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How to Overcome Barriers and Capitalize on Cooperation

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Contents

Chapter 1 | Introduction

One of the primary pillars of U.S. national security is a robust, innovative, and resilient industrial base that provides the U.S. military with the cutting-edge capabilities needed to perform complex missions. Access to such an industrial base has long been a key U.S. advantage that has delivered military capabilities unmatched by any other nation. The industrial base supports military-related research and development, production, logistics, sustainment, analysis, and a range of other functions that support U.S. strategy. In the United States, some elements of the industrial base are provided by publicly owned and operated industrial facilities, but the vast majority reside in the private sector. The largely private nature of the industrial base has been a tremendous source of strength over the years, allowing the Department of Defense (DoD) to leverage the capacity and innovation of the broader American economy. Because the American economy is closely linked to the broader global economy, another important source of U.S. military strength has been the ability to leverage the industrial capabilities of partner and allied nations, allowing the United States to access other nations' public- and private-sector industrial capabilities and to strengthen the military capabilities of allies and coalition partners in return.

The strategic importance of the industrial base has been appreciated by the U.S. government for decades. Facing concerns about the end of the Cold War's impact on the industrial base, the U.S. Congress in 1992 required the DoD to report annually on "steps necessary to foster and safeguard the National Technology and Industrial Base [NTIB]."[1] From the beginning of this requirement, the definition of the NTIB included entities outside U.S. borders, reflecting the long history of defense industrial cooperation between the United States and other nations, especially Canada.[2] The recognition by Congress that certain international suppliers are an important part of the industrial base is less surprising than it may at first seem. While Congress's strong desire to ensure that defense spending primarily supports the domestic industrial base is well demonstrated by a range of U.S. domestic source legislation, implicit in much of this legislation is the recognition that both commercial and defense supply chains are global. Most U.S. domestic sourcing requirements allow for foreign content in U.S.-produced goods, and the Buy America Act provides a range of appropriate exceptions for things such as overseas purchases and items not available from U.S. suppliers. Even during the height of U.S. manufacturing dominance in the middle of the twentieth century, when most domestic source requirements were established, U.S. policy has recognized the importance of retaining access to global technology and industrial capabilities.

The Changing Strategic Environment and the Industrial Base

Today's strategic environment requires an even greater focus on ensuring access to a robust, innovative, resilient industrial base. The case for this was forcefully made in the 2017 National

[1] 10 U.S. Code § 2446a—Annual Report to Congress, https://www.law.cornell.edu/uscode/text/10/2504.

[2] For an extensive look at the impact of the U.S.-Canada defense industrial partnership, and for background on its history, see: Kristina Obecny et al., *U.S.-Canadian Defense Industrial Cooperation* (Washington, DC: Center for Strategic and International Studies, June 2017), https://csis-prod.s3.amazonaws.com/s3fs-public/publication/170628_Obecny_USCanadianDefenseCoop_Web.pdf?rgkZWhKSPLu_2LKlSj0TYT144uc82xzP.

Security Strategy (NSS) and in the 2018 National Defense Strategy (NDS). The NDS, in particular, notes the changing nature of the industrial base in the current global strategic environment, arguing that "new commercial technology will change society and, ultimately, the character of war" and that the "Department's technological advantage depends on a healthy and secure national security innovation base that includes both traditional and non-traditional defense partners."[3] In the new global strategic environment the NDS describes, where the development of technologies with major national security application is increasingly led by commercial firms, the United States cannot assume that all of the capabilities it needs will be found domestically or that the availability of these capabilities can easily be managed through U.S. technology controls. The NDS goes on to emphasize the criticality of working closely with allies and partners to secure common security interests. Indeed, one of the more notable phrases in the NSS and the NDS is the introduction of the term "National Security Innovation Base" as an expansion of the traditional concept of the defense industrial base. In remarks at the Center for Strategic and International Studies (CSIS) on January 22, 2018, at an event entitled "Charting a New Course for the Industrial Base," Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy Eric Chewning stated that the National Security Innovation Base differs from the traditional definition of the defense industrial base primarily in its inclusion of large commercial technology providers, small emerging technology providers, and universities in addition to the traditional industrial base as part of the full ecosystem on which DoD depends. He also commented later in the same event that the NTIB is indeed an important part of this ecosystem.

Observing the same changes in the strategic environment that informed the NSS and NDS, the U.S. Congress has acted in recent years to streamline the process of acquiring commercial technology for defense purposes and also, in Section 881 of the National Defense Authorization Act for Fiscal Year 2017, to expand the statutory definition of the NTIB to include persons and organizations in the United Kingdom and Australia as well as those in the United States and Canada. Section 881 further directed the DoD to "develop a plan to reduce the barriers to the seamless integration between the persons and organizations that comprise the national technology and industrial base."[4] The NTIB partner nations have been meeting regularly as part of the effort to respond to the mandate in Section 881 and have developed a framework of pathfinder efforts to explore NTIB integration, which included discussions on cybersecurity, controlled goods, and industrial and investment security.

Integrating the National Technology and Industrial Base

CSIS undertook a project in 2017 to examine what it might mean to more seamlessly integrate the NTIB, particularly in light of NTIB expansion. This report summarizes the major themes and findings identified by the CSIS project team over the course of four workshops held with representatives from all four NTIB partner nations as well as experts from industry and the policy community,

[3] Department of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge* (Washington DC: Government Printing Office, January 2018), https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf.
[4] National Defense Authorization Act for Fiscal Year 2017, Public L. No. 114-328 (Washington, DC: 114th Congress, 2016), https://www.congress.gov/114/plaws/publ328/PLAW-114publ328.pdf.

includes two case studies that highlight many major issues in deepening NTIB integration, and provides recommendations for the NTIB partners based on this work.

The project began with an examination of what strategic objectives NTIB integration can help achieve and what areas of discussion were most likely to help the NTIB partners facilitate these objectives. There was strong consensus that NTIB integration has the potential to foster the shared objectives of encouraging innovation and leveraging of commercial technology for military purposes; advancing key technologies needed for common security challenges in Europe and Asia; making the industrial base more resilient to shocks and able to deliver capabilities at lower cost; and facilitating allied interoperability. The second workshop focused specifically on innovation, examining how mechanisms such as Other Transaction Authority (OTA) agreements and other innovative business arrangements might play a role in NTIB integration. This discussion found that OTAs as well as more traditional tools like cooperative research agreements have the potential to help the NTIB partners work collaboratively with each other and with key players in industry to advance critical technologies especially in areas where there is significant congruence between military and commercial applications.

The project then turned to two cases studies intended to highlight both opportunities and barriers to NTIB integration: one case study focused on performance-based logistics (PBL) and one case study focused on open systems architecture. These case studies were carefully chosen because both seem to present obvious opportunities for NTIB integration. In the case of PBL, the opportunity for the NTIB arises from all four NTIB partners operating a range of common systems, such as the Chinook helicopter, and in many cases, all four NTIB partners are currently engaged in PBL arrangements to sustain these common platforms. In the case of opens systems, the opportunity for the NTIB arises because open systems approaches are by their very nature designed to create the opportunity for a wide variety of industrial partners to work together and to lower the cost and complexity of integration.

Drawing on these workshops and case studies, this paper gives a tour of the potential and obstacles the NTIB faces, in Chapter 2 and 3, respectively. Chapters 4 through 6 examine three case studies, PBL, open-system architecture, and OTAs, which represent possible avenues for further industrial integration, drawn from CSIS research and workshops. The paper then proceeds to recommendations, based on the breadth of these research efforts, before concluding with a summary of key findings and recommendations.

Chapter 2 | Integrate for What? Benefits of Expanded NTIB Collaboration

The initial stage of this project focused on exploring the strategic aims served by integrating the NTIB, and participants from the NTIB partners offered several ideas about what these objectives should be. The project team proposed the following list of objectives for NTIB integration to guide discussion:

- Expand existing relationships (mil-to-mil and industrial) to promote interoperability in support of allied strategic interests, force objectives, and warfighting capabilities
- Secure access to unique technologies and innovation, military and civilian
- Deliver the best available defense material in a timely and cost-effective manner
- Strengthen industrial capacity and preparedness by leveraging a broader base of suppliers and engineering, manufacturing, and sustainment capabilities
- Achieve savings through cost sharing and economies of scale between NTIB countries
- Strengthen industrial partnerships to allow for increased complementarity and specialization among NTIB countries
- Enhance partnership capacity building through more integrated, collective NTIB efforts

Participants saw integration of the NTIB as an opportunity to maximize delivery of capability to the warfighter to protect against common threats. They also noted that no one nation has a monopoly on ideas, high technology, or STEM (science, technology, engineering, and math) talent, and further integration will allow the NTIB to leverage a broader industrial capacity and to accrue economic gains for mutual benefit. A point of emphasis was placed on the important U.S. role in underpinning security in the Asia-Pacific region and continuing a global rules-based order. Interoperability between U.S. and allied forces has been and will continue to be paramount to support Coalition operations, and the NTIB should promote military capabilities that enable partners to work alongside U.S. forces. Participants also noted the complementary nature of the NTIB legislation with U.S. and NTIB partner objectives to take advantage of global innovation and manufacturing expertise. Many partners commented they were ready to expand upon the cooperative programs they already have with the United States.

One participant noted that the initial CSIS list should be expanded to account for the Section 881 language that is specifically geared toward better accessing and acquiring commercial technologies. Relatedly, the need for greater integration across technology bases and for mechanisms to promote early vectors for integrated R&D planning and cooperation was highlighted during the discussion. A coordinated, strategic framework for R&D cooperation would

allow NTIB countries to pull together at an early stage to help drive industrial activities toward common goals. Participants also acknowledged that innovation is moving increasingly to the private sector—requiring that each country broaden the pool in which they “fish” for technologies. The challenge lies in whether NTIB countries can remove barriers and be more agile in accessing collective STEM talents than potential adversaries.

Workshop participants then discussed the role that institutions might play in promoting NTIB integration. CSIS highlighted the Warfighter Senior Integration Group (SIG) as an example where a high-level initiative was established to coordinate across multiple offices and agencies to promote rapid acquisition solutions. A similar high-level initiative may help drive implementation and troubleshoot problems as they arise. Participants seemed wary of too much centralized management and coordination. One participant advocated a bottom-up approach, whereby institutions should follow from, not precede, an effort to identify processes for standardization and streamlining.

Other members noted that integration does not just implicate coordinating bodies, but that reciprocal institutions often need to be established to work effectively with the U.S. system. Canada has had to make adjustments to their policies and processes as the United States adjusted theirs. In the case of Canada’s International Traffic in Arms Regulations (ITAR) exemption, maintaining that exemption came with obligations including investing in and setting up an entire department, the Controlled Goods Program, to meet U.S. standards and requirements. There is a *quid pro quo*, where both partners must make investments to sustain the relationship, even when there may be disagreements on policies. The Canadian Commercial Corporation, for example, was established as an interlocutor and contract guarantor to increase U.S. confidence and ease of doing business with Canadian firms. These mutual obligations are worthwhile to form a broader community of effort, and over the years, Canada and the United States have been able to change policies to the benefit of both countries.

Chapter 3 | Barriers to NTIB Cooperation

This section focuses on the barriers in the U.S. system that can obstruct collaboration even when the United States deems it a priority. Most of these barriers are the consequences of acquisition processes, policy, or culture that follow U.S. law and seek to promote security, support U.S. industry, and prevent destabilization. These core interests are in tension with one another and the challenge for the NTIB is balancing the United States' protection of these core interests with the benefits of greater cooperation.

This report examines barriers through two lenses. First, the study team uses the results of sectoral case studies executed for CSIS's prior report on the *U.S.-Canadian Defense Industrial Cooperation*.[5] These case studies involved looking at four different sectors of the industrial partnership,[6] examined multinational contract data, interviewed government and industry experts of both nations, and included multiple workshops with a wide range of experts. The Canadian experience is worth the focus because, of the four NTIB partners, Canada has had the most success overcoming the barriers in the U.S. system. As a founding member of NTIB, Canada has developed a strong, integrated defense trade relationship with the United States over the last 70 years. This integration was built slowly, with many reciprocal measures from both countries, and is continuously evolving to overcome the challenges of an everchanging security environment. The history of the United States-Canada relationship thus shows highwater marks with potential for other NTIB members and barriers that yet remain in even the most integrated industrial relationship.

The second lens of this report was an NTIB-wide workshop hosted by CSIS in February 2017 looking at challenges and opportunities after the expansion of NTIB to the United Kingdom and Australia. That workshop, and subsequent CSIS research, provided the context and additional data points necessary to summarize and update the Canada case study results to look at barriers across the entire NTIB.[7] Between these two sources, CSIS has identified four key categories of barriers: restrictions on foreign acquisition, export controls, national security and foreign disclosure policy, and cultural or institutional barriers.

Restrictions on Foreign Acquisition

Each member of the NTIB has "no-go zones" in their respective industrial bases where they choose to adopt protectionist policies that are unlikely to change. In the United States, the relevant

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[5] Obecny et al., U.S.-Canadian Defense Industrial Cooperation, 48–49.
[6] The four sectors were Air, Land, Sea, and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR).
[7] This is the first openly published output of that workshop, which was held under Chatham House rules to encourage frank and open discussion. As a result, research stemming from the Canada report will specify sources based on already published materials. However, for the NTIB workshop, which included participants from all four countries as well as government and industry, the affiliation of experts and some of the identifying details of examples are excluded to protect participant confidentiality.

restrictions are: "the Berry Amendment, which restricts purchasing of food, clothing, fabrics, specialty metals,[8] and measuring tools," and "the Byrnes-Tollefson Amendment, which restricts contracting for construction or repair of vessels in foreign shipyards."[9] Restrictions on shipbuilding are not unique to the United States and other countries more open to foreign acquisition tend to balance that openness with seeking industrial or economic benefits via offset policies. Foreign acquisition barriers can disrupt cooperation but, like discussions of offset policies, are places where change is unlikely.

The approaches to mitigating these foreign acquisition restrictions are well established. Foreign firms will sometimes respond to these acquisition barriers by establishing subsidiaries within the country doing the purchasing using technologies supplied by the parent company. As in other areas of trade, government-to-government negotiations often increase industrial access; however, the pace of change is long term and will miss the window of opportunity for present operational needs or industrial cooperation.

NTIB workshop discussions did not reveal an appetite for taking on these somewhat intractable challenges. As a result, the discussions focused more on small business set-asides and preferences, a category of exclusion directly pertinent to innovation goals and harder to mitigate with subsidiaries or other cross-border partnerships.

Small Business Set-Asides and Preferences

Promoting small and medium enterprises is important to all the governments across the NTIB, and understandably, each partner is focused on the firms within their own country. The U.S. system for small business promotion is multifaceted. Vendor size is classified using the Small Business Administration standards that vary depending on the industrial sector in question. The effect of small business categorization in U.S. contracting is significant:

> As far as the volume of defense contract obligations impacted, the FAR requires that contracting officers set aside acquisitions for U.S. small business participation as long as there is a reasonable expectation that there are at least two such firms that are competitive in terms of market prices, quality, and delivery. [10] A specific FAR paragraph mandates that all contracts exceeding the USD $3,500 micro-threshold and below the USD $150,000 Simple Acquisition Threshold (SAT) be automatically reserved exclusively for U.S. small business concerns. Additionally, the Office of Small Business Programs (OSBP) at DoD sets annual goals for the percentage of contract dollars going to U.S. small businesses. For FY2016, this goal was set at 21.26 percent of total DoD prime contracts and at 34.5 percent of total DoD

[8] "Exceptions for foreign acquisition of specialty metals are made when these items cannot be acquired as and when needed in sufficient quality or quantity in the United States." See Defense Federal Acquisition Regulation System § 225.7002-2 - Exemptions, https://www.acq.osd.mil/dpap/dars/dfars/html/current/225_70.htm#225.7002-2.
[9] Obecny et al., *U.S.- Canadian Defense Industrial Cooperation*, 49.
[10] See Federal Acquisition Regulation (FAR) Subpart 19.502-2 - Total Small Business Set-Asides, http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/19.htm#P498_101899.

subcontracts.[11] According to OSBP's latest Scorecard,[12] in FY2015, DoD awarded 24.64 percent, or USD $52.4 billion, of total eligible prime contract dollars to small businesses and 32.3 percent of total eligible subcontract dollars.[13]

No matter their size, under the Federal Acquisition Regulations, firms located in, or primarily operating from, other nations, including NTIB partners, cannot qualify for small business status, although there are marginal exceptions to this policy. [14] For example, Canada has an exception that defense supplies developed under the original Defense Development Sharing Program (DDSP) may be subjected to small business set-asides in subsequent contracts for procurement or support.[15] Although, "[i]n recent years, however, the [Defense Development Sharing Agreement] has not been used often, and the preferred Canadian business strategy to increase access to smaller contracts is to pursue partnerships or joint ventures with U.S. small businesses."[16] Additionally, there are geographic and funding-based exceptions. Regardless of country, small business goals do not track prime contracts performed outside the United States and its territories or Foreign Military Sales (FMS) funded by an international source.[17]

In interviews with industry and government stakeholders regarding the U.S.-Canadian cooperation, small business set-asides and targets were raised as a "high market access barrier" and emphasized more than the other foreign acquisition restrictions previously mentioned in this section. Canadian businesses typically pursue smaller contracts via joint ventures or partnerships with U.S. small businesses, although when there are high U.S. content requirements (discussed later under "Challenges of Foreign Military Sales") this approach is generally not effective.

Barriers to Innovation

While the larger workings of the U.S. Small Business promotion system are well established, the implications for the NTIB are worth special attention because they can be disruptive to a top U.S. defense industrial policy: gaining access to innovative new technology from firms such as small businesses and nontraditional suppliers. The United States-Canada sectorial case studies found that many of the mechanisms DoD has established to address barriers to entry for small businesses and nontraditional suppliers are not available to equivalent vendors from NTIB members:

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[11] U.S. Small Business Administration, *Department of Defense: FY2016 Small Business Procurement Scorecard* (Washington, DC: SBA, 2017), https://www.sba.gov/sites/default/files/aboutsbaarticle/FY16.DepartmentofDefense.pdf.
[12] U.S. Small Business Administration, *Department of Defense: FY2015 Small Business Procurement Scorecard* (Washington, DC: SBA, 2016), http://business.defense.gov/Portals/57/Documents /FY15_DOD_SB_Procurement_Scorecard.pdf?ver=2017-06-16-122644-590.
[13] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 49.
[14] For additional detail on the qualifications for Small Business status, see: 10 U.S. Code §2505 – National technology and industrial base: period defense capability assessments; FAR Part 19; Department of Defense Office of Small Business Programs (OSBP), *Government Contracting: The Basics* (Washington, DC: DoD OBSP, 2011), http://www.acq.osd.mil /dpap/cpic/cp/docs/Government_contracting_-_the%20Basics_-_June_2011.pdf.
[15] DFARS Subpart 219.5 -Set-Asides for Small Business, https://www.acq.osd.mil/dpap/dars/dfars/html/current /219_5.htm.
[16] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 49–50.
[17] Henry B. R. Beale, *Evaluation of the Small Business Procurement Goals Established in Section 15(g) of the Small Business Act Appendices* (Washington, DC: SBA, 2014), 96, https://www.sba.gov/sites/default/files/files/rs423app.pdf.

> Further, Canadian firms are de facto disqualified from accessing a number of DoD programs established to improve small business access and development opportunities. These include the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, as well as various other forums and consortiums to promote technical exchanges. The National Advanced Mobility Consortium (NAMC) was raised as a specific example, where collaboration on R&D, feasibility studies, and testing alternatives occur, but where membership is limited to U.S. only.[18]

The origins of these restrictions vary and are often a result of export control and foreign disclosure rules. However, regardless of origin, these restrictions lead to institutions reinforcing the barriers to small businesses' participation in the NTIB, instead of mitigating them to promote innovation.

Similarly, another typical approach to overcoming these barriers is to partner with a U.S. firm to enhance their competitive position. In CSIS case studies of the Canadian industrial base, the study team found that many such firms, even after demonstrating expertise, will not become a prime contractor to the United States directly. CSIS's Canada Report explores this question in detail and concludes:

> This is particularly true for high-profile, large U.S. programs, for work in sensitive technology areas (e.g., space), and for major overhaul or system-level service support. In all but two of the cases studied, Canadian firms needed to either establish a joint venture with a U.S. firm, leverage their U.S. parent company or U.S. sister division, or establish a U.S. subsidiary to ultimately come under a prime contract. These arrangements were generally necessary even when a U.S. service component was actively seeking greater access to Canadian technology, engineering know-how, or production capacity, and even when all parties recognized that the intellectual property would remain in Canada.[19]

This practice, however, poses the risk that innovative suppliers are absorbed into larger companies and lose the competitive edge and agility that makes them appealing as a vendor. At the other end of the spectrum, larger vendors with technology of great interest to the DoD, but also with a strong desire to retain their independence, may reject any interest in cross-NTIB collaboration. These potential outcomes are risks that the DoD is actively trying to avoid in the U.S. context.

DoD innovation initiatives are promoting a range of new approaches to address barriers to access, NTIB workshop participants proposed the possibility of implementing similar initiatives in the other NTIB partners, or cross-NTIB collaboration on small business promotion, but there are additional barriers to that sort of approach. First, definitions of business size categories vary by country, with the U.S. definition of small business setting size thresholds often notably higher than small and medium enterprises in other countries. Second, many of the parameters of the U.S. small business system come directly from the law, rather than regulatory or policy implementation. As a result, they cannot be changed by executive branch agreement alone, but would require the support of Congress.

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[18] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 50–51.
[19] Ibid., 57.

Export Controls

While foreign supplier restrictions are focused on building and maintaining a country's industrial base, export control restrictions are oriented toward limiting who can gain access to exported arms, technology, and related information. The United States has multiple systems of technology controls, but the most important one for defense trade and cooperation is the International Traffic in Arms Regulations (ITAR). To manage the dissemination of technology, ITAR can restrict defense products as well as who has access to the knowledge behind developing them.

Export licenses are primarily granted on a transactional basis, which means that the effort of applying for and evaluating a license application must be repeated many times over the life of a project. One NTIB workshop participant suggested the long-discussed idea of "program licensing," which would set upfront rules for what can be exported or transferred. The F-35 program was provided as an example of how transactional licensing inhibits collaboration and complicates production. Even though the program was precleared for the partner nations and FMS purchasers, participating companies still had to seek transactional licenses at every stage of the process. Revised regulations could allow for program licensing upfront based on what each country wants to see exported/transferred. Particular frustration was noted in how industry must engage with third party transfer policies and the lack of clarity on regulations that restrict transfers among NTIB countries even within the same company.

As another example of these concerns, one workshop participant pointed to an example in quantum computing where universities in an NTIB partner nation were hesitant to work with U.S. universities. The fear was not that the export control system would prove a hard block to cooperation, but that the opportunity costs of time and money spent on compliance would outweigh the benefits of cooperation.

Ineffective Defense Trade Cooperation Treaties

The UK and Australian Defense Trade Cooperation Treaties were raised repeatedly in workshops and discussions with international partners as a cautionary tale. These bilateral arrangements with the United Kingdom and Australia have language describing common interests and goals, but officials from both governments found that they were ineffective in practice. The limitations cited for these treaties were twofold. First, Congress excluded many critical technology areas from the jurisdiction of the treaty. Second, the implementing agreements included additional complex requirements to the existing processes. In the eyes of critics, the outcomes fall short of the objectives laid out in the treaty language.

In defense of the agreement, other NTIB workshop participants noted that the treaties should be seen in the context of a larger and sustained export control reform effort. The principal focus of that effort had been to concentrate the U.S. munitions list on those items that are most important to protecting, and moving the remaining items to the Commerce Department control list,[20] within

[20] Responsibility for U.S. export controls is divided between the State Department, the Commerce Department, and the Department of Defense. The Commerce Control List, an outcome of Export Administration Regulations, primarily covers items with potential civilian uses and is less restrictive than the U.S. Munitions Control List, which is managed by the State Department.

the limits allowed by law. The State Department over a multiyear course of the export control reform effort processed all but three of the 21 U.S. Military List categories. This effort has had measurable effects for the NTIB, reducing licensing by two-thirds for the United Kingdom and by half for Australia. That said, the change had still left the United Kingdom with the second-highest number of commercial licenses.

Critics acknowledged these points but argued that many of the challenges with export controls that inhibit cooperation do not come from legislation but from fears of the system. This concern about perception appears to be borne out in industrial behavior and is a recurring theme that cuts across the four categories of barriers considered in this piece. After the Munitions List cleanup is completed, the next stage for export control reform is improving management of the remaining list, which includes hot topics like commercially available items, technical data, and third-party transfers. That said, there seemed to be little confidence that export control reform efforts would singlehandedly revitalize these treaties. Based on past NTIB experiences, major steps toward integration involve partner countries developing reciprocal institutions to better work with the U.S. system.

Lessons from the Canada ITAR exemption

By comparison, Canada is unique in holding an "exemption" from ITAR licensing regulations.[21] This exemption means that licenses are not necessary for U.S. exports into Canada or temporary imports from Canada into the United States for large swaths of technical data, services, and unclassified defense articles. While Canada's ITAR exemption has paved pathways for greater industrial cooperation with the United States, there are three main areas of issues where the new NTIB members can learn from: handling of technical data, sectors heavily restricted by ITAR, and implications for commercial operations. Which features of the U.S.-Canada defense-industrial partnership will be extended to other NTIB members remains an open question. There is some ambiguity for NTIB-specific benefits because the Defense Federal Acquisition Regulations (DFARs) are inconsistent in their language, often referencing the NTIB interchangeably with Canada. This means that new, explicit language is necessary for Australia and the United Kingdom to be included in the same NTIB regulations that currently refer to Canada exclusively. Moreover, the "Part 126" ITAR exemption is specific to Canada rather than being a feature of the NTIB. While creating exemptions for the United Kingdom and Australia specifically, or the NTIB more generally, are possible paths forward, in the absence of such an exemption, ITAR remains one of the greatest obstacles facing closer NTIB collaboration.

Canada's reciprocal arrangements are also critical to understanding the investment and quid pro quo necessary to maintain their defense trade relationship with the United States, which tends to maintain lower barriers than the other NTIB members. Canada temporarily had its ITAR exemption revoked over questions regarding dual-nationals and unlicensed export of defense articles originated in the United States. The United States was concerned that citizens of countries such as North Korea or Venezuela could divert ITAR-controlled goods. This targeting, particularly of

[21] Canada stands alone in having not been required to enter into a bilateral prior to receiving exemptions. The United Kingdom and Australia do exemptions but are dependent on the bilateral terms. Canada-specific exemptions are listed in 22 CFR § 126.5-Canadian exemptions, https://www.pmddtc.state.gov/regulations_laws/documents/official_itar/ITAR_Part_126.pdf.

individuals who were also citizens of Canada, risked running afoul of the Canadian Charter of Rights and Freedom protections against discrimination on the basis of nationality. Restoring the exemption required setting up a department to manage the Canadian Controlled Goods Program (CGP) that seeks to ensure defense trade rule compliance. Both countries have also had to work to maintain the relationship even in the presence of policy disagreements. In 2011, this led to the Canadian Enhanced Security Strategy that sought to make protections more robust but also ensure that "security assessments of individuals accessing controlled goods are conducted in a uniform manner."[22] A workshop participant noted that U.S. law requires that certain conditions must be met before an extension of the Canadian exemption to other countries would be possible, and concerns over dual citizens and third-country nationals may need particular solutions for each nation.

The Canada case shows that categories of items that are omitted from the overall exemption may complicate strategic cooperation in the NTIB in some areas. Even for Canada some items on the U.S. Munitions List are not exempted, including:

- All classified defense articles, services, and technical data;
- All nuclear, strategic delivery, Missile Technology Control Regime (MTCR), and missile technology;
- All defense services and technical data related to applied research, design methodology, engineering analysis, and manufacturing knowhow, as defined in ITAR Section 125.4;
- All defense services other than those required to prepare and bid on a proposal, or to produce, design, assemble, maintain, or service a defense article;
- All aircraft (manned and unmanned) defense articles;
    - All developmental aircraft engines and components;
    - All manufacturing knowhow related to aircraft and inertial navigation systems;
- All manufacturing knowhow related to radar systems and electronic combat equipment;
- All defense articles and services specific to spacecraft and satellites (except commercial communications satellites);
    - All designed and modified systems, components, parts, accessories, attachments, and associated equipment of spacecraft/satellites;

[22] Government of Canada, "Key Events That Shaped the Controlled Goods Program," Public Works and Government Services Canada, March 31, 2016, http://ssi-iss.tpsgc-pwgsc.gc.ca/dmc-cgd/ei-ke-eng.html.

- All defense articles and services related to submersible vessels, oceanographic, and associated equipment.[23]

These omissions mean that the ITAR exemption does not apply to some promising areas of U.S. and Canadian cooperation, such as for space operations, where Canadian commercial technology has made major strides.[24] That said, some challenges have been mitigated by U.S. export control reform efforts, for example, moving many parts for the F/A-18 Hornets from the U.S. Munitions List to the Commerce Control List, which is not as highly regulated. Additionally, while the Canada exemption does not include satellites, export control reform efforts have moved several space systems to the Commercial Control List, including "Lower-Performance Remote Sensing Satellites."[25]

The sectorial case studies found that experts within Canadian industry viewed ITAR as a primarily administrative burden and "accepted part of the business." The ITAR rules were not a hard barrier to cooperation even if they created delays and required a compliance and security "learning curve," which could be a greater challenge for smaller businesses. ITAR is a manageable obstacle for those U.S. corporate partners that wish to cooperate and an easy excuse for those that wish to say no. Admittedly, Canada does have a geographic advantage over other NTIB members because sharing a border makes it less expensive and onerous to send Canadian personnel to the United States for design and engineering purposes when a component of a U.S. system cannot be sent to Canada due to export controls.

CSIS's past research found three areas where barriers remain, even with the ITAR exemption in place:

1. Technical data, particularly in the context of engineering and developmental work.

2. Sectors still heavily restricted by ITAR, that is, the space sector and submersibles.

3. Secondary effects on the commercial operations of companies.[26]

First, barriers to technical data sharing presents a challenge that is company-to-company oriented, as opposed to company-to-government oriented. Engineers reported challenges when sharing information despite the specific allowances.[27] This is consistent with a larger observation from the NTIB partners workshop that ITAR interpretation was highly variable between different countries, with industry growing more conservative in how they apply it. The second challenge, where some sectors are still heavily restricted by ITAR, was discussed earlier in this section as a barrier caused by U.S. regulations. However, in the space sector specifically, barriers can arise from both nations.

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[23] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 51–52.
[24] Ibid., 30–33.
[25] Bureau of Industry and Security, "Export Control Reform Spacecraft/Satellites" (Washington, DC: Department of Commerce, 2014), 7, https://www.bis.doc.gov/index.php/documents/pdfs/1095-satellites-and-spacecraft-nov-14-2014/file.
[26] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 52–53.
[27] "22 CFR §126.5(b) allows for the license-free export of unclassified defense articles and defense services, which does not exclude technical data." See: Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 52.

The United States and Canada each seeks to maintain a level of industrial capacity in space, which complicates cross-border hardware acquisition as well as mergers and acquisitions.[28]

The final challenge facing NTIB integration is secondary effects on commercial operations, touching on the recurring barrier theme of the challenges for commercial players. The Canadian defense industry is dual-use focused and relies heavily on exports, which makes them concerned about preexisting products falling under the jurisdiction of the U.S. export control system (this was referred to by a NTIB workshop participant, somewhat pejoratively, as "ITAR contamination"). The U.S.-Canadian sectorial case study found that Canadian industry was concerned with the risk of losing control of their components when they are integrated into a U.S. defense system or modified at the request of the DoD. This challenge was addressed by maintaining up to three different lines of operations within an individual vendor, which allows for separate treatment for advanced ITAR-controlled items, other items subject to Canadian export controls, and purely commercial items.

Collectively, the ITAR exemption does appear to have allowed for genuinely greater industrial integration within the original NTIB, which included Canada and the United States. Nonetheless, these three issues—handling of technical data, sectors heavily restricted by ITAR, and implications for commercial operations—can still impede on U.S.-Canadian cooperation. Therefore, if the Canada model is used, these issues could remain as barriers even if an exemption is added for other NTIB members.

Challenges of Foreign Military Sales (FMS)

The United States maintains a Foreign Military Systems, which allows for government-to-government agreements for arms export and support. This system works through the U.S. contracting system and can be favored by countries for a variety of reasons. For instance, a partner nation could want the U.S. government to carry more of the contracting risk or want longer-term U.S. supported sustainment.[29] NTIB partners can participate in the FMS process in multiple ways. On the exporter side, they may sell an ITAR-controlled item as a prime, such as light armored vehicles, or they may sell a component or subsystem that is integrated into a larger system, typically one manufactured by a U.S. prime.[30] NTIB partners may also purchase U.S. defense products through the FMS system, which may be their only option if they wish to acquire an FMS-only system.[31]

[28] "Govt. confirms decision to block sale of MDA space division," CBC News, May 9, 2008, http://www.cbc.ca/news /technology/govt-confirms-decision-to-block-sale-of-mda-space-division-1.698584.
[29] Recipients of U.S. Foreign Military Financing also typically use the Foreign Military Sales system, but some funding is spent through direct commercial sales. For more on the topic, see: National Defense Industrial Association, "Foreign Military Sales vs Direct Commercial Sales," *National Defense Magazine*, 2017.
[30] "The Canadian land industrial sector is known for its industry leadership in light armored vehicles, but also has a base of smaller firms operating in various niche areas, especially in its ability to provide adaptive, innovative technology and industrial capacity to quickly respond to emerging (and urgent) U.S. military requirements such as armor and ballistics protection." Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, IX.
[31] FMS-only refers to times when, for technological sensitivity or control of weapons or munitions reasons, a military product must go through the FMS system rather than having the option of a Direct Commercial Sale. See Defense Security Cooperation Agency, "Security Cooperation Overview," in *2014 Foreign Customer Guide* (Washington, DC: Department of Defense, 2014).

According to NTIB workshop participants and the findings of United States-Canada sectorial case studies, the FMS system is often unappealing. The first reason is that it can be time and cost intensive because foreign defense articles, and those receiving new modifications, must go through the U.S. testing and certification process regardless of whether they have been certified by their own country. This is less of an issue for large-volume sales of full systems, where relationships with the U.S. program officer and the Defense Security Cooperation Agency (DSCA) are already in place. However, for sales to small countries who often seek nonstandard solutions, the additional testing required by the FMS system can make it less efficient than using national approaches, such as Canadian exporters contracting to the Canadian Commercial Corporation (CCC), which partners with the foreign government.

The second challenge for NTIB partners working with FMS is that the U.S. Arms Export Control Act (AECA) actively promotes U.S. supply chain participation at the expense of vendors from other nations. When a contract relies on Foreign Military Financing, via grants or loans, DSCA guidelines are that the prime contractor must be a U.S. vendor, 51 percent of the content must be of U.S. origin, and the final manufacture and assembly must be in the United States. Finally, any non-U.S. content must have a source other than Foreign Military Funding. Waivers are available regarding offshore procurement and funding of non-U.S. content for mixed items; however, the other restrictions still apply. The work of foreign subsidiaries, such as vendors from NTIB partners, counts as foreign content.[32]

The United States is hardly atypical in seeking to promote its own defense industry, particularly when it is providing financing. However, some of the present properties of the FMS system make it challenging for NTIB partners to collaborate on equipment support. Based on interviews with Canadian vendors, it requires a cross-border partnership with a U.S. prime or subsidiary and then may require a reworking of the NTIB's vendor supply chain to add U.S. suppliers to meet Arms Export Control Act requirements.

Due to these challenges, the FMS system is often seen as unappealing to NTIB partners. One alternate path is direct commercial sales, though one workshop participant argued the necessity for larger reforms of the system's efficiency as well as a specific look at which FMS-only defense articles and services truly deserve that status. Other alternatives, often involving bilateral Memorandums of Understanding (MOUs), can lack the breadth and clarity needed for success. One workshop participant pointed out that standard MOUs allow sharing of information but leave the defense article itself to be handled separately. In summary, there is still a great deal of ambiguity in third-country transfers, FMS, and transfer licensing that has caused embarrassing delays.[33]

National Security and Foreign Disclosure Policy

All countries have their secrets and rules on who can access those secrets. These rules are often particularly strict when it comes to transmitting secrets to foreign governments, including allies.

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[32] Defense Security Cooperation Agency, "Guidelines for Foreign Military Financing of Direct Commercial Contracts" (Washington, DC: Department of Defense, 2009), http://www.dsca.mil/sites/default/files/2009_guidelines_for_fmf_of_dccs_0.pdf.
[33] Paraphrase is originated in the Summary of the February 2017 workshop.

Classification and foreign disclosure policy can mutually reinforce export control barriers, for example, the exclusion of classified defense articles, services, and technical data from Canada's ITAR exception. U.S. National Disclosure Policy-1 is straightforward on this matter: "classified military information is a national security asset that shall be protected and shall be shared with foreign governments only when there is a clearly defined benefit to the United States."[34]

Because clearly defined benefits are often available, the United States has a variety of formal agreements to enable such sharing. In the case of Canada, there has been a series of bilateral agreements dating back to 1952 with associated institutions like the Contract Security Program to help contractors obtain facility and personnel clearances and to bid on classified contracts from other countries and NATO. Multilateral arrangements also exist, but can be an awkward fit for NTIB as Australia is not a member of NATO and the NTIB does not include New Zealand and thus only four-fifths of Five Eyes. The workshop participants did not raise this as a significant concern, except as reminder of the limitations of purely NATO-based solutions.

Dealing with classified material across borders can pose a challenge, but existing arrangements help to facilitate government-to-government and government-to-vendor cooperation. That said, workshop participants and interviewees did raise two relevant concerns, both involving possible misclassifications. First, some competitions are marked as "not foreign," sometimes even when no classified material is involved, which prevents a vendor from an NTIB partner nation from even offering a possible technical solution. Second, over-classification can introduce regulatory burdens to what could be straightforward cooperation. The United States-Canada relationship provides one illustrative example: "Although Canadian industry was providing engineering support to U.S. F/A-18 Hornets, the depot-level maintenance contract solicitation was originally released as U.S.-only (but was later changed) due to sensitive onboard equipment."[35] As subsequently discussed in the OSA section, making portions of an open architecture classified makes it dramatically harder to use for international partners.

NTIB partner vendors often establish U.S.-based operations to overcome the challenge of classified information transfer, this is most prevalent in areas like technology where classification is more common. As evident in earlier sections of this report, foreign vendors open facilities in the United States to work around a variety of barriers. That said, using foreign technology to perform U.S.-based work can be its own challenge due to U.S. Foreign Ownership, Control, or Influence mitigation measures. [36] This may involve a subsidiary taking on a board of directors, comprised of U.S. citizens, that must be approved by the U.S. government. In some instances, these measures can significantly complicate operations: "under the Proxy Agreement, the U.S. subsidiary became effectively 'firewalled' from all communication with the Canadian parent company, such that even basic communication (e.g., phone calls) required a seven-day approval process, disrupting everyday company operations."[37]

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[34] See Department of Defense, *Directive 5230.11—Disclosure of Classified Military Information to Foreign Governments and International Organizations* (Washington, DC: DoD, 1992), https://fas.org/irp/doddir/dod/d5230_11.htm.
[35] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 68.
[36] U.S. Department of Defense, Defense Security Service, "FOCI Mitigation Instruments," http://www.dss.mil/isp/foci/foci_mitigation.html.
[37] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 68.

In other cases, the U.S.-Canadian sectorial case studies found that Canadian vendors believed that when they had appropriate clearance from their government, they could access U.S. classified documents in a timely manner. Instead, the challenges arose when accessing U.S. manufacturer facilities, which were less likely than their government counterparts to accept foreign visitors even when covered by reciprocal security clearance agreements. Similarly, the U.S. industry may set stricter standards than those required by existing agreements in their relationship with Canada. For instance, "In at least two cases, firms were not aware of the Joint Certification Program, which allows for U.S. and Canadian contractors to have access to unclassified controlled military data on an equal basis."[38]

Cultural and Institutional Barriers

Cultural and institutional barriers refer to widespread practices that are neither legal, regulatory, nor top-level administrative decisions, but still hinder cooperation. For example, even though Canada has been formally part of the NTIB for 70 years, it is still often considered a "foreign source" even when no regulatory hurdles apply. This wariness that resulted from overlooking Canada's NTIB status was not an issue in cases where there were long-standing relationships or government-level joint development projects. However, these specific scenarios are not options for most firms, forcing many would-be prime and NTIB vendors instead will often become a subcontractor.

With regard to this paper's case study of performance-based logistics (PBL) contracts within the NTIB, the barriers to entering the U.S. contracting system as a prime, or graduating to direct prime contracting after being a subcontractor, are particularly pronounced in service-related industries. Case studies of Canadian industry found unexpectedly high barriers:

> U.S. military service components appear hesitant to award large in-service support contracts to Canadian industry, even where relevant engineering capabilities exist as a result of Canada maintaining similar systems, particularly air platforms. Similarly, one provider of integrated training services only began providing fully combined product and service support after establishing a U.S. subsidiary. This delay came even though DoD had been purchasing the included products for decades and NATO and other allied countries had been buying similarly combined products and services for over a decade.[39]

Existing contract lock-ins with original equipment manufacturers (OEMs) can contribute to this challenge. This barrier is not particular to cooperation between NTIB members, and can also hold for potential domestic competitors. The U.S.-Canadian sectorial case studies findings elaborate on this problem:

> Another cultural challenge raised frequently was the tendency of U.S. service components to default to OEMs or to bundle contracts such that OEMs control the market for components, subsystems, and in-service support. In some cases, this limits opportunities for firms not already considered 'preferred suppliers' for the OEMs. It can also limit

[38] Ibid., 60.
[39] Ibid., 57.

> competition where the incentive structure is perverse, for example, this happens when a supplier brings a product or engineering solution that eats into the OEM's allowable costs.[40]

The discussion of PBL later in this paper is relevant to this problem because PBLs seek to align prime incentives with the best cost and performance outcomes, which would reasonably include looking abroad to suppliers in NTIB partner nations.

Another cultural barrier comes from unfamiliarity with NTIB arrangements. Even with its 70-year history, the study of the U.S.-Canadian relationship found that ignorance of agreements or variable interpretation of the relevant standards could lead to difficulties and inhibit cooperation. In many cases, solicitations might be marked as being open only to U.S. suppliers even though the regulations would permit participation by anyone in the NTIB. As with the factors driving Canadian firms to subcontract, this was most common with new programs or contracting offices lacking experience working with NTIB members. One example of this lack of familiarity creating barriers is directly relevant to the open systems architecture case study addressed later in this report:

> This, in some cases, created delays in accessing technical data during contract solicitation processes and challenges in gaining access to government intellectual property repositories. In one case, a Canadian firm, with a history of cooperation with DoD in its product area, was denied access to a repository of DoD-owned technical data. The repository was created as part of DoD's effort to move toward more open architectures and increase competition; however, without access to this information, the Canadian firm could not compete on an equal basis.[41]

Canadian industry representatives reported that awareness of the agreements had declined among contracting personnel in recent years. Interviewees speculated that this was due to high turnover rates, or perhaps a decrease in contracting command training on doing business with Canada. These problems were not insurmountable, but were delayed until interventions by the Defense Contract Management Agency or the CCC. There are official attempts to counter this confusion, including Defense Acquisition University training modules on Canada and DoD policy guidance reinforcing the arrangements.[42]

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[40] Ibid., 57–58.
[41] Ibid., 58–59.
[42] DoD Instruction 2035.01, "Defense Economic Cooperation with Canada."

Chapter 4 | Performance-Based Logistics

For nearly three decades, all four NTIB partners have utilized various performance-based logistics (PBL) contracting mechanisms in their defense acquisition practices. Whether the underlying motivation for using PBL was getting improved performance and complementing its organic sustainment system, as in the United States; to maintain readiness, availability, and supply, as in the United Kingdom; or to improve the organic inability to sustain some systems, as in Australia, PBL is a common contracting mechanism across the NTIB. While all four NTIB partner nations have utilized performance-based logistics, both surface-level and conceptual-level differences exist between the four partner nations. Despite these differences, that all four partner nations are practitioners of PBL suggests an opportunity for integration. In this section, CSIS focuses on the various iterations of PBL across the NTIB to identify both the similarities and differences in PBL practices. The study team then uses these similarities and differences to illuminate potential pathways for NTIB integration with respect to logistics and where barriers pose limits on greater NTIB integration.

What Is PBL and How Does It Differ across the NTIB?

The United States

In the U.S. DoD, PBL originated in response to the simultaneous increase in operations and maintenance (O&M) costs and decrease in readiness of U.S. military capabilities. Referred to as a "death spiral" by then-Under Secretary of Defense for Acquisition, Technology and Logistics (USD[AT&L]) Jacques Gansler in 2000, these conditions in DoD were draining the budget, pulling money from research and development (R&D) and modernization to maintain traditional "pay for service" O&M contracts, and created an unstable acquisition environment.[43] DoD utilization of PBLs began in 1999 with the F-117 Nighthawk contract between the United States Air Force (USAF) and Lockheed Martin that aimed to improve system readiness.[44] Performance-based contracting mechanisms were then implemented as part of DoD Directive 5000.1 in 2000 and was encouraged to be "used whenever practical."[45] PBLs have been consistently emphasized since then in the 2001 Quadrennial Defense Review, DoD Directive 5000.02, and the Better Buying Power series. PBLs are now a major acquisition tactic used by the DoD for complex weapon systems contracts that require a prolonged commitment of resources for sustainment. Since the budget drawdown, however, DoD's use of PBL contracting mechanisms in practice has waned.

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[43] Bill Kobren, *What Performance Based Logistics Is and What It Is Not—and What It Can and Cannot Do* (Washington, DC: Defense Acquisition University, 2009), http://www.dtic.mil/dtic/tr/fulltext/u2/1016070.pdf.
[44] U.S. Department of Defense, *PBL Guidebook: A Guide to Developing Performance-Based Arrangements* (Washington, DC: DoD, 2016), https://www.dau.mil/guidebooks/Shared%20Documents%20HTML/PBL%20Guidebook.aspx.
[45] U.S. Department of Defense, *Department of Defense Instruction Number 5000.1: The Defense Acquisition System* (Washington, DC: DoD, 2003), https://www.dau.mil/guidebooks/Shared%20Documents%20HTML /DoDD%205000.01.aspx.

DoD defines PBLs as "performance-based life cycle product support, where outcomes are acquired through performance-based arrangements that deliver Warfighter requirements and incentivize product support providers to reduce costs through innovation.."[46] In the United States, PBL contracting mechanisms have also been appreciated for their ability to correct misaligned incentives. An example of such a misaligned incentive occurring is when a contractor earns more revenue by regularly repairing a persistent failure in a military system than it does by implementing efficient preventative maintenance. DoD utilizes a suite of incentive mechanisms through PBL to close the gap between the outcomes incentivized in the contract and the outcomes motivating DoD.

A 2018 CSIS study analyzes this suite of incentives thoroughly and groups the incentives into three categories: financial incentives, time-based incentives, and scope-based incentives.[47] DoD implements financial incentives through a variety of mechanisms including payments based on fleet size or usage, linking payments to performance metrics, and profit-sharing. Furthermore, performance payments can be enforced either positively or negatively where vendors are financially rewarded or punished depending on their performance. Time-based incentives are particularly desirable for commercial vendors because they reduce the uncertainty in future work. As a result, vendors are more likely to substantially and adequately invest in R&D, equipment, and process improvements. However, the U.S. acquisition rules and culture are less willing to utilize PBL mechanisms for long-term contracts. Scope-based incentives are beneficial to the commercial vendors working with DoD because they give the vendors more control over the entire procurement process. In turn, this allows the vendor to increase efficiency. This approach is also less employed by DoD. In particular, PBLs that cover an entire weapon system can be more complex than in other NTIB nations, because the U.S. prioritization on maintaining in-house maintenance expertise via depots can make it challenging to clearly draw lines of responsibility for top-level outcomes.

The United Kingdom

The United Kingdom originally pursued the use of PBL mechanisms so that its Ministry of Defense (MoD) would no longer have to retain the personnel and facilities required for the defense acquisition process. This was the result from the 1998 Smart Procurement reforms that made major organizational transformations reducing the amount of personnel and facilities required for the defense acquisition process. A 2006 MoD Defense Industrial Strategy discusses how the use of PBL mechanisms were further emphasized throughout the early 2000s, when the MoD recognized that the previous organizational transformations and concurrent defense drawdown meant that there would be less work on designing and manufacturing new military platforms and, instead, more work on through-life maintaining and upgrading of existing military platforms.[48] Specifically, the Industrial Strategy stated:

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[46] U.S. DoD, *PBL Guidebook.*
[47] Andrew Hunter et al., *Use of Incentives in Performance-Based Contracting* (Wahington, DC: Center for Strategic and International Studies, February 2018).
[48] House of Commons Defence Committee, *The Defence Industrial Strategy Seventh Report of Session 2005–06, the Defence Committee* (London, UK: House of Commons, 2006), https://publications.parliament.uk/pa/cm200506/cmselect/cmdfence/824/824.pdf.

> We consider it critically important that MoD develop clear criteria for deciding which sectors of the [defense] industry it is vital to retain in the future. Issues such as security of supply, specifically to meet urgent operational requirements, should not be underestimated in making such decisions. Much equipment being procured today will be in-service for the next 20–30 years or more and will need to be upgraded and maintained. The imperative of retaining the skills within the UK to undertake such work must be [recognized]. This applies across the range of equipment: from the highest level to the most basic of military requirements.[49]

The next big step for UK implementation of PBL practices was in 2006, when the Defense Acquisition Change Program (DACP) came to fruition. The DACP's purpose was to facilitate the policy requested by the Defense Industrial Strategy of Through Life Capability Management (TLCM) in the acquisition process that is "designed to allow the MoD to manage and trade off attributes of its equipment, manpower and infrastructure."[50] In utilizing this acquisition strategy, the MoD intended to overcome financial and organizational barriers so that more effective partnerships with industry could improve the acquisition process.

The MoD utilizes PBL mechanisms through two avenues. First, with the previously discussed TLCM and, second, through contracting for availability. TLCM is based on PBL contracting for long-term sustainment projects defined as "an approach to the acquisition and in-service management of military capability in which every aspect of new and existing capability is planned and managed coherently across all Defense Lines of Development from cradle to grave."[51] Contracting for availability focuses more on designing the contract between government and industry in a way that appropriately incentivizes both entities to pursue both efficiency and effectiveness throughout the life cycle of the agreement. As the name implies, contracting for availability uses availability as the metric for success. According to Def Stan 00-49 (IEC 60050-191), availability as a metric is defined as: "The availability (of an item) is the ability to be in a state to perform as required, under given conditions, at a given instant, or over a given time interval. Intrinsic/inherent availability is the value determined when maintenance and operational conditions are assumed to be ideal."[52] Furthermore, the United Kingdom's concept of availability revolves around three key factors: availability, reliability, and maintainability and logistics.[53] As a result, the UK practice of PBL mechanisms involves long-term strategy and utilizes more tangible metrics such as hours of use as

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[49] Ibid.

[50] Bernard Gray, *Review of Acquisition for the Secretary of State for Defence An Independent Report Review of Acquisition* (London, UK: Secretary of for Defence, 2009), https://www.bipsolutions.com/docstore/ReviewAcquisitionGrayreport.pdf.

[51] Tom McKane, *Enabling Acquisition Change: An Examination of the Ministry of Defence's Ability to Undertake through Life Capability Management* (London, UK: Ministry of Defence, 2006), https://www.bipsolutions.com/docstore/pdf/15938.pdf.

[52] Richard Denning, *Applied R&M Manual for Defence Systems: Part G – Miscellaneous, Leaflet 5 - Contracting for Availabilty* (London: UK SARS, 2012), http://sars.org.uk/BOK/Applied%20R&M%20Manual%20for%20Defence%20Systems%20%28GR-77%29/p7l05.pdf.

[53] Ibid.

benchmarks for success. Some examples of MoD PBL contracts include the Harrier GR9, Tornado GR4, Merlin Mk1/Mk3,[54] C-130 Hercules,[55] and CH-47 Chinook.

Australia

Australia's use of PBL-based mechanisms initiated with the government utilizing performance-based contracts (PBC) in 1990 to employ commercial industry for roadway maintenance and sustainment.[56] With respect to Australia's Department of Defence (ADoD), the establishment of the Defense Material Organization (DMO) in 2000 gave prominence to PBC as one of several new procurement reforms to be pursued.[57] PBC mechanisms became increasingly common as government officials recognized the value in increasing the cooperation and convergence between government and industry as a means of improving the acquisition process. In 2003 the Australian Defence Aerospace Sector Strategic Plan (ADASSP) emphasized "an outcomes-based approach to contracting" as the priority for the future of Royal Australian Air Force (RAAF) sustainment contracts.[58] The DMO Aerospace Systems Division (ASD) released the first version of the Performance-Based Contracting Handbook in 2005.[59] This report mandates that all future ASD contracts that deal with through-life support contract maintenance repairable item support, or engineering services support, are to be issued as PBCs whenever possible. The handbook offers detailed explanations of how to go about defining the parameters of a PBC, including expectations and incentives. The PBC Handbook was updated, with the second version released in 2007.[60]

A formal definition of Australian PBL contracting mechanisms can be found in the 2007 PBC handbook that defines PBC as "a product support strategy utilized by Program Managers to achieve measurable war-fighter selected performance outcomes for a weapon systems or subsystems."[61] The key metrics that the Australian DoD utilizes in defining performance outcomes are availability, reliability, maintainability, supportability, and total ownership cost.[62] Furthermore, there is a significant focus put on quantifiable levels of operational performance that would be defined in the contract from the outset. While there are shorter versions in lighter PBC methods, PBCs in Australia are generally applied to contracts from 5–15 years and utilize contract duration as a primary incentive. For instance, while a contract may initially be for a period of five years, the

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[54] Jacques S Gansler, William Lucyshyn, and Lisa H Harrington, *An Analysis of Through-Life Support Capability Management at the UK's Ministry Of Defense* (College Park, MD: Center for Public Policy and Private Enterprise, 2012), http://cpppe.umd.edu/publications/analysis-through-life-support-capability-management-uk%E2%80%99s-ministry-defense.
[55] LockheedMartin.co.uk, "Hercules Integrated Operational Support (HIOS)," https://www.lockheedmartin.co.uk/uk/what-we-do/products/HIOS.html.
[56] Malcolm Frost and Christine Lithgow, "Improving Quality and Cutting Costs through Performance Contracting Australian Experience," Article for the World Bank Road Management Training Seminar, 1996, http://www.zietlow.com/docs/frost.htm.
[57] David Abraham, *Performance Based Contracting—a Panacea for Supporting Legacy Aerospace Platforms?* (Canberra, Australia: Australian Command and Staff College, 2011), http://www.defence.gov.au/ADC/Publications/Geddes/2005/PublcnsGeddes2005_310310_PerformanceBased.pdf.
[58] Ibid.
[59] Australian Department of Defence, Defence Materiel Organisation, *Performance Based Contracting Handbook: Guiding Principles and Performance Framework* (Canberra, Australia: DMO, 2007), http://www.defence.gov.au/casg/Multimedia/asd_pbc_v2-9-8869.pdf.
[60] Ibid.
[61] Ibid.
[62] Ibid.

government can begin a review process in the second year that has the option to extend the contract longer than the initial five-year period if the vendor demonstrates that they have met the specified performance benchmarks.[63] In the past decade, PBC has been the default for a wide range of contracts in Australia and the contract mechanisms generally change with scope. Some examples of Australian PBCs are the C-17 Globemaster III,[64] MRH-90 Helicopter,[65] KC-45 (A330) Multi-Role Tanker Transport,[66] and CH-47F Chinook.[67]

Canada

The Canadian government started using PBL on civilian engineering projects long before it became a standard practice in defense acquisition. PBL was first used in Canada for road and public infrastructure maintenance, which were privatized in 1988. After the conclusion of the Cold War, the Canadian Department of National Defence (DND) saw a significant drawdown from $13.3 billion (1.9 percent of GDP) in 1990 to $11 billion (1.2 percent) in 1997.[68] This drawdown resulted in a 45 percent cut in the civilian and military workforce, which led to schedule delays and reduced availability and readiness.[69] Influenced by the United States and UK's implementation of PBL contracting mechanisms in defense acquisition, coupled with reduced systems availability under budget constraints, the Canadian armed forces put forth the Optimized Weapon System Management (OWSM) strategy for Aerospace Equipment Maintenance Program (AEPM) contracts in 2002.[70]

The purpose of OWSM was to use a performance-based contracting approach that decreases the number of total contracts for one program by issuing individual long-term contracts in lieu of several short-term ones. As a result, more responsibility is transferred to the commercial contractor, decreasing the number of government personnel needed to meet the contract objectives. These contracts are intended to last approximately five years while offering incentives and penalties to increase productivity at reduced cost to the government. OSWM is primarily used for the production and maintenance of major subcomponents of an airframe with the contractor and weapons system manager (WSM) working closely together and the director general of AEMP

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[63] Andrew Hunter et al., *Performance-Based Logistics: A Process Analysis for the Defence Logistics Agency* (Washington, DC: Center for Strategic and International Studies, 2015), https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/151014_Performance-Based_Logistics.pdf.
[64] Boeing Australia, "Boeing Awarded C-17 Globemaster Australian Sustainment Services Contract," June 28, 2017, http://www.boeing.com.au/news/releases/2017/june/boeing-awarded-c-17-globemaster-contract.page.
[65] Auditor General, *Multi-Role Helicopter Program,* (Canberra, Australia: Australian National Audit Office, 2014), https://www.anao.gov.au/work/performance-audit/multi-role-helicopter-program.
[66] Australian Department of Defence, Capability Acquistion and Sustainment Group, *Factsheet 001—History of PBC and Major Defense Projects* (Canberra, Australia: Austrlian DoD CASG, 2016), http://www.defence.gov.au/casg/Multimedia/PBC_Factsheet_001_History_and_Background-9-8871.pdf.
[67] "Boeing Wins Five-Year CH-47F Maintenance Contract," *Aviation Voice,* October 25, 2016, https://aviationvoice.com/boeing-wins-five-year-ch-47f-maintenance-contract-201610251104/.
[68] Bill Robinson and Peter Ibbott, *Canadian Military Spending: How Does the Current Level Compare to Historical Levels? …to Allied Spending? …to Potential Threats?* (Waterloo, Ontario: Project Ploughshares, 2003), http://ploughshares.ca/wp-content/uploads/2012/08/WP3.1.pdf.
[69] D.A.G. Waldock, *The Use of Performance Based Service Acquisition within the Department of National Defence* (Ontario, Canada: Canadian Forces College, 2009).
[70] Chief Review Services, *Evaluation of Aerospace Equipment Maintenance* (Canada: National Defence Chief Review Services, 2013), http://www.crs-csex.forces.gc.ca/reports-rapports/pdf/2013/p0941-eng.pdf.

(DGAEMP) acting as the systems integrator. OWSM is used for the CC-130 Hercules, CF-18 Hornet, CP-140 Aurora, and CH-146 Griffon.[71]

In 2008, the DND deepened its commitment to the PBL model when the assistant deputy of defence for material (ABM(Mat)) instituted the In-Service Support Contracting Framework (ISSCF) for long-term weapons sustainment.[72] This framework grants the original equipment manager (OEM) a larger scope of the contract, managing all aspects of the systems' In-Service Support (ISS). Consequently, the OEM has the power to subcontract different aspects of the systems' maintenance at their discretion.[73] ISSCF is used for the CC-177 (U.S. C-17) Globemaster III, CC-130J Super Hercules, CH-148 Cyclone, and the new fixed-wing search and rescue (FWSAR) C295W (U.S. HC-144A).[74] In both ISSCF and OWSM contracts, Canadian forces perform much of the on-location corrective and in-house component maintenance of the aircraft. ISSCF contracts are mandated for all new procurements at the fleet level and typically last for 20 years or more as opposed to the approximate five-year duration of OWSM contracts.[75]

NTIB Integration through PBL: Opportunities for Harmonization

When considering NTIB as a mechanism for leveraging each partner's respective industrial bases for mutual advantage, one clear opportunity for adding value comes from considering how the individual strengths and weaknesses of each industrial base can potentially complement one another. This is best accomplished by each country continuing to practice and evolve what already gives them value and utilizing their partners' own unique value to supplement each country's weaknesses through comparative advantage. While all four partner nations use PBL contracting mechanisms, it is likely that there are limits to how closely the NTIB is able to coordinate on PBL due to fundamental differences across the four countries. Instead, PBL offers an opportunity to foster greater NTIB cooperation in certain circumstances. There are also potential benefits to NTIB collaboration on logistics that can be pursued independently of cooperation on PBL. To optimally benefit from the use of PBL contracting practices as a tool for NTIB integration, it is crucial to understand the differences of PBL across the four partner nations. This section reviews these differences by identifying three areas where although partner nations differ, opportunities for cooperation still exist. These areas are contract duration, contract type, and performance metrics.

Key Differences of PBL across the NTIB

Contract Duration

The first area where NTIB partner nations exhibit obvious differences in their practice of PBL contracting is contract duration, a key element of PBL implementation. Generating the greatest

[71] Ibid.
[72] Darryl Taylor, *Performance Based Contracting* (Brussels: Royal Military Academy, 2013), https://www.dau.mil/cop/pbl/DAU%20Sponsored%20Documents/Performance%20Based%20Contracting%20Research%20Paper%2026%20Apr%202013.pdf.
[73] Chief Review Services, *Evaluation of Aerospace Equipment Maintenance.*
[74] Auditor General of Canada, *2011 Fall Report of the Auditor General of Canada* (Ontario, Canada: Office of the Auditor General of Canada, 2011), http://www.oag-bvg.gc.ca/internet/English/parl_oag_201111_05_e_35937.html.
[75] Ibid.

efficiencies requires that industry partners make critical capital investments and develop technology alternatives necessary for creating efficiencies in long-term sustainment. However, absent a longer-term commitment from the government, industry partners are reluctant to makes those investments out of fear of not seeing a return on their investment. Contract duration, however, is an area where the four partner nations differ in practice. For instance, the U.S. policy typically recommends PBL contracts to aim for five to seven years in total, with time-based incentives that can increase the contracts' duration on a yearly basis.[76] This is due to the U.S. regulatory environment that prevents contractors from easily implementing long-term PBL contracts. For instance, Title 10 U.S. Code § 2304a (f) prevents a contract from exceeding 10 years and extensions for contracts funded from the Operation and Maintenance account are limited to extensions in one-year increments.[77] Furthermore, the U.S. budget environment poses barriers on the ability for services to sign long-term contracts with commercial vendors.[78]

Compared to the United States, the other three NTIB partners more frequently practice time-based incentives through longer contract durations. The UK MoD, for instance, uses PBL mechanisms to pursue long-term TLCM agreements that from the outset can last decades in total, although costs can be negotiated and paid every five years or so.[79] This negotiation allows for the contractor to justify investing in long-term cost saving initiatives with the confidence that they will be in continued business with the MoD. Additionally, a regular renegotiation of the contract saves the MoD money because it allows them to receive a return on their intellectual and physical investments and to see how their money is spent, offering opportunities to gain further value from each renegotiation. The United Kingdom finds value in this practice because it recognizes that a large amount of weapon systems from the 2000s will remain in service until 2030 or further, thus requiring high levels of sustainment and maintenance in the upcoming decades.[80] As a result, PBL contracting mechanisms in the United Kingdom generally last from 10 to 25-plus years.

Similar to the United Kingdom, Australian PBL policies prioritize longer contracts as a primary incentive. A common Australian practice is agreeing to an initial PBL contract duration of five years with the option for a review in the second year that can extend the contract if the vendors have met the predetermined performance benchmarks.[81] In fact, the Australian DoD's PBC handbook states that one of four key principles of PBC is that PBC contracts should be long term and implement features that ensure continued performance improvements and reduced costs over the lifecycle of the contract.[82] A demonstration of how the Australian DoD utilizes contract durations is by examining the Australian DMO'S definition of four different levels of PBL contracting mechanisms: PBC lightest, PBC lighter, PBC light, and PBC. The four levels increase in both scope and contract duration, where the PBC level's typical scope of work is defined as "large scale, long term support contracts with PSIs/OEMs for all elements of support (e.g. engineering, maintenance,

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[76] Defense Acquisition University, "Performance Based Logistics (PBL) Contract Lengths," *DAU Acqusition Encyclopedia*, 2017, https://www.dau.mil/acquipedia/Pages/ArticleDetails.aspx?aid=906d5f79-fb28-4721-a2e3-905bfa71a338.
[77] "One-Year (Annual) Authority. Budget authority that is available for obligation only during a specified fiscal year and expires at the end of that period. For example, operations and maintenance (O&M) and personnel appropriations."
[78] Hunter et al., *Performance-Based Logistics: A Process Analysis for the Defense Logistics Agency*.
[79] Gansler, Lucyshyn, and Harrington, *An Analysis of Through-Life Support.*
[80] Ibid.; House of Commons Defence Committee, *The Defence Industrial Strategy Seventh Report.*
[81] Hunter et al., *Performance-Based Logistics: A Process Analysis for the Defence Logistics Agency.*
[82] Australian DOD DMO, *Performance Based Contracting Handbook.*

supply chain, training, etc.)."[83] The fact that contract duration is a crucial PBL mechanism used by Australia is clear. On the one hand, this characteristic differs from the U.S. PBL culture and on the other hand, aligns well with the United Kingdom's.

Canadian practice of PBL mechanisms varies and can be compared to both the U.S. and the UK/Australia model. As previously discussed, Canada's use of PBL mechanisms can be parsed into two buckets: OWSM and ISSCF, where the former has a shorter duration more similar to the United States and the latter utilizes a longer contract duration that is more comparable to the United Kingdom and Australia. Canada's implementation of ISSCF was directly in response to recognizing the pattern of PBL contracting practices used in other countries to increase the use of longer-duration contracts that tackle the costs presented by having to sustain high levels of personnel and aging fleets.

Figure 1: PBL Contract Duration between NTIB Partners

United States	United Kingdom	Australia	Canada
5-7 years (not to exceed 10 years) recommended for complex systems	10-25+ years	5-15 years	5+ years (OWSM) 20+ years (ISSCF)

Although the four NTIB partner nations vary in their practice of contract duration when using PBL contracting mechanisms, there are areas of opportunity where the four partner nations can align despite these differences. A summary of the contract duration differences across the partner countries can be seen in Figure 1.

Contract Type

The second area where various practices differ across the NTIB partners is contract type. When pursuing a performance-based contract, governments can capitalize on various incentive schemes that utilize the nature of the contract and the types of fee structures offered to the contractor. Three contract types typically associated with PBL contracting are fixed-price, fixed-price incentive fees, and cost-plus. Consistently across the NTIB, the two types of fixed-price contracting are preferred for PBL contracts in theory; however, when sufficient system data is not yet available, cost-plus contracting may be a more commonly pursued option.[84] The U.S. *2016 PBL Guidebook* prefers firm-fixed price contracts and promotes them as a tenet of best practices in PBL contracting, although other contract types such as fixed-price incentive fees and cost-plus are possible options as well. The United Kingdom's standard policy is to use firm-fixed price with the understanding that it might be most efficient for long-term contracts to have the flexibility to change elements of the pricing during predetermined milestones. Similarly, Australia and Canada both recognize that the use of time incentives is routine and although fixed-price contracts are preferred, longer contracts that cater to time-based incentives might not be optimal for fixed-priced mechanisms. CSIS's 2018 study also found that in practice, both international government practitioners and some vendors are more open to cost-based contracts as at least a second-best

[83] Hunter et al., *Performance-Based Logistics: A Process Analysis for the Defence Logistics Agency.*
[84] U.S. DoD, *PBL Guidebook.*

practice than official recommendations would imply. That said, industry's strongest objection to this practice is when cost reporting and accounting standards flow down to suppliers that are not directly a party to the PBL.[85]

Performance Metrics

Performance metrics are the third area where NTIB partners have historically differed in practice. The underlying nature of PBL contracting relies on incentives tied to performance outcomes. Although NTIB partners differ with regard to the metrics used to measure performance outcomes, similarities also exist. According to the *2016 PBL Guidebook*, the United States has specific key performance parameters (KPP) and key system attributes (KSA) in addition to defined warfighter requirements specific to each program that are used as performance metrics. The performance metrics in the KPP include material availability and operational availability, while the performance metrics in the KSA include reliability in addition to operating and support costs.[86] While these categorical definitions for performance metrics exist, they allow flexibility to vary depending on the program.

The United Kingdom's MoD measures the success of a PBL on a standard unit of "hours of availability" for a systems procurement and/or sustainability contract.[87] The MoD places maximum responsibility on the contractor for the maintenance of the contracted system, giving the contractor the ability to control every aspect of sustainment and therefore properly budget their resources and thus increasing efficiency.[88] Contracting for availability is beneficial because it offers a simple, measurable standard that can be applied across multiple systems. Finally, as is covered in the prior section, availability PBLs are normally fixed-price contracts, making the contractor responsible for unforeseen costs. This makes the process of writing the contract incredibly complex as allocating risk for unforeseen future complications is difficult, but also encourages the contractor to pursue reliable technology easy to sustain.[89]

The Australian DoD's selection of performance metrics is a flexible process that varies depending on the program and follows the guideline stated in the Australian DoD's Performance based Contracting Handbook. The handbook specifically outlines tiers of performance metrics that are generally categorized as "performance metrics" and "system health indicators." The former tier focuses on the effectiveness of the weapon system in question while the latter tier is broader, and aims to forecast future performance trends so that management of the program is proactive to potential performance anomalies.[90]

Similarly, Canada's use of performance metrics varies depending on which of the two performance-based contracting methods the government pursues; OWSM or ISSCF. A 2011 Auditor General Report recognizes that the common use of readiness as a performance metric is not uniquely meaningful enough. Furthermore, it was reported that other commonly used

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[85] See section 5.2.1 in Hunter et al., *Use of Incentives in Performance-Based Contracting.*
[86] U.S. DoD, *PBL Guidebook.*
[87] Denning, *Applied R&M Manual for Defence Systems.*
[88] Duarte Rodrigues et al., "Review of the Modelling Arrpoaches for Availability Contracting in the Military Context," *Procedia CIRP,* Vol 30 (2015), https://www.sciencedirect.com/science/article/pii/S221282711500445X.
[89] Ibid.
[90] Australian DOD DMO, *Performance Based Contracting Handbook.*

performance metrics such as turnaround time for repairs and availability of spare parts are not quantifiable enough and need more, complementary measurements. Thus, it was recommended that the department of defense create a more systematic process of using performance metrics during performance-based contracting.

Differences in Operational Usage and Ownership of the Maintenance Process

Setting aside the specific mechanisms used for PBL contracts, there is also a notable gap between how different partners use their weapon platforms and the degree to which they maintain organic expertise. These operational differences can result from different capabilities—for example, the United States flies F-18 off aircraft carriers while Canada primarily flies them from ground bases—or different operational cultures or tempos. The difference is starker when it comes to maintaining organic capacity. Title 10 USC 2466 requires that at least 50 percent of depot-level maintenance and repair work be conducted by DoD employees.[91] Contrast this to the histories discussed in the prior section for other NTIB partners, particularly the United Kingdom, which chose to give up personnel and facilities at the start of its use of PBL. Each country has chosen its own balance of reliance on contractors and in-house expertise and tunes this balance based on real-world results.

Challenges Due to these Differences

These differences in contract duration, contract type, and performance metrics create various challenges that may create barriers to using PBL contracting mechanisms specifically as a way to integrate the NTIB. These challenges fall into four categories: legal challenges, security challenges, operational challenges, and cultural challenges. The study team gleaned information on these challenges through the previously mentioned roundtable discussion on the potential for partners in the NTIB to use PBL contracting mechanisms to integrate their defense industrial bases.

Legal Challenges

During the roundtable, the United States' law mandating organic depots (10 USC § 2464) and 50-50 requirement (§ 2466) were immediately brought up as barriers to the United States' ability to best utilize PBL contracts and participate in the NTIB. Due to these Title 10 restrictions, sharing sustainment and maintenance responsibilities for U.S. systems with allies or contractors is not always a feasible option. This puts partner nations in a difficult position because exporting technological data alone is not profitable enough to warrant the investment in developing their maintenance infrastructure. As previously discussed, ITAR is a significant legal barrier that extends to the use of inter-NTIB PBL.

[91] 10 U.S. Code § 2446—Limitations on the performance of depot-level maintenance of materiel, https://www.law.cornell.edu/uscode/text/10/2466.

Security Challenges

The discussion also addressed several security challenges to using PBL contracting as a tool for NTIB cooperation. One key challenge to collaboration is that of information sharing. Raw data underpins all performance arrangements and needs to be collected and made available. Currently, nations tend to only share information gathered from their analysis of the data with trade partners. Limited access inhibits individual scrutiny of the data to create a contract framework that caters to the individual needs of each ally, thus limiting their purchasing power. One roundtable participant noted that existing technical coordination groups exist for the purpose of sharing information and data and can help overcome these challenges.

Another key security concern regarding PBL collaboration through the NTIB relates to the issue of readiness. Historically, sovereign nations tend not to position themselves where their readiness is contingent on nations of another flag. Instead, it is more often seen that national security issues champion self-sufficiency from a capabilities-readiness standpoint. It is understandable that Australia would not want their Chinook helicopter maintenance done on the other side of the world in the United States or UK, in case they needed the aircraft immediately to address a domestic concern (e.g., a natural disaster), despite any cost savings it may provide.

Operational Challenges

Overcoming operational barriers and aligning objectives is crucial to NTIB collaborative success through PBL. Many of these barriers come from poor or improper communication and inconsistent methodologies. One anecdotal example was shared of an industry team that had been sending emails that involved key analytical information to another contact for months without response. It was later discovered that the contact had retired many months prior and that the emails were effectively lost, setting the contract far behind schedule.

Inconsistency of data provided by the contractor is another major operational hurdle for integration through PBL. What contractors classify as an institutional cost can vary widely, even within a single country or industry, making it difficult for the customer to get straight answers when attempting to draw a new contract. Additionally, the NTIB nations vary in their technological capabilities. This makes it difficult for vendors to effectively sell a platform without a cooperative agreement to move technology between partners, and nations often refuse to share key logistical information on systems due to classification. This logistical information is important for a PBL contract because it could influence how different members negotiate contracts to deal with system needs like engine maintenance. Thus, barriers against information sharing tend to negatively affect operational fluidity that would negatively impact PBLs. One participant suggested utilizing offsets that build up a nation’s technological capabilities and place the responsibility of transfer in the hands of industry could be considered to ameliorate this process.

Further, leveraging supply chain efficiencies through PBL contracting, while acknowledged as a key potential benefit of collaboration, is also a complicated task with several regulative and operational barriers that need to be overcome. On the one hand, new system procurement contracts could benefit from inter-NTIB collaboration through PBL sustainment contracting for various reasons, like efficiently allocating work through shared sustainment in cases where a nation’s infrastructure gets saturated by a new major weapon system purchase. On the other hand, the partner nations

have intentionally adopted regulation and policies to ensure they maintain their capacity indigenous maintenance.

Cultural Challenges

How nations deal with the issue of who has responsibility for the product was a key difference in the cultural approaches to PBL. This challenge can also be an opportunity to observe and evaluate methods used by other partners. One method raised during the workshop is to integrate a contractor in a program from the initial stages, therefore placing the burden of investment on both government and industry. Outside of the NTIB, the Japanese have a contracting model that does just this, identifying domestic companies to partner with the government at the early negotiation stages of a contract. This strategy encourages contractors to invest in the life cycle of the weapon system, becoming fundamentally ingrained into the program and therefore able to perform services to the end user that go beyond common obligations.

One major cultural barrier lies in the fact that the United States has not embraced PBL in the same way as its NTIB allies, specifically in the context of long-term contracts. This leads to issues when the United States and its partners each operate the same system but the United States opts not to use a PBL sustainment contract in line with the other partners. Much of the cultural resistance in the United States comes from the pushback against contractors supporting the U.S. platforms due to fears that the DoD would lose its organic sustainment capability, putting security at risk. An additional cultural barrier separating the United States from its NTIB partners is the timing in which they determine their logistical support strategy. The United States often develops and procures systems first, and then looks to a PBL contract for sustainment. This is different from its partners, who typically implement a logistical strategy in tandem with the procurement contract, declaring their intention for long-term use of a system and acknowledging the importance of contracted sustainment support. This strategy is most common in the context of aerospace, but varies in the domains of land or maritime system sustainment.

What Makes for a Good PBL Arrangement

Having shared outcomes is a fundamental characteristic to the successful use of PBL across the NTIB. To better sync these outcome objectives, it is important to discuss the origins of PBL to better understand the key differences across NTIB partners. For instance, the long-term commitment inherent in PBL mechanisms initially faced resistance, but for some NTIB members governments were eventually prioritized pressing budgetary constraints over their earlier objections. Additionally, once PBL contract arrangements allowed for integration of armed forces personnel, the skillset and knowledge base was maintained and improved the outcomes, increasing its appeal to government customers.

There is no single PBL method that is optimal for the procurement and sustainment of every system. Thus, when considering service-based contracting, the goal is to determine which metric is best for measuring success. One practice that multiple roundtable participants supported for a good PBL arrangement was leveraging the combined value of the NTIB economies and defense budgets to incentivize OEMs to be more proactive, share information, and ensure that software updates are operable across platforms. It is important for customers using PBL to have a strong,

collaborative relationship with the OEM and supply base, and by removing the corporate barriers that prevent partnering, the door for better cooperation is opened.

Export control arrangements are another key component of a good PBL arrangement and need to be negotiated to ensure logistical support is provided effectively across borders, especially for time-sensitive matters. Platforms purchased through FMS and later supported by a PBL with the OEM display how favorable export-control arrangements can increase efficiencies. It was noted in the workshop that the U.S. DoD’s Lead-Nation Procurement Initiative (LNPI) allows for NATO members to procure standard items and nondevelopmental services or support with limited export restrictions. LNPI provides an infrastructure that helps to facilitate the release of information, whose framework could be adapted for an exclusive NTIB procurement partnership. There are instances where the United Kingdom will purchase a system through FMS but then opt for sustainment through different contracts, often using PBL. This is because export-control issues prevent the OEM from being the most cost-effective option for sustainment. Smaller contractors that specialize in sustainment offer alternative options to the customer that may contain less bureaucratic restrictions.

Another characteristic of a good PBL is one that cooperates through logistical support to maintain security of supply. Having a large, integrated industrial base of trusted nations allows major contracts to be adjusted to fit the needs of each nation without having to be redrawn from scratch. As a result, the industrial base broadens and becomes a more secure source of supply, without the need to have an indigenous capability for everything. This model is inherently dependent on NTIB partners’ willingness to compromise some level of individual control in favor of increased efficiency.

Moving Forward: Integrating NTIB through PBL

One main takeaway from the roundtable is that thinking about the NTIB as an extension of each partner’s respective industrial base presents the best opportunity to gain the most value of an expanded industrial-base alliance. Moreover, approaching the NTIB from this perspective is beneficial because it can create a larger industrial base with more room for specialization. The only way to effectively benefit from the NTIB expansion is for each country to continue practicing what already gives them value, collaborating in areas where one partner can contribute to an undersupplied demand of another. In doing so, it’s crucial to remain aware of each nation’s national security and economic interests because insensitivity to these needs will cause cooperation to break down. Lastly, NTIB partners can improve cooperation through PBL in sustainment and life maintenance of commonly used platforms by learning from each other’s practical differences and contextual advantages.

In summary, different approaches by NTIB partners in their use of PBL makes transnational collaboration on any contract impractical without compromise. As home to the majority of OEMs in the global market, the United States is ultimately responsible for the success or failure of a comprehensive NTIB strategy to PBL. However, the United States has a distinct PBL strategy that is inconsistent with their partnering nations. U.S. laws prevent the DoD from taking advantage of the cost benefits of long-term contracts or from conceding the scope of responsibility in a PBL. Additionally, trade regulations limit the ability of allies to take full advantage of the U.S. supply

chain. Canada is a founding member of the NTIB with a long history of a close defense trade relationship with the United States, simplified by a shared border. This circumstance has led to Canada benefiting from ITAR exemptions that make collaboration with the United States relatively seamless and mutually beneficial. Australia benefits from the fact that they have minimal defense requirements and a small infrastructure, making them more willing to grant the scope of the contract to the U.S.-based OEMs and supply chain. The United Kingdom faces the greatest challenge to collaboration in joining the NTIB. They do not yet benefit from the same trade relationship as Canada, and their requirements far outweigh those of Australia. Due to these challenges, the United Kingdom may look to contractors outside the United States for sustainment and upgrade PBL contracts to overcome bureaucratic and logistical hurdles. While seeking alternatives often proves to be the best option for the United Kingdom it also comes with considerable risks, as evident by the failed and costly[92] attempt to upgrade the Chinook independent of Boeing.[93] Trade regulations are the most significant limiting factor to the potential benefits of the NTIB partnership for the United Kingdom, while Title 10 restrictions are the main problem for the United States' ability to take advantage of the full potential of PBL.

[92] Comptroller and Auditor General, *Ministry of Defence: Chinook Mk3 Helicopters* (London, UK: National Audit Office, 2008), https://www.nao.org.uk/wp-content/uploads/2008/06/0708512.pdf.
[93] Michael Evans, "Missing Software Kept Chinook Mk3 Helicopters in Wiltshire Hangar," *The Times*, August 25, 2009, https://www.thetimes.co.uk/article/missing-software-kept-chinook-mk3-helicopters-in-wiltshire-hangar-hnpplh5qsnd.

Chapter 5 | Open-Systems Architectures

For greater NTIB collaboration to occur, it must offer mutual benefits to the partners either with respect to military effectiveness, industrial participation, or both. One acquisition model that is explicitly designed to facilitate integration of products made by a variety of industry partners that may not typically work together is the use of an open-systems architecture approach (OSA). Thus, OSA seems to offer significant potential as a mechanism for the NTIB partners to integrate more fully, both with respect to interoperability and to industrial collaboration. OSA can help the NTIB partners move away from existing business models that favor proprietary systems that can be difficult to share with partners and difficult to upgrade rapidly, and instead move toward more open systems that can better keep pace with global technological advances through the rapid insertion of new capabilities, regardless of the country of origin. From the United States' perspective, the OSA model aligns well with the three lines of effort Secretary Mattis outlined in the 2018 National Defense Strategy: "build a more lethal force; strengthen alliances and attract new partners; and reform the Department for greater performance and affordability."[94] From the NTIB partners' perspective, the benefits of greater usage of the OSA model might include, but are not limited to, greater market access for their defense companies, greater interoperability of deployed systems during coalition operations, and increased lethality. This case study examines the potential for the OSA model to facilitate NTIB collaboration (or if poorly implemented hinder it) by creating clear opportunities for technologies from across the NTIB countries to integrate into or with partner nations' systems

What Is an Open-Systems Architecture Approach?

There is no single agreed-upon definition of OSA, but generally, most definitions agree that OSAs are characterized by certain features. OSA should be modular. Components of a system using an OSA should be able to be removed and replaced without having to redesign the entire system. Additionally, an OSA has publicly available, nonproprietary standards. Any vendor should be able to attain access to baseline standards of the systems so that they could produce retrofits, upgrades, or add-ons without access to the proprietary intellectual property of another firm.

The OSA model has been widely used in the commercial sector for decades, with the wireless telecommunications sector being a regularly cited example. However, usage in the defense sector has proven much more difficult despite various policies pushing greater usage of OSAs for the better part of the last three decades. This limited adoption in the defense sector has left fundamental questions unanswered, despite general agreement on the spirit behind adopting an OSA approach. Most would agree that the spirit behind adopting an OSA in the defense acquisition process is to enable greater competition, reduced costs, and a greater pace of technological development based on nonproprietary, established, open standards. However, questions such as how to create that framework, or who owns the standard, remain unanswered.

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[94] DoD, *Summary of the 2018 National Defense Strategy*.

What Are the Potential Advantages and Disadvantages of OSA?

In examining the potential for OSA to facilitate integration of the NTIB, it is important to examine the potential benefits of implementing OSA and compare them to the potential costs. The following section examines the potential advantages and disadvantages of greater adoption of OSA.

Advantages

There is a widespread consensus within industry and government of the benefits that OSA can produce if properly designed and executed. These benefits are primarily fiscal as OSA is generally agreed to reduce life-cycle and initial procurement costs. However, research and development also benefit from OSAs by speeding up new system integration and allowing smaller niche companies to innovate on major weapon systems.

Fiscal Benefits

Fiscal benefits from OSA derive primarily from the way that it facilitates a broad ecosystem of suppliers at a broad range of prices. Where this ecosystem exists, it generates price and capability competition among suppliers that lowers the cost of incorporating capabilities in OSA-based systems as they are designed. The use of standard defined interfaces also lowers integration costs by limiting the need to design new interfaces when upgrades are performed and redesigning existing systems to accept new inputs. Significant savings derive from not having to pay firms to perform these integration functions. For example, the U.S. Navy's Acoustics RAPID COTS Insertion (A-RCI) program has employed OSA to allow it to rapidly integrate new commercial processors and new algorithms into submarine combat systems. A-RCI decreased operating and support costs by 13 percent through use of OSA.[95] Additionally, the European Defense Agency estimated that utilizing an OSA for land vehicles could achieve 10 to 25 percent total life-cycle savings.[96] One of the implications of EDA's analysis to the NTIB is that multinational development efforts can be facilitated by the use of OSA to enable the assignment of workshares in segregable elements a best practice in international joint development.[97]

If a system is truly following an OSA model, then any third-party vendor would be able to develop components or accessories for the system because the standards and specifications of key interfaces would be nonproprietary and accessible. Systems that do not employ an OSA approach in development are very difficult for firms other than the firm that developed the system to work on. The third-party firm would not be as familiar with the intricacies of a system as the firm that originally developed it. This gives the prime contractor effective control of all design changes and many critical maintenance activities, potentially reducing the effectiveness of competition among

[95] U.S. Government Accountability Office, *DOD Efforts to Adopt Open Systems for Its Unmanned Aircraft Systems Have Progressed Slowly* (Washington, DC: GAO, July 2013), 8, https://www.gao.gov/assets/660/656419.pdf.
[96] European Defence Agency, *LAVOSAR Study Delivers Results* (Brussels: EDA, June 2014), https://eda.europa.eu/info-hub/press-centre/latest-news/2014/06/16/lavosar-study-delivers-results.
[97] Andrew Hunter, Gregory Sanders, and Samantha Cohen, *Designing and Managing Successful International Joint Development Programs* (Washington, DC: Center for Strategic and International Studies, January 2017), https://csis-prod.s3.amazonaws.com/s3fs-public/publication /170125_Sanders_IntlJointDevelPrograms_Web.pdf?6CJdjahdu6eaSqqv0vZnfioPn.nrHcgr.

suppliers for both upgrades and maintenance. When a system is developed in accordance with an OSA standard, the prime will not have that same advantage since all the key interface specification would be available to third-party firms.

For the same reasons that total life-cycle costs decrease on OSA systems, the cost of upgrades also declines using OSA standards. In a GAO report published in 2013, upgrades on systems that use OSA were discussed and it was reported that "because standards are publicly available, many suppliers can compete in the marketplace and consumers no longer have to be dependent on any single supplier for parts or upgrades."[98] For example, the Navy's A-RCI program has seen a 17 percent decline in program development and production costs using an OSA model.[99] Given that DoD spent $11 billion in FY 2014 modifying and upgrading existing systems, greater adoption of OSA could spur significant savings.[100]

Research and Development Benefits

An OSA model also theoretically results in "accelerating development and integration by composing systems from reusable components more easily."[101] Development is quickened since developers of upgrades, add-ons, and retrofits will be able to use the nonproprietary, publicly accessible standards as a base. Developers will not have to start from scratch every time a system requires work. In addition, integrating upgrades into systems can happen much quicker due to the "plug and play" characteristic that is the result of open standards interfaces. Essentially, one can be reasonably sure that if an open standard was abided by, when an upgrade is introduced to a system, it will work successfully without extensive modification.[102] This dynamic has played out in the Navy's A-RCI program, which has seen an 80 percent decline in production time since adoption.[103] In addition, if OSAs are implemented effectively, it should allow smaller niche firms to do research and development work on major weapon systems independent of major defense contractors, in theory. These niche firms could use this opportunity to produce new capabilities that might not have been developed otherwise.

Potential Disadvantages

Greater usage of OSA is not without potential downsides. A basic overarching concern with the OSA model comes in the development of cutting-edge systems that are pioneering and integrating technical approaches that have never been done before. Particularly for systems that require a high degree of subsystem integration, an OSA model may not allow for optimized designs that trade off performance between subsystems. A related concern would be attempting to implement the OSA model in areas where well-developed, consensus open standards do not exist. In such a case, the benefits of OSA are highly unlikely to be achieved because the lack of consensus open standards

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98 GAO, *DOD Efforts to Adopt Open Systems*
99 Ibid.
100 Ibid.
101 Carol Sledge, "A Discussion on Open-System Architecture," *SEI Blog*, November 23, 2015, https://insights.sei.cmu.edu/sei_blog/2015/11/a-discussion-on-open-systems-architecture.html.
102 Arthur Ollett and John Coleman, "Break the stove-pipe stranglehold on capability with an open systems approach," *Journal of Battlefield Technology* 18, no. 3 (November 2015).
103 GAO, *DoD Efforts to Adopt Open Systems*; U.S. Congress, Senate, Committee on Armed Services, Department of Defense Authorization for Appropriations for Fiscal Year 2009: Hearings Before the Committee on Armed Services United States Senate Part 1, 110th Cong., 2nd sess., 2008, 309.

means there is no viable path for developing the competitive ecosystem of potential suppliers that is desired. Two additional concerns associated with OSA are cybersecurity and testing/reliability. Of note, these concerns are not necessarily limited to just OSA approaches and are not insurmountable.

Some observers have expressed concerns that OSA systems might be more vulnerable to cybersecurity threats than more-traditional weapons platform due to greater accessibility of standards to potential adversaries. Additionally, there are concerns about whether open standards could keep pace with cyber security threats given the ever-evolving nature of these threats. However, other observers argue that open standards often implement cyber security best practices, and open standards provide access to cyber security expertise throughout industry, both in the initial establishment of the standard and as the standard is updated. The British experience in developing PYRAMID includes integrating cybersecurity from the outset by building in methods to counter cybersecurity threats.

Concerns over testing and reliability are another potential disadvantage identified for OSA. Many nations' processes for doing testing and assessing reliability were developed in an era of highly specified, proprietary designs. An OSA model presents challenges for doing integrated testing and reliability assessment when design elements operating through open interfaces may have completely different architectures, code, and data structures than those of the main system. However, these concerns are also not insurmountable. An OSA model can include parameters for testing and reliability of critical functions to ensure that testing and reliability standards are fulfilled.

What Are the Existing OSA Policies across the NTIB?

The following sections examine the evolution of top-level policies and definitions guiding OSA usage within the NTIB partners.

The United States

There have been policies in place in the United States since 1994 pushing DoD to promote greater usage of OSAs. In 1994, Paul Kaminski, then-under secretary of defense of acquisition and technology (USD(AT&L)), directed that "open systems specifications and standards (electrical, mechanical, thermal, etc.) be used for acquisition of weapon system electronics to the greatest extent practical."[104] Although policies have been in place since 1994, and reemphasized in new policies and regulations such as the Better Buying Power (BBP) series and DoD Directives 5000.01 and 5000.02, OSA usage across DoD remains low and inconsistent across the military services.[105]

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[104] Paul G. Kaminski, "Acquisition of Weapons Systems Electronics Using Open System Specifications and Standards," Memorandum, Office of the Under Secretary of Defense, November 29, 1994, https://www.dau.mil/cop/mosa/DAU%20Sponsored%20Documents/OSJTF%20Memo%20and%20Charter%20November%2029%201994.pdf.

[105] Ashton B. Carter, "Implementation Directive for Better Buying Power—Obtaining Greater Efficiency and Productivity in Defense Spending," Memorandum, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD, AT&L), November 3, 2010, https://www.acq.osd.mil/fo/docs/USD(AT&L)_Implementation_Directive_Better_Buying_Power_110310.pdf; Department of Defense, *Department of Defense Instruction Number 5000.02: Operation of the Defense Acquisition System* (Washington, DC: DoD, 2015), http://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002_dodi_2015.pdf; Department of Defense, *Department of Defense Instruction Number 5000.1:*

For example, a 2013 Government Accountability Office (GAO) report found that only the Navy has successfully incorporated OSA approaches into the development of their unmanned aircraft systems (UAS), but that the Air Force and Army have not in spite of existing policy guidance.[106]

Most recently, Congress stipulated in section 2446a of the FY 2017 National Defense Authorization Act (NDAA) that any "major defense acquisition program that receives Milestone A or Milestone B approval after January 1, 2019, shall be designed and developed, to the maximum extent practicable, with a modular open system approach to enable incremental development and enhance competition, innovation, and interoperability."[107] At that time, Congress defined a modular open systems approach in the defense sector as:

> [A]n integrated business and technical strategy that:
>
> (A) employs a modular design that uses major system interfaces between a major system platform and a major system component, between major system components, or between major system platforms;
>
> (B) is subjected to verification to ensure major system interfaces comply with, if available and suitable, widely supported and consensus-based standards;
>
> (C) uses a system architecture that allows severable major system components at the appropriate level to be incrementally added, removed, or replaced throughout the life cycle of a major system platform to afford opportunities for enhanced competition and innovation while yielding—
>
> > (i) significant cost savings or avoidance;
> >
> > (ii) schedule reduction;
> >
> > (iii) opportunities for technical upgrades;
> >
> > (iv) increased interoperability, including system of systems interoperability and mission integration; or
> >
> > (v) other benefits during the sustainment phase of a major weapon system; and
>
> (D) complies with the technical data rights set forth in section 2320 of this [10 USC] title.[108]

The changes written into the FY 2017 NDAA were not a significant change to existing DoD open-systems policies, but instead, an attempt by Congress to legislatively mandate that the Department

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The Defense Acquisition System (Washington, DC: DoD, 2003), https://www.dau.mil/guidebooks/Shared%20Documents%20HTML/DoDD%205000.01.aspx.

[106] GAO, *DoD Efforts to Adopt Open Systems.*

[107] National Defense Authorization Act for Fiscal Year 2017, Public L. No. 114-328 (Washington, DC: 114th Congress, 2016), https://www.congress.gov/114/plaws/publ328/PLAW-114publ328.pdf.

[108] 10 U.S. Code § 2446a—Requirement for modular open system approach in major defense acquisition programs; definitions, https://www.law.cornell.edu/uscode/text/10/2446a.

enforce existing preferences.[109] However, the extent to which the new legislation is likely to accelerate greater usage of OSA for MDAPs will depend in large part on the level of commitment demonstrated by the military services given the changes in the FY 2016 NDAA devolving milestone decision authority away from the Office of the Secretary of Defense (OSD) to the military services.[110] As previously mentioned, the GAO found that the usage of OSAs varied widely among the services in spite of existing OSD guidance pushing the usage of open systems to the greatest extent possible. Comparing the different services UAS acquisition programs, the GAO found that the Navy was the only service to institutionalize and follow existing policy guidance on using OSA wherever possible. In comparison, the Air Force and the Army failed to use an OSA for any of their UAS programs. The Army and Air Force have since made progress toward better utilizing OSA according to subject-matter experts that spoke with CSIS, but those two services still have much work to do. Whether the services have made the necessary changes to institutionalize the usage of OSAs remains to be seen.

[109] Jared Serbu, "House Defense chairman pushes open architectures as fix to DoD acquisition system," Federal News Radio, March 16, 2016, https://federalnewsradio.com/defense/2016/03/house-defense-chairman-pushes-open-architectures-fix-dod-acquisition-system.
[110] Andrew P. Hunter, "The Secretary of Defense's Crucial Role in Acquisition," *CSIS Commentary*, July 15, 2015, https://www.csis.org/analysis/secretary-defense%E2%80%99s-crucial-role-acquisition.

Case Study: USAF UAS Command and Control Interface (UCI) Standards

In early 2006 the USAF created the UAS C2 initiative (UCI). The goal of the UCI program was to further the standardization of UAS's mission-control element by establishing an open architecture for the control element.[111] This would enable a single operator to command and control multiple different types of UASs at once. The UCI standards seek to enable:

1. Mission-Level, machine-to-machine control of multiple heterogeneous UAS by multiple heterogeneous users, thereby breaking the one-user to one-vehicle paradigm.

2. Supervisory participation by a control node in the mission planning and mission execution of multiple UAS

3. Reporting of plans and status from UAS directly to multiple heterogeneous users.

4. Dissemination of data products, including ISR products, from UAS directly to multiple heterogeneous users.

5. Assignment of tasking authority and priority to multiple heterogeneous users.[112]

Although the technical goals of the UCI program are capability and performance focused with an orientation to increasing the interoperability of UAS, this standardization effort has the explicit goal of decreasing acquisition and operational costs.[113] This goal is quite different from the objective of STANAG 4586, which was established to improve interoperability. Any cost savings that came out of STANAG 4586 were unintended.

The UCI program was developed by a government-industry consortium consisting of Northrop Grumman, Lockheed Martin, Boeing, General Atomics, and Raytheon.[114] Until recently, the government had taken a hands-off approach toward developing standards regarding UASs. Traditionally, the prime vendors of UASs have had complete control over the internal standard of the systems.[115] Despite a potential decrease in control, industry has been quite cooperative in helping to establish the UCI standards. Within government it has been widely acknowledged that industry and expert input is critical when establishing specification standards for an OSA to be successful.[116] This participation of industry in developing the UCI standards could serve as a model for future standardization efforts.

The UCI program has produced tangible results. For instance, in 2015 Northrop Grumman demonstrated that a Global Hawk utilizing UCI standards was "capable of integrating advanced mission management capability without changes to the air vehicle software."[117] Lockheed Martin has also succeeded in utilizing the UCI standards, but on a non-UAS platform. In December 2013, Lockheed Martin tested an F-22 and F-35 cooperative avionics test bed (CAT-B) in flight, utilizing the USAF UCI messaging standards, to assess whether the two varied systems could share information seamlessly in real time.[118] Although the UCI program represents a step toward a true OSA based on industry standards, there are still concerns over how accessible these standards will be to other firms outside the major defense contractors.[119]

[111] U.S. Air Force Virtual Distributed Laboratory (VDL), "The Unmanned Aerospace Systems C2 Standards Initiative (UCI)," https://www.vdl.afrl.af.mil/programs/uci/index.php.
[112] U.S. Air Force Virtual Distributed Laboratory (VDL), "About UCI," https://www.vdl.afrl.af.mil/programs/uci/about.php.
[113] Ibid.

Case Study: The Future Airborne Capability Environment (FACE) Approach

The FACE consortium is a government-industry partnership that seeks to define an open avionics environment for all military airborne platforms.[120] FACE's efforts to establish this Common Operating Environment (COE) were spurred by advances in mobile devices that also use a COE. In the commercial market, mobile devices are composed of both an application and hardware that access the operating system through an established interface. The distinction between various mobile devices is the operating systems and the applications while the interfaces stay constant. In contrast with the commercial market, the defense market has a fair deal of variability among all programs, systems, and software. The FACE consortium seeks to define and promote a set of standard interfaces that would allow application to be installed onto the software of military avionic systems in much the same way that new "apps" are downloaded onto mobile devices. [121]

In theory, the FACE approach allows smaller firms to better compete with major defense contractors and thus spur innovation in the market. In 2016 the USAF joined the consortium and FACE has had considerable support within the Army and Navy. The FACE standards are easily accessible via the Open Groups website and thus meets the standard of "openness" expected of an OSA. However, concerns have been raised that the standards may prove too wide in scope to be applied to some communities of systems.[122] There have been demonstrations of application utilizing the FACE standards successfully but the extent to which FACE standards are truly applicable has yet to be seen.[123]

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[114] Kerry Fisherkeller, "Emerging Interoperability Standards for Unmanned Aerial Systems," 19th Annual INCOSE Region II Fall Mini-Conference, November 1, 2014, San Diego CA, https://sdincose.org/wp-content/uploads/2014/11/Emerging-Interoperability-Standards-for-UAS-Final.pdf.
[115] Dan Gonzales and Sarah Harting, *Designing Unmanned Systems with Greater Autonomy: Using a Federated, Partially Open Systems Architecture Approach* (Santa Monica, CA: RAND Corporation, 2014), 31, https://www.rand.org/pubs /research_reports/RR626.html.
[116] U.S. Government Accountability Office, *Defense Acquisitions: Review of Private Industry and Department of Defense Open Systems Experiences* (Washington, DC: GAO, June 2014), 2, https://www.gao.gov/products/GAO-14-617R.
[117] Northrop Grumman, "Northrop Grumman Demonstrates New Capabilities in Mission Management and Control Systems," August 11, 2015, https://news.northropgrumman.com/news/releases/northrop-grumman-demonstrates-new-capabilities-in-mission-management-and-control-systems.
[118] Lockheed Martin, "Lockheed Martin-Led Team Demonstrates Interoperability with Legacy and Stealth Fighters Using Open Systems Architecture," February 25, 2014, https://www.lockheedmartin.com/us/news/press-releases/2014/march/140307ae_lockheed-martin-demonstrates-interoperability.html.
[119] Joyce Tokar, "A Comparison of Avionics Open System Architectures," *ACM SIGAda Ada Letters,* Vol. 36, Issue 2 (December 2016), http://sigada.org/conf/hilt2016/paper-Tokar.pdf.
[120] The Open Group, "About the FACE consortium," http://www.opengroup.org/face/about.
[121] Tokar, "A Comparison of Avionics Open System Architectures."
[122] Ibid.
[123] Tokar, "An examination of Open System Architectures for Avionics Systems."

Case Study: USAF Open Mission Systems

The Open Mission Systems (OMS) program's goal is to develop a nonproprietary mission system architectural standard that would enable affordable upgrades, increase intersystem integration, growth in interoperability, and provide a more competitive allocation process.[124] Through working with industry partners, the USAF has developed OMS architecture that defines key system interfaces between subsystems such as Payload and Sensors connected through an Avionics Service Bay.[125] The first version of the Open Mission Standards was released in April 2014.[126]

Since then, major defense contractors have demonstrated the feasibility and the benefits gained from using an OSA like OMS. In December 2014, Lockheed Marin could integrate four sensors and three electronic warfare systems with the U-2 SYERS-2C sensor along with a modernized internet protocol-based data link.[127] All four of these systems were from different suppliers but were seamlessly integrated in a relatively short amount of time because they were all OMS-compliant.

Northrop Grumman also has had success in utilizing the OMS to quickly integrate systems and subsystems. In July 2015 Northrop was able to rapidly integrate new subsystems onto the B-2 Spirit Stealth Bomber and NASA's Global Hawk UAS.[128] This was achieved by using OMS-compliant computing architecture. Although major defense contractors have succeeded in effectively utilizing the OMS, some concerns have been raised that although OMS is technically an OSA, it might prove inaccessible to developers outside of the major defense contractors.[129] If this lack of openness is not addressed, many of the major benefits that come from an OSA could be left unrealized.

The United Kingdom

In January 2013, the UK Ministry of Defense (MoD) published its Systems of Systems (SOSA) *Open Systems Strategy.* The SOSA open systems strategy established the vision of the MoD to implement an Open Systems Approach. The document defines an open modular design as a system that "uses widely supported and consensus-based standards for its key interfaces and has been subjected to successful validation and verification test to ensure the openness of its key interfaces."[130]

In February 2013 the MoD presented to parliament the *National Security through Technology: Technology, Equipment, and Support for UK Defence and Security* white paper. This document illustrates a potential "new approach" to meeting the future technology, equipment, and support

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[124] U.S. Air Force Virtual Distributed Laboratory (VDL), "Open Mission Systems (OMS)," https://www.vdl.afrl.af.mil /programs/uci/oms.php.
[125] Joyce L. Tokar, "An Examination of Open System Architectures for Avionics Systems—An Update" (paper presented at The U.S. Air Force FACE™ Technical Interchange Meeting, Dayton, Ohio, March 2017), https://www.researchgate.net /publication/315736224_An_Examination_of_Open_System_Architectures_for_Avionics_Systems_-_An_Update.
[126] UASF VDL, "Open Mission Systems."
[127] Lockheed Martin, "Lockheed Martin Demonstrates Continued Commitment to Air Force OMS Vision," December 10, 2014, https://www.lockheedmartin.com/us/news/press-releases/2014/december/lockheed-martin-demonstrates-commitment-to-air-force-oms-vision.html.
[128] "Northrop Grumman Demonstrates Open Mission Systems Architecture across Manned and Unmanned Systems," CISION PR Newswire, July 20, 2015, https://www.prnewswire.com/news-releases/northrop-grumman-demonstrates-open-mission-systems-architecture-across-manned-and-unmanned-systems-300114895.html.
[129] Tokar, "An Examination of Open System Architectures for Avionics Systems—An Update."
[130] UK Ministry of Defense, *System of Systems Approach (SOSA) open systems strategy* (London: UK MoD , January 2013), https://www.gov.uk/government/publications/system-of-systems-approach-sosa-open-systems-strategy.

needs of the MoD in which a requirement of "specifying open systems / using modular approach wherever possible" is suggested.[131] In the white paper, the MoD defines open systems as "systems which are based on publicly known standard interfaces that allow anyone to use and communicate with equipment that adheres to the same standard . . . [with the goal of] creating more scope for upgrading and easing interoperability with new capabilities."[132] The result of this white paper was the implementation of the Joint Service Publication 920 (JSP 920). JSP 920 "supports the strategic intent to put NATO at the heart of defence by improving the MOD's approach to standardization management. This is achieved through the use of a common set of principles and standards whenever possible to ensure flexibility and agility to upgrade capability incrementally, and to maintain the right level of interoperability with our allies."[133] The UK Defense Standardization (DSTAN) is responsible for implementing the UK defense standardization policy as well as representing the MoD at the NATO Committee for Standardization.[134]

DSTAN currently has published over 650 extant standards for defense articles that are all publicly available via the U.K Defense Standards portfolio accessible on DSTAN's website.[135] The SOSA Open Systems Strategy stated that "open standards are the cornerstone of an open architecture."[136] Thus, the extent of DSTAN's publication of standards should be viewed as a positive step toward achieving the vision outline in SOSA Open Systems Strategy.

One notable UK OSA is PYRAMID, an OSA originally developed for UAS but is being expanded to include broader air platforms. The UK MoD invested £100 million and for two to three years focused on answering the question: How do we build a componentized system? The result of that effort was PYRAMID, which broke down a system into various functional subsystem components. For those subsystem components, PYRAMID defined certain ins and outs necessary for integrating back into the main platform, but otherwise treated these components as "black boxes." Within the "black box" the MoD left it to industry to develop components without taking their intellectual property or dictating how they should do it so long as it had the required ins and outs. According to the team working on PYRAMID, this approach is one of the first of its kind in either the commercial or defense sector. As PYRAMID has expanded beyond UAS, the MoD is prioritizing systematic reuse, the idea that components can be used on multiple air platforms. This approach creates an incentive for companies to invest in developing quality components, as there can now be a market of multiple aircraft systems, not just a singular aircraft platform.

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[131] UK Secretary of State for Defense, *National Security through Technology: Technology, Equipment, and Support for UK Defence and Security* (London: UK MoD, February 2012), 16, https://www.gov.uk/government/uploads/system/uploads /attachment_data/file/27390/cm8278.pdf.
[132] Ibid., 21.
[133] UK Ministry of Defence, "Standardization Policy," DSTAN, https://www.dstan.mod.uk/policy/index.html.
[134] UK Ministry of Defence, "Guidance: UK Defence Standardization," GOV.UK, https://www.gov.uk/guidance/uk-defence-standardization.
[135] UK Ministry of Defence, "Frequently Asked Questions," DSTAN, https://www.dstan.mod.uk/services/faq.html.
[136] UK MOD, "SOSA open systems strategy."

Case Study: NATO STANAG 4586

The interest of NATO in standardizing Unmanned Aerial Vehicles Control Systems (UCS) started in 1998 when a NATO specialist team commenced work on NATO Standardization Agreement (STANAG) 4586. The goal of STANAG 4586 is to increase interoperability of present and future UAS within the NATO environment to increase "flexibility and efficiency to meet mission objectives through sharing of assets and common utilization of information generated from UAV systems."[137] The first edition of STANAG 4586 was released in 2003, and has since been updated three times in 2007, 2012, and 2017.[138]

STANAG 4586 defines the standards for present and future UAS's data link interface (DLI) and the command and control interface (CCI). The DLI enables communications between a variety of other air vehicles and NATO standardized systems, while the CCI enables interfacing between UCS core systems and external command, control, communications, computers, and intelligence (C4I) systems.[139] If all coalition UASs abided by these standards, issues of intervehicle / intercountry communication and interoperability would be greatly decreased.

STANAG 4586 also establishes definitions for five different levels of interoperability for UAS. Level 1 is the lowest level of interoperability while level 5 is highest. The definitions are as follows:

> Level 1: The ability to indirectly receive or transmit sensor products and associated meta data.
>
> Level 2: The ability to directly receive or transmit sensor product data and associated metadata.
>
> Level 3: The ability to control and monitor the payload of the UAS.
>
> Level 4: The ability to control and monitor the UAS except for the launch and recovery functionalities.
>
> Level 5: The ability to control and monitor the UAS including launch and control functionalities.[140]

It is important to note that all standardization within NATO are completely voluntary.[141]

Australia

Australia established a desire to move toward the OSA model in its "Priority Industry Capability (PIC) Health Check for Through Life and Real Time Support of Mission and Safety Critical Software – 2012." In the 2012 PIC, concerns were raised over how Australia's reliance on an off-the-shelf equipment procurement strategy and Australia's struggle to procure source code from out-of-

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[137] The NATO Standardization Office (NSO), *STANAG 4586: Standard Interfaces of UA Control System (UCS) for NATO UA Interoperability* (Brussels: NATO, April 2017).
[138] Curtis L. Blais, *Unmanned systems interoperability standard* (Monterey, CA: Naval Postgraduate School, September 2016), https://calhoun.nps.edu/bitstream/handle/10945/50386/NPS-MV-16-001.pdf?sequence=1.
[139] Ibid.
[140] Terry Bandzul, *STANAG 4587-Enabling Interoperability* (Calgary, Canada: CDL Systems Ltd), http://www.avcs-au.com/library/files/stanag/4586-presentation.pdf.

country developers.[142] The PIC stated that a more open systems type approach could resolve these issues. However, at the end of the report no concrete policy regarding OSA was established.[143]

Furthermore, in the 2013 PIC Health Check for High End Systems and Systems of Systems Integration, concerns were raised about the difficulty of integrating new capabilities onto preexisting systems. The report notes that issues surrounding integration stem from:

1. An increasing need for both defence and industry to coordinate their integration efforts with those of Australian allies, in order to achieve higher levels of weapons interoperability.

2. The need for integration efforts to adapt to rapidly changing military technologies.

3. The requirement to support the integration of military platforms and systems of different types and ages.

4. The often-rudimentary nature of protocols and standards that facilitate the integration of differently designed systems infrastructure.[144]

The report argues that at the time, no significant steps could be taken to remedy these issues.[145] However, broader coordinated adoption of OSA across the NTIB could help overcome many of the issues identified by this PIC health check.

The Australian Department of Defense is certainly not unfamiliar with the concept of OSAs. In the most recent edition of the Australian Department of Defence Standardization Manual (STANMAN), open-systems architecture is defined as:

> A logical, physical structure implemented via well defined, widely used, publicly maintained, nonproprietary specifications for interfaces, services, and supporting formats to accomplish system functionality, thereby enabling the use of properly engineered components across a wide range of systems with minimal changes.[146]

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[141] The NATO Standardization Office, *Production, Maintenance and Management of NATO Standardization Documents: Edition J version 3* (Brussels: NATO, December 2015), 11, http://nso.nato.int/nso/nsdd/APdetails.html?APNo=2180&LA=EN.
[142] Australian Government Department of Defence, Defence Materiel Organization (DMO), *Priority Industry Capability Health Check-2012: Through-Life and Real Time Support of Mission and Safety Critical Software* (Canberra, Australia: DMO, 2012*),* http://www.defence.gov.au/spi/docs/pic%20factsheet%20support-9-4446%202012.pdf.
[143] Ibid.
[144] Australian Government Department of Defence, Defence Materiel Organization (DMO), *Priority Industry Capability Health Check-2012: 'High-End' System and 'System of Systems' Integration* (Canberra, Australia: DMO, 2012), http://www.defence.gov.au/SPI/Docs/PIC%20FactSheet%20Systems%20Integration-9-4451%202013.pdf
[145] Ibid.
[146] Australian Government Department of Defence, *Australian Defence Publication: Defense Materiel Standardisation Manual* (Canberra, Australia: Australian DoD, 2013), 2-2, http://www.defence.gov.au/dmo/Multimedia/STANMAN-9-5998.pdf.

The STAMAN advises that efforts to standardize should only be undertaken if there are tangible benefits to the Australian DoD.[147] However, beyond this definition it appears that Australia has done very little to implement an open-systems approach to their defense procurement process.

Canada

Unlike the other NTIB partners, Canada lacks an overarching defense policy regarding the use of OSA approaches. However, the lack of top-level guidance has not precluded the use of open systems in Canadian defense procurement. Instead of an overarching policy, the decision whether to use an OSA approach is made on an individual program basis. For example, Canada recently recapitalized its Halifax-class frigates with the Combat Management System (CMS) 330, which uses an OSA at its core.[148]

What Are Potential Barriers for Greater NTIB Collaboration Using OSA?

The potential for utilization of the OSA model as a mechanism for facilitating NTIB collaboration and integration must confront several challenges beyond those that each partner can expect individually in pursuing OSA. First and foremost, the lack of a common taxonomy for talking about OSA among the different NTIB partners needs to be addressed. Second, there are cultural differences within the NTIB partners in both government and industry in the usage of the OSA model. Finally, there are legal and regulatory issues that can arise with OSA usage across national boundaries, notably ITAR, that can serve as a barrier in the NTIB.

Common Definitions and Goals

A potential barrier to greater usage of OSA approaches across the NTIB is the diversity of terminology used by the NTIB partners for OSA. Where there have been ongoing attempts to facilitate greater collaboration on OSA standards, the NTIB partners have found that even though they are using the same terms and words, they can have very different meanings between the different countries. For one joint effort, two countries spent the better part of the first year of the program talking at each other using different lexicons before reaching a common understanding.

In addition to the lack of a common taxonomy, the NTIB partners may differ in their goals and priorities for using and developing OSA. Should the primary goal of encouraging cross-NTIB OSA be promoting military interoperability in operations or better industry collaboration in development and production? The partners have also differed on the question of what "ownership" of an OSA standard looks like. Today, "ownership" of OSA standards can mean government ownership (as with the U.S. Air Force's OMS), third-party NGO ownership (such as The Open Group or Society of Automotive Engineers), or shared ownership and management of a standard by a contractor acting on the government's behalf (as with the United Kingdom's PYRAMID). Also, there are differences in measuring OSA conformance and compliance. Some existing OSA standards require components only meet a certain percentage of that standard's requirements, while others require complete

[147] Ibid., 3-3.
[148] Richard Scott, "Halifax frigate upgrade leads to international success," *Jane's 360 – CANSEC 17D1,* May 31, 2017, http://www.janes.com/article/70974/halifax-frigate-upgrade-leads-to-international-success-cansec17d1.

conformance before certification. These are just a few examples of the different understanding of OSAs that exist among the NTIB partners that complicate efforts by the partners to harmonize their usage of the OSA model. These barriers are not insurmountable, but require the acknowledgment that it will take time to resolve these issues. In fact, many of these issues have been the subject of debate among NATO partners for decades. Resolving these divergent understanding would enable the OSA model to facilitate far more NTIIB collaboration.

Acquisition Workforce

A key challenge to greater implementation of OSA for the NTIB partners is developing a common understanding of key principles of the OSA model within the acquisition workforces of the partner nations, in both the government and industry. Even though the United States has had policies in place promoting OSA usage for the better part of three decades, the broader government acquisition workforce does not always have the knowledge or skills necessary to properly execute OSA. Given the strong U.S. requirements for OSA in FY 2017, U.S. program managers are going to be judged on whether their systems are "open." This dynamic creates an incentive within the workforce to declare their systems open even if key OSA principles are not fully or correctly implemented.

Of note, there are pockets of the acquisition workforce that do understand OSA approaches and are developing best practices. In the United States, the acquisition workforce at the Navy's Naval Air Systems Command (NAVAIR) is a leader in this area. A key step in overcoming this barrier will be learning the applicable lessons and best practices from NAVAIR, and similar organizations among the NTIB partners, and applying them to the broader acquisition workforce.

Legal and Regulatory

ITAR is the most significant legal barrier to greater OSA usage among the NTIB partners. For NTIB collaboration to succeed, the partners must be able to share information about their standards, and the interfaces within those standards, across national boundaries in a way that doesn't effectively preclude participation by NTIB partners. Among the existing standards in the United States, there are discrepancies between how different existing OSAs are handled under the ITAR. For example, the Joint Common Architecture (JCA) developed in the Army and the Future Airborne Capability Environment (FACE) standard developed by the U.S. Navy and The Open Group are not subject to ITAR restrictions. However, the Air Force decided that its Open Mission Systems (OMS) standard needed to be ITAR restricted. The Army's Victory standard has also been subjected to ITAR restrictions.

Additionally, ITAR makes it difficult for industry partners across the different NTIB countries to collaborate out of fear of inadvertently transferring IP rights to another country. This fear can lead to situations where even with the necessary agreements in place, a U.S. national serving an industry fellowship at a foreign firm to promote cooperative development of an OSA standard is prohibited from speaking in meetings for fear that anything he or she says will be considered an ITAR violation. Additionally, industry is not willing to even speak with each other without an existing technical assistance agreement (TAA), project agreement (PA), or MOU in place. Moreover, the U.S. process for negotiating these agreements is slow and hinders cooperation. It recently took the United States and the United Kingdom 11 months, a comparatively fast process, to sign a PA for the

Collaborative Open Systems Architecture (COSA) program. According to one expert that spoke with CSIS, it took four days on the UK side, the rest of the delay was on the United States.

OSA Conclusion

Greater usage of OSA among the United States, Canada, Australia, and the United Kingdom has the potential to spur greater NTIB collaboration, but requires critical up-front time investments to gain its full, long-term benefit. By coordinating and harmonizing their implementation of the OSA model, the NTIB partners can reduce total life-cycle costs and gain access to critical new capabilities, regardless of the country of origin. Before the totality of these benefits can be gained, there are several issues that will need to be addressed such as the lack of a common lexicon, deficiencies in the acquisition workforce, and legal and regulatory barriers such as ITAR. These barriers are not insurmountable if the NTIB partners are willing to commit the necessary time and resources.

Chapter 6 | OTAs and Other Innovative Approaches

In September 2017, the Center for Strategic and International Studies (CSIS) hosted a roundtable discussion on the potential for partners in the National Technology and Industrial Base (NTIB) to collaborate on high-value, innovative approaches to national security problems through mechanisms designed and devoted to this purpose such as Other Transaction Authority (OTA) agreements.[149] The following sections summarize that discussion.

What is the potential for the NTIB partners to collaborate on high-value, national security research and development projects through innovative approaches such as OTAs?

Participants agreed that there was a strong potential and value for the NTIB partners to engage on high-value, cooperative R&D, prototyping, and production using OTAs and other innovative approaches. When used appropriately, OTAs permit NTIB partners to overcome certain structural barriers and gain benefits where the impact is greater than the dollars invested. For example, previous OTA agreements have allowed for revenues resulting from the OTA to be reinvested in the project, amplifying the government's original financial contribution over time. Participants stressed that it is important to focus on specific objectives in talking about OTA usage with NTIB partners because the objective is crucial to understanding whether OTA is the right mechanism and how an OTA should be structured.

A critical issue in establishing an OTA with the private sector is the business case. Many of the current DoD OTA authorities have requirements for cost sharing from private entities party to an OTA agreement.[150] Private-sector firms are only likely to provide such funding if they see a business case for the development work being performed. All sides need to understand the other sides' business cases to ensure that the incentives are properly aligned for everyone. This factor means that the government must consider the relationship of the OTA to the underlying market when determining which areas of research are likely to lend themselves to an OTA arrangement. Additionally, it is important that NTIB partners have a common understanding of a project's purpose and desired outcome: Are you trying to move the technology forward, increase manufacturing capabilities or competitiveness across an industry, or are you trying to procure something? Participants discussed providing funding to innovative start-ups as one relevant model for use of OTAs. Understanding these objectives also informs how the OTA will handle complex issues such as intellectual property and technology controls. Once you've clarified your objectives,

[149] The original roundtable was made possible by the generous support of the Embassy of Australia.
[150] The Senate's version of the 2018 NDAA contains a provision (Sec. 871) that modifies the DoD OTA prototype authority (section 2371b of Title 10, United States Code) to replace the current language requiring some entities party to an OTA to meet OTA cost-sharing requirements with new language permitting cost-sharing requirements to be met by any source other than the federal government.

it is easier to think about whether an OTA, a Federal Acquisition Regulation (FAR)-based agreement, or another innovative approach is best suited for the project.

Concerns about OTAs

Some participants expressed concerns that the recent legislative changes favoring OTAs could lead to these mechanisms being overused or misused, and that the potential for blowback could lead to the eventual repeal of the Department of Defense's (DoD) OTA authorities. These participants pointed out that OTAs should not be considered as a magical mechanism that allows agencies to completely avoid the FAR and other supplemental regulations or an alternative acquisition structure. A common view among warranted contracting officers is that OTAs should be carefully managed activities and used only where a traditional contract wouldn't work. An example for the use of OTAs is in efforts focused on engineering challenges with limited production quantities carried out through the OTA mechanism. Echoing other members' warning about the recent legislative changes to spur the overuse of OTAs, some participants highlighted that the purpose of the acquisition system is not just to procure goods and services, but ensure fairness and deliver value for taxpayers.

There was pushback on these concerns from other participants who argued that OTAs have been underutilized and have been constrained from their original intent. They argued that the initial intent of OTAs was always to create an alternative acquisition system from cradle to grave through prototyping and down selects. Additionally, some participants pointed out that when DoD was first given OTA authorities, the purpose was to enable the prototyping and acquisition of dual-use technologies from all sources. The OTA cost-sharing and nontraditional defense contractor requirements were not introduced until the FY 2000 National Defense Authorization Act (NDAA).

OTA Limitations: Human Factor

The human factor, whether it be a general unfamiliarity across the defense enterprise and within senior leadership, or assorted issues with contracting officers such as their preference for FAR-based approaches, was the most frequently cited limitation of potential NTIB collaboration using OTAs. Outside of a select few Centers of Excellence (Defense Advanced Projects Agency, Army Contracting Command–New Jersey, NASA, National Geospatial-Intelligence Agency), participants agreed that there is a general lack of familiarity of OTAs.

Participants highlighted two primary concerns related to contracting officers and OTAs. The first concern discussed was that that the defense acquisition system was not set up for contracting officers to learn how to execute OTAs. The defense acquisition system's traditional schooling, training, and career path leads to the average warranted contracting officer being incapable of properly executing OTAs. One participant described that at DARPA, only half of the contracting officers had the expertise and skills necessary to create and execute OTAs. The second concern discussed was that warranted contracting officers actually preferred FAR-based approaches over OTAs and other non-FAR-based approaches because they knew the FAR's "rules of the road." The existing models and guidance for FAR-based approaches were preferable to the freedom of the blank sheet of paper. Participants also acknowledged that given the risk averseness of the defense acquisition system, acquisition regulations create top cover for decisions given the disproportionately negative consequences for making a mistake, rather than the rewards for taking

a risk. Next steps in improving uptake of innovation are to create incentives to reward behavior that drives innovation—not that which minimizes risk.

OTA Consortiums

Consortiums are not a required element of an OTA, but have become a notable component of the OTA ecosystem. Participants noted that consortiums can serve a useful role in certain OTAs to the extent that a consortium allows for collaboration between DoD and an entire industry sector as happened in the Semiconductor Manufacturing Technology (Sematech) consortium, and as is the case more recently with the manufacturing innovation institutes.[151] In these cases, the consortium provides a useful mechanism to support an objective that would be impossible or unnecessarily tedious to carry out via separate agreements. Furthermore, the nature of the consortium enables robust competition in the sector at later stages in the development/procurement cycle. There is also historical precedent for the use of consortiums in international OTAs such as a U.S.-UK collaboration on network warfare as demonstrated by previous agreements in this area.

However, participants also expressed apprehensions about consortiums and OTAs. One participant expressed concerns about the structure of consortiums preselecting players and restricting the available market for competition. Second, there were concerns that consortiums collecting fees to join creates a perception of pay-to-play. Third, participants mentioned that there is a current OTA competition only open to one consortium, but that specific consortium will only accept U.S. companies as members. The U.S.-only membership rule is not wide-ranging, but just the rule of this specific consortium. Beyond ensuring that consortiums are open to international companies from NTIB countries, participants advocated the need for an alert system, or some other function that notifies the other NTIB partner countries when these types of opportunity for consortium members to compete or collaborate are released to industry by DoD. One participant summarized it as the U.S. demand signal should not stop at the U.S. border when its allies may well be able to make a material contribution.

Finally, some participants argued that some consortiums today were more like services contracts. Instead of embodying the spirit of an OTA, these consortiums were just a way to allocate money across multiple years and commit it quickly when appropriate. Participants pointed to the Integrated High-Performance Turbine Engine Technology (IHPTET) consortium as an example of a true consortium. The consortium had no prime contractor, but had the signatures of the seven participating engine manufacturers who were left to govern themselves.

Other Innovative Approaches

Participants noted that OTAs were just one innovative approach and identified additional approaches. One participant highlighted that they were seeing a lot of creative energies coming out of prize competitions and that, as far as this participant was aware, they were all open to international partners. Collaborative R&D agreements have been used effectively in the international context to enable innovative research.

[151] Sematech was not created using an OTA, but an MOU as defined by sections 271-276 of the FY 1988/1989 NDAA. However, the Sematech MOU requirements resemble the intentions and structure of an OTA even if it was not specifically created using an OTA.

Another approach identified was the Commercial Solutions Opening (CSO) mechanism used by the Defense Innovation Unit Experimental (DIUx). DIUx published a useful guide on the CSO mechanism on their website that outlines their interpretations of how an OTA can be best used under the CSO mechanism to rapidly demonstrate innovation. Additionally, participants noted DoD was given the statutory authority in the FY 2016 NDAA to transition prototype projects to production if the original contract was awarded competitively, but did not use that authority until the fourth quarter of FY 2017 when DIUx used this new authority for the first time in the fourth quarter of FY 2017, transitioning two pilot contracts into follow-on production contracts.[152]

Several participants noted the use by the NGA of an arrangement where the agency agreed to provide government data, such as imagery, to companies as the primary government contribution to an effort designed to spur innovative analysis capabilities. In this case the nontraditional companies were not attracted to NGA because of the revenue from the OTA, but the access to unique and vast data holdings, and the advancements in big-data analytics that could be made without sacrificing their intellectual property.

What capability areas best lend themselves to these innovative approaches?

CSIS identified five areas of potential shared interested among NTIB countries: space, cyber/future computing capabilities, integrated/joint intelligence, surveillance, and reconnaissance (ISR), unmanned and autonomous systems, and hypersonic technologies. CSIS asked the workshop participants to discuss these questions: Are these the right capabilities? Are there other potential capability areas that might lend themselves to these approaches?

Participants agreed that these five capabilities were among the right ones and acknowledged that there are already ongoing activities in some of these areas. Examples given of ongoing work included the U.S.-Canada work on space arms, the U.S.-United Kingdom work in quantum computing and unmanned systems, and the U.S.-Australia hypersonic technologies research.

Other areas of potential shared interest identified by participants included predictive analytics, emerging biotechnologies, materiel sciences, machine learning, and additive manufacturing.

Outside of specific capability areas, participants offered guiding principles for NTIB countries to consider in investment decisions. First, outside of certain niche areas such as hypersonic technologies, areas where there is high overlap between commercial and military applications are the most attractive investment opportunities for OTAs, especially those requiring a private-sector match. Second, for companies, early-stage research funding that helps them pursue technologies is likely the most attractive option. Third, investments should have a commercial business case in addition to a DoD business case. One of the problems with the Advanced Concept Technology Demonstration (ACTD) program during the 1990s was that there wasn't enough money to fund both successful prototypes and the services' preexisting priorities. The ACTD mechanism didn't necessarily solve this problem. For companies to be willing to invest their own funds to span the

[152] DIUx, *DIUx Quarterly Progress Results: Q4 2017* (Mountain View, CA: DIUx, October 2017), https://www.diux.mil/download/datasets/1372/DIUx%20Q4%20FY2017.pdf.

"valley of death" from the end of an ACTD to a potential program of record, there must be an expected return on investment that makes the expenditure worthwhile. This means that the private partner needs a strong commercial element in the business case so that companies can continue even if the DoD business case does not work out or is slow to develop.

Finally, areas where small quantities are produced, but require high-level engineering, are ripe for this approach.

What are the potential barriers, such as intellectual property rights, for these innovative approaches?

Participants generally agreed that export controls and intellectual property (IP) rights are two of the biggest barriers to greater NTIB collaboration.

Export Controls

The restrictions imposed by International Traffic in Arms Regulations (ITAR) on transferring technologies to and from the United States were the greatest concern among workshop participants. For U.S. NTIB partners, ITAR tracking requirements make it burdensome to execute simple things like moving equipment around their own country. Additionally, ITAR raises a bigger point for these countries: If they have a sovereign technology, why would they share it with the United States if it were to subsequently fall under the ITAR, and due to the extraterritorial application of the ITAR limit the sovereignty of the country that initially developed the system? For our NTIB partners, this is a huge disincentive for cooperating with the United States.

The discussion on ITAR led to a conversation about the current state and effect the U.S.-UK and U.S.-Australia defense trade treaties have had on export controls. Workshop participants commented that although the treaties have helped in a limited number of instances, they have not had the desired effect. Comparing those treaties with the U.S.-Canada defense trade treaties, participants highlighted that there have been over eight thousand transactions under the Canadian ITAR exemption compared to the hundreds under the U.S.-Australian defense trade treaty, and just a handful under the U.S.-UK treaty. Additionally, participants pointed out that the current treaties, inadequate as they may be now, have yet to be tested in an operational environment in which transactions need to occur even more quickly than today. Though participants agreed that treaties' benefits have yet to be realized, they were adamant in recommending not to set aside the treaties, but to improve the onerous implementing arrangements.

CSIS asked workshop participants whether it was feasible to negotiate ITAR preapproval as part of an OTA. Workshop participants generally agreed that creating a mechanism for preapproval, while not easy, is plausible and worth getting people to think about. Participants did note that because export controls have so many stakeholders and power in the system is so diffused, many people outside DoD can say no. However, creating this type of mechanism for NTIB countries would not be impossible and the State Department is already working to broaden the export control aperture. Participants suggested that once established, OTAs can enable greater collaboration between multiple parties given that the OTA authorities permit such agreements to have multiple parties all brought in under the same agreement containing export control preauthorization.

One participant raised the question of whether export controls were adequately considered in the Committee for Foreign Investment in the U.S. (CFIUS) process. Given China's active interest and investment in U.S. dual-use technology companies, adding a carve-out when considering foreign investment from NTIB countries would add to the pool of assured suppliers.

OTA Concluding Thoughts

In summation, workshop participants generally agreed that OTAs and other innovative approaches offered significant potential for NTIB partners to collaborate on high-value, innovative approaches to national security problems in areas where there are mutual benefits. By collaborating with our NTIB partners through these innovative approaches, the United States works to ensure its continued technological superiority through greater access to the global innovation marketplace. While there are barriers to using OTAs to create greater NTIB collaboration, they are not insurmountable. Given the proper senior leadership attention, on all sides, work can be done to reduce the export control and IP barriers, and ensure that OTAs are properly used for their intended effect.

Chapter 7 | Recommendations

7.1 Recommendations: Big Picture

The U.S. export control system is one of the most frequently discussed challenges for NTIB integration. Both Australia and the United Kingdom have bilateral defense trade cooperation treaties with the United States that were intended to mitigate these challenges; however, the CSIS team found that the path created by these treaties is not necessarily simpler or faster than the regular export control system. As discussed in the barriers section, even policies that are key cooperation enablers, such as Canada's ITAR exemption, have complications and cannot address every barrier. Thus, CSIS recommends that the NTIB partners identify common strategic priorities and pursue multiple approaches to improve present defense trade arrangements and regulations. This reform approach should seize the opportunity to learn from the 70-year defense-trade relationship between Canada and the United States.

Recommendation 1.1: Focus first on priority capabilities of mutual interest

In the initial stages of NTIB integration, setting specific, measurable goals for cooperation that can attract senior leader support is more likely to succeed than trying to "boil the ocean" of the entire system. Therefore, NTIB partners should focus their initial collaboration efforts on capability areas of high priority and mutual interest to all parties. These capabilities areas could include, but are not limited to, space; cyber and future computing capabilities; integrated/joint intelligence, surveillance, and reconnaissance (ISR); unmanned and autonomous systems; hypersonic technologies; and land vehicles. Approaching barriers on a case-by-case basis will have the benefit of demonstrating the immediate value of collaboration to the respective military leaders of each partner nation. Additionally, these initial successes will set a foundation for broad collaborative policies to be built upon in the future.

Recommendation 1.2: Create new ITAR exemptions for the NTIB

The 70-year defense-trade relationship between Canada and the United States can act as a valuable reference for the NTIB partners. As discussed in the barriers section, Canada and the United States have been able to overcome some of the challenges to NTIB cooperation, but still face important obstacles to achieving strategic goals for both countries.[153] As the Canadian Controlled Goods Program shows, export control liberalization is a two-way street with reciprocal control moves made to bring the United States and partner countries' systems closer into alignment. Negotiations on a new exemption should seek not only to replicate what the United States and Canada have achieved, but also to focus attention on overcoming some of the challenges they have encountered.

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[153] For greater detail on CSIS's recommendations for the United States-Canada bilateral defense industrial relationship, see Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 61–68.

If the United Kingdom and Australia were to receive their own version of the Canadian ITAR exemption ("part 126"), or if an additional ITAR exemption was created that applied to all NTIB partners, it would be a big step forward. The study team believes that NTIB-related ITAR exemptions should be adopted in addition to the current Canadian ITAR exemption, which should be retained. However, it is important to note that the Canadian ITAR exemption still excludes certain priority technologies where closer integration among NTIB countries is needed. In particular, the current Canada exemption limits collaboration on NTIB priority issues such as cyber security and the critical technologies identified in the National Defense Strategy. Limitations on some of the priority areas mentioned in Recommendation 1.1 may be mitigated by export control reform effects that have refined the U.S. munitions list. Nonetheless, the NTIB should aim to ensure that any present and future ITAR exemptions do not have carve outs that undercut NTIB members' ability to cooperate on strategic priorities.

Recommendation 1.2A: Consider other areas for updating agreements

Beyond the headline of the ITAR exemption, there is also room for smaller improvements to enable closer NTIB cooperation. While there are arrangements already in place for Canada-U.S. defense trade that can be extended to the United Kingdom and Australia, there are challenges associated with these arrangements. Some of these challenges are straightforward: workshop participants found that text in the Defense Federal Acquisition Regulations (DFARs) are inconsistent with its usage of the term and definition of "NTIB," in that they only include Canada. CSIS also found that the outcomes of the current Defense Trade Cooperation Treaties for the United Kingdom and Australia should be viewed as a cautionary tale because although the treaty language reflects mutual interests and objectives, the implementing arrangements render the treaties ineffective. If Congress wished to increased use of these agreements, workshop participants raised excluded technology areas and overly complex process as two areas that would be ripe for reform.

Recommendation 1.2B: Make program-wide licenses available

It was further found that third-party transfer policies and a lack of clarity on regulations that restrict transfers among NTIB countries is frustrating for partners and prohibits effective integration. In response to these barriers, CSIS recommends that regulatory approval processes for defense trade could be streamlined under cooperative industry-government programs that allow program licensing upfront based on what each country wants to see exported or transferred. Were the United States to make such licenses available, the benefits would be available beyond NTIB because other U.S. collaborators may also qualify, although NTIB industry partners are better positioned to meet license criteria from having already established the experience and investments necessary to do so. Program licenses would not remove many of the intrinsic burdens of export controls because technology security is not an easy task to pursue. However, they would reduce the friction of transfers within participating companies and industries and add clarity on third-country transfers. One reason to be hopeful about the benefits of such licenses is the outcomes already achieved by NTIB industry partners where the infrastructure already exists in all four NTIB countries and the industry has developed trust with its partner.

Recommendation 1.3: Strengthen the acquisition workforce across the NTIB

Implementing any of the mechanisms discussed in this report—performance-based logistics, other transaction authorities, or open-system architectures—requires strengthening the acquisition workforces across the NTIB. This study found that, outside of select organizations, both government and industry workforces tend to lack the knowledge, skills, or experience needed to best leverage the various acquisition mechanisms. Therefore, employing the proper personnel on both sides of the platform is required to achieve the maximum benefits from greater NTIB integration.

Strengthening the workforce can be accomplished in several ways. First, the government will need to ensure that it can competitively recruit personnel with the necessary technical skills. Properly using OSAs and similar approaches requires technical knowledge and understanding beyond what is currently required of program management personnel. Second, the Defense Acquisition University (DAU) coursework should be expanded to include more inclusive courses on these issues beyond the current approach, which focuses on familiarizing participants with the concept, instead of providing a more in-depth understanding.[154] Finally, the NTIB partners should align program managers' incentives beyond a binary checkbox for these, and other, potential innovative approaches. The program manager's first consideration when applying a new consideration should be whether or not it is appropriate in this instance, and not simply whether it has high potential in the abstract.

Recommendation 1.3A: Encourage NTIB partners to consider setting up an NTIB acquisition center of excellence.

One of the biggest barriers to greater NTIB collaboration is the lack of familiarity with the potential offerings of the other NTIB partners, and the mechanisms enabling cooperation. The history of U.S.-Canadian defense cooperation shows that as program managers and contracting offices become familiar with the offerings and mechanisms enabling NTIB collaboration, the previously perceived barriers to cooperation disappear. Creating an NTIB acquisition center of excellence can enable contracting officers to familiarize themselves with the various laws and regulations that specifically pertain to the different NTIB partners. In addition to those benefits, other multilateral training programs, like the Euro-NATO Joint Pilot Training Program, have been shown to reduce costs and create a stronger training environment, as well as build important future relationships.[155]

7.2 Recommendations: PBL as a Tool (Not a Solution) for NTIB Integration

The next set of recommendations focus on the prospect of utilizing PBL contracting mechanisms as a solution for NTIB integration. In theory, PBL is a logical tool for NTIB integration because all four partner nations have an extensive history of PBL utilization. In practice, however, the four partner nations exhibit differences in their use of PBL contracting mechanisms. Although CSIS

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[154] GAO, *DOD Efforts to Adopt Open Systems.*

[155] 82nd Training Wing, "Euro-NATO Joint Jet Pilot Training Program (ENJJPT), Sheppard Air Force Base, October 17, 2012, http://www.sheppard.af.mil/Library/Fact-Sheets/Display/Article/367537/euro-nato-joint-jet -pilot-training-program-enjjpt/.

found three areas where the partner nations may be able to align these differences—contract duration, contract type, and performance metrics—these differences stem from multiple sources baked into the structure and management of each country's industrial base. Furthermore, conversations with experts from both government and industry suggested that stakeholders from the NTIB are not enthusiastically motivated to use PBL as a solution for NTIB integration. Despite this general mood, CSIS recommends a series of practical measures for how the NTIB can align their practices in PBL to improve cooperation.

Recommendation 2.1: Align milestones to mitigate persistent differences in systems

Given the systematic and cultural differences in PBL practices across the NTIB discussed in Chapter 4, the study team recommends that the NTIB countries understand their respective partners' history of PBL use so that the cultural barriers are anticipated and minimized. First, the NTIB partners should be aware of the varying levels of contract duration utilized in PBL contracting by each country. These differences are a result of divergent regulatory environments and acquisition cultures. Instead of having one country adapt to another's contract duration practices, CSIS recommends that the NTIB partners can align key milestones associated with cooperative programs contracted by PBL. For instance, the United States tends to implement PBL for sustainment while the United Kingdom might implement PBL contracting mechanisms from the outset of a program. The two nations could harmonize these practices by engaging in an FMS or DCS contract and later plan to cooperate through a PBL sustainment MOU.

Recommendation 2.2: Learn from one another

Participation in the NTIB presents valuable opportunities to learn from one another. On the one hand, learning from one another in the context of PBL contracting facilitates the understanding of the respective partners' history and culture of PBL use, which fosters productive integration. On the other hand, NTIB partners can take advantage of one another's acquisition laboratories. The divergent histories and cultures of the respective NTIB partners' use of PBL affect countries' decisions to utilize fixed-price or cost-plus based contracting for PBLs. Furthermore, these inherent country-level differences affect the usage of performance metrics associated with PBL contracting. As a result, it is crucial for the NTIB partners to understand these inherent differences so that when working together, the barriers dues to cultural differences are anticipated and averted.

Once the partners achieve the intellectual tools to effectively combat the cultural barriers to integration through PBL contracting mechanisms, the NTIB partners have a fruitful opportunity to learn from one another's acquisition environments. PBL contracting is highly particular and thus requires a significant amount of tuning. Learning from what succeeded and failed for one another can expand each partner's cookbook for the use of PBLs and through life sustainment practices. Although there is a tendency for parochialism in the U.S. acquisition culture, all NTIB partners have valuable practices to share with respect to PBL contracting and the management of through-life sustainment. Thus, CSIS recommends that the partners become experts on each other's PBL contracting practices to best accrue the benefits of cooperation.

Another learning opportunity that the NTIB brings to the four partner nations is through the testing and certification process associated with the FMS system. As previously discussed, there are certain

aspects of the FMS system that create barriers to efficient NTIB integration. Specifically, the FMS system can be excessively time and cost inefficient due to the requirement that foreign defense articles, and those receiving new modifications, must go through the U.S. testing and certification process regardless of whether the foreign defense article has already been certified by its origin country. This often results in partner nations intentionally avoiding the FMS process entirely. To mitigate this barrier, CSIS recommends that the NTIB partners should instead acknowledge the test and evaluation of one another's country so that the excessive time and cost inefficiencies that result from the current process are avoided. If one NTIB partner certifies a system, this certification should be valid throughout the NTIB partner nations.

Recommendation 2.3: Apply NTIB's potential to address the challenge of aging air fleets

The CSIS study team also recommends that the NTIB can optimally benefit from the use of PBL cooperation when they apply PBL practices to readiness and aging air fleets. Readiness and obsolescence are issues collectively facing the NTIB. The NTIB partners have individually exhibited PBL practices to address these issues and CSIS recommends that this is an area of opportunity for cooperation moving forward. A large industrial base translates to more room for specialization. Certain NTIB partners have already demonstrated the successful capacity to sustain older U.S. aircraft such as the F-18. Thus, there is an opportunity for the other NTIB partners to learn from these sustainment practices and utilize one another's specialization to efficiently continue readiness and avoid obsolescence. In the F-18 example, the United States incorporated one Canadian supplier that made innovative use of robotics as an additional alternative for F-18 maintenance. This step did not just increase the competition available to the United States, it also expanded the capacity of the industrial base to address an ongoing crisis in F-18 readiness.[156] Additionally, CSIS recommends that the ability to have shared outcomes—whether these are operational (e.g., aligning operational requirements) or performance outcomes (e.g., hours of availability)—would be fundamental to success if the NTIB were to embark on cooperation for readiness and sustainment of old aircraft.

7.3 Recommendations: OSA as a Tool (Not a Solution) for NTIB Integration

Recommendation 3.1: Take the up-front time necessary to reach a collective understanding on OSA

The primary barrier to improving OSA usage among the NTIB partners is the lack of a common taxonomy stemming from varied understandings of the process and value to developing an OSA approach. It is essential to address the basic goals and purpose behind adopting an OSA before more technical, policy-oriented discussions can take place. Setting a universally accepted understanding of OSA to inform both industry and government will yield long-term benefits to an integrated NTIB, despite the initial time investment required. For example, the United States and the United Kingdom spent the first year of the COSA program trying to reach a more common lexicon, and are now starting to reap the benefits from taking the time to reach that mutual understanding. Finally, making the long-term investment in reaching a collective understanding of

[156] Obecny et al., *U.S.-Canadian Defense Industrial Cooperation*, 29–30.

OSA can contribute to buy-in from all stakeholders by ensuring that everyone involved is held accountable to the same standards.

Recommendation 3.2: Don't make a "perfect" standard the enemy of good

The NTIB partners should not set out with the goal of developing the "perfect" universally adopted OSA standards from the outset. Facilitating greater NTIB collaboration using OSA approaches is best achieved through an iterative process of successes building on successes. This process is best accomplished by targeting existing standards that are deemed acceptable, and building upon them using agreements based on the collective understanding of OSA discussed above.

Recommendation 3.2A: Recognize that universal multilateral standards are good, but are a long-term aspirational goal. In the short term, focus on standards "interoperability"

The development of universal multilateral standards should not be the NTIB partners' immediate priority, but a long-term aspirational goal. In the early stages of integration, the four countries will likely be slow to stray from using some version of their own standards. Therefore, near-term goals should focus on making it as easy as possible to move between each nation's specific standards. This can be accomplished by structuring components to be easily retested against the standards of multiple countries, whenever possible.

Recommendation 3.2B: Limit development of new separate OSA standards

The NTIB partners should limit the development of new separate OSA standards, and only do so after determining that similar ones do not already exist, or are insufficient for their needs. Creating repetitive standards dilutes the value of an open-systems approach, leading to market segmentation. This makes it difficult to achieve buy-in from the necessary stakeholders because the standard to which they are supposed to meet is continuously changing. To mitigate this, partner nations should look to the other NTIB countries' existing standards before setting out to define new ones. For example, the United States should be willing to consider adopting a United Kingdom/Canada/Australia standard if one does not exist in the United States and vice versa. Adapting an ally's standards saves on the cost of new development as well as works toward the long-term goal of achieving universal multilateral standards for an integrated NTIB. Finally, if it is necessary to develop a wholly new standard, being familiar with the strengths and weakness of what exists will inform where the new standard fits in the bigger picture.

Recommendation 3.3: Adopt good governance structures for OSA standards

The four NTIB countries should adopt the best governance practices from existing OSA such as FACE and PYRAMID. First, they should establish a collaborative forum for the four governments, and representatives from their respective defense industries, to discuss the benefits and drawbacks of each standard in a private setting. This forum should seek a consensus between government and industry wherever possible, but allow for the government to direct decisions in critical areas where a consensus cannot be reached.[157] The developments reached in this private forum should lead to opening the standards to the wider public. An example of this approach is FACE, which

[157] Sledge, "A Discussion on Open-Systems Architecture."

originated and matured in NAVAIR before eventually transferring to The Open Group. After a standard has been released, the NTIB partners should establish a formalized conformance-testing program that independently certifies that vendors are meeting the standard's requirements.[158] Finally, unless the NTIB partners can demonstrate unequivocal necessity, OSA standards should not be subject to ITAR or other export controls. If their export controls are unequivocally necessary, exemptions should be built for the NTIB partners.

Recommendation 3.4: Leverage existing institutions where possible

This type of work on coordinating standards is already being done at places such as The Technical Cooperation Program (TTCP), which comprises the four NTIB partners and New Zealand. Building off the progress of existing organizations limits the cost of the NTIB developing new institutions for collaboration.

Recommendation 3.4A: Create Standards "repositories" across the NTIB partners

One of the problems with adopting OSA approaches is that vendors and customers often do not know where to go to find the information on the appropriate standards. To remedy this, each of the NTIB partners should create an easily found repository of all the relevant standards. In some countries, there are already organizations that have done this to varying degrees, like the Open Systems Joint Task Force (OSJTF) Office of the Secretary of Defense (OSD) of the United States. In those instances, governments should continue to build off the existing work.

[158] The Open Group, "About the FACE consortium."

Chapter 8 | Conclusion

The ability of the American military to field unmatched military capabilities in large part relies on a private-sector industrial base to develop and sustain these technologies. That observation has been true for decades, although the policies, institutions, and regulations required to nurture this industrial base have varied depending on global circumstances. During the Cold War, much of the world was divided between two competing and largely mutually exclusive economic blocks, with government research programs the source of much new technology and innovations on both sides. In our present environment, the global economy and supply chains are far more integrated and a great deal of cutting-edge technology originates in the commercial sector.

The 2017 NSS and 2018 NDS both highlighted these changes, paying special attention to commercial technology and the national security innovation base, a larger conception of the defense industrial base's ecosystem that includes the NTIB. It is not a coincidence that Congress turned to the NTIB, which was founded in 1992, to address the question of how to seize the benefits of integration available in this present environment while seeking to minimize its risks. Integration with close allies—first Canada, now the United Kingdom and Australia—can act as a multiplier for the U.S. industrial base, which in the decades to come may no longer be the clear-cut largest in the world, and even today is not the exclusive home of the world's leading technologies. The challenge for policymakers is determining how to best leverage the potential of this larger base while considering legitimate competing concerns. This study sought to make these potential benefits concrete by examining PBL contracts, OSA standards, and OTAs as well as other mechanisms for accessing innovation.

Summary of Case Studies and Recommendations

An overriding theme of these case studies was how national differences in terminology, statute, policy, and missions provide both opportunities and barriers for NTIB integration. The opportunities arise because there are numerous areas where the NTIB partners could better harmonize their approaches to open systems and PBL to support common objectives, allow greater sharing of the information, and facilitate closer NTIB integration. However, the national differences identified in these case studies combined with overarching policies such as ITAR regulations highlight clear challenges to NTIB integration. A major lesson drawn from examining these case studies is the degree of importance from the senior leadership in all four NTIB partner nations is likely to play in achieving the benefits of integration anticipated by Congress in the FY17 NDAA. It will take senior leadership to link the NTIB integration effort to the common strategic objectives of the NTIB partners, and to tackle the opportunities and barriers presented by differences in policy and statute where appropriate. The pathfinder efforts currently being pursued by the NTIB partners have significance for the issues identified in the case studies. However, the case studies also identify a range of additional issues relating to differing terminology, language, and contractual practices that are likely to be significant as efforts toward deeper NTIB integration evolve.

Finally, CSIS identified recommendations for the NTIB partners to consider, drawing from each element of the project. An inescapable element of all the projects' discussions is that NTIB integration is powerfully affected by technology controls, and just as clearly, that there is not a single "silver bullet" solution likely to solve this problem quickly. The 70-year evolution of the defense industrial relationship between the United States and Canada—as well as the limited success of the defense trade treaties between the United States and the United Kingdom and between the United States and Australia—make it clear that developing effective approaches to technology controls for successful defense trade among the NTIB partners is a major concern today, and an issue likely to need continued focus for many years. Opportunities for progress exist in simplifying the implementing procedures for the two defense trade treaties and considering additional and expanded ITAR exemptions in support of NTIB priorities. In addition, adoption of a program licensing approach could significantly facilitate a range of NTIB activities, especially technology transfers within firms operating across the NTIB partner nations.

Another overarching recommendation relates to the opportunity for common acquisition workforce training on NTIB priority processes. By sending acquisition workforce members to get common training with their NTIB peers, the NTIB partners can address areas of need in the execution and administration of OTAs, open-systems approaches, and PBL while powerfully communicating to the workforce the expectation that they will work with partners across the NTIB.

With respect to the specific case studies, the NTIB partners can harmonize their approach to sustainment of common platforms through greater information sharing and harmonizing their timelines and incentive structures for PBL arrangements. Likewise, there is great utility in the NTIB partners coordinating their effort in the development of open standards and ensuring that these standards are available throughout the NTIB in ways that allow for NTIB integration.

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