 and supplemented by a much broader 25-year economic agreement in 2021.<sup>63</sup> Although the agreement provides for a security component (no details of which have been published), that element appears to be focused on joint naval exercises, not arms transfers. However, the agreement also provides for \$28 billion in Chinese investment in Iran's oil and gas sector, as well as \$120 billion in infrastructure investment. Due to these economic ties and other geopolitical factors, China has been a consistent diplomatic supporter of Iran in its various regional disputes.

## Deepening PRC-Russia Collaboration

The PRC has become increasingly involved in European military affairs through its relationship with Russia. For example, the PRC conducted military exercises in July 2024 at the Belarus-Poland border including the airborne delivery of Chinese troops on a Chinese Y-20 aircraft.<sup>64</sup> Both states are collaborating to control maritime traffic throughout the Arctic Ocean region, where Russia has extended its territorial claim encompassing the entire region, and China and Russia have signed an "Arctic Security" agreement between the Russian intelligence service, Federal Security Service (FSB) border guards, and China's Coast Guard.<sup>65</sup>

Defense-industrial collaboration within the emerging coalition is also especially pronounced between China and Russia. China is providing access to sophisticated export-controlled components, machine tools, and subsystems as displayed in **Figure 20**.

<sup>62</sup> A. Deutsch et al, **Exclusive: Iran to deliver hundreds of ballistic missiles to Russia soon, intel sources say**, *Reuters*, August 10, 2024, <https://www.reuters.com/business/aerospace-defense/iran-deliver-hundreds-ballistic-missiles-russia-soon-intel-sources-say-2024-08-09/>.

<sup>63</sup> Full Text of **Joint Statement on Comprehensive Strategic Partnership between Islamic Republic of Iran and People's Republic of China**, President of the Islamic Republic of Iran, January 23, 2016, <https://president.ir/en/91435>. This agreement will expire in 2025, another agreement signed in 2021 appears the main driver of the bilateral relationship; The Iran-China Comprehensive Strategic Partnership, <https://rasanah-iiis.org/english/wp-content/uploads/sites/2/2021/04/The-Iran-China-25-Year-Comprehensive-Strategic-Partnership-Challenges-and-Prospects.pdf>.

<sup>64</sup> Elena Doronina, **Concern Over China-Belarus Drills Near the NATO Border**, *DW*, July 13, 2024, <https://www.dw.com/en/chinas-joint-maneuvers-with-belarus-is-the-sco-behind-it/a-69649357>; Army Recognition, **Chinese troops arrive in Belarus on Xian Y-20A transport aircraft for parade**, July 1, 2024, <https://armyrecognition.com/news/aerospace-news/2024/chinese-troops-arrive-in-belarus-on-xian-y-20a-transport-aircraft-for-parade>; Liu Xuanzun, **China, Belarus joint army exercise 'reaches preset goals'**, *Global Times*, July 21, 2024, <https://www.globaltimes.cn/page/202407/1316413.shtml>.

<sup>65</sup> D. Cusick, **Are Russia and China Teaming Up to Control the Arctic?**, *Scientific American*, January 3, 2024, <https://www.scientificamerican.com/article/are-russia-and-china-teaming-up-to-control-the-arctic/>; J. Hager, **Russia's Claim to North Pole Territory Officially Confirmed**, *Polar Journal*, February 21, 2023, <https://polarjournal.ch/en/2023/02/21/russias-claim-to-north-pole-territory-officially-confirmed/>; T. Nilsen, **Russia's Coast Guard cooperation with China is a big step, Arctic security expert says**, April 28, 2023, *Barents Observer*; <https://www.thebarentsobserver.com/security/russias-coast-guard-cooperation-with-china-is-a-big-step-arctic-security-expert-says/164360>.

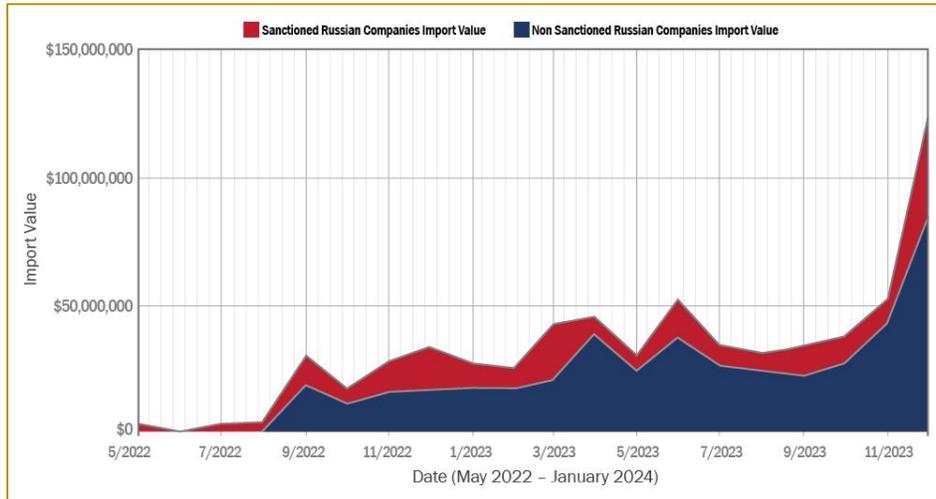


Figure 20. Import Value of the Top 50 Russian Importers of Restricted Tier 1 CHPL Goods from China  
 [Adapted from: <https://isis-online.org/isis-reports/detail/chinese-export-of-restricted-high-priority-battlefield-items-to-russia/>]

These transfers facilitate Russia's ability to sustain existing weapon systems that have become difficult to support or replace because of U.S. and allied sanctions on Russia's traditional suppliers.<sup>66</sup>

The PRC is also funding Belt-and-Road rail transportation projects to connect Western China to Europe via rail across southwest Asia. The network of overland connections between China, the DPRK, Iran, and Russia enable the emerging coalition to avoid any risks that maybe associated with sea-lines of communication. The Eurasian rail network that China has developed to facilitate trade with Europe would also facilitate the commercial and defense-industrial integration of the coalition.

The rail network also would enhance the coalition's ability to conduct and sustain multi-theater operations designed to over-stress U.S. and allied military capabilities. Unlike U.S. circumstances in World War II, where it had an ability to prioritize the European theater over the Pacific theater of operations, the capacity of this coalition could diminish U.S. and allied abilities to manage and sustain a global multi-theater conflict.

## Additional Threats and Future Economic Developments

Bilateral incentives for collaboration began to emerge between each of the four nations. The DPRK historically provided clandestine support for Iran ballistic missile development as did China.<sup>67</sup> Russia has provided support for Iran's nuclear and missile aspirations as well.<sup>68</sup> Russia is now providing advanced

<sup>66</sup> B. G. Carlson, *The Growing Significance of China-Russia's Defense Industry Cooperation*, U.S. Army War College, September 18, 2024, <https://ssi.armywarcollege.edu/SSI-Media/Recent-Publications/Display/Article/3908561/>.

<sup>67</sup> Maya Carlin, *North Korea Helped Turn Iran Into a Missile Powerhouse*, *National Interest*, March 4, 2024, <https://nationalinterest.org/blog/buzz/north-korea-helped-turn-iran-missile-powerhouse-209829>; P. K. Kerr, *China: Nuclear and Missile Proliferation*, Congressional Research Service, October 3, 2024, <https://crsreports.congress.gov/product/pdf/IF/IF11737#:~:text=Official%20U.S.%20government%20sources%20indicate,to%20Iran%20and%20North%20Korea>.

<sup>68</sup> A. Wickham, *Russia Sharing Nuclear Secrets With Iran Fuels US-UK Worries*, *Bloomberg*, September 14, 2024, <https://www.bloomberg.com/news/articles/2024-09-14/us-uk-on-edge-as-russia-shares-nuclear-secrets-with-iran?sref=boE5Wq9G>; E. Avdaliani, *Iran and Russia Seek to Reshape Global Hegemony with New Bilateral Agreement*, *Eurasian Daily Monitor*, November 4, 2024, <https://jamestown.org/program/iran-and-russia-seek-to-reshape-global-hegemony-with-new-bilateral-agreement/>.

missiles to Iran's controlled Yemeni proxy, the *Shia Ansar Allah* group ("Houthi") who are targeting scores of allied commercial shipping in the Red Sea and Gulf of Aden.<sup>69</sup>

The process of intensifying the infrastructure for collaboration between the United States' Eurasian adversaries also appears to be accelerating. The *Russia-Iran Treaty on a Comprehensive Strategic Partnership* is likely to include further integration of the economies as well as their defense and defense-industrial collaboration. According to Foreign Minister Sergi Lavrov, "it will confirm the parties; desire for closer cooperation in the field of defense and interaction in the interests of peace and security at the regional and global levels."<sup>70</sup>

The agreement will include Iran's rail network which will be integrated with the rail network of Russia's Commonwealth of Independent States. In addition, Russia will build a larger rail connection from Russia through Iran to Indian Ocean ports employing the Russian rail gauge (1,520- mm) rather than the European standard gauge (1.435-mm) used elsewhere in Iran and Europe.

The rail connection will extend Russia's access to both the Iranian Persian Gulf port of Bandar Abbas and its port on the Gulf of Oman/Indian Ocean in Chabahar.<sup>71</sup> The port of Chabahar will be operated by India based on a recent Iran-India agreement.<sup>72</sup> This port is only 170-km west of the China's port in Pakistan in Gwadar. China's control of the Port of Gwadar is its connection from the Arabian Sea to Tibet and Western China through a network of "land ports" in Xinjiang Province including the city of Kashgar.<sup>73</sup> This route is depicted in **Figure 21**.

The integrated terrestrial network of the four-nation's road, rail, and communications infrastructure extending through Europe, the Middle East and East Asia (see a portion of this network in **Figure 22**). is a powerful complement to their diplomatic network. Each element of the four-power coalitions are interconnected by a shared overland transportation infrastructure diminishing the prospect that any member of the coalition will be detached from support from the other parties.

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<sup>69</sup> H. Meyer, *US Concerned About Russia Supplying Missiles to Yemen's Houthis*, *Bloomberg*, September 30, 2024, <https://www.bloomberg.com/news/articles/2024-09-30/us-concerned-about-russia-supplying-missiles-to-yemen-s-houthis?sref=boE5Wq9G>.

<sup>70</sup> Reuters and TOI, *Russia says 'comprehensive' treaty with Iran will include defense cooperation*, *Times of Israel*, October 31, 2024, <https://www.timesofisrael.com/russia-says-comprehensive-treaty-with-iran-will-include-defense-cooperation/>. The final text of the Treaty signed in Moscow on January 17 includes extensive defense and intelligence cooperation. *Joint Comprehensive Strategic Agreement Between Iran and Russia*; <https://en.irna.ir/news/85722405/Text-of-joint-comprehensive-strategic-agreement-between-iran>.

<sup>71</sup> *Russia presents new INSTC vision: broad gauge corridor through Iran*, *Rail Freight*, November 18 2024, <https://www.railfreight.com/corridors/2024/11/18/russia-presents-new-instc-vision-broad-gauge-corridor-through-iran/>.

<sup>72</sup> A Rao, *India Signs 10-Year Pact with Iran to Operate its Chabahar Port*, *India Briefing*; 11-2024, <https://www.india-briefing.com/news/india-signs-pact-with-iran-to-operate-chabahar-por-t-32647.html/>.

<sup>73</sup> Chen Meiling, *All vibrant on the western front*, *China Daily*, December 29, 2023, <https://www.chinadailyhk.com/hk/article/369045>.



Figure 21. Route of International North-South Transport Corridor

[Source: <https://avim.org.tr/Blog/INTERNATIONAL-NORTH-SOUTH-TRANSIT-CORRIDOR-INSTC-06-07-2023>]

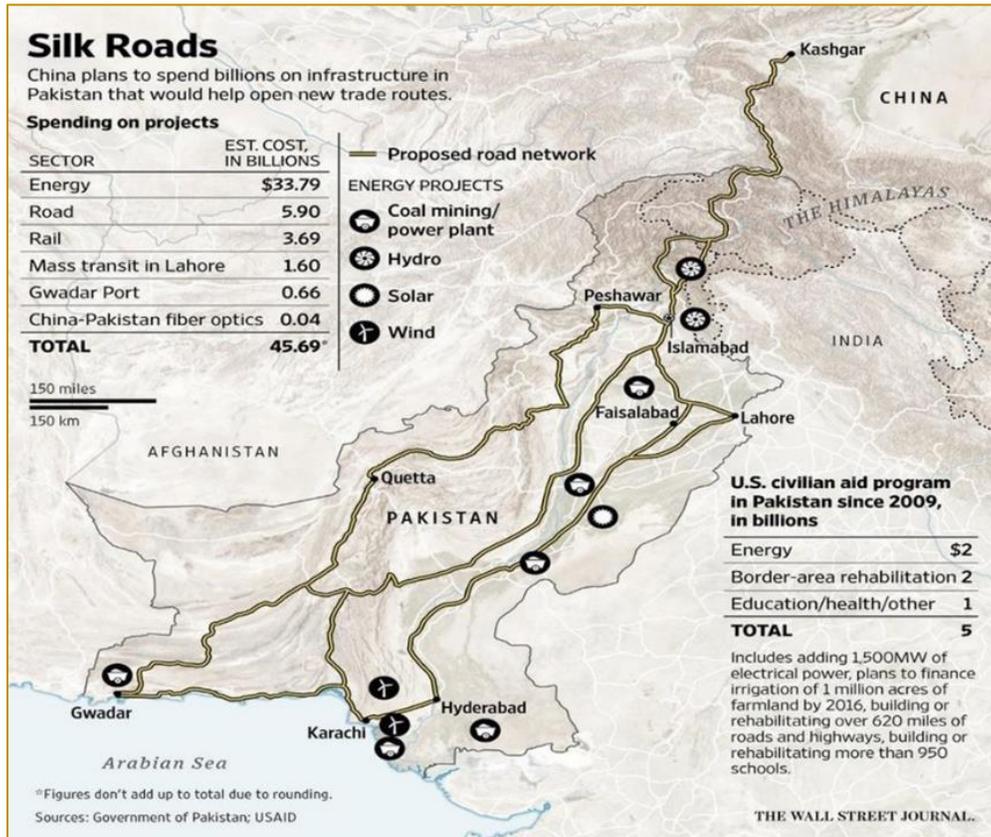


Figure 22. Internal Map of the China-Pakistan Economic Corridor

[Source: <https://www.wsj.com/articles/BL-CJB-26591>]

This approach was an aspiration of Japan's war planners in the run-up to its attack on the United States in World War II in 1941. In August 1939, Germany and the Soviet Union became allies with the signing of the *Treaty of Non-Aggression between Germany and the Union of Soviet Socialist Republics*. In September 1939 Germany invaded Poland, and under the then-secret provisions of the German-Soviet agreement, divided and occupied Polish territory. In April-May 1940 Germany invaded Denmark and Norway, the Low Countries, and France.

These quick victories that built on the German-Soviet rapprochement caused Japan to undertake a diplomatic initiative to negotiate a four-power alliance between Germany, Japan, Italy, and the Soviet Union. This alliance would create coalition of anti-democratic regimes to establish a new international order able to confront the Anglo-American order established by post-World War I treaties. Japan's diplomatic effort ended abruptly with the German invasion of the Soviet Union in June of 1941.<sup>74</sup>

In less than a month following the German invasion of the Soviet Union, and six months prior to the Japanese attack on Pearl Harbor, President Roosevelt took a major step to implement the defense-industrial dimension of preparations for World War II that had been in the planning phase for more than a decade. In his address to Congress on July 10, 1940, The President asked Congress to appropriate \$4.8 billion (~ \$105 billion in FY 23 dollars) for an increase in troop strength of 800,000 (including 15,000 aircraft) and other equipment for the armed forces.<sup>75</sup>

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<sup>74</sup> Japan's diplomatic initiative to create a four-power alliance is described in A. Iriye, *The Origins of the Second World War in Asia and the Pacific*, (New York: Longman, 1987).

<sup>75</sup> President Franklin D. Roosevelt, *Message to Congress on Appropriations for National Defense*, July 10, 1940, <https://www.presidency.ucsb.edu/node/209802>.

## V. Industrial Base for National Defense

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A quarter century of international aspirations shaped by hope, expectations, and conjectures following the end of the Cold War have dissipated. Cold War-era arms control arrangements could no longer be sustained as Russia abandoned compliance and exited post-Cold War conventions. Nuclear non-proliferation norms no longer sustain the aims of the 1968 *Treaty on the Non-Proliferation of Nuclear Weapons (NPT)*, and the post-World War II consensus on the security of national boundaries is no longer honored. Global stability's "safety net" has declined both sharply and incrementally through a series of international crises.

The deterioration of the international environment since the end of the Cold War has also had unanticipated diplomatic and military consequences. Armed conflicts with peripheral nations (e.g., the Balkan Conflict, the Gulf War, and the NATO campaign in Libya) created expectations that advanced technology including intelligence, surveillance, and reconnaissance (ISR) and precision strike capabilities would cause future conflicts to be brief, violent, and decisive.<sup>76</sup>

The post-9/11 imperative focused the U.S. military, and the supporting industry, on a protracted war on terror lasting over two decades. Peer competitors were not part of the overarching strategic imperative. Although some in the Department warned of the potential emergence of peer or near-peer competitors, those voices of concern regularly gave way to more immediate needs.

Moreover, future great power conflict will likely be prolonged compared to the early post-Cold War experience with heavy demands imposed on the industrial base to produce, repair, replace, and modernize military capabilities. Production must outpace entrenched processes that were designed for an era of requirements that no longer align with the threat. The employment of conventional artillery ammunition in the Ukraine-Russia conflict is illustrative of this trend. Russia is producing 4.5 million artillery rounds per year (375,000 rounds/month compared to the current U.S. effort to increase artillery round production to 100,000 rounds/month by 2025). Russia, at the time of this report, was currently firing ~12,000 artillery rounds per day, a rate comparable to World War II levels of intensity.<sup>77</sup>

The inversion of post-Cold War planning assumptions about the scope and scale of military conflict affects the industrial base for national defense directly. Expectations of much less demanding circumstances for the DIB led to a significant elimination of defense industrial capacity in the United States, particularly in munitions production. While the reduction in the number of major weapons system producers is now well-known, the impact of these changes on the industrial structure supporting the industrial base for munitions production is less well appreciated. At the same time, the U.S. DIB structurally transformed in ways no longer capable of meeting the demands of the Nation faced with the threats the United States and like-minded democracies now face—and will face for the foreseeable future.

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<sup>76</sup> Center of Military History, U.S. Army, *War in 2001. Persian Gulf, Operations Desert Shield and Desert Storm, August 1990-March 1991*, [https://www.history.army.mil/html/books/070/70-117-1/CMH\\_70-117-1.pdf](https://www.history.army.mil/html/books/070/70-117-1/CMH_70-117-1.pdf); NATO, *Operation UNIFIED PROTECTOR NATO-led Arms Embargo against Libya*, June 2011, [https://www.nato.int/nato\\_static\\_files2014/assets/pdf/pdf\\_2011\\_06/20110608\\_Factsheet-UP\\_Arms\\_Embargo.pdf](https://www.nato.int/nato_static_files2014/assets/pdf/pdf_2011_06/20110608_Factsheet-UP_Arms_Embargo.pdf); B. Lambeth, *NATO's Air War for Kosovo*, RAND, 2001, [https://www.rand.org/pubs/monograph\\_reports/MR1365.html](https://www.rand.org/pubs/monograph_reports/MR1365.html).

<sup>77</sup> Josh Luckenbaugh and Stew Magnuson, *Arms Manufacturers Catching Up with World's Insatiable Need for 155mm Rounds*, *National Defense*, September 11, 2024, <https://www.nationaldefensemagazine.org/articles/2024/9/11/arms-manufacturers-catching-up-with-worlds-insatiable-need-for-155mm-rounds>; B. Nikolov, *Every day, Russia produces 12,320 artillery shells at \$1K each*, *Bulgarian Military.com*, May 26, 2024, <https://bulgarianmilitary.com/2024/05/26/every-day-russia-produces-12320-artillery-shells-at-1k-each>.

A recovery in production capability is feasible, but it cannot be done by simply augmenting production from the legacy DIB. This report stresses the imperative of leveraging historical practice to expand defense production by bringing to bear the full industrial potential of the United States and its allies and partners to enable the industrial base to deter security challenges, and if deterrence fails, to prevail in a future conflict on a global scale.

The underlying sources of difficulty in establishing an industrial base able to meet the needs of current and anticipated security environments are derived from three separate, but-related, policies established in the early post-Cold War period.

1. **The “Last Supper” and the Structure of the Defense Industry.** In 1993, a decision was made to adapt the U.S. defense industrial structure toward then-anticipated security needs. This decision to eliminate ~80% of DoD prime contractors took place at an event that became known as the “Last Supper.”<sup>78</sup>
2. **Globalization.** The decline of Soviet military power and authority in Europe in 1989, followed by the collapse of the Union of Soviet Socialist Republics (USSR) in 1991, led to the elimination of most Cold War-era international trade and technology restrictions that enabled the “third wave” of globalization in the international economy. New technologies (particularly in information, autonomy, microelectronics, and communications sectors) enabled globalization, and they intensified and accelerated the commingling of “commercial” and “defense-related” capabilities in this period. The DoD strongly committed itself to benefiting from the globalization process while incurring strategic supply chain risks and sourcing vulnerabilities.<sup>79</sup>
3. **PRC admission to the World Trade Organization (WTO).** Admitting the PRC to the WTO has been the most consequential development for the U.S. DIB. By opening nearly every sector of the U.S. market to Chinese products, investment, technology, and presence has enabled the PRC to become the global center of manufacturing. In several significant cases, these policy changes led to deindustrialization in segments of U.S. industry and contributed to the PRC establishing a manufacturing sector that matched the United States in 2010 and is now triple the size of the United States, with the Chinese manufacturing advantage continuing to grow.<sup>80</sup>

These initiatives were widely supported within DoD, Congress, and the U.S. policy process at the time. However, the stresses created by these policy choices emerged gradually as the international security environment deteriorated leading to the current situation, where a diplomatic alignment of a coalition of major U.S. nuclear-armed Eurasian adversaries threatens the United States and its allies with multi-regional conflict against a coalition of nuclear-armed peer competitors.

This new global environment and the implications for a future U.S. NSIB must be understood by the USG and its allies and serve as the impetus for rapid and sustained transformation of the DIB.

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<sup>78</sup> Doug Berenson, Chris Higgins, and Jim Tinsley. *The U.S. Defense Industry in a New Era*, *War on the Rocks*, January 13, 2021; <https://warontherocks.com/2021/01/the-u-s-defense-industry-in-a-new-era/#:~:text=At%20a%201993%20dinner%20held,the%20major%20players%20in%20business.>

<sup>79</sup> J. S. Gansler et al, *The Impact of Globalization of the U.S. Defense Industrial Base*, February 4, 2014; <https://dair.nps.edu/handle/123456789/2597>.

<sup>80</sup> U.S. Mission to International Organizations in Geneva, *US Statement at the Trade Policy Review of the People’s Republic of China*, July 17, 2024, <https://geneva.usmission.gov/2024/07/17/u-s-statement-at-the-trade-policy-review-of-the-peoples-republic-of-china-2/>; and P. Bajpai et al, *Why China is the “The World’s Factory,”* Investopedia, May 24, 2024, <https://www.investopedia.com/articles/investing/102214/why-china-worlds-factory.asp>; *US Trade Representative, Background Information on China’s Accession to the World Trade Organization*, December 11, 2001, [https://ustr.gov/archive/Document\\_Library/Fact\\_Sheets/2001/Background\\_Information\\_on\\_China%27s\\_Accession\\_to\\_the\\_World\\_Trade\\_Organization.html](https://ustr.gov/archive/Document_Library/Fact_Sheets/2001/Background_Information_on_China%27s_Accession_to_the_World_Trade_Organization.html).

## VI. Industrial Structure of the U.S. Defense Industry

Post-Cold War expectations for a sharp attenuation in security threats aimed at U.S. interests resulted in a squeezing out of excess industrial base capacity and shaped the defense industrial environment for a new paradigm. The surviving prime contractors after consolidation would focus on systems engineering and integration of vendor components and subsystems, with innovation largely funded and directed by DoD. The most immediate effect of this shift was to reduce competition for major military systems. Conglomerate firms that previously had defense-related divisions dropped out of the market because of their inability to compete with specialist prime contractors focused on those market segments, as seen by changing shares in **Figure 23**. The remaining primes have not proven agile competitors to the fast-paced demands experienced in commercial markets and by technology focused companies.

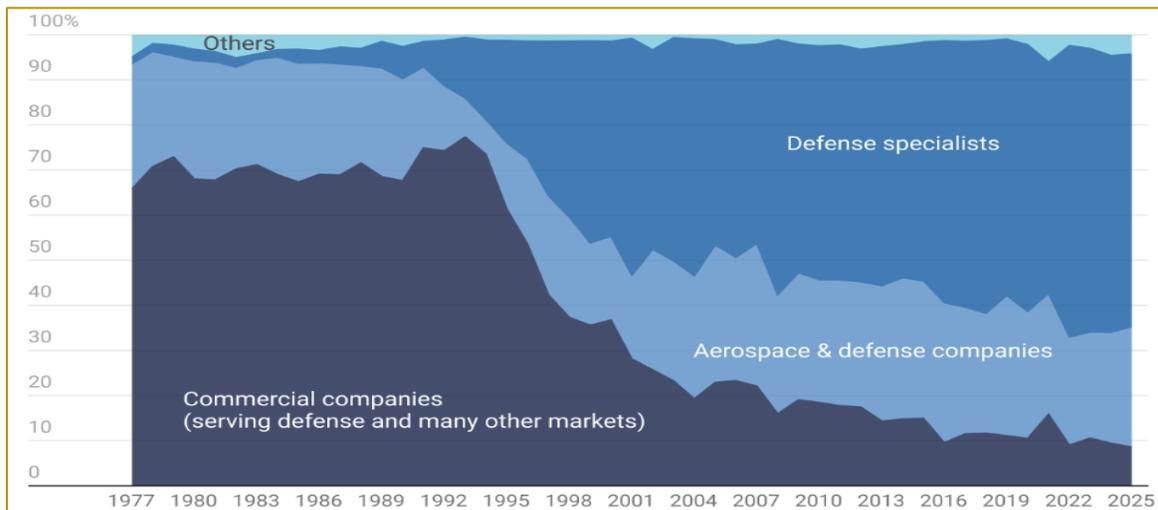


Figure 23. Major Weapon System Acquisition Budget: Share by Industrial Base Category  
 [Source: <https://www.csis.org/analysis/why-us-defense-industrial-base-so-isolated-us-economy>]

The emergence of the current DIB post “Last Supper” has significantly reduced participation by companies with a commercial focus whose products have a dual-use character and with whom the bulk of U.S. technology investments and production now resides often isolating the DIB from rapidly advanced commercial technology. This previously enabled them to succeed in both the commercial and defense markets. For example, military and civil inertial navigation systems were previously produced by commercial vendors who have little interest in the often-Byzantine peculiarities of entrenched acquisition practices—some real and some perceived.<sup>81</sup> These developments intensified the barriers to entry into the defense market for commercial firms and created gaps that have been filled by offshore suppliers, particularly those from the PRC.

Increasingly, civil-military models are developing for supplying commercial capabilities and capacity to meet defense national security needs and that progress should be lauded. The five-prime contractor model of providing system engineering and integration remains a de facto state where the United States finds itself; corporations are linked to major platform development and sustainment and largely control the IP of those systems. This environment limits the Department’s ability to break out of the prime relationship for vital

<sup>81</sup> *Litton Industries Offers for Sale Its Advanced Electronics Segment to Pursue Higher-Growth Markets*, November 7, 2000; <https://www.defense-aerospace.com/litton-to-sell-advanced-electronics-unit-nov-7/>.

sustainment and upgrade needs. This model has led to the primes anticipating long-term sustainment profits, driven by control of IP, and thus reducing their up-front prices, understanding they can “make up” the initial lower margins with locked in upgrade and sustainment opportunities for major platforms that historically are often operational for 25+ years.

This cycle is attractive to all currently involved. It appears to reduce upfront costs to the customer without understanding the longer-term money to maintain the systems. The cycle is fundamentally broken and resembles the classic “razor Blade” model where firms are incentivized, due to short-term or annual budget constraints, to give the razor below actual cost, but maintain the rights to be the only ones that can see the razors.

Over the last few years there has been a welcome influx of innovative, privately funded companies dedicated to addressing the emerging needs of the Department. These emerging mid-tier firms are a welcome competitor to the traditional primes and offer capabilities more in line with the commercial technology development cycle.

Of note is recent collaboration among these new entrants to compete with the historic DIB by pooling resources and aligning themselves to compete more effectively in the defense marketplace.

While the Department has yet to see the demonstrated success of such arrangements, the signs are encouraging, and the Department should embrace the new entrants and their collaboration with one another to address the needs of the warfighter.

## VII. PRC's Ascendance and its Civil-Military Fusion Industrial Base Approach

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After a decade of attempts, the PRC was admitted to the WTO in 2001. The decision by the United States to allow the PRC's entry was dependent on PRC commitments to adhere to WTO protocols, which were seen by the United States and many allies as a path for the PRC's peaceful integration into the global economy and a way for the country to become a force for peace and stability. U.S. leadership expectations of the PRC's compliance with the WTO Protocols were high,<sup>82</sup> and in her remarks on the final Congressional approval in December 2000, Secretary of State Albright expressed the widely-held view that PRC accession would also benefit U.S. national security interests:

*As important as this vote is to the economic well-being of America and to sustaining the economic growth that we have experienced these past eight years, it is just as important to our national security. The PRC's WTO accession and the extension of PNTR to the PRC will help lay the groundwork for building a constructive bilateral working relationship in years to come.<sup>83</sup>*

Unfortunately, the PRC did not comply with the WTO Protocols as U.S. leadership had hoped. By skirting WTO protocols and rules, the PRC's subsequent development of its industrial base and exploitation of worldwide market opportunities produced extraordinary domestic economic, financial, and industrial benefits.<sup>84</sup> In the decades since, the scale of the PRC's industrial base and its military-civil fusion program has significantly strengthened the PRC industrial base's capacity for defense production, and the Chinese Communist Party intends to continue implementation of the civil-military fusion program in service of a "world-class military" by 2049. Great progress has already been made in the reorganization of education, commercial industry, and military production to simultaneously advance economic and military development, resulting in greater manufacturing and R&D capacity within China.

The PRC's priorities are similar to those of the DoD and focus on dual-use technologies such as AI, semiconductors, 5G, nuclear technology, quantum computing, etc. The PRC's centrally planned economy and rapid expansion of both commercial and military capabilities, has allowed them to further develop and expand an integrated, interchangeable manufacturing capacity.<sup>85</sup>

The scale of the PRC's manufacturing sector compared to the United States and its allies is the greatest difference between the U.S. industrial mobilization effort in World War II and a defense-industrial mobilization initiative today. The circle chart in **Figure 24** (previously introduced in Figure 8), summarizes these differences and highlights the importance of alliances to mitigate the effect of the PRC's integrated civil-military manufacturing infrastructure.

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<sup>82</sup> Department of State Fact Sheet, **China: WTO Accession and Permanent Normal Trade Relations (PNTR)**, May 24, 2000, [https://1997-2001.state.gov/regions/eap/fs-china\\_pntr-wto\\_000524.html](https://1997-2001.state.gov/regions/eap/fs-china_pntr-wto_000524.html), and <https://1997-2001.state.gov/statements/2000/000524d.html>.

<sup>83</sup> M. Albright, **Statement on House of Representatives Vote on Normal Trade Relations with China**, May 24, 2000, <https://1997-2001.state.gov/statements/2000/000524d.html>.

<sup>84</sup> P. Kine, **China joined rules-based trading system – then broke the rules**, *Politico*, December 9, 2021, <https://www.politico.com/news/2021/12/09/china-wto-20-years-524050>.

<sup>85</sup> The Chinese Communist Party's Military-Civil Fusion Policy, *State Department Fact Sheet*, <https://2017-2021.state.gov/military-civil-fusion/>.

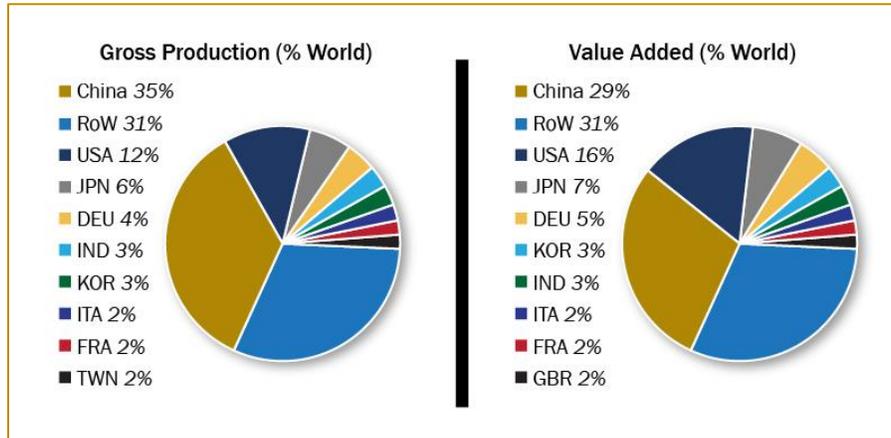


Figure 24. World's Biggest Manufacturing Economies

[Adapted from: <https://cepr.org/voxeu/columns/china-worlds-sole-manufacturing-superpower-line-sketch-rise>; data derived from OECD TiVA database, 2023 update]

Only when the manufacturing sector of major allies of the United States are considered is the sum industrial potential approximately equal to that of the PRC. These data reaffirm the importance of the U.S. alliance structure to defense-industrial capacity and its essential role as a dimension of deterrence.

The increasing defense-industrial collaboration between the PRC, Russia, Iran, and North Korea makes their combined industrial capacity an important national security consideration. Closer economic ties between these nations suggest that their capacity to sustain military operations in Europe, the Middle East, and the Indo-Pacific region may be reinforced by internal lines of supply within the Eurasian region. This capability has been demonstrated as Russia's 2022 invasion of Ukraine continues.

It is likely that cooperation between the PRC, Russia, Iran, and North Korea will evolve into an integrated security-related commitment or alliance that functionally combines their industrial capacities. Moreover, the defense industrial dimension of their relationships were implemented rapidly after bilateral agreements among the nations were signed. In response to current bilateral agreements and defense-industrial cooperation between a potential multi-nation adversary coalition, U.S. and allied actions have been limited to economic, financial, personal, and trade sanctions, none of which have achieved significant effects on adversary behavior.<sup>86</sup>

The PRC, Russia, Iran, and North Korea also have considerable resources, particularly if they establish a formal diplomatic and institutional basis for such collaboration. Preliminary evidence collected since the 2022 Russian expanded invasion of Ukraine shows that these four nations have developed an approach that supports their mutual aims. In addition to defense-industrial needs, their shared need to avoid the burden of U.S. and allied sanctions have been met, in part, by the development of alternative transit routes, outlets for their exports, and opaque sources of access to the controlled technologies they restricted from

<sup>86</sup> Edward Wong, *U.S. and Allies Sound Alarm Over Their Adversaries' Military Ties*, September 30, 2024, <https://www.nytimes.com/2024/09/30/us/politics/us-axis-china-iran-russia.html>; Office of the Director of National Intelligence, *Assessment of the Effects of Sanctions in Response to the Russian Federation's Invasion of Ukraine*, September 2023, <https://www.odni.gov/files/documents/FOIA/DF-2023-00313-Assessment-of-the-Effects-of-Sanctions-in-Response-to-the-Russian-Federations-Invasion-of-Ukraine.pdf>.

buying directly from U.S. and European sources.<sup>87</sup> (Economic comparisons between the United States-PRC-DPRK-Iran-Russia between 1960–2022 is shown in **Figure 25.**)

Nominal GDP	U.S.	PRC	Ratio U.S. to China
1960 GDP (in billions)	\$545	\$60	9.1
2022 GDP (in billions)	\$25,400	\$17,960	1.4

GDP in Purchasing Power Parity (PPP) (CIA Factbook)	U.S.	PRC	Ratio U.S. to China
1960 U.S. GDP in PPP	--	--	--
2022 U.S. GDP in PPP (CIA)	\$21,538	\$25,684	.08

Manufacturing GDP in PPP	U.S.	PRC	Ratio U.S. to China
Percent Manufacturing in Economy	11.4%	28.4%	.04
Manufacturing GDP in PPP	\$2,455	\$7,294	.03

GDP in PPP (CIA Factbook)	U.S. Coalition	PRC + Russia + Iran + DPRK	Ratio U.S. to China
1960 U.S. GDP in PPP	--	--	--
2022 U.S. GDP in PPP (CIA)	\$21,538	\$25,684	.8

Figure 25. U.S.-The PRC-DPRK-Iran-Russia Economic Comparison 1960–2022  
[adapted from: <https://www.cia.gov/the-world-factbook/>]

**Bottom Line: We Must Change our Industrial Base Approach**

The threat to the U.S. homeland is real, as it is real for U.S. allies.

The United States faces a determined and credible threat not from one but four nation-states that now aid each other in substantive ways.

The United States must advance the structure of its own industrial base, and lead cooperation with our allies to harness more capabilities from the collective alliance of democratic nations to meet a clear and present danger.

<sup>87</sup> Christopher S Chivvis and Jack Keating, *Cooperation between China, Iran, North Korea, and Russia: Current and Potential Future Threats to America* | *Carnegie Endowment for International Peace*, Carnegie Europe, October 8, 2024, <https://carnegieendowment.org/research/2024/10/cooperation-between-china-iran-north-korea-and-russia-current-and-potential-future-threats-to-america?lang=en>.

## Appendix A. Terms of Reference

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RESEARCH  
AND ENGINEERING

### UNDER SECRETARY OF DEFENSE

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WASHINGTON, DC 20301-3000

CLEARED  
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Department of Defense  
OFFICE OF PRODUCTION AND SECURITY REVIEW

28 March 2023

#### MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Refocused Terms of Reference – Defense Science Board Task Force on 21<sup>st</sup> Century Industrial Base for National Defense

As potential threats have evolved, the Department of Defense (DoD) needs a strategy to improve the defense industrial base resilience and to protect its supply chains for the development of current and future defense systems and technology. For some defense supply chains, critically important materials and components come from foreign sources, and the DoD needs options for reducing supply chain risk due to threat disruption. The DoD also needs to develop options for increasing the scale and resilience of its industrial base to address the needs for rapid mobilization and potential extended conflict.

On October 30, 2019, the Task Force on 21st Century Industrial Base for National Defense (“the Task Force”) was established as a subcommittee of the Defense Science Board (DSB). The Task Force met May 2020 through January 2021 prior to the Secretary of Defense’s Zero-Based Review (ZBR) and was paused during the ZBR. This Terms of Reference (ToR) refocuses the Task Force from the original ToR to reflect the evolution in the industrial base environment since January 2021. The refocused ToR mirrors both the Under Secretary of Defense for Research and Engineering (USD(R&E)) and the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)) industrial base current areas of interest.

The DSB, working through the Task Force, should review the state of the defense industrial base and provide recommendations to improve our capabilities, capacity, and resilience and diminish our vulnerabilities and susceptibility to adversary actions. The refocused Task Force should consider, at minimum:

- Finding approaches for effective adaption of commercial technology and non-traditional suppliers to defense industrial needs;
- Developing ways to increase the resilience and capacity in the defense industrial base and associated supply chains to sustain both legacy capabilities for surge and mobilization purposes, as well as to anticipate the needs of the industrial base to support future capabilities;
- Assessing means to increase the resilience of the supply chain and the industrial base and reduce the risk of kinetic and non-kinetic attacks by potential adversaries,;
- Identifying opportunities to broaden the defense industrial base and supply chains through collaboration with close allies, including the use of existing regulatory and statutory authorities;

- Identifying opportunities to strengthen the supply chain industrial base associated with the U.S. strategic deterrent, including the nuclear enterprise through the Office of the Secretary of Defense role in the Nuclear Policy Council, and;
- Developing opportunities to drive more innovation into the defense industrial base through technology investments and demonstrations;
- Identifying critical materials unavailable in the US required for defense articles and recommending appropriate additions to the Defense Logistics Agency critical material stocks, and;
- Cataloguing critical machinery imported from overseas and exploring alternatives to these dependencies, to include stockpiling spares in the United States as necessary.

The Task Force findings, observations, and recommendations will be presented to the full DSB for its thorough, open discussion and deliberation at a properly noticed and public meeting, unless it must be closed pursuant to one or more of the exemptions found in subsection 552b(c) of title 5, United States Code (U.S.C.). The DSB will provide its findings and recommendations to USD(R&E) as the Sponsor of the DSB. The nominal start date of the study period for this refocused ToR will be within 30 days of the appointment of Task Force members. In no event will the duration of the Task Force exceed 24 months from the start date.

In support of this ToR and the work conducted in response to it, the DSB and the Task Force have my full support to meet with Department leaders. The DSB staff, on behalf of the DSB and the Task Force, may request the Office of the Secretary of Defense and DoD Component Heads to timely furnish any requested information, assistance, or access to personnel to the DSB or the Task Force. All requests shall be consistent with applicable laws, applicable security classifications, DoD Instruction 5105.04, "Department of Defense Federal Advisory Committee Management Program," and this ToR. As special government employee members of a DoD federal advisory committee, the DSB and the Task Force members will not be given any access to DoD networks, to include DoD email systems.

Once material is provided to the DSB and the Task Force, it becomes a permanent part of the DSB's records. All data/information provided is subject to public inspection unless the originating Component office properly marks the data/information with the appropriate classification and Freedom of Information Act exemption categories before the data/information is released to the DSB and the Task Force. The DSB has physical storage capability and electronic storage and communications capability on both unclassified and classified networks to support receipt of material up to the TS/SCI level.

The DSB and the Task Force will operate in conformity with and pursuant to the DSB charter; chapter 10 of title 5, U.S.C.; subsection 552b(c) of title 5, U.S.C.; and other applicable federal statutes, regulations, and policy. Individual DSB and Task Force members and the Task Force as a whole do not have the authority to make decisions or provide recommendations on behalf of the DSB nor report directly to any Federal representative. The members of the Task Force and the DSB are subject to

DEFENSE SCIENCE BOARD

certain Federal ethics laws, including section 208 of title 18, U.S.C., governing conflicts of interest, and the Standards of Ethical Conduct regulations in 5 Code of Federal Regulations, Part 2635.

A handwritten signature in black ink, appearing to read "Heidi Shyu". The signature is fluid and cursive, with the first name "Heidi" being more prominent than the last name "Shyu".

Heidi Shyu

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## Appendix B. DSB Membership

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Dr. Eric Evans, Chair

Mr. Michael Appelbaum

Dr. Jennifer Bernhard

Dr. Alison Brown

Mr. James Carlini

Ms. Laetitia de Cayeux

Dr. Tomás Díaz de la Rubia

Mr. Fred Dixon

Adm William Fallon, USN (ret.)

Mr. Robert Giesler

Dr. Johney Green

Dr. Robert Grossman

Dr. Daniel Hastings

Dr. Evelyn Hu

Hon. Shirley Ann Jackson

Dr. Ashanti Johnson

Dr. Paul Kaminski

Dr. Ann Karagozian

Dr. John Manferdelli

Dr. Katherine McGrady

Dr. James Miller

Dr. DJ Patil

Dr. Gary Polansky

Dr. Sanjay Raman

Dr. David Relman

Dr. Reshma Shetty

Dr. Alfred Spector

Dr. Dorota Temple

Dr. Jan Tighe

Dr. Bradford Tousley

Dr. David Van Wie

Ms. Mandy Vaughn

Dr. Dinesh Verma

Dr. Steven Walker

Dr. Robert Wisnieff

## Appendix C. Task Force Membership

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### Co-Chairs

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Mr. Brett B. Lambert

### Task Force Members

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Dr. Paul Kaminski

Mr. Michael Bayer

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Lt Gen Chris Bogdan, USAF (ret.)

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Ms. Laetitia de Cayeux

Dr. Alfred Spector

Mr. Kevin Doxey (consultant)

Ms. Mandy Vaughn

Mr. Kevin Fahey

Dr. Robert Wisnieff

Mr. Frank Finelli

### Government Advisors

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Mr. David Pendall, SCO

### DSB Secretariat

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DSB Executive Director and  
Designated Federal Officer (DFO)

Mr. Sean Hagerty, DSB Senior Advisor and Alternate  
DFO

Dr. Troy Techau, DSB Senior Advisor and Alternate DFO

### SAIC Study Support

Ms. Brenda Poole

Ms. Hannah Gonzalez

## Appendix D. Munitions Industrial Base

A discussion of the munitions industrial base needs to be addressed in a context that considers U.S. international security policy and interests, arms transfer policy, and the planning process for the readiness of the munitions industrial base to meet national surge and mobilization requirements.

The United States has had a succession of circumstances where changes in the policy environment ran ahead of the ability of the capital-intensive munitions industrial base to adapt. In the 1980s, the United States adopted its Assault Breaker/Air-Land Battle approach to large-scale conventional military operations. The introduction of precision strike capabilities made accuracy independent of range. As a result, the United States—and its NATO allies—no longer required large inventories of conventional “dumb” ammunition apart from training, foreign military sales, and war-reserve stocks. Henceforth, maneuver forces would be able to conduct day/night all-weather operations supported by modern intelligence, surveillance, and reconnaissance (ISR), and both point and area air defenses.

The policy change in U.S. munitions requirements enabled by the 1980s technology was stark. In a 60-day period during the Korean War (June-July 1953), the U.S. and allied forces fired nearly 5 million artillery rounds against Chinese forces.<sup>1</sup> In the 1991 Gulf War (January-February 1991) where modern air-ground combined arms long-range precision strike dominated the capabilities employed by the United States and its allies, the United States only needed to fire 9,200 cannon artillery and 1,900 rocket artillery rounds supported by 100,000 air sorties in the brief but decisive conflict. The adversary had 3,000 main battle tanks, 1,400 armored personnel carriers, and 2,200 artillery pieces destroyed.<sup>2</sup>

The policy environment that shaped the U.S. response to the Russian invasion of Ukraine constrained both U.S. arms transfers to Ukraine and has served to sharply increase the demands imposed to the U.S. and allied munitions industrial base.<sup>3</sup> A policy decision taken by the administration to avoid the prospect of Russian escalation of the conflict by not arming Ukraine to fight with the same capabilities that NATO forces would employ if they were engaged in the conflict had consequences for munitions supply from the U.S. and allied forces. Munitions expenditure would be much higher than would have been the case if U.S. and allied arms transfer policies replicated U.S. arms transfer policies to NATO member states.<sup>4</sup>

As the technology of long-range precision strike proliferated among U.S. and allied forces, the diminished priority to modernize the munitions industrial base was reflected in a steep decline in both munitions stocks and the production base to support the munitions industry. A series of thoughtful studies have been undertaken by the Army, the U.S. Government Accountability Office (GAO), and the National Academy of

<sup>1</sup> H. G. Summers, *When it Comes to Artillery, U.S. is Outgunned by Enemy's Weaponry: The Korean War was the last time the United States had clear dominance*, *Los Angeles Times*, January 29, 1991, <https://www.latimes.com/archives/la-xpm-1991-01-29-mn-370-story.html>.

<sup>2</sup> Association of the U.S. Army, *Artillery Played a 'Decisive' Role in the 1st Gulf War*, August 5, 2020, <https://www.ausea.org/news/artillery-played-%E2%80%98decisive%E2%80%99-role-1st-gulfwar#:~:text=16%E2%80%9323%2C%201991.,rockets%20in%20combined%20arms%20formations>; U.S. Army Center for Military History, *Operation Desert Storm: 17 January to 28 February 1991*, <https://www.history.army.mil/html/bookshelves/resmat/desert-storm/index.html>.

<sup>3</sup> V. Banerjee and B. Tkach, *Munitions Return to a Place of Prominence in National Security*, *War the Rocks*, March 16, 2023, <https://warontherocks.com/2023/03/munitions-return-to-a-place-of-prominence-in-national-security>; L. Adams, *America's Arsenals Fuel Modernization: Depots and ammunition plants for the future*, *Army Sustainment*, August 21, 2021, <https://www.army.mil/article/249276/?st>.

<sup>4</sup> A.C. Arndt and L. Hirovitz, *Nuclear rhetoric and escalation management in Russia's war against Ukraine: A Chronology*, SWP, September 3, 2022, [https://www.swp-berlin.org/publications/products/arbeitspapiere/Arndt-Horovitz\\_Working-Paper\\_Nuclear\\_rhetoric\\_and\\_escalation\\_management\\_in\\_Russia\\_s\\_war\\_against\\_Ukraine.pdf](https://www.swp-berlin.org/publications/products/arbeitspapiere/Arndt-Horovitz_Working-Paper_Nuclear_rhetoric_and_escalation_management_in_Russia_s_war_against_Ukraine.pdf).

Sciences since 2000.<sup>5</sup> Each have reflected on the long-term industrial and financial commitment required to construct, operate, and sustain the complex in industrial processes required to maintain a “warm” production base while accumulating the stocks that can meet surge and mobilization requirements, particularly for allied and friendly nations who have not maintained a munitions industrial base. Consideration could be given to a resumption of Cold War-era practice of providing U.S. NATO allies with technical data packages that could permit them to produce U.S./NATO standard munitions and possibly leverage the commitment of the European Union (EU) to finance increased munitions production in Europe.<sup>6</sup>

Recovering the capacity to produce munitions at scale including drone-swarms and other modern munitions will be required by the United States, and allied and partner nations will require the adoption of modern manufacturing including additive manufacturing and automated flexible manufacturing techniques.<sup>7</sup>

One of the administrative constraints, especially for advanced technologies (including munitions), is associated with compliance with appropriations process constraints that limit the ability of the DoD and the Military Departments to easily move funds between appropriation titles (e.g., research and development (R&D), acquisition, Operations and Maintenance, etc.).

This constraint has had a significant effect on integrating advanced munitions, unmanned aircraft systems (UAS) swarms, and other advanced technologies in manners aligned with DoD’s processes that aligns doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) and is the framework for developing the design of a defense product. Proposed force designs are assessed through a Force Integration Feasibility Assessment (FIFA) which provides the analytic rigor to determine sufficiency of each DOTMLPF domain (depicted in **Figure D-1**). Only after all shortfalls are addressed will senior leaders approve the new force design.<sup>8</sup>

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<sup>5</sup> GAO, *Actions Needed to Improve Management of Procurement and Production Processes*, <https://www.gao.gov/assets/gao-23-105352.pdf> (October 2022); U.S. Army Environmental Command, *Army Ammunition Production, 1946-89* (2009), <https://aec.army.mil/application/files/1614/9505/0982/ammo-storage02.pdf>; National Academy of Science, *Munitions Manufacturing: A Call for Modernization* (2002), <https://nap.nationalacademies.org/catalog/10351/munitions-manufacturing-a-call-for-modernization>; R. R. Burleson et al, *Totally Integrated Munitions Enterprise: Affordable Munitions Production for the 21<sup>st</sup> Century* (2000), [https://digital.library.unt.edu/ark:/67531/metadc742342/m2/1/high\\_res\\_d/793979.pdf](https://digital.library.unt.edu/ark:/67531/metadc742342/m2/1/high_res_d/793979.pdf).

<sup>6</sup> Jaacabo Barigazzi, *EU seals deal to send Ukraine 1M ammo rounds*. *Politico*, March 20, 2023, <https://www.politico.eu/article/eu-seals-deal-send-ukraine-1-million-ammo-rounds-shells-war/>. There is considerable skepticism that the EU can make good on the commitment due to the Europe-wide shortage of the industrial materials and chemicals to produce large quantities of munitions. Henry Foy et al, *Explosive Shortage Threatens EU drive to arm Ukraine*, *Financial Times*, March 19, 2023, <https://www.ft.com/content/ae0e1a1c-4664-4af9-a1c8-73fcbc46ed17>.

<sup>7</sup> Army Research Laboratory, *Science of Additive Manufacturing for Next Generation Munitions*, <https://arl.devcom.army.mil/what-we-do/samm/>; B. Tan et al, 3D Printing for Explosives and Propellants, *Additive Manufacturing Frontiers*, September 2024, <https://www.sciencedirect.com/science/article/pii/S2950431724000418>, European Defence Agency, *Additive Manufacturing Techniques for Energetic Materials: New Opportunities for Defense Applications*, <https://eda.europa.eu/docs/default-source/posters/15---additive-manufacturing-techniques-for-energetic-materials---new-opportunities-for-defense-applications.pdf>.

<sup>8</sup> <https://ssl.armywarcollege.edu/dde/learningmodules/jsps/terms/DOTMLPF.cfm#:~:text=DOTMLPF%20is%20the%20framework%20for,approve%20the%20new%20force%20design>.

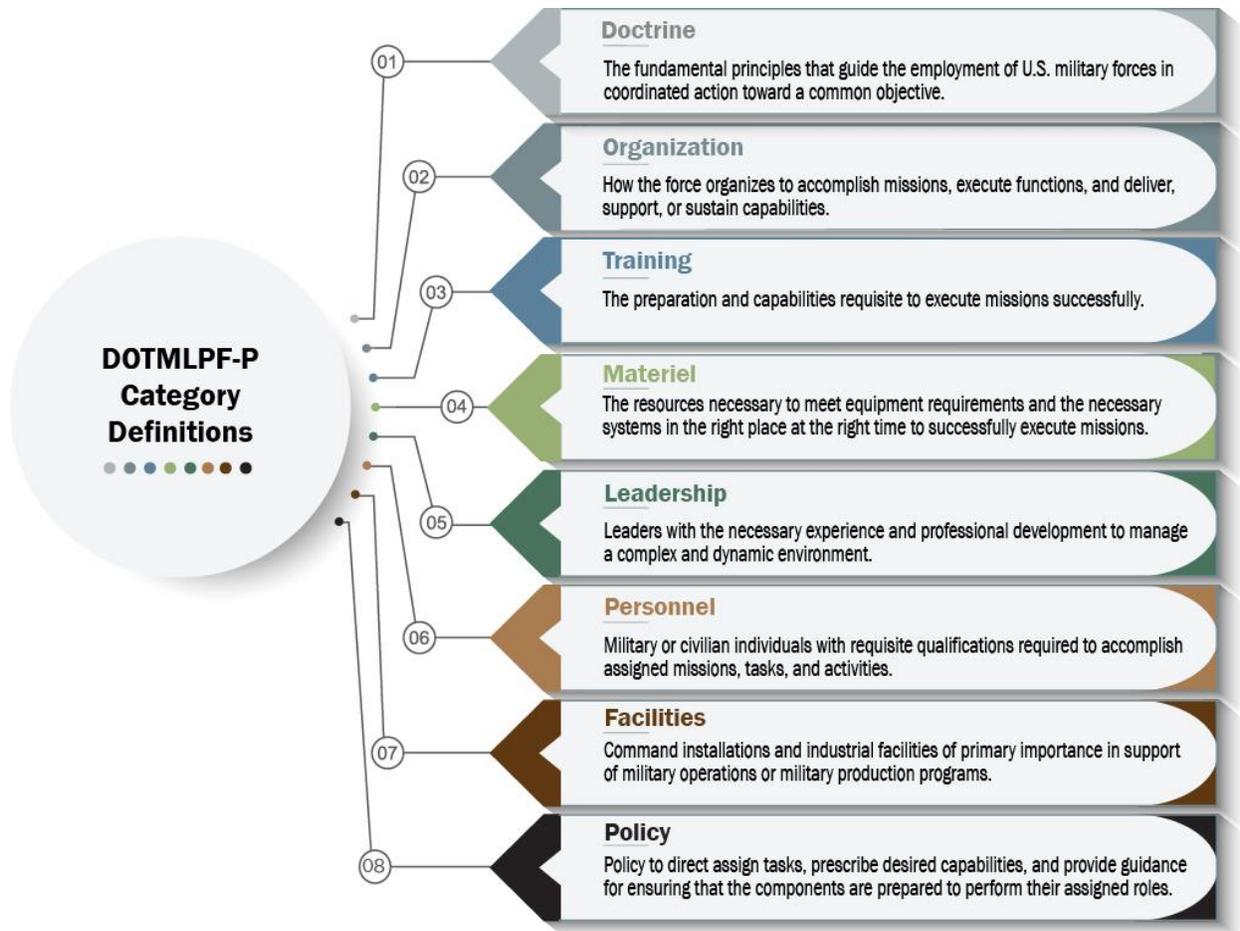


Figure D-1. DOTMLPF-P Category Definitions  
 [Adapted from: <https://mdharrismd.com/2013/11/09/dotmlpf-p-analysis-and-military-medicine/>]

This is an area where there is considerable scope for compromise with Congress as has been done in other circumstances where there are impediments imposed by the appropriations process such as multi-year procurements.<sup>9</sup>

<sup>9</sup> Congressional Research Service, *The Appropriations Process: A Brief Overview*, May 17, 2023, R47106, <https://crsreports.congress.gov/product/pdf/R/R47106>. The DoD has been able to gain an exception to the annual appropriations cycle for multi-year procurement in specific circumstances. DAU, *Multi-Year Procurement*, <https://www.dau.edu/acquimedia-article/multiyear-procurement#:~:text=Congress%20has%20mandated%20the%20following,of%20a%20proposed%20contract%20award.>

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## Appendix E. Impact of Globalization on the U.S. Defense Industry

The Warsaw Pact collapsed in 1991 along with the Former Soviet Union (FSU), and Russia soon began taking steps toward establishing a democratic order. Ukraine, the third largest nuclear power after the collapse of the USSR, responded to international calls for it to join the *Treaty on the Non-Proliferation of Nuclear Weapons* (NPT) in 1994 and returned roughly 1,700 warheads to Russia in exchange for assurances from the United States, the United Kingdom, and Russia to respect their existing borders. At this point in history, relations between the United States and the People's Republic of China (PRC) were primarily trade-driven with no significant sources of military conflict on the horizon. The Taiwan issue was successfully managed through a series of U.S.- PRC Joint Communiques.

Optimism about the trajectory of international security relations was reinforced by a powerful shift in the globalization of technology and the emergence of democratic nations around the world. The end of the Cold War sharply diminished policy and regulatory barriers to international trade, a trend which was reinforced by agreements such as the North America Free Trade Agreement between the United States, Canada, and Mexico. This effect was most broadly felt when the People's Republic of China (PRC) was admitted to the World Trade Organization (WTO) in 2000. The PRC gained access to the WTO on highly concessional terms, but even then, failed to honor the terms of its admission to the organization. The PRC's competitive advantages with its initially ultra-low wages and vast workforce, coupled with the international community's failure to enforce WTO rules enabled the PRC to become a global center of manufacturing that is at least 2.5 times the size of the U.S. manufacturing sector.

The global liberalization of trade had undeniable benefits for the defense industry that drove enthusiasm in DoD leadership at that time. Through it, the DoD and its industrial base had access to raw materials, manufactured products, and advanced services on a worldwide basis that could reduce the cost of defense products and substantially broaden the supply base. Focus on an ever-expanding and complex supply chain was rarely a priority concern for the defense industrial base (DIB) or the customers it served. Focus was instead placed on manufacturing efficiencies, including just-in-time supply chains. While these lowered costs, they had negative implications regarding both surge capability and reliable supplies at the 4<sup>th</sup> and beyond tier of the global supply chain. The DoD was slow in learning lessons of previous industrial base trends.

### The Three Waves of Globalization

The first wave of globalization, 1860–1914, reflected the global impact of the industrial revolution and the emergence of the “Victorian Internet,” enabling effective real-time global communication via electric telegraph.<sup>1</sup> This period was characterized by intense scientific and industrial development, modernization of trade and financial institutions, and free movement of capital. The collapse of major European monarchies—the Hohenzollern in Germany, the Hapsburg monarchy in Austria, the Romanov dynasty in Russia, and the Ottoman Empire in Turkey—led to a sharp decline in international trade and investment that persisted until the end of World War II.

Following World War II, the United States emerged as the leading nation among victors and was able to leverage its lack of major wartime destruction of the homeland into a period of rapid economic growth and

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<sup>1</sup> Tom Standage, *The Victorian Internet: The Remarkable Story of the Telegraph and the 19<sup>th</sup> Century On-Line Pioneers*, Wade & Co., 1998.

technological dominance. The revival of international trade and investment played to U.S. strengths and allowed it to benefit from this second wave of globalization.

A third wave of globalization followed the collapse of Soviet military power and authority in 1989 and its demise in 1991, producing a new, more widely distributed and liberalized system of international trade and investment. The globalization of technology offered broad benefits to the United States and its allies via access to global markets for components, finance, personnel, and industrial organizations. **Figure E-1** summarizes the characteristics of all three waves.

	The First Wave	The Second Wave	The Third Wave
Time Period	1860–1914	1944–1974	1989–
Technology	<ul style="list-style-type: none"> <li>▪ Steam engine</li> <li>▪ Telegraph</li> <li>▪ Electricity</li> <li>▪ Internal combustion engine</li> </ul>	<ul style="list-style-type: none"> <li>▪ Jet planes</li> <li>▪ Television</li> <li>▪ Communication satellites</li> <li>▪ Container traffic</li> </ul>	<ul style="list-style-type: none"> <li>▪ Microprocessors</li> <li>▪ Personal computers</li> <li>▪ Internet</li> <li>▪ Mobile telephones</li> </ul>
Political Leadership	<ul style="list-style-type: none"> <li>▪ Great Britain economic leader</li> <li>▪ Colonialism</li> </ul>	<ul style="list-style-type: none"> <li>▪ USA economic leader</li> <li>▪ Cold War</li> </ul>	<ul style="list-style-type: none"> <li>▪ Multipolar (USA, EU, PRC)</li> <li>▪ Global democratic processes</li> </ul>
Commerce	<ul style="list-style-type: none"> <li>▪ Initially free trade, but increasing protectionism</li> </ul>	<ul style="list-style-type: none"> <li>▪ Gradually reduced industrial tariffs</li> </ul>	<ul style="list-style-type: none"> <li>▪ More and more countries adopt free trade</li> </ul>
Trade in Services	<ul style="list-style-type: none"> <li>▪ Limited scale</li> <li>▪ Shipping industry most important</li> </ul>	<ul style="list-style-type: none"> <li>▪ Limited scale</li> <li>▪ Shipping industry most important</li> </ul>	<ul style="list-style-type: none"> <li>▪ Increased scale in more and more branches</li> </ul>
Capital Movement	<ul style="list-style-type: none"> <li>▪ Free</li> </ul>	<ul style="list-style-type: none"> <li>▪ Regulated</li> </ul>	<ul style="list-style-type: none"> <li>▪ Free</li> </ul>
Migration	<ul style="list-style-type: none"> <li>▪ Free movement</li> <li>▪ Emigration</li> </ul>	<ul style="list-style-type: none"> <li>▪ Regulated (excluding Nordic countries)</li> <li>▪ Labor migration</li> </ul>	<ul style="list-style-type: none"> <li>▪ Regulated (excluding EU)</li> <li>▪ Political migration</li> </ul>

Figure E-1. The Three Waves of Globalization

[Source: <https://archive.nordregio.se/en/Metameny/About-Nordregio/Journal-of-Nordregio/2008/Journal-of-Nordregio-no-1-2008/The-Three-Waves-of-Globalisation/index.html>.]

DoD leadership committed itself to addressing this third wave of globalization, one element of which was commissioning a DSB study on the subject in 1997. The *Final Report of the Defense Science Board Task Force on Globalization and Security* was then published in 1999.<sup>2</sup>

The DSB report described the globalization phenomenon as “irresistible” and “a fact to which policymakers must adapt,” and went on to describe globalization as:

- The integration of the political, economic, and cultural activities of geographically and/or nationally separated peoples.
- Not a discernible event or challenge, is not new, but it is accelerating.
- More importantly, globalization is largely irresistible.
- Thus, globalization is not a policy option, but a fact to which policymakers must adapt.

The report offered an approach that would enable the United States to harvest the benefits of this third wave of globalization while leveraging the domestic civil and defense sectors to sustain its security objectives:

<sup>2</sup> Defense Science Board, *Globalization and Security*, December 1999, <https://apps.dtic.mil/sti/tr/pdf/ADA371887.pdf>.

1. The Department needs a new approach to maintaining military dominance.
2. DoD needs to take full advantage of the commercial sector—not only commercial products and services but also commercial business practices.
3. The Department must act aggressively to ensure the integrity of critical software-intensive systems.
4. The Department needs to reaffirm periodically its willingness to consider cross border defense industry mergers and acquisition and to take steps to modernize the regulatory regime affecting both the export of defense products and services and transnational defense industrial integration.
5. DoD should adapt its personnel security program to the emerging global information technology environment.

These recommendations were not implemented by DoD, and the defense industrial environment remains engaged with many of the same issues a quarter-century later.

A consequence of post-Cold War trade and technology transfer deregulation was a large-scale increase in Chinese suppliers' penetration of the DoD supply chain as acquisition regulations were driven by "lowest-cost technically acceptable" components from vendors.<sup>3</sup> This trend can be seen in **Figure E-2**.

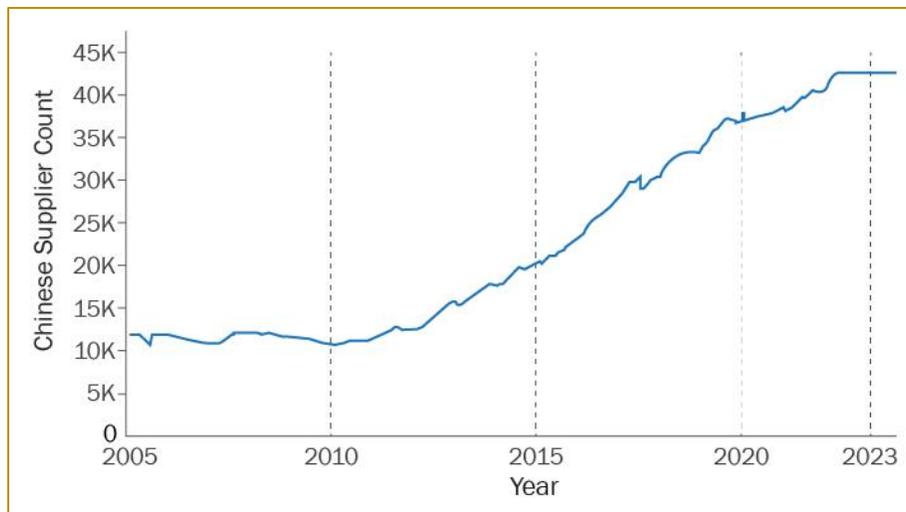


Figure E-2. Chinese Suppliers in U.S. Supply Chains, 2005–2023

[Adapted from: [https://cdn.prod.website-](https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/66104c1d4e3ae7809bcd8082_Govini_2024_Numbers-Matter.pdf)

[files.com/65e61e6392aba0fa1dba723e/66104c1d4e3ae7809bcd8082\\_Govini\\_2024\\_Numbers-Matter.pdf](https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/66104c1d4e3ae7809bcd8082_Govini_2024_Numbers-Matter.pdf).]

The broad scope of the PRC's industrial footprint has only become a focus of concern for much of the U.S. Government (USG) in the last decade, although many pockets of concern within DoD and other government agencies persistently attempted to sound the alarm earlier. The PRC continues to make inroads into an increasing number of civil technologies pertinent for defense applications. This steep increase in suppliers has provided the PRC with a competitive presence in each of the 18 core industry segments noted in **Figure E-3** even though the United States continues to be the dominant market participant.

<sup>3</sup> Federal Acquisition Regulations, **Lowest price technically acceptable source selection process**, <https://www.acquisition.gov/far/15.101-2>.

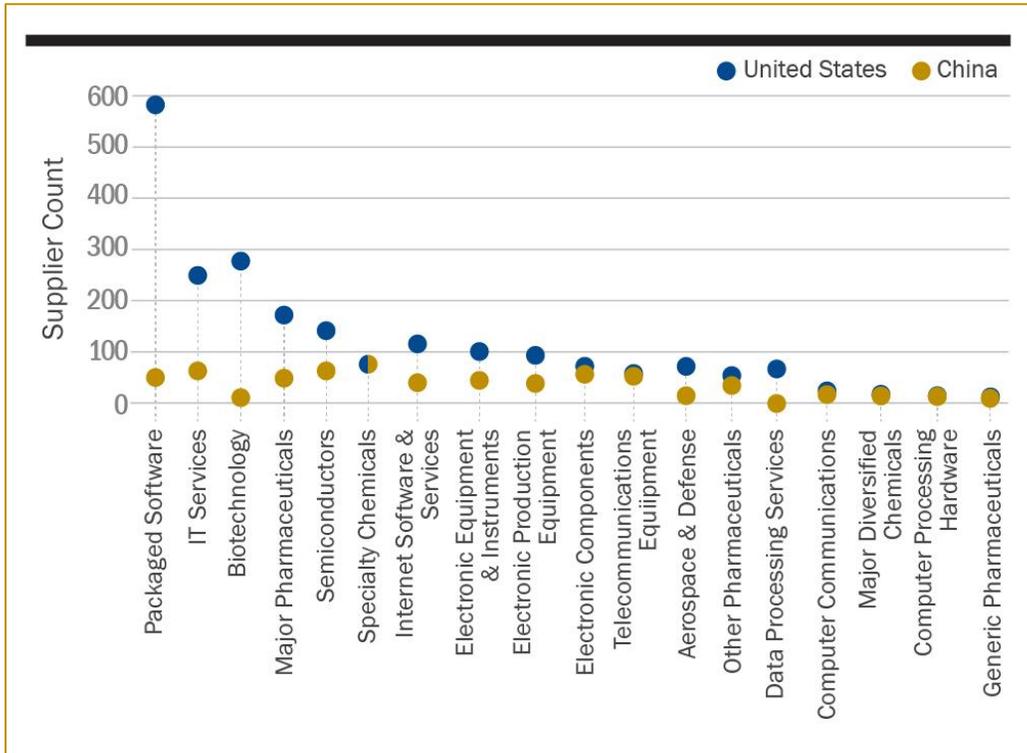


Figure E-3. Chinese Competitive Presence in Core Industry Segments

[Adapted from: [https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/6617fa6b7c037adc8663423f\\_Govini-DoD-Reshoring-Challenge.pdf](https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/6617fa6b7c037adc8663423f_Govini-DoD-Reshoring-Challenge.pdf)]

Furthermore, the PRC’s presence in most industrial and scientific segments pertinent to the defense market enables the PRC to increase access over time via the vendor growth that is a characteristic of complex weapon systems.

Consolidating providers of major platforms is only part of the story and obscures the overall scale and diversity of the supply chain. A diverse supply chain is increasingly needed to support the wide array of subsystems and sub-elements that comprise sophisticated platforms and associated support systems. This fact can be observed in the diversity of the vendor base. The DoD’s four tiered supply chain—original equipment manufacturer (OEM), tier 1 (major subsystem supplier), tier 2 (subsystem assemblies used by tier 1 suppliers), and tier 3 (component supplier)—is a complex ecosystem. Even tier 3 suppliers often rely upon a complex network of fourth, fifth, sixth, and even seventh tier suppliers to provide components and software necessary for successful deployment.

A recent study reported that a DoD OEM product produced by only one or two suppliers will have a supply chain of more than 1,000 vendors in successive layers.<sup>4</sup>

Moreover, at the same time products of PRC universities and firms became more integrated and essential for U.S. suppliers, the PRC was also focused on the future of technology development. **Figure E-4** highlights this focus, with the PRC surpassing the United States in patent applications filed for 2023.

<sup>4</sup> M. Kidd, *Social Network Analysis of DoD Supply Chain Vulnerabilities*, *Small Wars Journal*, 04-2019, <https://smallwarsjournal.com/jrnl/art/social-network-analysis-dod-supply-chain-vulnerabilities>.

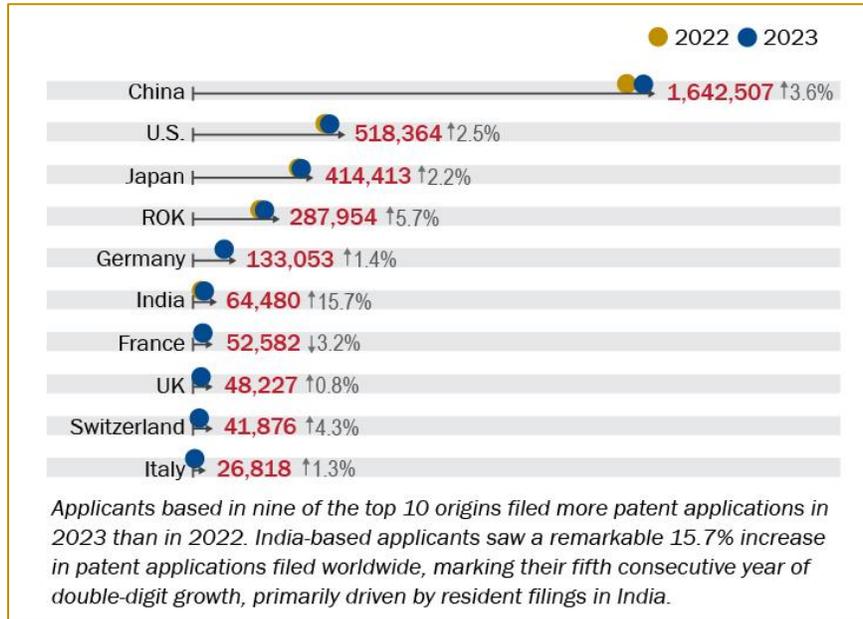


Figure E-4. Top 10 Countries Patent Applications 2023 vs 2022  
 [Adapted from: WIPO statistics Database, August 2024]

The PRC has also weaponized the periodic table of elements, establishing itself as the primary (if not single-source supplier) of nearly 30 critical materials for U.S. combat systems. The recent PRC embargo (issued December 4, 2024) of germanium, gallium, and antimony breaks the supply chain for tens of thousands of parts in U.S. weapon systems. Leveraging advanced commercial-off-the-shelf (COTS) supply chain products and services that use artificial intelligence-enabled advanced analytics would offer advantages in assessing supply chain risk for parts of DoD, the intelligence community, and individual companies. These commercially available systems processes assess hardware and software bill-of-materials, identify adversarial hardware and software suppliers, nominate U.S. and partner nation alternatives, and highlight those remaining vulnerabilities that the scientific community needs to develop alternatives for, such as ammunition that does not require antimony. Unfortunately, the Department is dedicating tremendous resources to develop its own government-controlled tools in programs that will take years to mature, such as efforts under the Assistant Secretary of Defense for Industrial Base Policy and the Chief Digital and Artificial Intelligence Office’s SCREEn initiative. DoD does not have the luxury of taking years to develop tools that will likely be inferior to COTS products currently in use by Fortune 100 companies and the intelligence community, as well as a range of existing DoD agencies and programs.

While the U.S. and allied reliance on components and raw materials is now well recognized, the future of technology development itself is increasingly problematic given the pace and scale of PRC innovation across a broad range of technologies.

The PRC’s practice of conglomerate operation of its major industrial firms has produced a rapid increase in the size of its defense industry.

The PRC’s “military-civil fusion” policy facilitates the exploitation of advanced civil technologies for military applications.<sup>5</sup> As noted previously, this is the reverse of current U.S. practice, which has isolated civil from

<sup>5</sup> Department of State, *Military-Civil Fusion and the People’s Republic of China*, May 2020, <https://www.state.gov/wp-content/uploads/2020/05/What-is-MCF-One-Pager.pdf>.

military technology through legal, regulatory, and procurement restrictions, limiting commingling among sources of advanced technology in defense products and services.

In cases where an adversary holds control or significant influence over the supply of raw materials essential in producing nearly every modern U.S. defense system and subsystem, the supply chain risk is high. This fact was recognized during the first Obama Administration. **Figure E-5** illustrates the sensitivity of many military applications to disruption in the critical raw materials supply chain.

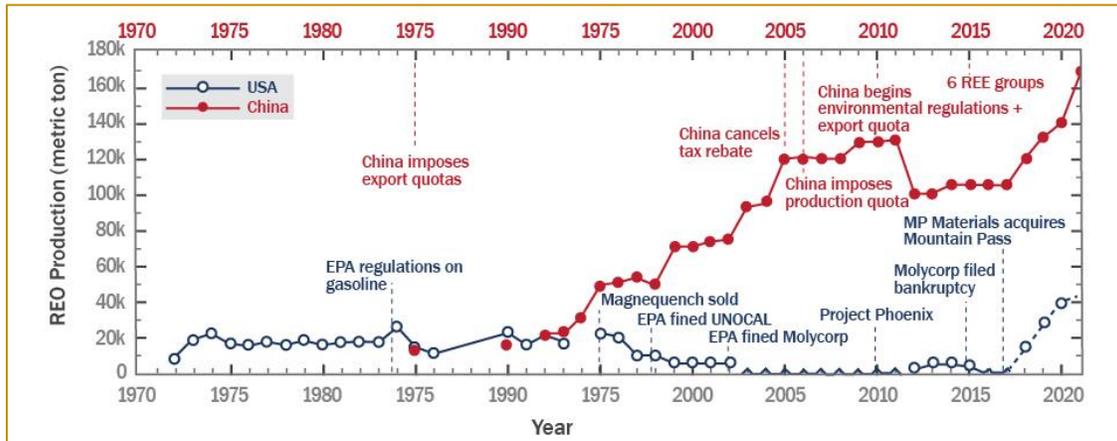


Figure E-5. REO Production

[Adapted from: <https://www.sciencedirect.com/science/article/pii/S030142072300733X>]

While some supply risks can be mitigated at higher cost and by collaboration with U.S. allies and partners, raw material sources and initial processing in many cases are controlled or influenced by adversary states.

More specifically, the PRC controls the world's supply of many critical materials and products, including solar panels, wind turbines, and batteries, with its dominance over the supply of processed rare earth metals being the most visible. While these metals are widely distributed in the earth's crust, mitigating undesirable externalities associated with their processing is costly and environmentally challenging. Enhancing the PRC's advantage even further, rare earth minerals mined in the United States are, for the most part, shipped to China for refining. The cost and administrative difficulties associated with mining and processing these minerals results in a very low level of production in the United States also illustrated in **Figure E-5**.

However, rare earths are not the only dimension of defense-industrial activity where Chinese investment has secured clear advantages. For example, there are no standard U.S. 5-G telecommunications offerings in global markets as the PRC set the international standard. The United States, historically a leader in setting international standards, has simply lost its leadership role. Other such areas include:

- PRC's telecom champion Huawei overwhelmingly controls the largest market share of global data, and has a world-leading 5G telecommunications offering.
- PRC solar panels and batteries dominate world markets, with nearly 90% market share of battery-grade lithium.
- PRC controls or operates major terminals in over 60% of the world's 100 largest ports, and its largest shipping company, the state-owned enterprise Costco, operates ships out of 569 global ports and participates in Chinese People's Liberation Army amphibious operation training exercises using ferries. There is no U.S.-owned global port operator at scale.

- PRC's commercial nuclear offering is among the most advanced in the world according to comments from leading physicists at Idaho National Labs. PRC nuclear capabilities are also enabling an expansion of its nuclear arsenal, which is planned to double from 500 to 1000 warheads by 2030. None of the top five commercial nuclear companies in the world are U.S. owned; yet, winning any global competition for a commercial reactor secures a nearly 40-year strategic partnership with the host country, encompassing fuel supply and technical services. [NOTE: when UAE awarded a 4-reactor program to Republic of Korea or the PRC's seven reactor program for Pakistan, each received a lengthy support agreement.]

The success of this military-civil fusion strategy is evident in the rapid and substantial dual-use growth of leading Chinese defense companies. According to the August 2024 edition of the *Defense News Top 100*, China has five of the world's top twelve defense companies (by defense revenue), while the United States has six. Those six U.S. companies have twice the defense revenues of those five Chinese companies, which should come as no surprise since the purchasing power (PP) multiple is around 2.0, yet those five Chinese companies have nearly 50% more total revenue, without adjusting for PP, than those six U.S. companies (e.g. AVIC 55% larger than The Boeing Company), demonstrating success in the PRC's dual-use approach under military-civil fusion. On a PP-adjusted basis, these Chinese DIB large capitalization companies ("large caps") are at least three times the size of the U.S. large caps and are involved with advanced mobilization plans which are routinely exercised. In addition, Chinese Communist Party (CCP)-controlled financial institutions provide broad financial support to this industrial base through subsidized loans for capital expansion, technology development, and working capital.<sup>6</sup>

The PRC practice of conglomerate operation of its major industrial firms has produced a rapid increase in the size of its defense industry. In 2024, five of the world's top 12 defense firms are now Chinese-owned—Aviation Industry Corporation of China, China State Shipbuilding Corporation Limited, China North Industries Group Corporation Limited, China Electronics Technology Group, and China South Industries Group Corporation. The complexity of modern supply chains and the way they are created for DoD products will be important dimensions of future industrial base challenges.

The PRC has assured its own supply chains in nearly all areas through binding bi-lateral financial agreements with approximately 150 of the world's 190 nations that secure access to global critical materials (e.g., Argentine Lithium coupled with Peru's newly opened deepwater Port of Chancay). The PRC also controls half the world's oil production through its influence over the expanded BRICS and Russia's dominance of OPEC+ policy. Lastly, the PRC has significantly derisked itself from the U.S. dollar, cutting its holdings of U.S. treasuries in half over the last 10 years from \$1.7T in 2014 to less than \$800B today according to U.S. Treasury Department data. Adjusted for inflation, this is a real reduction of more than two-thirds.

DoD's approach to supply chain development is the reverse of typical commercial practices: It funds the development of a defense product or system, tests it extensively, and only then establishes the supply chain. DoD products often are developed with specific acquisition quantities in mind; when the objective is achieved, the production line and its supply chain are shut down, although there are some conspicuous exceptions to this practice (e.g., the Navy's D-5 nuclear-armed submarine-launched ballistic missile). Hence, DoD has encountered problems with mainstream weapon systems such as Stinger and Javelin, and similar problems are being generated with conventional cannon, rocket, and mortar artillery munitions. The

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<sup>6</sup> U.S. Department of State (<https://2017-2021.state.gov/military/civil/fusion>).

extent to which many of these component and subcomponent suppliers rely on Chinese companies can be seen in **Figure E-6**.

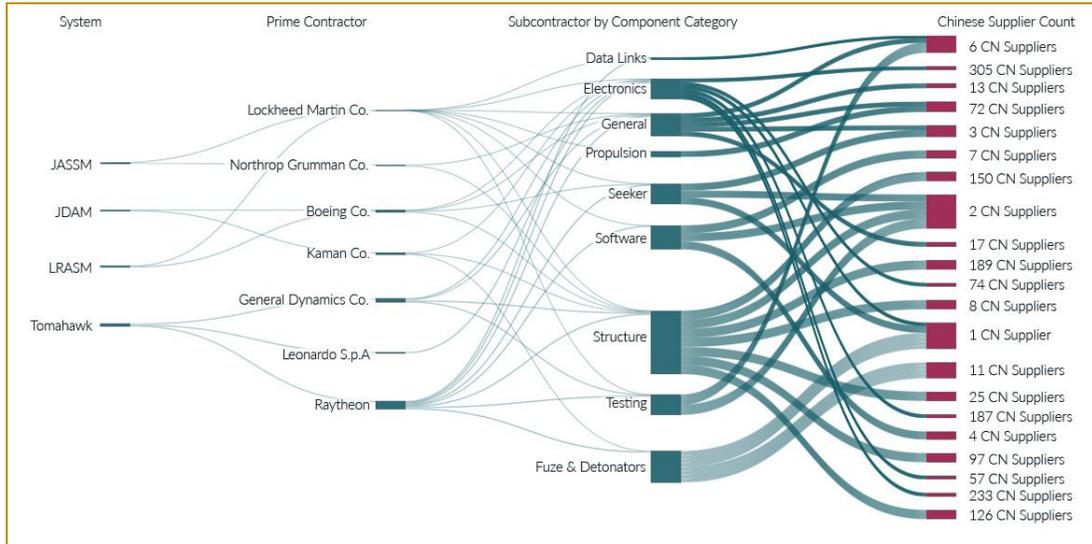


Figure E-6. Chinese Suppliers in U.S. Air-Launched Armament Supply Chains, 2023

[Source: [https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/66104c1d4e3ae7809bcd8082\\_Govini\\_2024\\_Numbers-Matter.pdf](https://cdn.prod.website-files.com/65e61e6392aba0fa1dba723e/66104c1d4e3ae7809bcd8082_Govini_2024_Numbers-Matter.pdf).]

This has been a particular issue with missiles and munitions, which have a history of production lulls and spikes as seen in **Figure E-7**. This leads to inefficiencies and supplier difficulties, becoming starkly apparent in the attempts to scale up production in response to Russia’s invasion of Ukraine. The coupling of uncertain production requirements and often-antiquated facilities that are ill-prepared for any significant surge capability has left the United States struggling to meet emerging and surge requirements at scale.

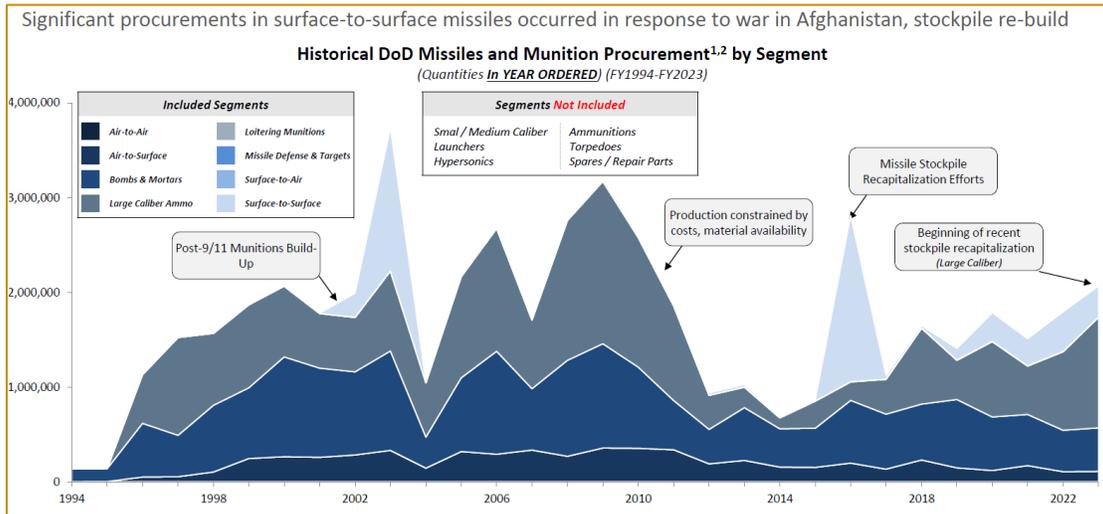


Figure E-7. Wartime and Post-Wartime Recapitalization Efforts Drive Spikes

[Source: Renaissance Strategic Advisors (RSA), November 2024 <https://rsadvisors.com/>]

DoD’s current approach to mitigate these production limitations is described in its February 2022 report, *Securing Defense-Critical Supply Chains: An action plan developed in response to President’ Bidens’ Executive Order 14017*. This report, published prior to the Russian invasion of Ukraine, may not be sufficient to address the complexities of a supply chain that is increasingly populated by non-traditional

defense suppliers and that must account for the prolonged service life of legacy systems. In January 2023 Deborah G. Rosenblum, Performing the Duties of Assistant Secretary of Defense for Industrial Base Policy, wrote in a Defense Acquisition University article that DoD has identified five key sectors and four enablers vital to providing needed capabilities to the warfighter:

- **Kinetic capabilities:** microelectronics, casting and forging, battery and energy storage, and critical and strategic materials.
- **Strategic enablers:** small business, cyber posture, manufacturing, and workforce.<sup>7</sup>

As non-traditional defense and commercial suppliers become more crucial for creating, producing, and sustaining capabilities, DoD's approach to its supply chain requires reconsideration at a fundamental level. Commercial sector supply chain practices adapt the development of a product to optimize its supply chain. Only by doing so can the commercial product developer assure that they will be able to produce at acceptable cost, production schedule, and performance.

## Rethinking Defense Financing for Innovation

These developments may also justify more fundamental and innovative approaches to financial practices sponsoring defense technology, product development, acquisition, and sustainment. Adaptations will also be needed to reflect shorter product cycles driven by rapid changes in technology, acknowledging the decisive role of software in the performance of defense hardware, and a host of related circumstances.

The DoD's Defense Production Act (DPA) Title III authority has been extensively used to finance the expansion of manufacturing capacity in the defense industrial base. More recently, the establishment of the Office of Strategic Capital (December 2022) to facilitate such financing by Federal loan guarantees is promising but still in a nascent state and operating without necessary appropriations.

These, and other specific efforts within the Department, are to be commended. However, they are tactical reactions to a much greater and systemic failure to meet the strategic need to transform into a comprehensive and strategic approach, one with the use of capital to recognize that the overarching processes and culture that successfully navigated the Cold War are no longer sufficient.

Legislation has (re)inserted lease finance as a basis for elements of the U.S. security assistance program. The *Ukraine Democracy Defense Lend-Lease Act of 2022* is a contemporary variant of the Lend-lease Act of 1941. During World War II, this statute enabled the United States to finance its largest arms transfer activity in its history: \$180 billion (FY22 dollars) to the USSR.<sup>8</sup> Through the U.S. capital markets, substantial opportunities exist to finance DoD infrastructure expansion (e.g., shipyards, test ranges, wind tunnels, training ranges). Consideration is being given by the U.S. Space Force to finance its on-orbit services for

<sup>7</sup> Deborah G. Rosenblum, *Progress Report: Securing Defense Critical Supply Chains*, January 1, 2023, *Defense Acquisition University*, <https://www.dau.edu/library/defense-atl/blog/SecuringDefenseCriticalSupplyChains>.

<sup>8</sup> DoD, *Biden signs Lend-Lease Act to Supply More Security Assistance to Ukraine*, May 9, 2022, <https://www.defense.gov/News/News-Stories/Article/Article/3025302/biden-signs-lend-lease-act-to-supply-more-security-assistance-to-ukraine/>. The original *Lend Lease Act of 1941* enabled the large-scale transfer of military equipment to the Former Soviet Union (and other U.S. allies) that supported its participation in World War II following the Nazi occupation of Western Europe, and the abrogation of the Hitler-Stalin Pact (September 1939-June 1941). The *Lend-Lease Act of 1941* did not contain human rights caveats on its implementation; National Archives. **Milestone Documents: The Lend-Lease Act of 1941**, <https://www.archives.gov/milestone-documents/lend-lease-act#:~:text=Passed%20on%20March%2011%2C%201941,defense%20of%20the%20United%20States.%22>.

space platforms as a service rather than a conventional procurement—an approach to finance which may be applicable elsewhere in DoD.<sup>9</sup>

Despite many demands for funding, there is no shortage of available capital in the U.S. private market. Far too much of it remains unobligated and unallocated, as seen in roughly \$3T of private equity dry powder and multiple trillions of dollars available in broadly syndicated bank loan and private credit capacity. The reality is that many classes of national security opportunities do not project an acceptable risk-adjusted return for investment. These financial resources could be made available for national security purposes if a suitable set of incentives were established to lower perceived investment risk, thereby more effectively competing for this capital in well-established American equity markets, which are a source of comparative advantage due to their roughly \$60T in scale with scope, depth, transparency, sophistication, and maturity. Furthermore, DoD should broadly consider the use cases for capital market funding beyond investment in technology development and transition, to also include scaling manufacturing capacity, increasing production output, and revitalizing national security infrastructure that is hampering force readiness (consider drydocks, maintenance facilities, test ranges, wind tunnels, etc.).

### Operating Margins, Stock Buybacks, and Industry Incentives

Defense companies generally have operating margins of 11-13%, considerably less than some leading technology firms where margins tend to be 2-3x greater (see **Figure E-8**).

	Sep-21	Dec-21	Mar-22	Jun-22	Sep-22	Dec-22	Mar-23	Jun-23	Sep-23	Dec-23	Mar-22	Jun-24	Dec-22
Boeing Defense, Space, Sec.	7%	-4%	-17%	1%	-51%	2%	-3%	-9%	-17%	-1%	2%	-15%	-43%
Gd-Defense	12	11	10	11	11	11	10	10	10	10	9	10	10
L3Harris (ex. Aviation)	18	19	16	16	5	15	14	14	15	10	15	15	16
Lockheed Martin	12	12	11	11	12	11	11	11	11	11	10	11	11
Northrop Grumman	12	11	12	12	11	11	11	11	11	-3	11	11	12
RTX (Raytheon)	12	11	11	9	12	10	10	11	9	9	9	2	10

Figure E-8. Operating Margins at Boeing Defense, GD (Defense), LHX, LMT, NOC, and RTX (Raytheon)

[Source: Capital Alpha Partners, Company Earnings Releases, Bloomberg]

Share buybacks by Lockheed Martin, Northrop Grumman, General Dynamics, L3Harris, and RTX totaled some \$1.65 billion in the third quarter of 2024. Lockheed accounted for over half of the total. Buybacks are still elevated relative to pre-pandemic levels and are expected to remain so, with Lockheed announcing another authorization of \$3 billion in early October 2024. From the USG perspective, reinvesting profits back into modernizing infrastructure, driving research and development (R&D), and expanding production is preferable to buybacks. Instead of reinvesting into advanced capabilities and warfighter needs, the leading defense primes prefer to return capital to shareholders, knowing DoD will provide a vast majority of any necessary money to the primes for next-generation systems. Unfortunately, the incentives to do so are absent in an industry where the free market ceases to operate and a small number of players dominate the playing field. As Charlie Munger, one of the most successful investors of our time and Warren Buffet’s partner, noted in his famous Psychology of Human Misjudgment speech at Harvard, “Show me the incentives, and I’ll show you the outcome.”

<sup>9</sup>Mandy Mayfield, *Industry offering On Orbit Satellite Servicing*, *National Defense*, January 29, 2021, <https://www.nationaldefensemagazine.org/articles/2021/1/29/industry-offering-on-orbit-satellite-servicing>.

A range of other financial and contractual tools can be effective in reducing risk and attracting capital, whether from private investors and lenders or the public markets. For example:

- **Allow companies to bill approved independent research and development (IRAD) to the government for reimbursement and open more scientific funding to competition.** In return for this funding, the companies receiving these funds should consolidate and report annually on their use. This has previously been requested of the major companies in the DIB and ensures there is alignment with DoD IRAD funding and industry priorities. The free market works best when companies develop products at the expense of the investor, not the customer. Today, IRAD projects are only reimbursed on cost-type contracts: it is often only the prime contractors on these contracts that have their IRAD expenses reimbursed, while subcontractors across the supply chains are not reimbursed unless their prime contractor includes their IRAD expense in its disclosure schedules. Defense companies are also leery of investing in R&D because a great share of the Department's scientific funding is spent internally through its research and development centers (RDECs), federally funded research and development centers (FFRDCs), and university-affiliated research centers (UARCs), where private industry cannot compete. Consequently, the output of a company's investment in research must often compete with DoD's homegrown solution on a slanted playing field which stifles the case for investment.
- **Remove profit caps on cost-plus contracting and be more flexible on intellectual property ownership and accounting.** Depending on the contract, Section 15.404-4 of the DoD's Acquisition Regulations caps profits at 10% or 15%. While the objective is to ensure fair pricing, its effect is to reduce returns to reinvest in R&D and to disincentivize the expansion of production capacity given the lower rewards even if those investments are successful. Companies should also be confident that they can protect the intellectual property developed through R&D investments even when DoD is coinvesting or providing contract funding. Commercial approaches to usage rights can often be applied, such that the financial upside for companies is not jeopardized. Lastly, DoD should implement commercial approaches to accounting standards for non-traditional companies that provide adequate visibility on costs and pricing while foregoing the extensive resources and time that must be committed to achieve cost accounting standards compliance.
- **Provide contractual support and transparency about market restrictions.** Defense companies are regulated by export control programs at the Departments of Defense, State, and Commerce. Those companies can invest in plant capacity or technology development to produce new or higher volumes of products, hoping to have those products bought by U.S. national security customers, but without contractual commitments, these companies have no assurance that their target USG customers will buy this increased output. Consequently, DoD should provide contingent contracts to purchase output or some form of off-take agreements, should companies successfully complete the desired technology development, production increase, or infrastructure revitalization. USG regulators should be as transparent as possible about a company's ability to sell their product or technology to U.S. commercial or foreign customers since restricted market access increases risk and lowers return on investment.

Collectively, the above approaches will influence the market's perception of risk-adjusted return and attract capital at lower expected rates of return. They will also help companies in the DIB find projects to reinvest their earnings in achieving higher risk-adjusted returns than buying back their stock. Further good news is that many of these financial tools are already widely deployed by the federal government. The Department has employed innovative contracting approaches across some of the Military Services, U.S. Special Operations Command (USSOCOM), and the defense agencies. It also has great experience and intellectual

property on early stage investing through the Defense Innovation Unit (DIU), In-Q-Tel, AFWERX, and other organizations. Lastly, there are organizations like the CHIPS program office under the Department of Commerce and the Export-Import Bank which have well-developed frameworks for direct lending and credit guarantees that are commercially accepted, as well as the Interagency Risk Assessment System to determine the level of reserves for a specific loan guarantee that must be placed with the U.S. Treasury. These tools can be rapidly implemented with the Office of Strategic Capital (OSC) and other DoD program offices.

In short, DoD must compete for the allocation of capital from companies in its current DIB, providing risk-adjusted rates of return for investments in plant capacity, supply chain, technology development, or other areas that are assessed to be roughly comparable to, if not better than, alternative uses of capital. In terms of tools for reducing risk to attract capital market funding, the Department should focus on contractual approaches to provide future revenue that generates acceptable cash flow and profit, as well as methods to assure debt service and principal repayment such as credit guarantees. Private and public companies generally do not need or want equity investments from the USG; those companies will be able to attract far greater levels of private sector funding on a multiple-of-earnings basis from successful execution of defense contracts which provide profitable revenue.

## Appendix F. Historical Dimension of the Industrial Base for National Defense

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**“The farther back you can look, the farther forward you are likely to see.”  
– Sir Winston Churchill**

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Establishing an industrial base that both supports and enables national defense has been an enduring concern throughout U.S. history. The constitutional duty of Congress to “maintain a Navy” and “raise an Army” has underpinned the foundational importance of the nation’s industrial base to respond to national defense contingencies.<sup>1</sup>

The modern concept of the central role of the industrial base for national defense emerged from the inability of the U.S. industrial base to meet mobilization needs for World War I. Congress declared war on Imperial Germany in April 1917, but significant numbers of troops and their equipment did not arrive until October 1917. When the United States entered the war, the Army had only 127,000 troops—a figure that grew to four million by the end of the war.<sup>2</sup> Sustaining this rapid increase in troop strength placed unachievable demands on the defense industrial base.

### Lessons Learned from World War I

United States experience shaped the planning process that preceded World War II. The West Point military historian, BG George A. Lincoln (USA, Ret.) summarized the World War I industrial mobilization experience in a manner that offers some contemporary resonance as well.<sup>3</sup>

1. Such wars require a total economic effort.
2. A war economy requires government control.
3. Careful allocation and adjustment are necessary to prevent shortages of critical items.
4. Economic interdependence with allies is inevitable.
5. The numbers and complexity of modern weapons require long lead time and expensive preparations.
6. Prior provisions of stores are necessary to support combat until new systems can be produced.

### A Summary of Pre-World War II Industrial Mobilization Planning

The historical approach of the U.S. Government (USG) to mobilization is based on the Constitutional obligation imposed on the Federal government; to “provide and maintain a Navy” but to “raise and support armies” (Article 1, Section 8, Clauses 12 and 13). These provisions created a Constitutional imperative as for force and industrial mobilization planning that was deeply embedded in the U.S. military practice prior to World War II. The Constitutional provisions reflected the antipathy toward standing armies arising from

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<sup>1</sup> **U.S. Constitution**, Article I, Section 8, Clause 12 and 13, <https://constitution.congress.gov/browse/article-1/section-8/>.

<sup>2</sup> Library of Congress, **American Expeditionary Forces**, <https://www.loc.gov/collections/stars-and-stripes/articles-and-essays/a-world-at-war/american-expeditionary-forces/>.

<sup>3</sup> Cited in Capt. M. T. England (USAF), **U.S. Industrial Mobilization 1918-1988: An Historical Analysis**, Air University, Air Force Institute of Technology, September 1989, <https://apps.dtic.mil/sti/tr/pdf/ADA214948.pdf>.

U.S. colonial experience while U.S. security aims would more generally achieved by a permanent Navy that could operate against adversaries abroad.

Pre-World War II mobilization was driven by the nation's poor experience with the industrial and force mobilization planning in World War I, where a lack of effective pre-war planning led to chaotic industrial mobilization under the War Industries Board. Delays, supply chain problems, and related issues resulted in a lack of weapons to support Army training needs and its subsequent participation in the conflict. To address these issues, Congress passed the *National Defense Act* in 1920, which gave mobilization planning and execution responsibility to the War Department and empowered the creation of an Assistant Secretary of War with overall responsibility for the function.<sup>4</sup>

U.S. pre-1941 mobilization planning began in 1930 with the publication of the War Department's Industrial Mobilization Plan (IMP). This concept of industrial mobilization anticipated the U.S. approach used during World War II and differs significantly from post-World War II practice.

*Mobilization of industry for military purposes during a national emergency is the operation of adjusting peace time energy and industry to meet the essential requirements of national life and the maximum requirements of military effort, with a minimum disturbance of normal conditions.*<sup>5</sup>

The War Department's implementation of the IMP had fortuitous leadership from the outset in 1930 with primary author Major Dwight D. Eisenhower (U.S. Army), who spent the next 30 months on the effort with strong support from the War Department's military leadership.<sup>6</sup> The IMP was modified several times before the outbreak of war between the U.S. and Axis Powers, but its incorporation into U.S. industrial mobilization was well-planned and executed (although the process has been largely forgotten due to profound changes in the post-World War II industrial, scientific, and security policy environment).

**Figure F-1** illustrates the major milestones on the path to mobilizing for World War II. The development of the IMP and its provisions over time are described in **Figure F-2**.<sup>7</sup>

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<sup>4</sup> Alan Milward, War, *Economy, and Society, 1939-45*, UC Press, 1979.

<sup>5</sup> H. W. Thatcher, *Planning for Industrial Mobilization, 1920-1940*, U.S. Army, 1943, <https://babel.hathitrust.org/cgi/pt?id=uiug.30112106754952&seq=9>.

<sup>6</sup> K. E. Irish, Apt Pupil: *Dwight Eisenhower and the 1930 Industrial Mobilization Plan*, George Fox University, 2006, [https://digitalcommons.georgefox.edu/hist\\_fac/27](https://digitalcommons.georgefox.edu/hist_fac/27).

<sup>7</sup> A.L. Gropman, *Mobilizing US Industry in World War II*, National Defense University, 1996, <https://apps.dtic.mil/sti/tr/pdf/ADA316780.pdf>.

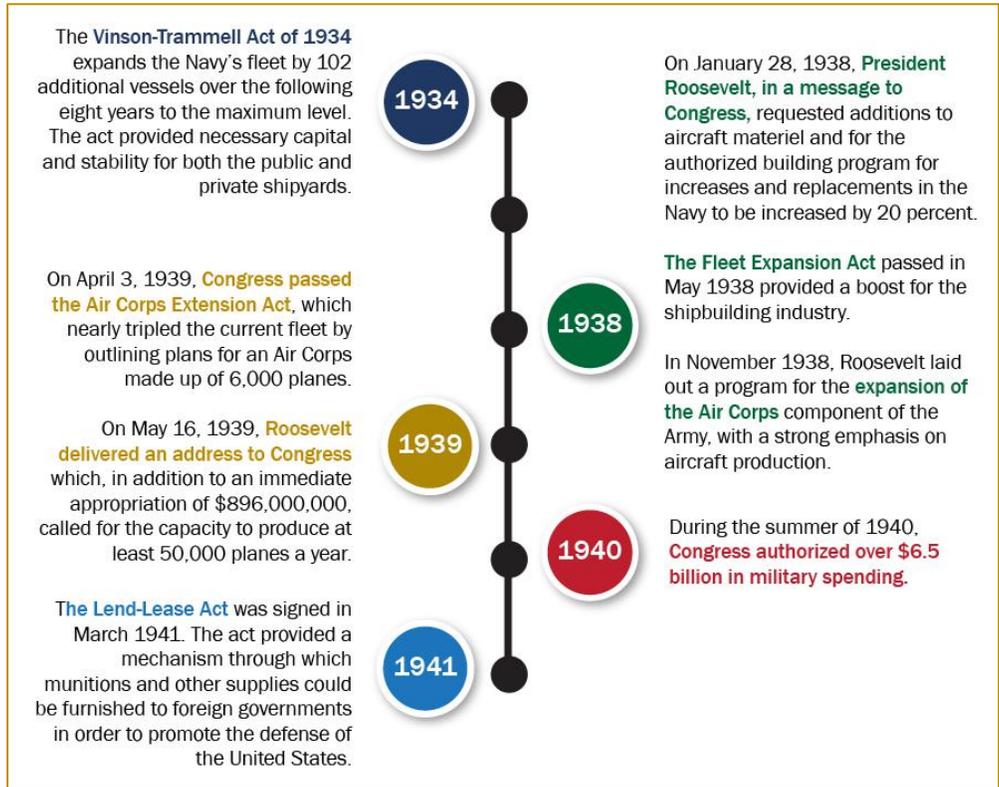


Figure F-1. Major Milestones on the Path to Mobilizing for World War II  
 [Adapted from: <https://dair.nps.edu/bitstream/123456789/4502/1/CSIS-AM-20-163.pdf>]

- **The 1930 Plan**
  - Set forth the general principles which the Assistant Secretary of War would follow in wartime procurement policies.
  - Created plans for prioritization, price controls, commandeering, trade with foreign countries, and government corporation.
  - Proposed a war cabinet to be composed of the Secretaries of Army and Navy, the Chief of Staff, the Chief of Naval Operations and the officials of four superagencies: Director of War Industries, Director of the Selective Service, Director of Public Relations, and Administrator of Labor (the next three plans used the 1930 plan as a model.)
- **The 1933 Plan**
  - Redesignated key superagency the War Industries Administration and centralized internal organization.
  - Provided for a Federal labor organization in wartime which was to be highly centralized.
  - Contained a "legislative appendix" listing seven bills deemed necessary should war break out.
- **The 1936 Plan**
  - Called for War Resources Administration (formerly the War Industries Administration) to be established at outset of war which would assume all functions destined for other superagencies until they could be organized. At the time, the Administration still lacked coordinating control over the other superagencies.
- **The 1939 Plan**
  - Called for an Administrator of War Resources to be at the top of the entire mobilization apparatus.
  - All other agencies formed to mobilize the country's industries were to assist the War Administrator.
  - Published after German invasion of Poland and was not implemented.

Figure F-2. Industrial Mobilization Plan  
 [Adapted from: <https://apps.dtic.mil/sti/tr/pdf/ADA316780.pdf>]

The 1930 IMP was built on a USG-led subordination of the entire economy to the needs of national defense as was recommended following the U.S. defense industrial experience in World War I. The scale of effort required to meet World War II requirements could not have been driven by the incremental measures used to strengthen the defense industrial base since the Korean War. A single metric illustrates the scale of the conversion effort: the industrial impact of the mechanization of U.S. Army forces compared to their circumstances two decades earlier. A World War II division required 400,000 mechanical horsepower compared to only 3,500 in World War I.<sup>8</sup>

The remarkable pace of U.S. industrial mobilization was noted at the December 1943 Tehran Conference of the World War II alliance leadership (including President Roosevelt), which also offers a hint of the role industrial bases can play in establishing deterrence. One of the leading figures in the wartime conference, Josef Stalin, offered his view of the decisive role played by the U.S. industrial base.

*I want to tell you from the Russian point of view what the President and the United States done to win the war. The most important things in this war are machines. The United States has proven that it can turn out from 8,000 to 10,000 airplanes per month. Russian can turn out, at most, 3,000 airplanes a month... The United States, therefore, is a country of machines. Without the use of those machines, through Lend-Lease, we would lose this war.<sup>9</sup>*

The United States produced over 300,000 aircraft during World War II, of which 14,717 were provided to the Former Soviet Union.<sup>10</sup>

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<sup>8</sup> J. L. Abrahamson, *The American Home Front: Revolutionary War, Civil War, World War I and World War II*, National Defense University Press, 1983.

<sup>9</sup> Cited in A. I. Gropman, *Mobilizing U.S. Industry in World War II: Myth and Reality*, McNair Paper 50, August 1996, INSS, National Defense University, ADA316780.pdf (dtic.mil).

<sup>10</sup> A. Herman, *Freedom's Forge: How American Business Produced Victory in World War II*. New York, NY: Random House 2012.

## Appendix G. Financing Module

The consequence of the loss in the U.S. lead for manufacturing capacity and capability in selected areas is that it can no longer rely on the differentiated ability to rapidly mobilize America’s industrial base for national security superiority as it did in World War II. Defense industrial infrastructure is designed to support the sustainment and modernization of DoD’s force structure, but it also must be expansible to address potentially far broader requirements during wartime through established mobilization procedures. Unfortunately, this infrastructure is already stressed by supporting emerging defense modernization needs as industrial capabilities are required to enable new (as well as existing) technologies to expand and sustain U.S. defense capabilities. Furthermore, adequate mobilization plans are neither developed nor exercised.

To assess the scale of defense infrastructure expansion required to support the Industrial Mobilization Plan (IMP) developed from 1930–1940, it is important to understand the scale of infrastructure needed to support a historical “extreme contingency” in World War II in three sectors, shipbuilding, munitions, and aircraft.

The scale of World War II shipbuilding for merchant ships, naval combatant vessels, and small naval and utility vessels is summarized in **Figure G-1**. Producing 2,140 vessels at the time required an infrastructure of 21 shipyards. Today, ten shipyards produce far fewer naval vessels but much larger and more complex vessels.<sup>1</sup> The Navy will have 287 combatant vessels and support ships in 2025 compared to 592 at the end of the Cold War in 1989. The production of naval vessels of all types have declined significantly as firms left the industry. Increasing costs, skill shortages, and a bar-belled industrial structure with huge prime contractors supported by a bunch of small businesses have further limited naval ship construction.

Private-Sector Shipyards that Built Ships for the U.S. Maritime Commission							
	Liberty Ships	Victory Ships	T2 Tankers	Other Oceangoing Ships	Coastal/Other Ship Types		Totals
# of Yards	17	6	4	33	30		59
# of Ships	2,718	550	533	1,216	575		5,602

Private-Sector Shipyards that Built Ships for the U.S. Navy							
	Surface Combatants	Submarines	Large Amphibians	Large Auxiliaries			Totals
# of Yards	21	3	15	6			35
# of Ships	946	133	1,014	47			2,140

Public-Sector Shipyards							
	Surface Combatants	Submarines	Large Amphibians	Large Auxiliaries			Totals
# of Yards	7	3	5	4			8
# of Ships	255	111	85	12			463

Private-Sector Shipyards that Built Small Naval and Military Vessels							
	U.S. Navy Patrol Craft	U.S. Navy Minesweepers	U.S. Navy Landing Craft	U.S Navy Small Auxiliaries	U.S. Coast Guard Vessels	U.S. Army Vessels	Totals
# of Yards	82	66	65	96	17	275	nk
# of Vessels	1,921	882	43,758	793	329	12,310	60,011

Figure G-1. Naval Combatant Vessel Production

[Adapted from: <https://web.archive.org/web/20070611063848/http://coltoncompany.com/shipbldg/ussbldrs/wwii.htm>]

<sup>1</sup> Zhara Ahmed, **10 Major U.S Shipyards Where Ships Are Built**, *Marine Insight*, December 23, 2023; <https://www.marineinsight.com/naval-architecture/major-u-s-shipyards/>

Similarly, munitions production required a vast expansion in infrastructure to meet wartime demands. The Army’s massive construction projects to support production and storage of ammunition during World War II were unprecedented in history and a significant factor in the allies’ victory. Between 1940 and 1943, 77 industrial facilities and 30 depots were established.

Some Army ammunition plants became operational within six months of construction to ensure military forces had what they needed to win the war. The environmental regulations that ostensibly preclude operating such a capability today did not exist. By 1945, Army ammunition facilities had produced 11 million tons of artillery ammunition, more than 475,000 tons of mortar ammunition, 6 million tons of bombs and rockets, and 39 billion rounds of small arms ammunition.<sup>2</sup> The infrastructure to support this vast production of munitions required 84 manufacturing plants. Based on the IMP, half began construction before December 1941.<sup>3</sup>

No other dimension of the defense industrial infrastructure in World War II illustrated the national capability to make necessary resource and capability compromises to achieve maximum production than the creation of the industrial base for military aircraft. Unlike shipbuilding and munitions manufacturing, the aircraft and engine manufacturing infrastructure was immature, as the industry was in the early years of its commercial development. **Figure G-2** summarizes the production of 303,221 aircraft, and 812,614 aircraft engines in 46 manufacturing facilities from 1940-1945. **Figure G-3**<sup>4</sup> illustrates tank and aircraft production of the major combatants in World War II.

Year	1940	1941	1942	1943	1944	1945	Total
U.S. Aircraft Production	6,019	19,433	47,836	85,898	96,318	47,474	303,221
U.S. Engine Production	22,667	58,181	138,089	227,116	256,911	109,650	812,614

Figure G-2. World War II Industrial Production—Aircraft and Engines 1940–1945

[Adapted from: <https://www.warbirdsandairshows.com/Aircraft%20manufacturing/aircraftmanufacturewwii.htm>]

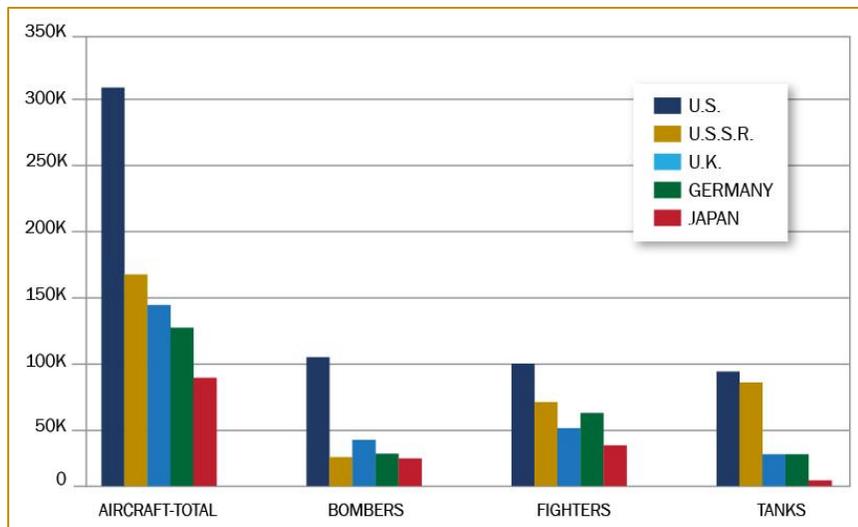


Figure G-3. Tank and Aircraft Production – World War II

[Adapted from: <https://apps.dtic.mil/sti/tr/pdf/ADA316780.pdf>]

<sup>2</sup> Kropp C., *Army ammunition plants continue serving nation*, September 16, 2020, [https://www.army.mil/article/239085/army\\_ammunition\\_plants\\_continue\\_serving\\_nation](https://www.army.mil/article/239085/army_ammunition_plants_continue_serving_nation).

<sup>3</sup> U.S. Army, *Joint Munitions Command: A Concise History*, <https://www.jmc.army.mil/Historian/JMCHistory.aspx>.

<sup>4</sup> A.L. Gropman, *Mobilizing US Industry in World War II*, National Defense University, 1996, <https://apps.dtic.mil/sti/tr/pdf/ADA316780.pdf>.

To be clear, these World War II combat platforms were much simpler in design architecture and did not have the advanced electronics or software commonly used today, but the output dwarfs what the modern defense industrial base can produce. The nature of requirements for modern military forces to confront adversaries in extreme contingencies differ significantly from U.S. experiences eight decades ago due to stark changes in both technologies and the global scale of the industrial sources of enabling technologies for modern warfare. The industrial infrastructure needed to support today's small military force (3.5% of GDP in FY 24) compared to the World War II requirements are much reduced from experiences then (~ 40% of GDP in 1945).

The restructuring of the defense industry after the 1993 *Last Supper* led to a steep decline in the number of commercial firms serving the DoD and other markets. In turn, the shrinkage in the number of commercial participants in the supply chain led to fewer competitors and higher costs to DoD.

### Why is DoD Infrastructure Inadequate for Current and Anticipated Needs?

A less well-known initiative undertaken following the restructuring of the defense industry in 1993 was the decision led by then Secretary of Defense, Les Aspin to significantly reduce defense industrial infrastructure. Secretary Aspin led the initiative following publication of the *Bottom-Up-Review* in October 1993,<sup>5</sup> which offered a description of the international security environment that was widely accepted at the time.

*[The] dramatic changes in the international security environment have fundamentally altered America's security needs.*

The Secretary noted that 57% of the Fiscal Year (FY) 94 DoD budget (\$264B) was associated with logistics and logistics support functions and that infrastructure costs are sensitive to changes in overall force structure. Hence, reductions in defense industrial infrastructure were aligned with post-Cold War plans to significantly reduce the number of U.S. military forces and capabilities.<sup>6</sup>

As the international security environment justified significant reductions in the U.S. force structure, it is not surprising that the DoD support infrastructure depicted in **Figure G-4** was similarly reduced. The force structure of the three Military Services was reduced by ~25% following the 1993 restructuring, and with it the infrastructure that supported the Cold War force similarly reduced.

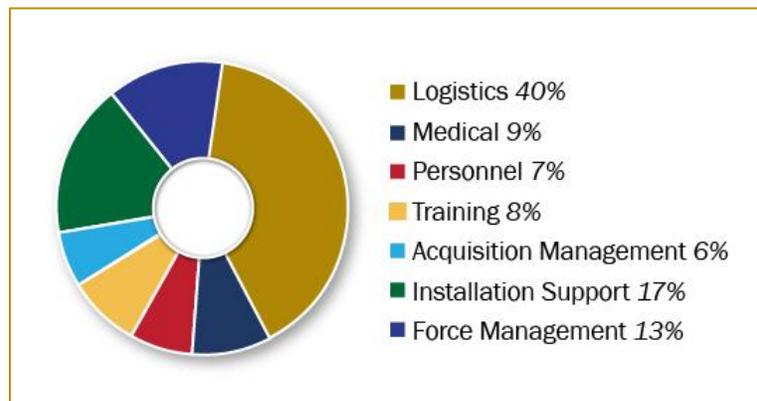


Figure G-4. Infrastructure Categories (As Percentage of \$160 Billion in FY 1994 Budget)

*[Adapted from: [https://history.defense.gov/Portals/70/Documents/dod\\_reforms/Bottom-upReview.pdf](https://history.defense.gov/Portals/70/Documents/dod_reforms/Bottom-upReview.pdf)]*

<sup>5</sup> Les Aspin, Secretary of Defense, *Report on the Bottom-Up-Review*, Department of Defense, October 1993, [https://history.defense.gov/Portals/70/Documents/dod\\_reforms/Bottom-upReview.pdf](https://history.defense.gov/Portals/70/Documents/dod_reforms/Bottom-upReview.pdf).

<sup>6</sup> John T. Correll, *The Legacy of the Bottom-Up-Review*, *Air and Space Forces*, October 1, 2003, <https://www.airandspaceforces.com/article/1003bur/>.

Recent experience with the reduction in DoD’s industrial base for munitions production illustrates the consequences of this drawdown.<sup>7</sup> At the Cold War zenith, DoD had two arsenals and 28 ammunition plants of which 16 were active. Only six core government-owned production facilities are now in operation with an additional four being retained for specific mission work. The number of commercial munitions production facilities has shrunk as well—in 1993 the number had dwindled to 150 facilities from 286 at the Cold War peak, and today there are only 52 commercially owned facilities. In addition to decreased scale, today’s ammunition industrial base has significant supply chain risk, relying on critical materials provided by adversarial sources with no path for obtaining environmental permits to build and operate the processing facilities needed to displace those Chinese suppliers. The current government-owned facilities are displayed in **Figure G-5**.

JMC 2010 Key Facility	Function	Core Facility	Active Facility	BRAC Closure in Progress	Construction in Progress
Scranton AAP, PA Quad City Cartridge Case Facility, IL	Metal Parts	█	█		█
Iowa AAP, IA Milan AAP, TN	Load Assembly & Pack	█	█		
Crane AAA, IN McAlester AAP, OK Pine Bluff Arsenal, AR	Specified Mission Facilities	█	█		
Radford AAP, VA Holston AAP, TN	Propellants & Explosives	█	█		
Lake City AAP, MO	Small Arms Ammo	█	█		
Letterkenny MC, PA Anniston MC, AL Red River MC, TX	Munitions Centers			█	
Blue Grass Army Depot, KY Hawthorne Army Depot, NV Tooele Army Depot, UT	Depots	█	█		
Defense Ammunition Center, OK	Ammo Knowledge & Logistics Support	█	█		

Figure G-5. 2010 Government-Owned Ammunition Industrial Base

[Adapted from: <https://www.jmc.army.mil/Docs/History/Ammunition%20Industrial%20Base%20v2%20-%202010%20update.pdf>]

Similarly, the industrial base for naval shipbuilding suffered a steep decline when the Navy fleet decreased from nearly 600 ships at the end of the Cold War to less than 300 in 2024. The decline in the shipbuilding infrastructure in turn was quickly reflected in the reduction in keel-laying after 1993 as summarized in **Figure G-6**. The Navy is now struggling to recover.<sup>8</sup>

<sup>7</sup> Joint Munitions Command, *History of the Army Ammunition Base*, 2010, <https://www.jmc.army.mil/Docs/History/Ammunition%20Industrial%20Base%20v2%20-%202010%20update.pdf>; LTC Moses Whitehurst, Jr., U.S. Army War College, *The Munitions Industrial Base, Past Present and Future*, 1997, <https://apps.dtic.mil/sti/tr/pdf/ADA326948.pdf>

<sup>8</sup> GAO, *Naval Shipyards: Ongoing Challenges Could Jeopardize Navy's Ability to Improve Shipyards*, GAO-22010599, May 10, 2022, <https://www.gao.gov/products/gao-22-105993>; Heberto Limas-Villers, *Improving the Shipbuilding Industrial Base*, *National Defense*, January 21, 2022, <https://www.nationaldefensemagazine.org/articles/2022/1/21/improving-the-shipbuilding-industrial-base>.

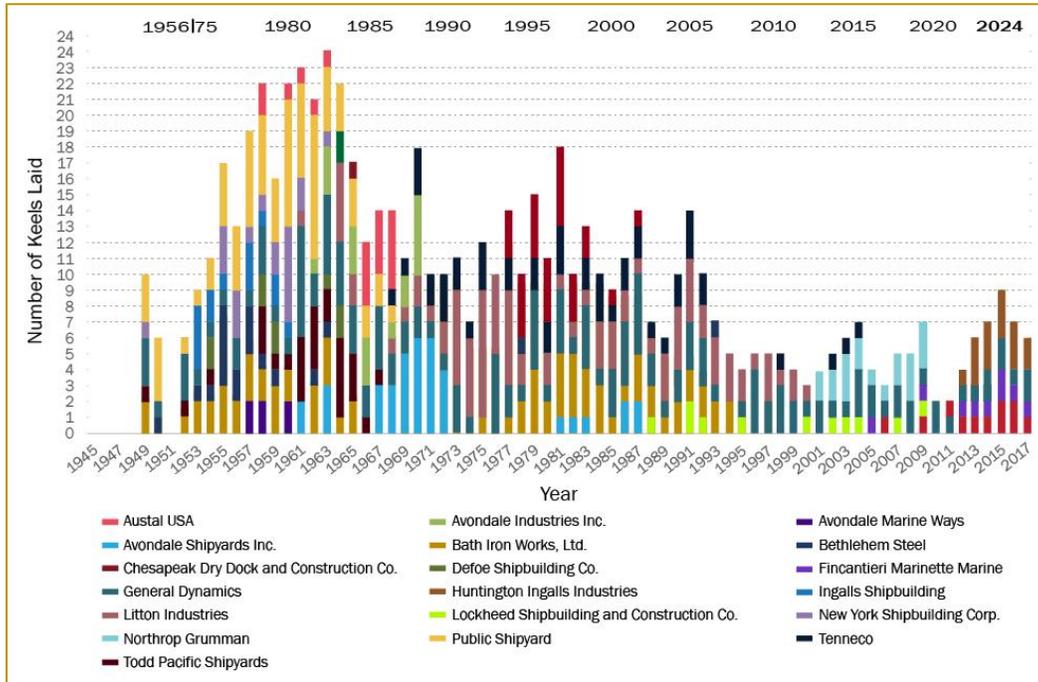


Figure G-6. Naval Keels Laid, 1949-2017  
 [Adapted from: <https://apps.dtic.mil/sti/pdfs/AD1114276.pdf>]

The PRC’s aggressive modernization of its shipbuilding infrastructure, both commercial and naval, is likely to have an adverse effect on the capacity of the U.S. Navy to project power abroad in the near future. “China’s shipbuilding capacity is 232 times greater than the United States. For every 359 large container ships China builds, we are building one.”<sup>9</sup> The PLA Navy’s number of combatant vessels exceeded those of the U.S. Navy in 2022. This surge in naval ship construction first exceeded that of the U.S. Navy in 2000, and the PLA Navy is also leveraging its larger ships to deploy more vertical launch cells than the U.S. by 2027 as seen in Figure G-7.

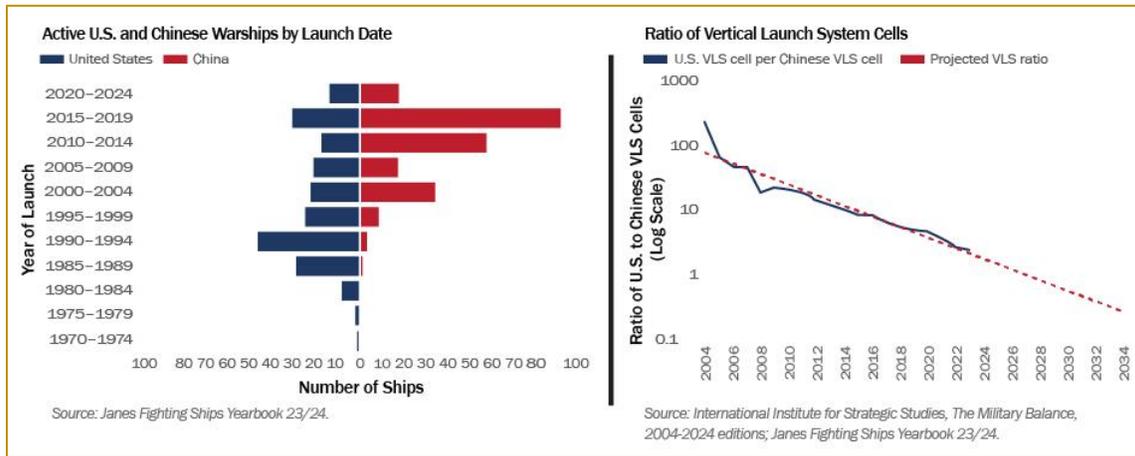


Figure G-7. Comparative Naval Production and Launch  
 [Adapted from: <https://www.csis.org/analysis/unpacking-chinas-naval-buildup>]

<sup>9</sup> [from Selwyn Parker, the interpreter, 10/11/24, quote from House Select Committee on CCP Ranking Member Krishnamoorthi.]

Data concerning munitions production and shipbuilding only captures two dimensions of the larger issue of rebuilding the U.S. defense industrial base.

U.S. collaboration with the industrial base of allied and partner nations as part of a broad NSIB will be essential to meet both current needs as well as enabling it to serve as both a deterrent, and a hedge against future contingencies.

**Figure G-8** summarizes the major segments of the U.S. National Security Industrial Base (NSIB). These segments in turn have sub-segments, many of which have multiple commercial producer and development infrastructures that can be accessed for defense applications, particularly in extreme contingencies where production will need to be scaled up significantly involving both indigenous, allies and partners, and repurposed facilities to meet national security needs.

Segments	Sub-Segments	Segments	Sub-Segments
Missile	<ul style="list-style-type: none"> <li>▪ Tactical Missile</li> <li>▪ Torpedo</li> <li>▪ Strategic Missile</li> </ul>	Ammunition	<ul style="list-style-type: none"> <li>▪ Bombs and Warheads</li> <li>▪ Cartridges and Fuses</li> <li>▪ Explosives</li> </ul>
Aircraft	<ul style="list-style-type: none"> <li>▪ Fixed Wing</li> <li>▪ Helicopter</li> <li>▪ Unmanned Aerial Vehicle</li> </ul>	Weapons	<ul style="list-style-type: none"> <li>▪ Small</li> <li>▪ Medium</li> <li>▪ Large</li> </ul>
Troop Support	<ul style="list-style-type: none"> <li>▪ Soldier Systems</li> <li>▪ Clothing and Textile</li> <li>▪ Subsistence/Medical</li> <li>▪ Smoke Obscurant</li> <li>▪ Nuclear, Biological, Chemical Systems</li> <li>▪ Launch Vehicle</li> <li>▪ Satellite</li> </ul>	Information Technology	<ul style="list-style-type: none"> <li>▪ Command, Control, Computers, and Intelligence</li> <li>▪ Information Security</li> <li>▪ Trainers and Simulators</li> <li>▪ Computer Peripherals</li> </ul>
Space	<ul style="list-style-type: none"> <li>▪ Launch Vehicle</li> <li>▪ Satellite</li> </ul>	Shipbuilding	<ul style="list-style-type: none"> <li>▪ Surface Ship</li> <li>▪ Subsurface</li> </ul>
Combat Vehicle	<ul style="list-style-type: none"> <li>▪ Tracked Vehicle</li> <li>▪ Tactical Vehicle</li> </ul>	Electronics	<ul style="list-style-type: none"> <li>▪ Electronic Warfare</li> <li>▪ Sonar</li> <li>▪ Radar</li> </ul>

Figure G-8. Major Segments of the U.S. NSIB

[Adapted from: <https://www.dhs.gov/xlibrary/assets/nipp-ssp-defense-industrial-base.pdf>]

## Financing the Expansion of the Defense Industrial Infrastructure in the United States

Establishing defense industrial infrastructure capable enough to be an effective deterrent in concert with U.S. allies and partners is unaffordable using conventional government finance based on annual appropriations. The cumulative effect of underinvestment in defense, particularly since the end of the Cold War has created a vast need to modernize the existing defense infrastructure. The scale of this issue has become more widely recognized, driving potential solutions. For example, the Atlantic Council, working with J P Morgan Chase Bank, has created a proposal for a multilateral lending institution (MLI), the *Defense, Security, and Resilience bank*.<sup>10</sup> More than 40 such MLI institutions have been created for a variety of

<sup>10</sup> Rob Murray, *How a new global defense bank—the ‘Defense, Security, and Resilience Bank’—can solve US and allied funding problems*, Atlantic Council, December 13, 2024, <https://www.atlanticcouncil.org/in-depth-research-reports/report/how-a-new-global-defense-bank-can-solve-us-and-allied-funding-problems/>.

international finance purposes, such as the U.S. Export-Import Bank, the Department of Energy Loan Program Office, and the Department of Commerce CHIPS Program Office, which have developed an effective set of commercially accepted loan and loan guarantee instruments.

European institutions have also proposed multilateral financing approaches. The European Investment Fund has proposed a €175 Defense Equity Fund which will mobilize an additional €500 million in support from European companies.<sup>11</sup>

The United States already has effective institutional alternatives to fund both defense infrastructure investment (e.g., industrial facilities, test ranges, wind tunnels, etc.) and the funding of maturation of innovative defense technology.

**Infrastructure Funding:** Defense infrastructure can be funded by leveraging a strength of the U.S. economy, its private capital markets. The U.S. private capital market is the largest in the world, with the U.S. equity and debt capital markets valued at \$120 trillion.<sup>12</sup> The U.S. capital market is 42% of the world’s total equity market of \$115 trillion, and ~40% of the world’s fixed income market of \$140 trillion. This share is contextualized within **Figure G-9**.

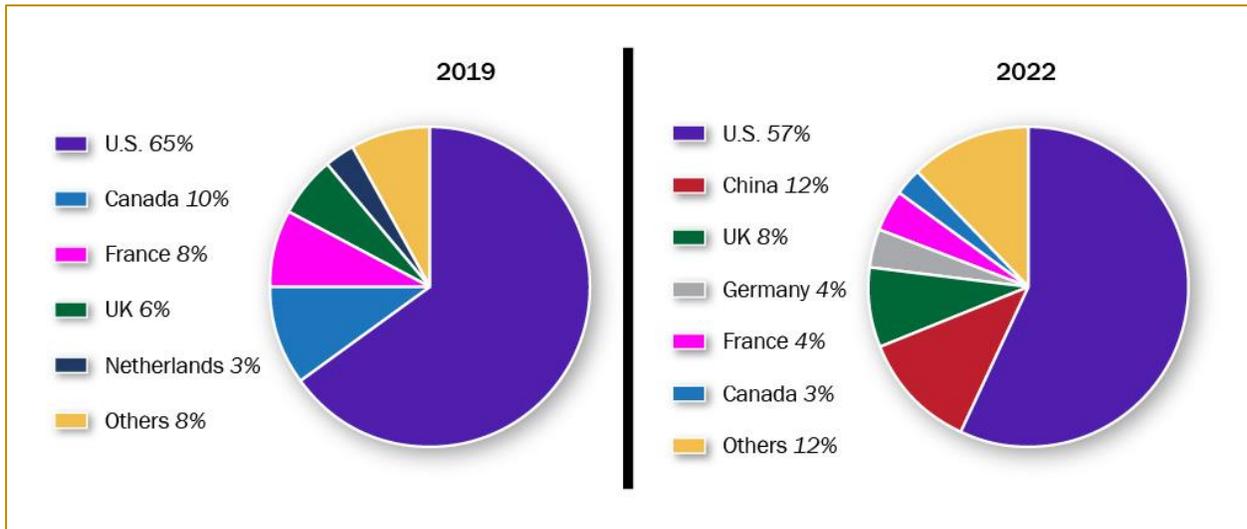


Figure G-9. Global Equity Market Capitalization/Global Fixed-Income Outstanding  
 [Adapted from: <https://www.sifma.org/wp-content/uploads/2023/07/2024-SIFMA-Capital-Markets-Factbook.pdf>]

Utilizing the capital markets to fund infrastructure has some constructive properties—i.e., accelerating the availability of defense industrial infrastructure as an enabling element of mobilization while reducing the cost of doing so by delivering the capability more rapidly than is possible from the current planning baseline. These financial instruments also support the dynamic draw of capital, so funding is only used when needed which lowers the carrying cost of a project. Doing so would also prepare the U.S. defense industrial infrastructure for possible mobilization contingencies years earlier than would be the case under current plans.

<sup>11</sup> European Investment Fund, *The European Commission and the European Investment Fund joint forces to boost investment in defense innovation through the Defence Equity Facility*, January 12, 2024.

<sup>12</sup> Gary Gensler, Chairman Securities and Exchange Commission, *Capital Markets, Competition, and the SEC*, December 5, 2024; <https://www.sec.gov/newsroom/speeches-statements/gensler-remarks-american-bar-association-120524>

- DoD defense industrial infrastructure (shipyards, test ranges, wind tunnels, etc.) are enablers of rapid mobilization as they support integration of advanced technologies into the Joint Force, but these were sharply reduced after the end of the Cold War.
- Eliminating significant portions of defense industrial infrastructure following the end of the Cold War has left the United States with a significant shortfall in the infrastructure needed to support future mobilization contingencies, especially in the case of multi-nation adversary coalitions.
- Current practice in recapitalizing defense industrial infrastructure spans extended periods of time. For example, U.S. naval shipyards are grossly inadequate to meet current needs and “given current shipyard capacity, the Navy is estimated to be 20 years behind in maintenance work.” Viable ships are being decommissioned because of the inability to maintain, overhaul, modernize, or complete service life extensions.<sup>[4]</sup>
- Under the Navy’s 2025 shipbuilding plan, \$40 billion per year will need to be appropriated annually over 30 years to implement the plan.<sup>13</sup>
- The Government Accountability Office (GAO) has assessed that the Navy’s Shipyard Infrastructure Optimization Plan (SIOP) will cost significantly more than the \$21B estimate reported to Congress in 2018 and will take significantly longer than 20 years to complete. Meanwhile, approximately 40% of the Navy’s submarine fleet is sidelined for maintenance, representing almost \$100B in assets at rest.

The long-term nature of DoD infrastructure is well aligned with the approach taken by capital markets which align long-term user needs with long-term financing aspirations.

There are some encouraging DoD infrastructure projects that have leveraged capital markets in addition to years of variations on enhanced use leases driving private sector investment for energy and other base support functions. In particular, the Navy’s Strategic Submarine Program Office partnered through one of its key suppliers, Austal, to provide roughly \$150M in collaboration with private sector investors to form the United Submarine Alliance Qualified Opportunity Fund and purchase Mobile Naval Yard, providing a 355 acre site that can be used for additional submarine fabrication capacity. This financing structure enabled the Navy to take advantage of opportunity zone tax incentives provided under the 2017 Tax Cuts and Jobs Act, which lowers the investment hurdle rate for this project. The goal of this investment is to develop 75% of the site to support submarine production and workforce training, creating approximately 3,000 jobs.

Another example relates to the Army’s rapid construction of a new ammunition plant in Mesquite, Texas, using over \$1B in appropriated funds in collaboration with General Dynamics to rapidly construct and equip a greenfield manufacturing plant that will achieve first article test in less than 18 months, far faster than incremental military construction (MILCON) design-build processes can support. Furthermore, the Army is now investigating approaches to leverage the capital markets through private investors to build out needed infrastructure around the Mesquite plant to support the growing local community of workers and their families as well as other business interests across the ammunition supply chain.

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<sup>[4]</sup> Maj. J. L. Seavy, *The United States Must Improve Its Shipbuilding Capacity*, U.S. Naval Institute, Proceedings, February 2024; <https://www.usni.org/magazines/proceedings/2024/february/united-states-must-improve-its-shipbuilding-capacity#:~:text=Currently%2C%20the%20United%20States%20and,insignificant%20capacity%20at%200.13%20percent>.  
<sup>13</sup> CBO, *Analysis of the Navy’s 2025 Shipbuilding Plan*, January 2025; <https://www.cbo.gov/publication/61155>

Financing for the maturation of advanced technology for the defense market. There has been growing interest in the funding of advanced technology for defense applications, as much of the technology is likely to have multiple civil and military applications (as seen in **Figure G-10**).

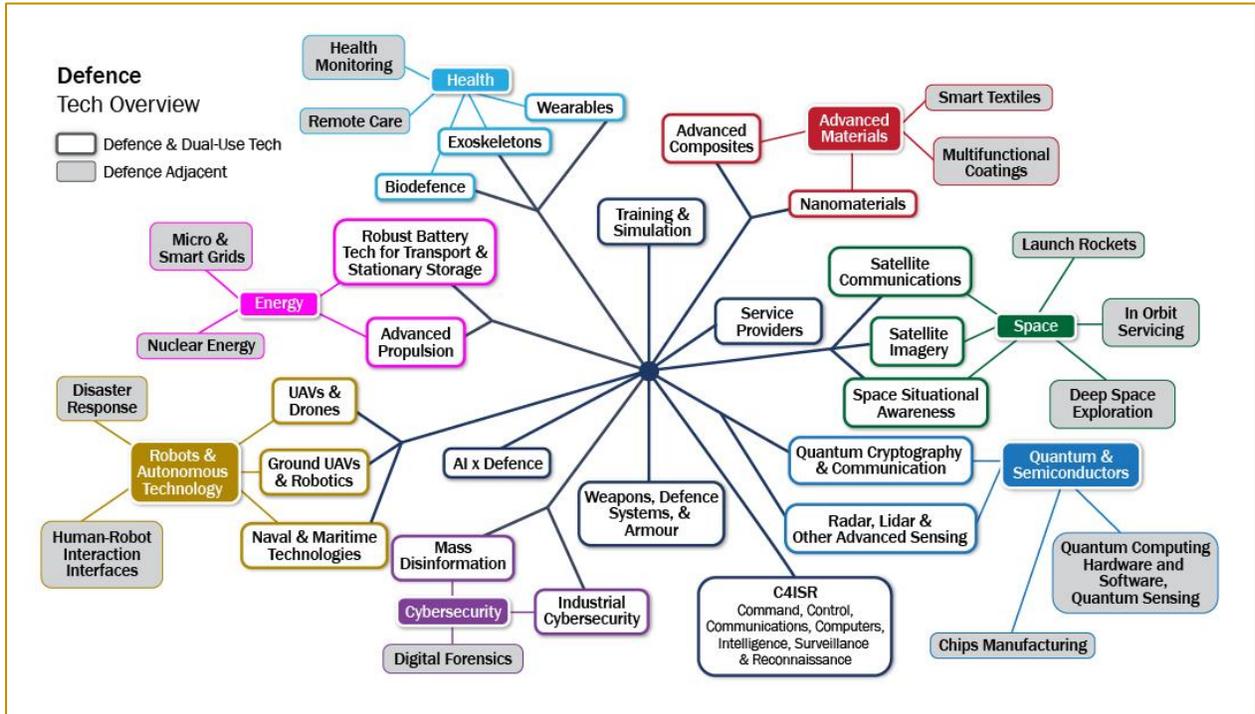


Figure G-10. Advanced Technology for Defense

[Adapted from: [https://dealroom.co/uploaded/2024/09/Dealroom\\_Resilience-Conference\\_Defence\\_Tech\\_Report-1727378277.pdf?x30228](https://dealroom.co/uploaded/2024/09/Dealroom_Resilience-Conference_Defence_Tech_Report-1727378277.pdf?x30228)]

However, DoD processes to convert demonstrated advanced technologies for military use are complex and time-consuming. A requirement must be established and funded through appropriated processes by the user service, which takes two years at minimum—far less agility than is needed to effectively innovate. Moreover, a host of associated requirements must be addressed and funded such as user training, maintenance and support, and other cost-imposing activities before the technology can be used.

DoD has initiated a process to use its authority to finance defense technology projects through Federal loan guarantees in addition to a range of other program funding, equity investment, and credit tools. This initiative was established in 2022 and is managed by the *Office of Strategic Capital (OSC)*.<sup>14</sup> The OSC creates a path to mature promising technology by permitting the user services to decide in funding the completion of the development in collaboration with its defense contractor base and technology innovators. Notwithstanding, DoD must recognize that it is competing with private markets for the allocation of capital on a risk-adjusted return basis. It has many approaches to lower the risk of capital market funding, which include contingent contractual commitments, co-investment, and parallel project funding, among others; thereby reducing the risk-adjusted return requirement.

<sup>14</sup> DoD, *DoD Announces Release of FY24 Investment Strategy for the Office of Strategic Capital*, March 8, 2024, <https://www.defense.gov/News/Releases/Release/Article/3700624/dod-announces-release-of-fy24-investment-strategy-for-the-office-of-strategic-c/s>.

## Appendix H. Briefings Received

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### Meeting 1 (25-26 September 2023)

SME Panel on Contested Logistics  
*OUSD(A&S)*

Surge Capacity Brief  
*(ODASD(MR))/(OASD(S))/OUSD(A&S)*

Discussion with Hon. Christopher J. Lowman, Assistant Secretary of Defense for Sustainment  
*ASD(S)*

Discussion with Joint Production Accelerator Cell (JPAC)  
*JPAC, OUSD(A&S)*

Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)) Perspective  
*USD(A&S)*

Defense Pricing and Contracting (DPC)  
*Principal Director, DPC, OUSD(A&S)*

Defense Contract Management Agency (DCMA) Perspective  
*DCMA*

ASD for Industrial Base Policy (ASD(IBP)) Opening Remarks and Overview of National Defense Industrial Strategy  
*ASD(IBP), OUSD(A&S)*

Industrial Base Resilience Overview: Analysis, Investment Roadmaps, DO/DX as a Tool  
*DASD(BR), OUSD(A&S), Director (PA&T), OUSD(A&S)*

DoD-Industry Engagement, Allies and Partners Engagements  
DASD for industrial Base Development & International Engagement

Economic Security Overview  
*Director of Global Investment and Economic Security (GIES), OUSD(A&S)*

### Meeting 2 (30-31 October 2023)

Discussion on Private Equity and Venture Capital  
*Task Force Member, Carlyle Group*

Creating Helpful Incentives to Produce Semiconductors (CHIPS) Act  
*CHIPS Program Office, U.S. Department of Commerce (DOC)*

Microelectronics from the Defense Industrial Base (DIB) and Supply Chain Perspective  
*Principal Director, Microelectronics, OUSD(R&E)*

DOC Perspective on the DIB  
*Under Secretary of Commerce for Industry and Security, DOC*

Export-Import Bank of the United States  
*China and Transformational Exports Program (CTEP), Export-Import Bank of the United States*

Office of Strategic Capital

*Deputy Chief Investment Officer, Office of Strategic Capital (OSC), USD(R&E)*

### Meeting 3 (15 November 2023)

Overview of the DoD Replicator Program  
*Deputy Director, Strategy, Policy & National Security Partnerships, Defense Innovation Unit (DIU)*

Munitions and OPLAN Discussion  
*OSD(A&S), Joint Staff, USINDOPACOM*

Advanced Capabilities in Conflict  
*PTDO The Assistant Secretary of Defense for Mission Capabilities, OUSD(R&E)*

### Meeting 4 (21 December 2023)

China Aerospace Industries Studies Institute  
*Director, China Aerospace Studies Institute*

In-Q-Tel Thesis Discussion  
*Vice President of Corporate Development, Headspace*

### Meeting 5 (24-25 January 2024)

DSB Digital Engineering Study—Application to Industrial Base  
*DE Task Force Co-Chairs*

DSB Test and Evaluation Study—Application to Industrial Base  
*T&E Task Force Co-Chair*

Industrial Base Policy Strategy Implementation  
*OASD for Industrial Policy, OUSD(A&S)*

DSB Space Study—Application to Industrial Base  
*DSB Commercial Space Task Force Co-Chair*

U.S. Department of State (DOS) Perspective on the Defense Industrial Base  
*Office of Regional Security and Arms Transfers, Bureau of Political-Military Affairs, DOS*

### Meeting 6 (20-21 February 2024)

Discussion with Program Executive Officers (PEOs)  
*Hypersonics, Directed Energy, Space and Rapid Acquisition, Office of the Secretary of the Army Acquisition, Logistics and Technology (AL&T), PEO—JPEO, Picatinny Arsenal*

Cooperative-Development/Production Discussion  
*Defense Acquisition University (DAU) and DSCU*

**Meeting 7 (19 March 2024)**

Discussion with General Motors Defense  
*GM Defense*

National Defense Industrial Association (NDIA)  
*NDIA*

Professional Services Council (PSC)  
*PSC*

**Meeting 8 (16-17 April 2024)**

Cypress International  
*VP Combat Vehicles, Soldier Systems, and Armaments, Cypress International*

Discussion with Forterra  
*CEO Forterra*

Ginkgo Bioworks  
*General Manager and Senior Director of Biosecurity, Ginkgo Bioworks*

**Meeting 9 (14-15 May 2024)**

MITRE Battery Brief  
*MITRE Labs Emerging Technologies Innovation Center*

**Meeting 10 (18 June 2024)**

Defense Logistics Agency (DLA) Discussion  
*Defense Logistics Agency*

Office of Small Business Programs Discussion  
*Director of the Office of Small Business Programs, OUSD(A&S)*

International Stability Operations Association  
*Multiple ISOA representatives*

Allied Industrial Base Concept Discussion  
*Air and Missile Defense Systems Senior Manager, Raytheon Missile Systems*

**Meeting 11 (16-17 July 2024)**

Discussion with Exiger  
*Exiger*

**Meeting 12 (13-14 August 2024)**

China Brief  
*China Mission Center*

## Appendix I. Acronym List

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ADFO	Alternate Designated Federal Officer
AI	artificial intelligence
ALT	Acquisition, Logistics and Technology
ASD(IBP)	Assistant Secretary of Defense for Industrial Base Policy
CEO	Chief Executive Officer
CCMDs	Combatant Commands
CCP	Chinese Communist Party
CIA	Central Intelligence Agency
COTS	commercial off-the-shelf
C-sUAS	countering small uncrewed aerial systems
DASD	Deputy Assistant Secretary of Defense
DAU	Defense Acquisition University
DCC	Direct Commercial Contracts
DCMA	Defense Contract Management Agency
DCS	Direct Commercial Sales
DE	Digital Engineering
DPA	Defense Production Act
DFO	Designated Federal Officer
DIB	Defense Industrial Base
DIBC	Defense Industrial Base Consortium
DIU	Defense Innovation Unit
DIUx	Defense Innovation Unit Experimental
DLA	Defense Logistics Agency
DOC	Department of Commerce
DoD	Department of Defense
DOS	Department of State
DPAP	Defense Production Action Plan
DPC	Defense Pricing and Contracting
DPRK	Democratic People's Republic of Korea
DSB	Defense Science Board
DSCU	Defense Security Cooperation University

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DEFENSE SCIENCE BOARD

FASA	Federal Acquisition Streamlining Act
FDI	foreign direct investment
FFRDCs	federally funded research and development centers
FMF	Foreign Military Financing
FMS	Foreign Military Sales
FSB	Federal Security Service (Russia)
FSU	Former Soviet Union
FY	Fiscal Year
<hr/>	
GDP	gross domestic product
GIES	Global Investment and Economic Security
GM	General Motors
GSA	General Services Administration
<hr/>	
ICAP	Immersive Commercial Acquisition Program
ICBM	intercontinental ballistic missile
IEEPA	International Emergency Economic Policy Act
IMP	Industrial Mobilization Plan
INSTC	International North–South Transport Corridor
IP	intellectual property
IR&D	independent research and development
ISOA	International Stability Operations Association
ISR	intelligence, surveillance, and reconnaissance
ITAR	International Traffic in Arms Regulations
<hr/>	
JPAC	Joint Production Accelerator Cell
<hr/>	
MCEIP	Manufacturing Capability Expansion and Investment Prioritization
MOU	Memorandum of Understanding
MRBM	medium-range ballistic missile
<hr/>	
NATO	North Atlantic Treaty Organization
NDIA	National Defense Industrial Association
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NSIB	National Security Industrial Base
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ODASD(MR)	Office of the Deputy Assistant Secretary of Defense for Material Readiness
OASD(S)	Office of the Assistant Secretary of Defense for Sustainment

DEFENSE SCIENCE BOARD

ODM	Office of Defense Mobilization
OSC	Office of Strategic Capital
OSD	Office of the Secretary of Defense
OTAs	other transaction authorities
OUSD(A&S)	Office of the Under Secretary of Defense for Acquisition and Sustainment
OUSD(R&E)	Office of the Under Secretary of Defense for Research and Engineering
OEM	original equipment manufacturer
PA&T	Policy, Analysis, and Transition
PEO	Program Executive Officers
PPP	purchasing power parity
PRC	People's Republic of China
PSC	Professional Services Council
R&D	research and development
RDP	Reciprocal Defense Procurement
ROK	Republic of Korea
S&T	science and technology
SCO	Strategic Capabilities Office
SPA	Space Development Agency
USA	United States Army
USAF	United States Air Force
USG	United States Government
USSR	Union of Soviet Socialist Republics
WTO	World Trade Organization

