National Security Innovation Base

Report Card

RONALD REAGAN
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"Free people must **voluntarily**, through open debate and democratic means, ***meet the challenge that totalitarians pose*** by compulsion. It's up to us, in our time, to choose and **choose wisely** between the *hard but necessary task* of ***preserving peace and freedom*** and the temptation to ignore our duty and blindly hope for the best while the **enemies of freedom grow stronger day by day."**

President Reagan || Strategic Defense Initiative Speech || March 23rd, 1983

RONALD REAGAN INSTITUTE

The Ronald Reagan Institute, the Washington, DC office of the Ronald Reagan Presidential Foundation and Institute, promotes our 40th President's ideals, vision, and leadership example through substantive, issue-driven forums, academic and young professional programming, and scholarly work.

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Introduction

In 2022, the Ronald Reagan Institute's Center for Peace Through Strength established a new program on the National Security Innovation Base. The foundation for the program was the Institute's 2019 Task Force on 21st-Century National Security Technology and Workforce, which highlighted the fragile health of America's national security technology and innovation community and its impact on our future economic and military competitiveness.

In its report, *The Contest for Innovation*, the Task Force proposed a set of recommendations to achieve long-lasting competitive advantage in technology and innovation. While some of these recommendations have since been implemented, many of the alarming trends related to the loss of the U.S. technological advantage have only accelerated. U.S. leadership in innovation, research, technology, development, and economic competitiveness continues to decline and faces a critical inflection point.

Key to addressing the current challenge will be finding common purpose and motivating coordinated efforts among a large group of stakeholders, from the most innovative industry and technology companies to investors to decisionmakers in Congress and the Executive Branch to academia—what is now referred to as the National Security Innovation Base (NSIB).

The concept of the NSIB, broader and more inclusive than the traditional defense industrial base, featured prominently in the Reagan Institute's 2019 Task Force report. The NSIB ecosystem includes a broad set of segments, our national security agencies and organizations, the National Laboratories, Federally Funded Research and Development Centers (FFRDCs) and University-Affiliated Research Centers (UARCs), universities and academia, traditional defense "primes," startups and disruptors in the commercial sector, venture capital, and the innovative systems of American allies and partners. These segments are often cooperative, but they are loosely federated, largely uncoordinated, and inconsistently defined by the government.

The NSIB adjusts and adapts to government policies, resources, and strategies as well as public and private investment affecting the productivity, resilience, and organization of this ecosystem. The collective impact of this ecosystem on our national security innovation has gone unmeasured—until now.

With recent reforms, new policy interventions looming on the horizon, and evolving investments in emerging technologies, there is an urgent requirement to evaluate how we prioritize, resource, and assess the balance across the ecosystem.

To do just that, the Reagan Institute has produced the inaugural **National Security Innovation Base Report Card** to measure the effectiveness, productivity, and resilience of our nation's innovation ecosystem and provide recommendations for improvement. As knowledge partners, McKinsey & Company provided the fact base to support this assessment. Eric Snelgrove served as a subject matter expert supporting the report card's findings. The Reagan Institute also convened policy experts and key stakeholders to form an experienced Advisory Board comprised of bipartisan, cross-sector national security leaders. We hope this report card serves as an innovative policy tool is useful to actors across the NSIB.

Methodology

Structured, Repeatable Approach

1. Identify the set of indicators that are most diagnostic for assessing the health of the NSIB
2. Formulate key assessment questions and criteria to evaluate each indicator
3. Develop set of key metrics to measure each criteria
4. Assign grading for criteria and indicators based on comprehensive fact base
5. Generate recommendations for improvement
6. Update indicators, fact base, and grades to be updated on an ongoing basis

Grading Rubric

A Best-in-class performance globally that lives up to U.S. potential; critical source of American distinctiveness

B Multiple key areas of strength, with some room for growth

C Vulnerabilities and/or inconsistencies identified, with flat-to-declining trendline

D Ongoing major vulnerabilities that are significantly undermining health of the NSIB

F Catastrophic area of weakness that will have major implications for American technical, military, and/or economic leadership, if unaddressed

Trendline Recent (last ~5 years) performance evolution against indicator

↑ Improving → Neutral/ flat ↓ Deteriorating

NSIB Report Card grades represent a holistic baseline assessment that incorporates the quantitative and qualitative analysis underlying each indicator while also (where appropriate) benchmarking performance against U.S. potential and/or the performance of other countries. Subsequent years will measure improvement and/or deterioration from baseline report card.

Key Indicators

"Inputs" Driving U.S. National Security Innovation

1. ***Customer Clarity:*** well-articulated demand signal for customer (government) innovation priorities, with funding and acquisition pathways that match the aspiration
2. ***Innovation Capital:*** holistic set of public and private financial capital – along with non-financial assets & infrastructure – available to resource the NSIB
3. ***Private Sector Innovator Base:*** broad-based, dynamic, and globally competitive/resilient ecosystem of traditional defense firms, startups, and commercial hyperscalers engaged in NSIB-relevant efforts
4. ***Public/Civil Innovation Base:*** defense/national labs, other FFRDCs/UARCs and academic institutions developing (and protecting) national security-oriented research
5. ***Government Alignment:*** degree of convergence between U.S. federal, state, and local efforts on NSIB priorities (e.g., national security infrastructure and workforce development)
6. ***International Alliances & Partnerships:*** level of linkage between U.S. and international partners (e.g., IP rights, data sharing)
7. ***Talent Base:*** pipeline of domestic and foreign-born talent trained and working in NSIB-relevant fields

"Outputs" of Strong NSIB Ecosystem

8. ***Innovation Leadership:*** overall quality of U.S. research and commercialization in priority technologies; center of global knowledge networks
9. ***Defense Modernization:*** translation of innovation into national security capabilities, in part by quickly adopting to new capabilities and models for acquisition
10. ***Pull-Through for Broader National Priorities:*** "multiplier" effort of NSIB on broader economy and government effectiveness

Interpretation and Cross-Cutting Themes

Interpretation of the Grades

The inaugural Reagan NSIB Report Card paints a mixed picture of the health of America's national security innovation engine. The grades generally provide a gauge of U.S. performance versus our full potential, with a bar that continues to rise as global technology competition accelerates. While there are some positive trends to celebrate, hard work remains ahead.

Among these indicators, areas of strength or emerging strength include *Innovation Leadership* (while fragile and under persistent threat of disruption), *Innovation Capital*, and the *Private Sector Innovator Base*.

Areas of greatest weakness or deficiency include *Customer Clarity* (notably access to sufficient and stable funding as well as fast-moving acquisition pathways), the *Talent Base*, and the depth and breadth of America's *International Alliances and Partnerships*.

Differentiating "input" from "output" indicators is a useful framing, as many policy interventions in the last decade have focused on inputs, irrespective of whether those efforts produce results.

Cross-Cutting Themes

In our discussions and analysis during the development of the report card, we consistently encountered five broad themes, which informed the policy recommendations presented later in the report:

1. **Broad consensus on the need to "go faster and be bolder" in reforming the NSIB, while the implementation shortfall remains.** Major Defense Acquisition Program (MDAP) cycle times remain close to their 20-year averages, record venture funding has not sufficiently addressed the "valley of death" for startups, and the talent gap is the widest in a generation—and growing. The metabolic rate of change will need to increase substantially, given the negative trendlines noted for many of the key outputs.
2. **Misaligned incentives are a key root cause of the slow pace of change.** DoD offers an atypical return profile for the entrepreneurs and investors that are encouraged to participate in the DoD ecosystem. Meanwhile, public market incentives drive traditional defense firms to underinvest in R&D on a relative basis versus their commercial, digital-native peers.
3. **There is no clearly-articulated pathway to a program of record for a majority of the priority NSIB technologies outlined by the U.S. Government.** This is particularly notable in "fast follower," commercially-led technology areas (e.g., AI, microelectronics, biotech) where the DoD does not have the same level of market power that it commanded from industry during the Cold War.
4. **NSIB actors lack sufficient coordination toward common goals.** Many of the grand challenges to improve the health of the NSIB (clear alignment on technology priorities, acquisition reform, a "GI Bill" for NSIB talent, and new global NSIB alliances, for example) are all being addressed piecemeal.
5. **America remains a leader in many elements of the NSIB, but there is a limited window for action on the deficiencies outlined in this report card before U.S. relative standing diminishes irreversibly.**

Summary 1/2

Inputs

Indicator	Grade	Trend	Grading Rationale
1. **Customer Clarity**	D	→	U.S. Government leaders consistently articulate a need to access diverse sources of innovation, but the follow through on that vision across the customer community (executive and legislative) has fallen short, blurring the demand signal for the NSIB. Mixed to poor outcomes on staffing, aligned tech priorities/roadmaps, tradeoffs in a constrained resource environment, and unclear/slow procurement pathways are all vulnerabilities for the NSIB.
2. **Innovation Capital**	B-	↑	At the aggregate level, significant capital is available for NSIB innovation priorities. However, there is room to more efficiently deploy capital against incremental and "breakthrough" innovation priorities at key lifecycle stages. There is a noticeable gap in the resources, infrastructure, and capabilities available to scale NSIB missions.
3. **Private Sector Innovator Base**	B	↑	The NSIB private sector base is large and growing – but this is not always reflected in market share concentration and ability to access contracts. Financial viability is threatened across several segments of defense value chains and the U.S. remains dependent on vulnerable foreign supply chains for materials and equipment.
4. **Public/ Civil Innovation Base**	B-	→	The constellation of American defense, civil, and academic labs & research institutions have been the home of numerous discoveries and breakthrough innovations that have transformed the NSIB. There is an opportunity improve the efficiency of the nearly $150B in NSIB-relevant investments across these institutions, however – which likely will require greater oversight.
5. **Government Alignment**	C	→	On some marquee federal programs (e.g., CHIPS and Science Act for semiconductors), U.S. Government investment/policy has spurred "trickle down" innovation outcomes in certain state and local jurisdictions. However, for most NSIB technology areas key federal/state/local investments are uncoordinated – particularly for national areas of collaboration e.g., workforce development and small business investment.

Summary 2/2

	Indicator	Grade	Trend	Grading Rationale
Inputs	6. **International Alliances & Partnerships**	C-	↑	Agreements with U.S. partners (e.g., Quad, G7) do not provide specific actions for cooperation on critical technologies, but the U.S. leads in foreign military sales and global R&D. Scrutiny of foreign investment and exports is increasing, but a low share of exports are subject to licensing and enforcement may not be feasible.
Inputs	7. **Talent Base**	D+	↓	The domestic NSIB talent pipeline is slowing. The defense workforce is aging and does not recruit diverse talent proficient in emerging technologies. The foreign talent pipeline is concentrated with declines in enrollment from top sources, and foreign talent faces visa obstacles.
Outputs	8. **Innovation Leadership**	A-	↓	America's overall innovation leadership across a range of emerging technology areas remains a competitive advantage – but one that cannot remain static. Strategic competitors are investing heavily to catch up.
Outputs	9. **Defense Modernization**	C	↓	America's ability to field technologically sophisticated, fit for purpose systems and platforms will be critical for fighting and winning future conflicts that take place across domains and at machine speed. However, uneven readiness, limited interoperability, and dated acquisitions processes are holding back defense modernization.
Outputs	10. **Pull-Through for Broader National Priorities**	B-	→	The U.S. remains the global leader in NSIB-relevant services and defense capabilities. The economy receives "spillover" benefits from NSIB investment (primarily via economic growth, productivity and employment), but the competitiveness outcomes are uneven (e.g., manufacturing lags global peers). Government digital capabilities and efficiency lag private sector counterparts.

1. Customer Clarity

Overall grade: D **Trend:** →

U.S. Government leaders consistently articulate a need to access diverse sources of innovation, but the follow through on that vision across the customer community (executive and legislative) has fallen short, blurring the demand signal for the NSIB. Mixed to poor outcomes on staffing, aligned tech priorities/roadmaps, tradeoffs in a constrained resource environment, and unclear/slow procurement pathways are all vulnerabilities for the NSIB.

Criteria #1: U.S. Government clearly communicates critical technology priorities needed to support national security missions.

Grade: C+

There are numerous overlapping/inconsistent tech priority lists across services/agencies, and there have been critical tenure gaps in key "customer" leadership roles.

- Only 65% of NSIB-critical DoD officials are permanent. Leadership roles (i.e., Under Secretaries of R&E, A&S, Policy) were filled permanently 65-75% of last five years.[1]
- 5 of 11 NSIB-critical services/agencies released publicly-available tech roadmaps in last 2 years, and most roadmaps do not explicitly align technologies to specific programs.[2]
- Early-stage RDT&E resourcing is largely aligned to stated tech priorities and service mission[3]:
  - Funding for technologies with broad applicability is shared across services or driven by DARPA/ OSD (e.g., integrated sensing and cyber, directed energy).[3]
  - Funding for technologies with narrower applicability is driven by rational owner (e.g., space technology).[3]
  - Some priority technologies are slated to receive ~$5B or less in early-stage RDT&E through 2027 (e.g., AI / autonomy), and ~$105B is directed to other priorities (e.g., platform upgrades).[3]

Criteria #2: U.S. government provides sufficient and stable funding to acquire and scale critical technology solutions, while making needed tradeoffs.

Grade: F

Procurement is not well-aligned to stated tech priorities, "trade-offs" generally favor legacy programs, and consistently tardy appropriations blur the NSIB demand signal.

- Within 2022-2027 procurement budgets, select stated tech priorities are projected to decline (e.g., planned procurement is flat or declining for UAS and command/control & battle management) while many deprioritized programs will grow (e.g., ~15% p.a. growth in amphibious ship procurement.)[3]
- During FY2023 "plus-ups" (final appropriations vs. President's Budget Reqeuest, only 4 of top 20 funding increases were directed to programs aligned to USG innovation priorities. Existing platforms had the largest increases.[3]

Top 20 Increases in Funding During FY2023 Appropriations

By categorization, number of programs

- DoD has operated under continuing resolutions for 1,500 days since 2010, driving inefficient funding / uncertainty.[4]

Criteria #3: Acquisition pathways that operate at the speed of relevance are available and well-utilized.

Grade: C-

Acquisition and requirements timelines are static over time, procurement paths are not clear for priority technology, and novel pathways remain small in scope.

- Over 20 years, MDAP cycle times continue to average ~7 years and MDAP cycle time growth is stable at ~31%, on average.[5]
- Use of OTA awards grew by 57% p.a. to ~$15B from FY 2016 to FY2021. Awards are typically small (e.g., avg. quantum award was ~$6M from 2019-21).[6]
- There are existing procurement pathways for only 5 of 14 stated priority technologies.[7]
- Joint Staff's JCIDS[8] process stated timeline is 103 days, but GAO finds no assessed capability documents were processed in that timeline – and Joint Staff lacks reliable data and a baseline to measure timeliness.[9]

How to Improve Grade

There is a noticeable gap in late-stage R&D, prototyping, and procurement funds available for NSIB actors. Recent efforts such as the Accelerate the Procurement and Fielding of Innovative Technologies (APFIT) program seek to address this gap but should be increased to $1 billion and minimum award size increased to $30 million.

On-time President Budget Requests and Appropriations bills are critical to effective governance, predictability, and budget execution. The failure of Congress to pass on-time appropriations adds additional delays and costs into an already strained defense budgeting and acquisition process that would benefit from increased flexibility within the year of execution, particularly for emerging technologies where the pace of technological change exceeds the rigid PPBE process.

2. Innovation Capital

Overall grade: B- Trend: ↑

At the aggregate level, significant capital is available for NSIB innovation priorities. However, there is room to more efficiently deploy capital against incremental and “breakthrough” innovation priorities at key lifecycle stages. There is a noticeable gap in the resources, infrastructure, and capabilities available to scale NSIB missions.

Criteria #1. Economy-wide R&D investment is sufficient to drive desired national security outcomes.

Grade: A-

The U.S. is the global leader in R&D, but federal R&D spend is low relative to historic highs.

- U.S. continues to lead the world in aggregate R&D investment: $719B in 2021 (up ~10% from 2020 and ~9% annual growth from 2016-2021).[1]
- The U.S. is also among world leaders in R&D as share of GDP, investing 3.4% of GDP in 2020 (compared to 2.4% of GDP invested in China and 2.6% worldwide).[2]
- Federal R&D investment grew to ~$180B in 2021, up ~7% vs. 2020 – but federal investment is small as a share of GDP vs. historical highs.[3]

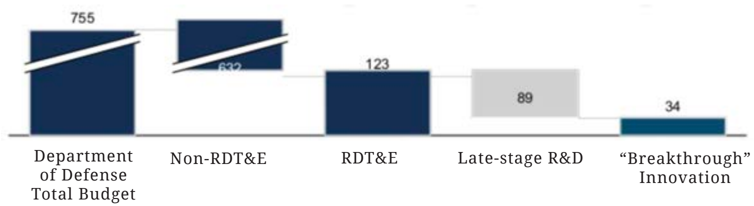
Criteria #2. Ample capital exists across sources (government, public, and private) for both incremental and “breakthrough” R&D.

Grade: B

Top-line DoD RDT&E spending is at record highs with stable growth and funding for “breakthrough” innovation is $34B and growing (dispersed across many tech areas). Public defense firms spend less on IR&D versus commercial technology peers.

- FY2022 DoD RDT&E funding reached $123B – and in-year RDT&E has been higher than FYDP forecasts each year since 2016.[4]
- Of this, ~$34B funds “breakthrough” innovation (up 10% p.a. 2016-22).[4]

Breakdown of FY2022 RDT&E Funding Into Late-Stage and “Breakthrough”, $B



Source: Radar by McKinsey

- Within “breakthrough” funding, ~$15B is allocated to stated technology priorities (e.g., autonomy / AI, microelectronics, hypersonics).[4]
- In 2021, the top 10 U.S. defense contractors by revenue spent on average less than 3% of revenue on internal R&D (excluding customer-funded R&D contracts), versus commercial software (15-18% of revenue on R&D).[5]

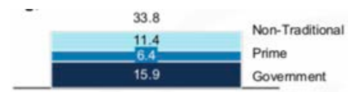
Criteria #3. Sufficient capital and other resourcing (e.g., infrastructure) is available to scale companies with national security applications.

Grade: C

Startup companies continue to face financial and infrastructure challenges to scaling.

- Of ~$34B in “breakthrough” funding, ~$11B is available to non-traditional (i.e., non-prime or government / academia) executors.[4]

Recipients of FY2022 “Breakthrough” Innovation Funding, $B



FY2022 “Breakthrough” Innovation

Source: Radar by McKinsey

- Defense tech received nearly $11B in venture capital in 2021.[7]
- NSIB disruptors face five non-financial challenges: classification (e.g., facilities), test infrastructure (e.g., hypersonic wind tunnels, high-performance compute),[8] sensitive materials handling certification, standards alignment/IP ownership, and broader compliance.[6]

How to Improve Grade

Expand the availability of government matching-fund programs (ie. AFWERX TACFI/STRATFI) for defense/dual-use startups raising private capital to accelerate and scale their capabilities, while simultaneously drawing additional capital into defense technologies.

Provide additional authorities to the Office of Strategic Capital (e.g., establish loan and loan guarantee programs for NSIB actors to scale their technologies).

3. Private Sector Innovator Base

Overall grade: B Trend: ↑

The NSIB private sector base is large and growing, but this is not always reflected in market share concentration and ability to access contracts. Financial viability is threatened across several segments of defense value chains, and the U.S. remains dependent on vulnerable foreign supply chains for materials and equipment.

Criteria #1. There exists sufficient breadth and depth in the NSIB to spur innovative outcomes.

Grade: B+

Number of DIB participants and other NSIB innovators is large and growing, but some key defense niches have limited concentration, which may limit incentives for innovation.

- In 2021, >7000 providers won $1M+ in DoD contracts, up from ~6,400 in 2017. In 2021, ~1,500 new vendors received $1M+ in defense contracts.[1]
  - However, non-defense-focused providers do not enter government procurement at the same rate: the number of vendors providing electronics and communications declined 37% over last 15 years.
- Some defense markets are "highly concentrated" based on standard competitiveness metrics (e.g., Naval aircraft), but services and emerging tech markets (e.g., unmanned aerial systems) are more competitive.[2]
- NBER research found that the defense sector punched above its weight in development of exploratory patents in the 1990s, but this has since declined to roughly in line with the overall economy.[3]
- The U.S. maintains the largest and most vibrant ecosystem of NSIB firms globally–with more AI firms than China as of 2021, for example.[4]

Criteria #2. The NSIB has sufficient economic dynamism to respond to shocks and global competition.

Grade: B-

U.S. defense firms outperform international peers, but low margins and other financial challenges pose risks to NSIB viability. Top tiers of supply chains are secure, but the U.S. continues to rely on foreign producers of commodities. Defense labor market dynamism lags that of other sectors, threatening knowledge and innovation flows.

- The defense sector maintains healthy profitability levels versus global peers: U.S. defense suppliers have higher margins than non-U.S. suppliers, particularly for small arms and fixed-wing aircraft. In 2021, U.S. suppliers' margins outperformed non-U.S. suppliers by 11.5% and 4.3% respectively.[7]
- However, some balance sheets are strained: Of the sample of public US-based firms in the top 100 of total defense contracts, less than half hold an investment-grade credit rating.[6]
- Several segments in A&D value chains demonstrate operating margins below 10% (e.g., missiles, naval platforms), threatening supply chain stability.[7]
- Top 10 U.S. defense contract awardees derived 76% of their 2021 revenues from defense vs. 27% for top Chinese firms.[5,8]
- The supply of many tier 1 systems are centered in U.S. or allied nations (e.g., 73% of aerostructure market),[9] but the U.S. relies on foreign commodities. China produces 33% of global titanium[10] and accounts for 63% of REE mining.[11]
- According to CSIS, the U.S. will need more than 8 years to replace MDAP stockpiles at current production rates.[12]

How to Improve Grade

Conduct an analysis of competition within the NSIB to better understand the impacts of DIB consolidation, supply chain limitations, sourcing constraints, and industrial base policy and incentives.

4. Public/ Civil Innovation Base

Overall grade: B- Trend: →

American defense, civil, and academic labs & research institutions have been the home of numerous discoveries and breakthrough innovations that have transformed the NSIB. However, there is an opportunity improve the efficiency of the nearly $150B in NSIB-relevant investments across these institutions, which likely will require greater oversight.

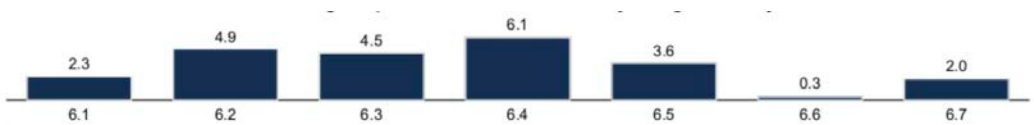
Criteria #1. There is sufficient funding for public sources of innovation (e.g., government labs, FFRDCs) and research alignment to national security priorities.

Grade: B

Funding for public / civil / academic innovation remains high, but individual awards may be too small to enable breakthrough innovation, and infrastructure is a challenge to innovation. For these institutions, their share of RDT&E awards for later-stage R&D is comparable to early-stage R&D, raising some questions about whether investment is deployed against the "right" stage of maturity.

- Large spend: In 2020, government agencies, FFRDCs, and academia deployed ~$147B in R&D ($42B, $24B, and ~$81B, respectively), up 4.6% p.a. from 2015 vs. 7.4% p.a. growth in total R&D.[1]
- Spread thin: In 2021, 43 FFRDCs deployed (median) ~$184M in executed R&D.3 Average DARPA awards to universities, FFRDCs, or non-profits averaged $6.9M in 2021, and SBIR grants averaged $1.1M.[2]
- In September 2022, the HASC Subcommittee on Cyber, Innovative Technologies, and Information Systems "noted a massive backlog in laboratory investment, more than $5.7 billion in the latest report to Congress."[3]
- Alignment of DoD-funded public / civil / academic research to mission and national security missions is mixed:
  - Of DoD funding for public / civil / academic RDT&E, 40% is allocated to budget activities 6.4 and 6.5 (prototyping/scaling), on par with the allocation to budget activities 6.1 and 6.2 (basic/applied research).[4]
  - Public / civil innovation in tech priorities with broad mission applicability (C4 and FutureG, hypersonics, integrated sensing and cyber, and microelectronics) received ~$5B in 2022 DoD funding.

Allocation of FY2022 DoD Funding for Public/ Civil Innovators by Budget Activity, $B



Criteria #2. Defense/civil labs catalyze scalable NSIB advances, and the research is adequately protected.

Grade: B-

Collaboration between public / civil / academic innovators remains robust, but there are not sufficient measures in place to assess research effectiveness or talent and IP protection.

- Federal collaborative R&D relationships (CRADAs) with non-federal innovators continues to grow, growing ~7% annually from FY 2015-2019.[5]
- Active licenses for federally-developed technologies declined ~4% p.a. from FY 2015-2019 and license revenues fell 14% p.a. over the same period.[6]
- In 2022, GAO found that the DoD and other sponsors receive limited access to information around FFRDC outputs and performance, making it difficult to assess research effectiveness.[7]
- The Los Alamos National Laboratory lost 162 researchers to a Chinese talent program, risking hypersonics, jet engines, and UAV IP. Only one agency, the DOE, banned participation in such programs.[8,9]
- Limited data is available on academic IP protection. Academic leaders (e.g., Kevin Gamache) highlight federal-academia collaboration as a barrier to security.[10]

How to Improve Grade

Congress should task the Defense Innovation Board and Defense Science Board with completing a study on the state of DoD labs/test facilities, an analysis of their contributions to defense modernization priorities, and an assessment on future defense laboratories and test facility requirements, with a special focus on emerging technologies where the private sector lacks the required infrastructure for R&D efforts (hypersonics, directed energy, quantum, etc).

5. Government Alignment

Overall grade: C Trend: →

On some marquee federal programs (e.g., CHIPS and Science Act for semiconductors), U.S. Government investment/policy has spurred "trickle down" innovation outcomes in certain state and local jurisdictions. However, for most NSIB technology areas key federal/state/local investments are uncoordinated, particularly for national areas of collaboration e.g., workforce development and small business investment.

Criteria: Federal, state, and local governments coordinate to support innovation priorities.

- The federal government offers selective financial incentives to advance NSIB innovation within some states. The CHIPS and Science Act is an example of a federal/state/local/private collaboration.[1] As of December 2022, CHIPS had spurred $200B in private sector investment for U.S. semiconductor production. Planned projects span 16 states and 20 discrete counties or municipalities.[2]
- The federal Industrial Base Analysis and Sustainment program (IBAS) has invested more than $80 million to upskill members of the workforce and improve manufacturing of defense tech and weapon development.[3]
- While DoD spending is geographically diversified, DoD budget allocated towards state government coordination is a small percentage of the total DoD budget. In FY2021, 41 U.S. states (including Washington, DC) and 81 distinct counties were home to at least $1B in DoD contracts (481 counties were home to at least some DOD contracts spend). When including personnel expenses, 47 states were home to at least $1B in total DoD spend.[4]
- In September 2022, the DoD announced Office of Local Defense Community Cooperation awards of $30M to support the Defense Manufacturing Community Support Program, largely aimed at workforce initiatives.[5]
- Legislation such as the Workforce Innovation and Opportunity Act provide federal funding towards state workforce development, with ~$3.9 billion appropriated in FY22[6], promoting regional workforce coordination within states. However, the program does not focus on coordination between states and the federal government.[7]
- State funding dedicated to promoting federal NSIB development is limited. While several states participate in SBIR fund matching, the commitments are relatively small, and only 16 states provide pre-acceptance to SBIR support. States typically award between $25,000 to $100,000 in Phase 0 or 1 of the SBIR program.[8]
- There are few avenues for formal support from states for the defense industry (e.g., Hawaii Defense Economy project, Pennsylvania Defense Industry Assistance Partnership).[9,10]
- Largely state-specific, other inter-government workforce development programs are emerging (e.g., collaboration between federal, state and local governments in Connecticut and Rhode Island to create a training pipeline for new shipbuilding recruits to complete Virginia Class submarine development, but delays continue, largely driven by talent).[11]

How to Improve Grade

The DoD must clarify the various defense innovation organizations' roles within the ecosystem and assign responsibility for coordinating across state and local governments. The organizational relationships between Defense Innovation Unit, the National Security Innovation Network, APEX Accelerators (formerly Procurement Technical Assistance Centers), the Office of Local Defense Community Cooperation, and various service-level organizations lacks clarity, coordination, and prevents scaling of best practices to state and local governments.

6. International Alliances & Partnerships

Overall grade: C- Trend: ↑

Agreements with U.S. partners (e.g., Quad, G7) often do not provide specific actions for cooperation on critical technologies, but the U.S. leads in foreign military sales and global R&D. Scrutiny of foreign investment and exports is increasing, but a low share of exports are subject to licensing, and enforcement may not be feasible.

Criteria #1. There are strong linkages between the U.S. and allies / partners in priority technology areas.

Grade: C

Few technology partnerships between the U.S. and allies describe specific actions on shared technology priorities. But foreign military sales continue to grow, and the U.S. remains a leader in cross-border R&D, tech flows, and data flows.

- Agreements issued by key multilateral partnerships (e.g., G7, Quad, EU-U.S. partnership) provide only high-level guidance on technology cooperation (e.g., Quad statements "affirmed importance for resilient technology supply chains"). Only EU-U.S. agreements prescribe actions (in the form of shared committees).[1]
- In FY2022 the U.S. provided ~$52B in foreign military support, with ~$43B in foreign military sales, both up from 2021 (~$35B and ~$29B, respectively).[2]
- The number of Science and Technology Agreements between the U.S. and foreign partners declined from 102 in 2013 to 47 in 2023.[3]
- In 2019, U.S. firms executed ~$105B in R&D in foreign nations (compared to ~$493B in domestic R&D), up ~6% p.a. since 2011 with ~$50B allocated to IT industries, and $13B invested in semiconductors alone.[4]
- However, U.S. tech flows are declining as compared to strategic competitors. In 2022, net tech exports represented 0.28% of GDP, down from 0.48% in 2011.[5]
- In absolute terms, the U.S. now lags China in high-tech exports (~$169B vs. $942B in 2021),6 but the U.S. remains a leading importer of high-tech products.
- China overtook the U.S. as the world leader in data flows in 2014, and the U.S. remained second in global data flows as of 2019.[7]

Criteria #2. U.S. balances protection of national security and IP while fostering innovation.

Grade: D

Scrutiny of foreign investment is increasing as measured by CFIUS reviews, but a small share of exports to China are subject to controls, Chinese investment into startups remains high, and digital protections are insufficient, resulting in IP theft.

- In 2021, CFIUS reviewed a record 272 "covered notices" for transaction approvals, up from 187 in 2020 and 238 in 2019. The share of notices related to Chinese acquirers also increased from 25 in 2019 to 44 in 2021.[8]
- As of 2020, 20% of the top U.S. AI startups had at least one Chinese investor. In 2022, Chinese investment in U.S. VC hit its second-highest level of the last 12 years.[9]
- In 2021, licensed exports increased as a share of total exports to China (0.8% in 2021 vs. 0.5% in 2019), and license-exempt exports decreased (0.2% vs. 1.1%).[10]
- Tech such as information security, software, navigation, and aerospace goods remain in the top 10 exported technologies exempt from, or not requiring, licenses.[10]
- Per a November 2022 CSIS assessment, the BIS is not equipped to enforce enhanced export controls.[11]
- Interactive intrusion campaigns in the U.S. grew ~60% 2020-2021 and CyberSheath found that 50%+ of DIB organizations were non-compliant with basic DFARS requirements.[12]
- From 2021-2022 the U.S. enacted more digital policies than any other nation (940) – but only 9 in 2022 were aimed at international trade considerations.[13]
- Assessments of total cost of Chinese IP theft range from $200B-$600B every year.[14]
- The U.S. remained the top destination for foreign direct investment (FDI) in 2021.[15]

How to Improve Grade

International partnerships should also be viewed as an opportunity to address the vulnerabilities within our defense industrial base, to include enhancing U.S. cooperation with allies to address global supply chain constraints and domestic manufacturing capacity limitations.

While strategic technology alliances play an important role in R&D cooperation, the DoD could also embrace and expand grassroots, service-driven initiatives such as the Navy's TF-59 in the Middle East (partnership with Israel, Bahrain, and Jordan to field unmanned surface vessels and artificial intelligence for maritime domain awareness).

7. Talent Base

Overall grade: D+ **Trend:** ↓

The domestic NSIB talent pipeline is slowing. The defense workforce is aging and does not recruit diverse talent proficient in emerging technologies. The foreign talent pipeline is concentrated with declines in enrollment from top sources and foreign talent faces visa obstacles.

Criteria #1. U.S. attracts, retains, and develops domestic NSIB talent (e.g., availability, quality, diversity), particularly in STEM and skilled trades.

Grade: C-

U.S. K-12 students underperform peers in NSIB-critical capabilities. The defense workforce does not fully engage the best of U.S. talent, is aging, and is under-indexed on talent proficient in priority technologies.

- In the latest OECD PISA[1] exams, American students scored near the OECD average, and lagged innovator peers e.g., China, UK, Canada, and Japan.[2]
- China graduates more STEM PhDs than the U.S. – and CSET forecasts that China's production will double that of the U.S. by 2025.[3]
- Per employee net promoter scores (NPS), aerospace & defense employers lag tech in perceived career opportunity, job culture, and compensation & benefits.[4]
- Talent proficient in critical tech (e.g., AI / ML) is underrepresented in defense – under 10% of the defense prime workforce is in software and deep-tech and only 1% in AI / ML.[5]
- In aggregate, the defense sector is exporting its talent to tech firms: 4% of defense talent inflows come from the tech sector, while 8% of talent outflows exit to tech firms.[6]
- The defense industry lags on proportion of women in the workforce, trailing U.S. economy benchmarks in share of women in every role from entry-level to senior executives.[7] This is also true in other NSIB sectors (e.g., 33% of total tech workforce is female).[8]

Criteria #2. U.S. leads in attracting and retaining a robust pipeline of foreign talent with in-demand skills needed for national security missions.

Grade: D

U.S. foreign talent pipelines are not diversified, and foreign NSIB talent faces challenges obtaining visas. However, once foreign talent is engaged in the NSIB, the U.S. excels at retaining it.

- Indian and Chinese students represent nearly 60% of all 2021 foreign graduate students. Chinese student enrollment decreased ~2% p.a. over the past three years, while Indian student decreased ~8% p.a.[9]
- NSF surveys indicate that ~70% of international PhD students wish to stay in the U.S. upon graduation, but intention-to-stay rates are declining among Chinese students.[10]
- As of 2021, the H1-B waitlist stood at 875,000 applicants, and in January of 2023 there were 387,000 eligible applicants pending interviews with only 36,000 applicants scheduled for an interview.[11]
- Over the past 20 years the share of the U.S. STEM workforce composed of foreign talent has grown from 16-23%.[12]

How to Improve Grade

The United States will need to foster a diverse global talent pipeline that not only attracts the world's top talent but provides a mechanism to remain in the country upon graduation. Interventions under discussion have included H1-B reform and Congress establishing a National Security Innovation Base Visa program.

Increase investment in programs that address our aging and underrepresented STEM and skilled trade workforce, including doubling the DoD's Scholarship for Service output (currently <500/year) and scaling early education programs that provide familiarization with national security challenges and career opportunities, such as Hacking 4 Defense. Make shorter-term training programs eligible for federal programs like Pell Grants.

8. Innovation Leadership

Overall grade: A- Trend: ↓

America's overall innovation leadership across a range of emerging technology areas remains a competitive advantage, but one that cannot remain static. Strategic competitors are investing heavily to catch up.

Criteria #1. U.S. leads knowledge output based on key indicators (e.g., patent volume/quality). America defines global tech standards and governance frameworks.

Grade: B+

Strategic competitors have overtaken the U.S. in total number of patents and leading standards membership. By some measures, they are reaching parity in patent quality.

- In 2021, China produced >13k telecommunications patents while the U.S. produced 4,387.[1] As of 2018, China produced 30,000 AI patents, more than 2.5 times the number filed by the U.S.[2] However, the U.S. emerged as a leader in quantum technologies with IBM, Northrup Grumman, Microsoft, and Bank of America among the top 5 holders of quantum patent portfolios.[3]
- China's patent quality has been contested with one Chinese official claiming, "90 percent of [Chinese patents] are 'trash.'"[4] But from 2017-2021, China led the US in share of engineering research cited in 11 of 14 categories and was largely at parity across computer science research.[5]
- Strategic competitors have prioritized standards membership to benefit domestic companies.[6] China currently has 176 members within 3GPP, and the U.S. has 94. China has 751 members in the ISO, while the U.S. has 568.[7]
- The U.S. still maintains "at least 50 percent of the votes in eleven of the thirty-nine organizations" evaluated by the Atlantic Council.[8]

Criteria #2. U.S. is a net knowledge exporter (e.g., global citations, research university rankings).

Grade: A

U.S. leadership in critical technology capabilities is mixed, but the U.S. remains the global leader in knowledge flows and caliber of higher education institutions.

- Based on third-party assessments, U.S. capabilities lead those of strategic competitors in select critical technologies (e.g., microelectronics, quantum, and biotechnology), while capabilities lag in FutureG and renewable energy.[9]
- The U.S. leads in global patents citing its academic papers.[10]
- From 2015-2019, China overtook the U.S. in percent of research papers in the 1% most highly cited list – an indicator of research influence / quality.[11]
- Among the top 100 global university rankings, 38 schools were based in the U.S. while only 7 Chinese universities were listed.[12]
- More than 950,000 students from other countries attend American schools, while only about 100,000 American students go abroad for higher education.[13]

How to Improve Grade

While the U.S. continues to be a global leader in critical technologies, strategic competitors such as China are gaining influence within international standards organizations. The U.S. must be more proactive in communicating the risks of Chinese influence within standard setting organizations when it threatens fair competition, impacts privacy considerations, or increases barriers to trade.

9. Defense Modernization

Overall grade: C **Trend:** ↓

The domestic NSIB talent pipeline is slowing. The defense workforce is aging and does not recruit diverse talent proficient in emerging technologies. The foreign talent pipeline is concentrated with declines in enrollment from top sources and foreign talent faces visa obstacles.

Criteria #1. NSIB innovations are converted into U.S. national security capabilities.

Grade: C+

Capabilities of fielded assets demonstrate pull-through of NSIB innovation, but readiness and interoperability lag expected progress.

Capability of Fielded Assets

- Per the Heritage Foundation 2023 Index of U.S. Military Strength, four services received weak or marginal capability scores,[1] but the U.S. leads in military rankings (e.g., Lowy Institute Asia Power Index[2]).

Asset Interoperability and Readiness

- As of January 2023, GAO assessed that the Air Force has not delivered JADC2 capabilities[3] and outcomes remain undefined across other service JADC2 initiatives (e.g., Navy's Project Overmatch).[4]
- In 2022, the DODIG found that of 1,100 DoD logistics tools, "none [meet] criteria for interoperability"[5]
- From 2001-2020 fighter aircraft availability rates declined across both Air Force (declining from ~57% to ~47%) and the Navy (from ~57% to ~38%) per CBO analysis.[6]
- DoD-wide deferred maintenance backlogs reached $137B in 2020, up from $116B in 2018[7] and per DODIG DoD has not reached full predictive maintenance capabilities in any weapons system.[8]

Defense-wide Enabling Capabilities

- GAO's 2022 Weapon Systems Assessment found that 59% of 29 assessed MDAPs reported delays and six of seven MDAPs assessed for cost reported increases[9] but programs like B-21 show promise, progressing from contract to rollout in 7 years and under budget.[10]
- The National Security Commission on Artificial Intelligence noted that the "single greatest impediment to the U.S. being AI-ready by 2025" was an "alarming talent deficit" in the DoD.[11]

Criteria #2. U.S. effectively adapts to new capabilities and models for acquisition.

Grade: C-

Novel pathways are growing in use, but large acquisition programs face process and oversight challenges while smaller acquisition pathways face pull-through challenges.

- Since 2018, number of programs under MTA increased to 17 in 2021, while number of future MDAPs decreased from 22 to 6.[12]
- But in Feb. 2023, GAO found a "lack of clear guidance, slow implementation of processes and data reliability issues hinder DoD from implementing and conducting oversight of the MTA pathway."[12]
- R&D drives 83% of non-COVID 2021 OTA awards, steady over 2019-2021. Production represents 7% of non-COVID 2021 OTA awards, down from 11% in 2019, implying OTAs remain R&D focused.[13]
- AFWERX awardees received an average of just ~$600K in post-award government awards.[14]

How to Improve Grade

While DoD use of prototype Other Transaction Authorities (OTAs) is on the rise, the increase is slowing. The key is to award follow-on production OTAs to field new capabilities.

There is an opportunity to expand the Software and Digital Technology Pilot Program to a greater number of programs, as requested by the Secretary of Defense in both FY22 and FY23. In order to justify growth of the pilot program, the DoD must provide the requested data to allow for a thorough evaluation of the programs impact.

10. Pull-Through for Broader National Priorities

Overall grade: B- Trend: →

The U.S. remains the global leader in NSIB-relevant services and defense capabilities. The economy receives "spillover" benefits from NSIB investment (primarily via economic growth, productivity, and employment), but the competitiveness outcomes are uneven (e.g., manufacturing lags global peers). Government digital capabilities and efficiency lag private sector counterparts.

Criteria #1. NSIB innovation improves American economic and competitiveness outcomes.

Grade: B

NSIB innovation translates into U.S. competitiveness across academic research, some critical tech sectors, and drives positive impact on human capital within aerospace & defense (A&D).

Return / Multipliers on NSIB Innovation Investment

- Academic research indicates that defense R&D investment drives a ~0.5x multiplier on economy-wide R&D, generating up to $85B in incremental economy-wide R&D.[1]
- U.S. featured 21 of the top 100 science and technology clusters in the 2022 Global Innovation Index (same number as China).[2]
- Semiconductors power an additional 300 sectors, and for each person directly employed in the semiconductor industry, an additional 5.7 jobs are supported economy-wide.[3]

U.S. Competitiveness in NSIB-Relevant Sectors

- The U.S. lags China in high-tech exports, in terms of absolute volume (~$169B vs. $942B in 2021) and as a share of manufactured exports (~20% vs. ~30% in 2021). Such exports are also declining as a share of U.S. manufactured exports (down from ~30% in 2007).[4]
- As of 2023, the U.S. was home to 10 World Economic Forum industry 4.0 lighthouses compared to 50 such lighthouses in China. Only one new 2022 lighthouse was in the U.S., compared to 14 new lighthouses in Mainland China and five in India.[5]
- In 2020, ICT services accounted for ~20% of U.S. exports, compared to only ~6% of Chinese exports. U.S. technology firms are also market-leading globally.[6]
- Only 12% of modern semiconductor manufacturing capacity is located in the U.S.[7]

Human Capital Impact of NSIB Innovation

- The A&D sector employs 2.1 million people in the U.S. per the Aerospace Industries Association, with employees in every state. A&D jobs are also highly-paid, with average salaries of $106,700, approximately 40% above the national average.[8]

Criteria #2. NSIB innovation advances government efficiency/ effectiveness across non-defense priorities.

Grade: C

Public sector digital capabilities have room for improvement, especially compared to the private sector and decreases in annual IT spending.

Government Efficiency Gains Driven by NSIB Innovation

- Public sector digital capabilities lag the private sector. Despite significant investment by the DoD (which made 3,232 IT investments in FY2021, only 31 major), only 12% of servers were virtual as of Q4 2022, up from 8% in Q2 2022.[9] Such growth is positive, but ~65% of private sector IT commitment is in the cloud.[10]
- IT spend per government employee declined from $17,500 to $14,500 from FY2021-FY2023 but remains above private sector benchmarks.[11]

How to Improve Grade

Ensure that key areas of innovation translate to economic competitiveness outcomes as well as government efficiency and effectiveness.

Signature Recommendations

1. ***Foster stronger relationships with the private investment community.*** With the preponderance of research and development funding originating from the private sector, Congress and the DoD must do more to incentivize investments in defense and dual-use technologies, including expanding public-private partnerships and exploring other financial mechanisms to scale NSIB companies. These actions will encourage NSIB actors to take greater risks, increase internal R&D funding, and invest in upskilling their workforce. Congress must also make permanent Section 884, the Pilot Program on Domestic Investment of the Fiscal Year 2020 National Defense Authorization Act, that eases restrictions on certain venture-backed small businesses from participating in DoD innovation programs.

2. ***Scale up workforce development programs to increase domestic STEM output and skilled trades.*** We must increase our investment in programs that address our aging and underrepresented STEM and skilled trade workforce, including doubling the DoD's Scholarship for Service output (currently less than 500 per year) and scaling early education programs that provide familiarization with national security challenges and career opportunities such as Hacking for Defense. We should also make shorter-term training programs eligible for federal programs like Pell Grants. This would help close the manufacturing skills gap, as students and employers could access federal funds that traditionally subsidize college degrees to fund credential programs, apprenticeships, and internships in trade skills.

3. ***Establish additional mechanisms to increase the foreign talent pipeline for critical national security technologies.*** The United States must create a more diverse global talent pipeline that not only attracts the world's top talent for educational opportunities but provides a mechanism to remain in the country upon graduation. This includes reforms to the H1-B process and Congress establishing a National Security Innovation Base Visa program, as has been proposed in the National Security Innovation Pathways Act, to address critical national security technologies workforce requirements with appropriate but expedited vetting of applicants.

4. ***Create additional technology-focused international alliances and partnerships.*** The United States must increase the number and scope of bilateral and multilateral technology alliances to better compete against growing Chinese investments. These partnerships must be strategically aligned against critical technologies, defense modernization priorities, and global supply chains and focus on frameworks for technology usage, supply chain resilience, human capital exchanges, and shared R&D investments. The DoD must also embrace and expand service-driven initiatives to develop and field emerging capabilities, similar to the U.S. Navy and USCENTCOM's establishment of TF-59 in the Middle East to experiment with unmanned surface vessels and maritime domain awareness capabilities with our partners in the region.

5. ***Make bigger, bolder, more flexible investments in new capabilities.*** The DoD must make bigger, bolder bets on investments in emerging capabilities in space, autonomy, and artificial intelligence that are more resilient and effective against today's changing threat environment. Congress should provide more flexibility in funding to help accelerate speed, keep up with new technological developments, and provide an avenue for get non-traditional suppliers.

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