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CSIS DEFENSE-INDUSTRIAL INITIATIVES GROUP

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Executive Summary

The United States and Canada forged a partnership in the wake of World War II that recognized the inherent commonality in the two nations' strategic interests, the interdependency of the two nations' security interests, and the advantages of economic integration across the U.S.-Canada border. It was readily apparent to U.S. leaders during the Cold War that cooperation between the United States and Canada was critical to countering the threat of the Soviet Union to the U.S. homeland and to carrying out the U.S. strategy of containment. It was also apparent to leaders on both sides of the border that this partnership would be supported and reinforced in all aspects by close defense industrial cooperation. This cooperation has now been in place for over 70 years. The strength of the U.S.-Canadian defense industrial relationship is tied directly to the strength of the broader U.S.-Canadian security partnership it is designed to enable. The historic strength of the U.S.-Canadian strategic partnership, in turn, is explained by the tremendous security benefits that have accrued to both sides. Although the United States and Canada today confront a world that is different in critical respects from the Cold War security environment, the importance of the strategic partnership remains, and in fact, there is significant opportunity to increase the value of the relationship by deepening aspects of industrial cooperation that present a compelling value proposition.

The United States' foremost national security interest is the protection of the American homeland, and this objective is critically supported in every respect by the cooperation between the United States and Canada in areas such as North American air defense, maritime domain awareness, border and cyber security, and space. In addition to the value of the partnership to U.S. homeland defense, Canada has been a critical partner of the United States in missions carried out around the globe. Canada has also clearly enjoyed significant security benefits in partnering with the United States in these same areas. Ultimately, the benefit to both partners exceeds what either could obtain solely by relying on its own national resources. This essential value proposition has kept the security relationship active and strong over the course of decades.

The United States and Canada also share a long history of economic relations and a volume of cross-border trade, in goods and technology, unmatched by any other two trading partners in the world. As an element of both this economic relationship and the security relationship, the joint U.S.-Canadian defense industrial cooperation has been built incrementally over more than seven decades. After the initial establishment of a strategic industrial partnership in the wake of World War II, the relationship has continued to develop on a more ad hoc, informal basis. The success of industrial integration efforts often fluctuated in effectiveness depending on domestic politics and the imminence of military threats or operational needs. Still, despite fluctuations and at times differing strategic calculations or policies in Washington and Ottawa, the U.S.-Canada defense relationship, and associated cross-border industrial ties, has shown remarkable resilience and adaptability as a result of strong military-to-military cooperation and shared national goodwill and desire for

cooperation. Furthermore, there is strong and growing demand in both nations to leverage and extend this partnership in the coming years to enable key investments in areas of common interest such as providing security in the Arctic, renewing North American air defense and providing for robust missile defenses, enhancing North American maritime security, and capitalizing on emerging technologies in robotics, space, and cyberspace.

The U.S.-Canadian defense industrial relationship has been incrementally institutionalized in several framework agreements and, on the U.S. side, in U.S. Department of Defense (DoD) directives and DoD and Department of State regulations. The essential integration of the two nations' defense industries is captured by their designation in both U.S. statute and regulation as the national technology and industrial base (NTIB).[1] Successful implementation of NTIB integration that involves both U.S. and Canadian defense interests has proceeded sporadically, depending on various and sometimes temporary political, security, and budgetary issues. As a result, bilateral cooperation and production sharing in research, development, testing, and evaluation (RDT&E) has expanded and then stabilized or retreated over time depending on changes in security factors such as urgency of threat, operational requirements, and surge needs.

A strong, stable foundation for the relationship, however, has always been provided by high-level government-to-government initiatives in support of mutual interests, such as air defense initiatives related to the bilateral North American Aerospace Defense Command (NORAD). Similarly, when other key value propositions have been presented, such as the need to step up maritime domain awareness and border protections after September 11, 2001, the need to provide industrial surge capacity in support of armoring and sustaining U.S. weapon systems during the wars in Iraq and Afghanistan, and the need to protect critical infrastructure from terrorist and cyber attack, the U.S.-Canadian defense industrial cooperation partnership has been a key enabler in helping to advance both countries' security interests and military operations.

The CSIS study carefully gathered and analyzed a wide range of data available on the U.S.-Canadian defense industrial relationship including Federal Procurement Data System (FPDS) data, information from Canadian government and industry sources including the Canadian Commercial Corporation, and information on defense trade from the Stockholm International Peace Research Institute (SIPRI). Overall, the contract data analysis supports qualitative findings that the Canadian defense industry plays a significant surge production role for DoD, as evidenced by large fluctuations in topline DoD obligations driven by purchases of ground vehicles by both the Army and the Navy/Marine Corps for land wars in Iraq and Afghanistan. Additionally, more detailed analysis of top products, as measured by total DoD obligations, backs literature review findings that much of Canada's defense trade with DoD is in components and sub-systems supporting U.S.-manufactured platforms, with some notable exceptions of full system production (e.g., land vehicles and tactical radios). The data shows that while the defense industry in Canada is mostly composed of relatively

[1] The National Defense Authorization Act for Fiscal Year 2017, Section 881, expands the NTIB to include the United Kingdom and Australia. While aware of this development and mindful in formulating recommendations for this study that this expansion will have implications for U.S.-Canada defense industrial cooperation, the implications of this expansion are outside the scope of this study.

small firms (90 percent of Canadian defense firms have fewer than 250 employees), these many small firms tend to access the market, particularly the international defense market, through a handful of large industry leaders (heavily characterized by U.S. firms that operate across the border). Eighty percent of defense sales and 90 percent of defense exports are done by firms with 250 or more employees, with cross-border firms constituting the largest share. This data shows that NTIB integration today is extensive in many market sectors.

In reviewing the data surrounding how the industrial relationship has actually operated in recent years, the most surprising finding is the extent to which product-related contracts dominated the total Canadian DoD market share (86 percent of total) as compared to services or research and development (R&D). While relative shares of each varied across DoD components and industrial sectors, the overall ratio of services, and particularly maintenance and repair contracts, to products is far lower than trends seen on the U.S. industry side, where products account for just under half of contract obligations and maintenance and repair contracts account for 5 to 9 percent of obligations. This signals a potential underutilization of industrial capacity, especially given the Canadian industry's demonstrated engineering and sustainment expertise and familiarity with U.S. systems. Likewise, the share of R&D contracts—just 3 percent of total obligations over the 15-year period—is lower than the 8 to 15 percent of obligations for DoD overall. Furthermore, early-stage R&D accounts for a substantial portion of total R&D contracts to Canadian vendors, supporting evidence of a gap between early science and technology (S&T) cooperation and later-stage advanced component and systems development. Given the increasingly global and commercial nature of the technology innovation ecosystem, detailed in more depth in other reports,[2] it is apparent that the United States and Canada have an opportunity to obtain great value and leverage by expanding their defense industrial cooperation in the research and development and services arenas.

To better understand the value proposition in areas where the United States and Canada might obtain better value through industrial cooperation, the study team performed qualitative case studies of four industry sectors: air, space, C4ISR (command, control, communications, computers, intelligence, surveillance, and reconnaissance), and land. The CSIS study team broke down the benefits observed across the case studies into the following topline categories: increased access to unique design and product innovation; increased production and advanced manufacturing capacity; enhanced training and sustainment support; and enhanced international armaments cooperation with allies and partners. Broadly speaking, the benefits accrued by U.S.-Canadian cooperation improve technology and industrial base preparedness, adaptability, responsiveness, and capacity. Leveraging a broader base of suppliers and engineering, manufacturing, and sustainment capabilities improves the quality, schedule, and cost-effectiveness of defense innovation, production, and sustainment. Additionally, the case studies also highlight the benefit of U.S.-Canadian cooperation and coordination in support of global allies and partners

[2] Andrew Hunter and Ryan Crotty, *Keeping the Technological Edge: Leveraging Outside Innovation to Sustain the Department of Defense's Technological Advantage* (Washington, DC: CSIS, September 2015), https://csis-prod.s3.amazonaws.com/s3fs-public/legacy_files/files/publication/150925_Hunter_KeepingTechnologicalEdge_Web.pdf.

In the air sector, simulation technology is a niche capability area where Canadian innovation and expertise have benefited U.S. and allied defense programs since the 1960s and that continues to expand its relevance and applications into the present day. Likewise, in-service support (ISS), specifically maintenance, repair, overhaul (MRO) and service life extension for various advanced fighter, helicopter, maritime patrol and transport aircraft, is a key Canadian industrial capability developed over decades but which only recently has been leveraged more extensively to support U.S. programs. In this sector, there is an opportunity for the United States to obtain more high-value services that can lower the cost of U.S. military operations and better support U.S. forces around the world.

The space component of Canada's defense aerospace sector is relatively small, as much of Canadian space industrial activity has been commercially focused to date. U.S.-Canadian defense and industrial cooperation has been limited, in part due to differing policies on space-based defense programs, and in part due to U.S. national security and export controls. Where there have been mil-to-mil relationships, they have been limited primarily to sharing agreements for satellite data and communications, vice contracting for space hardware. This relative lack of cross-border contracting for space capabilities, particularly outside of R&D, was evident in CSIS data analysis and represents a major opportunity to obtain greater value from cooperation in an area of significant technology need for both countries. The Canadian space industry has been a leader in satellite capabilities since the 1960s and has developed a number of dual-use space-based technologies, including space robotics, optical sensors and other space surveillance capabilities, and space-based synthetic aperture radar. U.S.-Canadian cooperation on the civil side has enabled valuable R&D collaboration, resulting in technology development that has spin-off military applications, as well as civil and commercial applications, and will likely continue to be a growth area for cooperation.

In the C4ISR sector, tactical radio communications is a key capability area of Canadian industry where the United States and Canada have had longstanding mil-to-mil and industrial relationships dating back to the 1960s. Canadian industry has supported U.S. and allied militaries producing high-capacity line-of-sight tactical radios with multiple generations of equipment developed via joint R&D under the U.S.-Canada Defense Development Sharing Program. Sensor technology, specifically advanced electro-optical/infrared (EO/IR) sensors, is an area that more recently has emerged as a specialized niche capability of Canadian industry and whose origins derive from commercially driven innovation now leveraged for military application to the benefit of U.S. and allied defense programs. EO/IR sensor technology is an area of continuing development and likely growing cooperation, as requirements emerge for enhancing multidomain awareness.

Land-related capabilities make up Canada's second-largest defense industrial sector. 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.

The study team looked at processes, policies, and dynamics that have the potential to present barriers to achieving full value in the U.S.-Canada defense industrial partnership. In

most cases, potential barriers arise from U.S. processes or policies that constitute necessary and appropriate mechanisms for complying with U.S. law and/or protecting security. However, it is much less clear that implementation of these processes and policies always strikes the right balance between achieving these legitimate objectives, and supporting DoD's need to obtain full value from the U.S.-Canada defense industrial partnership. The challenges the study team identified break down into the following topline categories: restrictions on foreign acquisition; export control/International Traffic in Arms Regulations (ITAR); National Security/Foreign Disclosure policy; cultural barriers; and institutional barriers.

While the overall U.S.-Canada defense industrial relationship remains sound, the CSIS study team did identify a range of recommendations to enhance its value to both partners. With recent changes of political leadership in both the United States and Canada, this is a natural time to look at the common interests of the two countries and plan next steps. To assist in that effort, CSIS has identified three areas where government-to-government cooperative efforts directly support national security priorities and also take advantage of the comparative industrial advantages of the two nations: enhancing RDT&E cooperation in the Arctic region; prioritizing air and missile defense, maritime domain awareness, and cybersecurity capability development and equipment modernization efforts; and accelerating and aligning innovation initiatives.

The CSIS study team also recommends that DoD examine reducing some barriers in the NTIB by improving small business and nontraditional supplier access mechanisms for Canadian industry, including by including Canadian firms in arrangements designed to spur innovation such as Other Transactional Authority agreements (OTAs) and the Small Business Innovation Research (SBIR) program, and by updating export control regulations and rules/procedures for Canada. DoD and Canadian Department of National Defense (DND) should modernize industrial framework agreements by updating and reaffirming the Defence Production Sharing Agreement (DPSA) memorandum of understanding and formalizing an agreement for cooperation on foreign sales, and strengthen the coordination between the NTIB and DoD's highest-priority S&T initiatives. Finally, the CSIS study team recommends DoD and DND work to improve awareness of the NTIB among research and development and contracting professionals in both countries.

1 Introduction

This report focuses on the longstanding relationship the U.S. defense industrial base has held with Canada. Starting with the historical context of defense trade agreements between the two countries, this report gives an overview of how policy has evolved over time and its effect on the relationship between the United States and Canada's defense industrial bases. The report shows the extent of relationship between DoD acquisition and Canadian defense firms.

The strength of the industrial relationship is tied directly to the strength of the broader U.S.-Canadian security partnership it is designed to enable. The strength of this partnership, in turn, is easily explained by the tremendous security benefits that have accrued to both sides. The United States' foremost national security interest is the protection of the American homeland, and this objective is critically enabled in every respect by the cooperation between the United States and Canada in areas such as North American air defense, maritime domain awareness, border and cyber security, and space. In addition to the value of the partnership to U.S. homeland defense, Canada has been a critical partner of the United States in missions carried out around the globe. Canada has also clearly enjoyed significant security benefits in partnering with the United States in these same areas. Ultimately, the benefit to both partners exceeds what either could obtain solely by relying on its own national resources. This essential value proposition has kept the security relationship active and strong over the course of decades.

The United States and Canada share a long history of economic relations and a volume of cross-border trade, in goods and technology, unmatched by any other two trading partners in the world.

As an element of both this economic relationship and the security relationship, the joint U.S.-Canadian defense industrial cooperation has been built incrementally over more than seven decades. After the initial establishment of a strategic industrial partnership in the wake of World War II, the relationship has continued to develop on a more ad hoc, informal basis. The success of industrial integration efforts often fluctuated in effectiveness depending on domestic politics and the imminence of military threats or operational needs. Still, despite fluctuations and at times differing strategic calculations or policies in Washington and Ottawa, the U.S.-Canada defense relationship, and associated cross-border industrial ties, has shown remarkable resilience and adaptability as a result of strong mil-to-mil cooperation and shared national goodwill and desire for cooperation. Furthermore, there is strong and growing demand in both nations to leverage and extend this partnership in the coming years to enable key investments in areas of common interest such as providing security in the Arctic, renewing North American air defense and providing for robust missile defenses, enhancing North American maritime security, and capitalizing on emerging technologies in robotics, space, and cyberspace.

CSIS drew on the findings from the case studies, interviews, and workshops, supplemented by the broader data and literature review, to devise the recommendations in the report. They are grouped in the three following categories: high-level government-to-government initiatives, export control and acquisition regulations, and agreements / institutions.

1.1 Report Organization

Chapter 2: Evolution of North American Technology and Industrial Base

This section reviews how policies, agreements/programs, and institutions have developed over time in the context of the North American technology and industrial base.

Chapter 3: Key Features of Canadian Industry under North American Technology and Industrial Base

This section highlights the defining characteristics of Canada's defense industry in their relationship with the United States and the niche capabilities that the Canadian defense industry is able to provide.

Chapter 3: Recent Trends in U.S.-Canadian Defense Industrial Cooperation

The recent trends in U.S.-Canadian defense industrial cooperation were found through collected and analyzed prime contract data from the publicly available U.S. Federal Procurement Data System (FPDS), focusing specifically on obligations of DoD to Canadian vendors from 2000–2015 to assess trends in the DoD contract relationship with Canadian industry. Additional data sources were reviewed, including SIPRI trade data and Canadian Department of National Defence (DND) data to contribute to this section of the report. SIPRI (Stockholm International Peace Research Institute) data over the past 15 years was used to identify Canada's relative position in global defense trade and their trade relationship with the United States. DND Major Crown Projects[3] data are categorized into three areas: air, sea, and land. CSIS reviewed Major Crown Projects in these three areas over the past 15 years to examine the role of U.S. industry in recent major Canadian defense procurements.

Chapter 4: Case Studies

To fully illustrate the value proposition in the U.S.-Canadian defense industrial cooperation, the report includes case studies to provide focused analysis across key segments of the Canadian defense industry. These key segments or "key industrial capabilities" were selected during the course of the literature and data review process and aim to cover a cross-section of niche Canadian industrial capability areas within four major industrial sectors: air, space, C4ISR, and land.

Chapter 5: Case Study Findings

Case study findings were consolidated into three categories:

[3] "Major Crown Projects" are Canadian procurements above a CDN$100 million threshold.

Findings on the **benefits** of U.S.-Canadian industrial cooperation

Findings on the **challenges** of and barriers to U.S.-Canadian industrial cooperation

Findings on the **nature of cross-border relationships**

Chapter 6: Recommendations

Annex A: Literature Review

The literature review focuses on the fact that it has been 75 years since the first formalized defense industrial agreement between the United States and Canada, yet literature addressing the topic remains relatively sparse. The relative lack of literature is in some ways a reflection of the ad hoc nature of U.S.-Canada defense industrial cooperation.

Yet, in viewing the literature as a whole it is possible to identify certain themes, trends, and critical milestones in the evolution of the U.S.-Canada defense industrial base. Ultimately, the available literature depicts that the joint U.S.-Canada defense industrial base has been built incrementally and largely on an ad hoc, informal, and reactive basis.

These trends in the literature review were founding by looking at the origins and evolution of U.S.-Canadian defense industrial cooperation starting in the 1940s. World War II allowed for the laying of a foundation for further defense cooperation, while the post–World War II era led to formalizing a new framework for this relationship. The time after the Korean War was focused on restructuring and institutionalizing defense development and production-sharing agreements between the United States and Canada. During the 1960s and 1970s, we saw a divergence of defense policies and politicization of defense procurement. The 1980s saw a re-convergence of defense policy and the Shamrock Summit Re-commitment took place during this time period.

Annex B: Supplementary Information on Trends

This annex provides additional details on trends by Canadian industrial sectors and trends in the Canadian vendor base. Furthermore, the annex provides explanation of how Canadian vendors were defined, the U.S. federal procurement data, and the industrial sectors chosen in this report.

2 Evolution of North American Technology and Industrial Base—Summary of Key Themes[4]

2.1 Policies

More than 70 years ago, the governments of both the United States and Canada recognized the value of strong bilateral cooperation in creating and maintaining a vibrant North American defense industrial base. In 1950, the two nations began to develop the well-defined, nuanced, and deep U.S.-Canada defense economic cooperation policy that exists today. From that initial decision to develop a strategic partnership, this policy has been incrementally institutionalized in several framework agreements and, on the U.S. side, in DoD directives and DoD and Department of State regulations. Successful implementation of national technology and industrial base (NTIB) integration that involves both U.S. and Canadian defense interests has proceeded sporadically, depending on various and sometimes temporary political, security, and budgetary issues. As a result, bilateral cooperation and production sharing in research, development, testing, and evaluation (RDT&E) has expanded and then stabilized or retreated over time depending on changes in security factors such as urgency of threat, operational requirements, and surge needs.

A strong, stable foundation for the relationship, however, has always been provided by high-level government-to-government initiatives in support of mutual interests, such as air defense initiatives related to the bilateral North American Aerospace Defense Command (NORAD). Similarly, when other key value propositions have been presented, such as the need to step up maritime domain awareness and border protections after September 11, 2001, the need to provide industrial surge capacity in support of armoring and sustaining U.S. weapon systems during the wars in Iraq and Afghanistan, and the need to protect critical infrastructure from terrorist and cyber attack, the U.S.-Canadian defense industrial cooperation partnership has been a key enabler in helping to advance both countries' security interests and military operations.

In general, the partnership has been appropriately balanced over time. Reciprocity in laws and regulatory regimes (e.g., export controls) has been maintained; however, the Canadian exemption from the U.S. International Traffic in Arms Regulations narrowed over time as U.S. laws and regulations became more stringent; these rules (e.g., technology exclusion list) may be dated in light of ongoing U.S. export control reform efforts, which have been underway since 2010. U.S. firms have not generally faced significant barriers to accessing Canadian technology. That said, the United States and Canada have both leveraged national security and industrial base policies to protect key industry segments, namely in the space and marine sectors, but also for promoting small businesses. This area will no doubt be a watch item for

[4] For the full literature review on the evolution of the national technology and industrial base, see Annex A.

Canada as the United States examines changes to its domestic source policies as outlined in the Presidential Executive Order on Buy American and Hire American issues on April 18, 2017.[5]

2.2 Agreements/Programs

The trend toward industrial integration across the border accelerated after the United States and Canada signed the Defense Development Production Sharing Agreement (DDPSA) in 1963; thereafter, Canadian firms generally specialized their industrial capabilities with a focus on components/subsystems, relying largely on the United States for the system-level design, development, and production of key military systems such as the F-18 Super Hornet fighter. As a result, Canada procures the vast majority of its military aircraft from U.S. sources. Most prime contract awards are made to U.S.-based Original Equipment Manufacturers (OEMs), while subcontractors are a mix of Canadian firms and subsidiaries of U.S. firms. From 2012–2016, 73 percent of Canada's total defense-related imports came from the United States. Likewise, the United States remains Canada's largest importer of defense-related exports.[6]

Because the U.S.-Canadian defense industrial cooperation has been so comprehensive, and enduring, framework agreements and their implementing arrangements were necessary to balance and satisfy both domestic and collective needs, in light of the interdependency that integration creates. This approach has also led to the development of a web of supply chain relationships with a handful of cross-border firms, such as General Dynamics, L-3, Pratt and Whitney, Boeing, Lockheed Martin, and a few others that anchor much of the cross-border defense trade. The most vibrant cross-border industry investments and collaboration occurred where U.S. and Canadian government R&D funding targeted mutual requirements (e.g., air defense, electronics, land vehicles, space).

Together with the DDPSA, a comprehensive set of framework agreements facilitate collaborative activities throughout the defense acquisition system. These framework agreements set broad terms for cooperation, and greatly helped in the 2000s when Canada provided critical industrial surge capacity in helping to armor and sustain land vehicles used by the U.S. Army and Marine Corps in the wars in Iraq and Afghanistan. However, with the drawdown in U.S. overseas operations, this cooperation appears to have lost some momentum and is likely underutilized today, particularly in support of R&D (e.g., P-3 vs. P-8 collaboration) and technical services. Program/project-specific memoranda of understand (MOUs) or project arrangements (PAs) are also frequently used to elaborate on the framework agreements; however, each such project-specific agreement can take up to two years to put in place, adding time and significant complexity to the relationship. In addition, although the study identified some success in efforts to cooperate on the sale of joint U.S.-Canadian produced systems such as the General Dynamics Light Armored Vehicle overseas, no formal framework agreement exists for cooperating on international arms sales to other

[5] White House, Office of the Press Secretary, "Presidential Executive Order on Buy American and Hire American," April 18, 2017, https://www.whitehouse.gov/the-press-office/2017/04/18/presidential-executive-order-buy-american-and-hire-american.
[6] Stockholm International Peace Research Institute (SIPRI), https://www.sipri.org/sites/default/files/Trends-in-international-arms-transfers-2016.pdf.

allies and partners. There is great potential in such cooperation to increase U.S. and Canadian defense exports and enhance the security of other partners around the world, particularly in small nations where the volume of trade may not justify taking on all of the burdens of the U.S. foreign military sales (FMS) process directly.

2.3 Institutions

There is a strong, but fairly diffuse, institutional basis for U.S.-Canadian defense industrial cooperation that supports collaboration in research and development, production, and sustainment activities. Perhaps unsurprisingly given the complexity of all things acquisition, the matrix of cross-border government and industry relationships became increasingly intricate over the years and bureaucratic structures related to industrial cooperation increasingly stovepiped over time. The North American Technology and Industrial Base Organization (NATIBO) was chartered in 1987 to help coordinate technology and industrial base programs, policies, and activities and to reduce barriers to integration. After the end of Cold War, initiatives and organizations in this area became less frequent. The link between NATIBO—in its facilitation role—and broader high-level U.S. DoD and Canadian DND acquisition and technology initiatives is not always apparent. There is tremendous leverage to be obtained, however, in linking high-value initiatives to the detailed structures in place for U.S.-Canadian industrial cooperation as the case studies examined in this report illustrate. Institutionally, there also appears to be a gap between cooperation in science and technology and other early-stage research and later-stage development and production. This institutional gap appears to be reflected in the fact that U.S. contract spending with Canadian firms is almost entirely engaged in the production or sustainment of already-developed systems and technologies, rather than on development activities, as illustrated in greater detail in Chapter 3.

3 Key Features of Canadian Industry under North American Technology and Industrial Base

3.1 Canadian Defense Industry Characteristics

Perhaps unsurprisingly given the size of the Canadian armed forces and the small size of the domestic Canadian defense market, Canadian defense industry is very export oriented. Sixty percent (CDN $5.9 billion) of overall Canadian defense sales (CDN $9.9 billion) are related to exports.[7] Also unsurprisingly given the close industrial cooperation between the United States and Canada, the largest share of Canadian defense sales overseas go to the United States. Canadian defense industry, for the most part, is characterized by specialized industrial capabilities. This dynamic developed in many respects as a result of conscious decisions by the Canadian government to leverage its partnership with the United States to provide capabilities to the Canadian military and also the significant draw of the large U.S. defense market. It is worth noting that Canadian defense firms work at the cutting edge in many technology areas; engineers, scientists, technologists, and other innovation-relevant occupations comprise over 30 percent of workforce. In addition, Canadian defense industry, in contrast in many respects to the U.S. defense industry, remains heavily involved in related commercial markets. Defense accounted for less than 20 percent of total sales for almost half of Canadian defense firms and two-thirds of firms have significant commercial/civil business lines.

In no small part because of the U.S.-Canada industrial cooperation relationship, the defense industry in Canada is mostly composed of relatively small firms, a broad, diverse base of small business suppliers, with only a handful of large industry leaders dominant within each market sector. Ninety percent of firms have fewer than 250 employees, and present an overwhelming percentage of the market in terms of the number of firms. However, these many small firms tend to access the market, particularly the international defense market, through the industry leaders. Eighty percent of defense sales and 90 percent of defense exports are done by firms with 250 or more employees. Canadian industry is characterized by greater than average foreign ownership of large firms (heavily characterized by U.S. firms that operate across the border), which are advantaged in export markets. Eighty-five percent of businesses are Canadian-owned, accounting for 34 percent of defense sales and 20 percent of defense exports; whereas 8 percent of businesses are U.S.-owned but they account for 46 percent of defense sales and 57 percent of defense exports. While these facts capture the essential structure of the Canadian defense industry and demonstrate how thoroughly it is tied to its U.S. counterpart, the full scope and scale of the ties between U.S.

[7] Department of Innovation, Science and Economic Development Canada, "State of Canadian Defense Industry, 2014," Annex G, 2014, https://www.ic.gc.ca/eic/site/ad-ad.nsf/vwapj/DefenceIndustry2014.pdf/$file/DefenceIndustry2014.pdf.

and Canadian industry are hard to fully measure, as roughly 60–70 percent of defense trade is estimated to occur at the subcontracting level and/or to operate as part of nominally commercial supply chains that sell into defense supply chains but may not be captured in defense industry data.

3.2 Canadian Key Defense Industrial Capabilities

As part of Canadian defense industry focuses on specialized industrial capabilities, a portfolio of leading world-class products and services have developed in Canada. Over the past several decades and in the experience of the recent wars in Iraq and Afghanistan, the United States has been able to preferentially access and leverage these specialized capabilities. Going forward there is tremendous opportunity for the two countries to work collaboratively to leverage these capabilities for technological advantage. The key Canadian defense industrial capabilities identified and examined as part of this study fell into five industry sectors and included:

Air: Components/subsystems—landing gear, engines, sub-assemblies; advanced engineering and manufacturing; maintenance, repair, and operations (MRO) services and life-cycle management/life extension; light/medium dual-use helicopters

Space: Space-based synthetic aperture radar (wide area surveillance), space robotics, satellites (commercial)

C4ISR: Simulation training and equipment; avionics; tactical communications; digital fires control; sensor systems (EO/IR, acoustics, sonar); acoustics processing, micro-UAVs, computing (quantum)/cyber

Land: Light armored vehicles; survivability systems (e.g., armor); personal protective clothing/equipment, including cold weather

Sea: Electronics subsystems, including integrated platform management systems; underwater autonomous vehicles

4 Recent Trends in U.S.-Canadian Defense Industrial Cooperation—Data Analysis

4.1 Trends in U.S. Defense Procurement from Canadian Sources (2000–2015)

4.1.1 Topline Trends

The CSIS study team collected and analyzed prime contract data from the publicly available U.S. Federal Procurement Data System (FPDS), focusing specifically on obligations of DoD to Canadian vendors from 2000–2015 to assess trends in the DoD contract relationship with Canadian industry.[8]

Overall, the contract data analysis supports qualitative findings that Canadian defense industry plays a significant surge production role for DoD, as evidenced by large fluctuations in topline DoD obligations driven by purchases of ground vehicles by both the Army and the Navy/Marine Corps for land wars in Iraq and Afghanistan. Additionally, more detailed analysis of top products, as measured by total DoD obligations, backs the literature review (Annex A) findings that much of Canada's defense trade with DoD is in components and sub-systems supporting U.S.-manufactured platforms, with some notable exceptions of full system production (e.g., land vehicles and tactical radios).

Analysis of DoD contract obligations broken down by industrial sectors shows that the air and C4ISR sectors were the most stable and diversified in terms of both buyers and vendors, indicative of longstanding collaboration on air defense and electronics under NORAD and of a high level of supply chain integration for air platforms. On the other hand, the absence of more surge-related contracting in air and C4ISR also may signal underutilized industrial capacity, particularly in areas (e.g., unmanned aerial vehicles) where DoD had and will likely continue to have high demand and/or urgent requirements. The sector breakdown also supports qualitative evidence that the smallest sectors for defense trade were the sea and space sectors, reflecting, in part, U.S. restrictions related to foreign acquisition, technology security, and export controls.

The most surprising finding is the extent to which product-related contracts dominated the total DoD market share (86 percent of total) as compared to services or R&D. While relative shares of each varied across DoD components and industrial sectors, the overall ratio of services, and particularly maintenance and repair contracts, to products is far lower than

[8] Canadian vendors were defined using a broad standard that includes vendors labeled as Canadian, contractors that appear on Canadian Commercial Corporation vendors lists, and contracts that list Canada as the country of origin or place of performance. For more detail, see Annex B, Note about Definition of Canadian Vendor.

trends seen on the U.S. industry side, where products account for just under half of contract obligations and maintenance and repair contracts account for 5 to 9 percent of obligations. Again, this signals a potential underutilization of industrial capacity, especially given Canadian industry's demonstrated engineering and sustainment expertise and familiarity with U.S. systems. Likewise, the share of R&D contracts—just 3 percent of total obligations over the 15-year period—is lower than the 8 to 15 percent of obligations for DoD overall. This discrepancy supports evidence from interviews that R&D collaboration may have declined since the Cold War, particularly in the last decade. Furthermore, early-stage R&D accounts for a substantial portion of total R&D contracts to Canadian vendors, supporting evidence of a gap between early science and technology (S&T, a subset of broader R&D efforts) cooperation and later-stage advanced component and systems development.

Finally, the data shows that contract obligations within each industrial sector are fairly concentrated among the top three or five vendors and generally these "larger" vendors, especially those owned by U.S. parent companies, appear to be advantaged in accessing the DoD market. This and other market access issues will be discussed in more detail as part of the case study analysis.

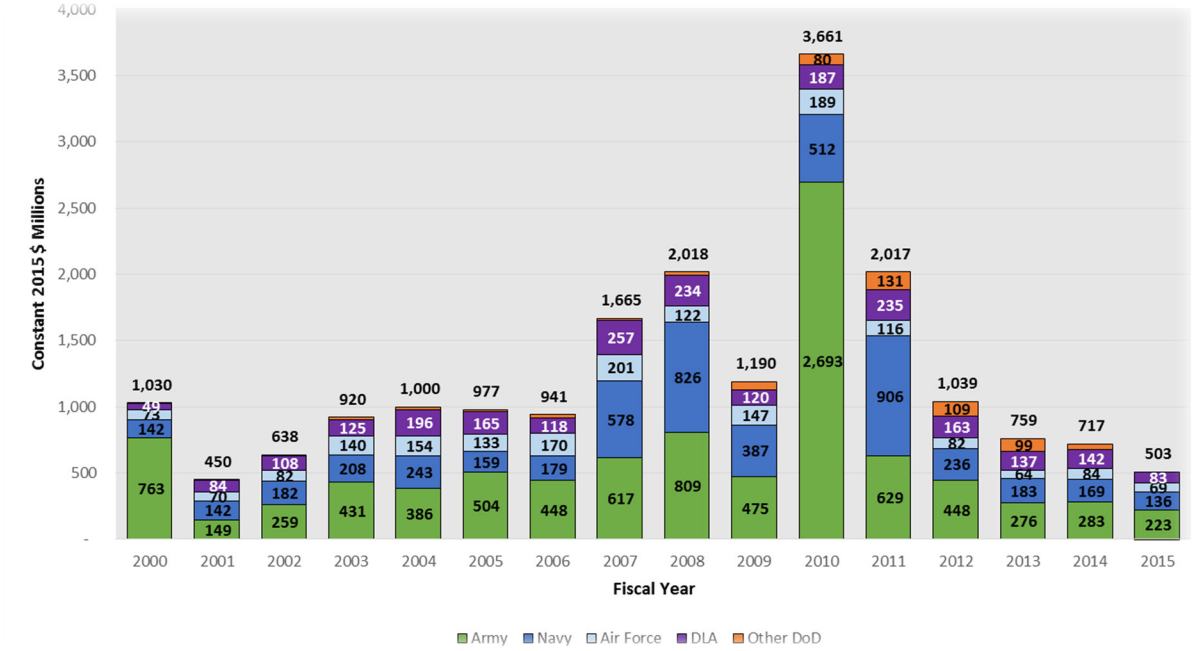
The following sections will describe these contract trends in more detail, specifically looking at total DoD contract obligations to Canadian vendors by major DoD component, by industrial sector, and by top Canadian vendors in each industrial sector. CSIS data analysis is focused at the prime contract level.[9]

4.1.2 Overall DoD Obligations to Canadian Vendors

The overall trend of contract obligations by DoD with Canadian vendors has been a mixture of periods of relative stability and of significant year-to-year volatility, as shown in Figure 1:

[9] See Annex B, Note about U.S. Federal Procurement Data, for details on data limitations.

Figure 1: DoD Contract Obligations to Canadian Vendors, by Major DoD Component, 2000–2015



Source: FPDS; CSIS analysis.

In constant 2015 U.S. dollars, Canadian vendors received slightly more than USD $1 billion in contract obligations from DoD in 2000. Though those totals fell by over half between 2000 and 2001, obligations to Canadian vendors returned to near 2000 levels from 2003–2006. Total DoD contract obligations to Canadian vendors spiked starting in 2007, due primarily to contracts for combat assault and tactical vehicles for use in Iraq and Afghanistan. Contract obligations peaked in 2010, at just under USD $3.7 billion, a nearly fourfold increase over the baseline of USD $1 billion established from 2003–2006. Obligations quickly declined after 2010, however, as procurement related to combat operations in Iraq and Afghanistan began to wind down. By 2012, total DoD contract obligations had returned to the 2003–2006 baseline, and have continued to decline since. In 2015, DoD obligated only USD $503 million to Canadian vendors, down more than 70 percent since 2011 and the lowest total since 2001.

Overall, over the 15-year period, products accounted for 86 percent, services for 11 percent, and R&D for 3 percent of total DoD obligations to Canadian vendors. Again, the product focus and year-to-year variability in contract obligations reflects the industrial mobilization and production role Canadian industry plays for DoD. Additionally, apart from the drawdown in Iraq and Afghanistan, the decline in contract obligations to Canadian vendors in recent years magnifies the decline in overall DoD spending under sequestration, and is consistent with historical trends where, under more constrained budget conditions, DoD is less likely to go to Canada as a source of supply. Other drivers of these trends will be discussed in more detail in the following sections, broken down by major customer and major industrial sectors.

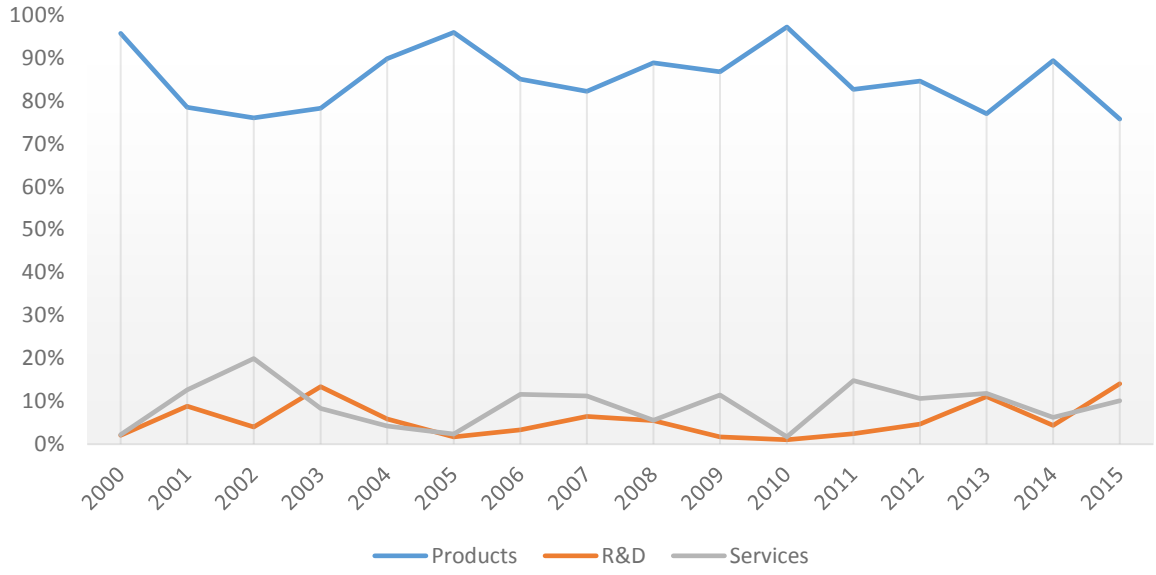
4.1.3 Trends by Major Department of Defense Components

The following sections will cover trends in contract obligations to Canadian vendors by major DoD components: Army, Navy, Air Force, the Defense Logistics Agency (DLA), and "Other DoD," a catch-all category for DoD contracting entities not captured by the first four categories.

Army

As shown in Figure 1, contract obligations by the Army have been a primary driver of trends in overall DoD contracts with Canadian vendors following the same broad pattern as the topline and representing a significant share of total spend, even in "trough" years. Army contract obligations to Canadian vendors have dropped off precipitously in recent years, following overall DoD trends; in 2015, Army contract obligations fell to just USD $223 million, the lowest level since 2001 and just a third of the level seen as recently as 2011. However, despite this decline, in 2015 Army remained within historical range as a share of overall DoD contract obligations to Canadian firms. For the majority of the 2000–2015 period, that share remained within a few percentage points of 40 percent, albeit with some notable spikes (74 percent in 2000 and 2010) and troughs (31 percent in 2011). In 2015, despite the significant decline in Army contract obligations, Army still accounted for 44 percent of total DoD contract obligations to Canadian vendors.

Figure 2: Army Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

Throughout the 2000–2015 period, contract obligations for products, shown in Figure 2, have made up the vast majority of Army contract obligations to Canadian vendors, with that share never falling below 76 percent in any year during the period, and 89 percent of obligations over the entire period. The bulk of these obligations were tied to the Army Stryker

program and included production and survivability upgrades for multiple variants of the light armored vehicle (LAV) fleet. Aside from LAVs and other wheeled vehicles (and miscellaneous vehicle components), the next largest Army contract obligations, that is, over USD $150 million over the 15-year period, were for tactical communications equipment and various calibers of ammunition. These two categories—tactical radios and munitions supply—are two areas of longstanding cooperation, the former a result of Cold War-era joint R&D and the latter a reflection of industrial readiness cooperation.

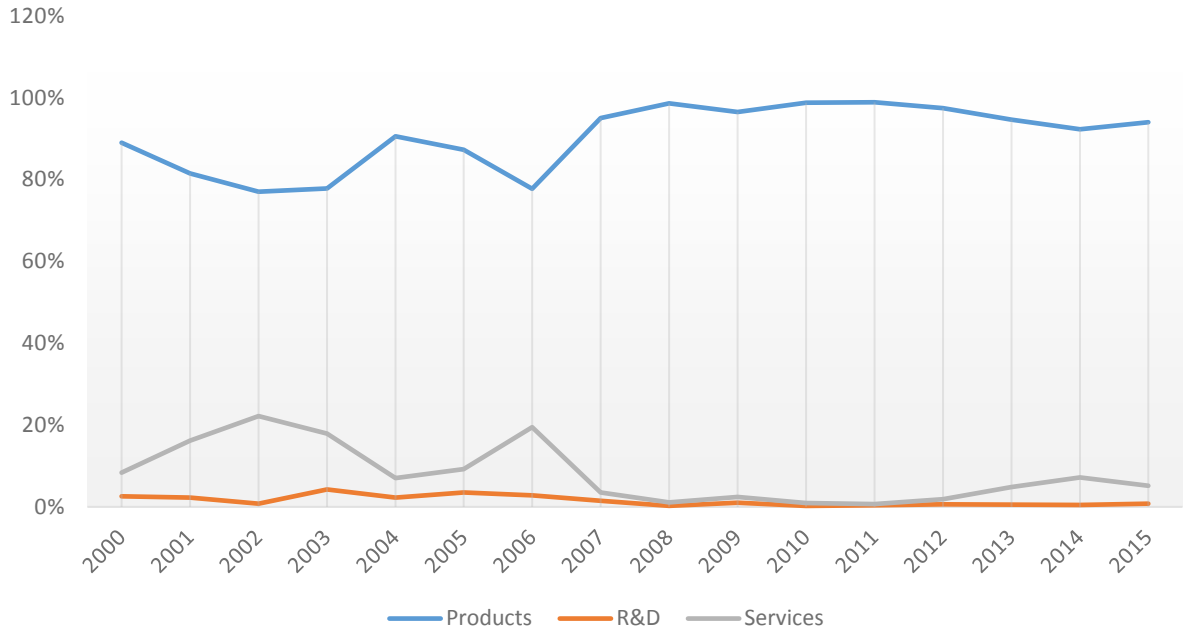
Services fluctuated significantly year-to-year and accounted for only 7 percent of total Army contract obligations over the 15-year period, surprisingly low given the high DoD obligations for ground vehicles. Almost 65 percent of all service-related Army obligations were made from 2006–2012, the same period as major LAV-related production contracts, but maintenance and repair contracts for ground vehicles were virtually nonexistent. The types of services with the highest relative share among service contracts were those related to engineering and technical services, including technical representatives, which supports evidence from interviews that suggested that engineering services for LAVs might occur in Canada, but major maintenance, repair, and overhaul would occur in the United States, albeit occasionally with the help of technical representatives from Canada. The disparity between products and services could also be explained, in part, by the fact that CSIS data analysis is limited to prime contracts and would not account for subcontracting in services.

R&D accounted for 4 percent of Army contract obligations over the 2000–2015 period, and similarly saw significant year-to-year volatility, accounting for 2 percent or less in five separate years, but rising to a high of 14 percent in 2015, largely due to increased obligations for biomedical research. Again, the relatively low R&D contract obligations may be explained by or reflect the limits of prime contract data, as it misses all R&D cooperation at the subcontract level, as well as that occurring through grants, exchanges, and other transactional mechanisms.

Navy

As shown in Figure 1, Navy contract obligations to Canadian vendors have been relatively stable through most of the 2000–2015 period, hovering roughly between USD $140 and USD $240 million in most years. The 2007–2011 period was a notable exception, as contracts for combat assault and tactical vehicles for the Marines in Iraq and Afghanistan caused a four- to fivefold surge in obligations. Obligations levels returned to within prewar ranges starting in 2012, however, and in 2015, the Navy obligated only USD $136 million to Canadian vendors, the lowest level during the 15-year period, albeit by only USD $6 million. For the period, the Navy accounted for 27 percent of total DoD contract obligations to Canadian vendors. That share fluctuated significantly year-to-year, driven largely by purchases in combat vehicles, falling as low as 14 percent in 2000 and 2010 during years of large Army vehicle purchases, and rising as high as 45 percent in 2011 due to large Navy vehicle purchases. In 2015, despite the lowest obligation level of the period, Navy obligations still accounted for 27 percent of total DoD obligations to Canadian vendors, owing to the fairly stable defense trade in night vision equipment, engines, electronics, and aircraft-related components, particularly landing gear.

Figure 3: Navy Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

Figure 3 shows that, to an even greater degree than for the Army, contract obligations for products dominated the Navy's work with Canadian vendors, accounting for 94 percent of obligations in the 2000–2015 period. This dominance was far more consistent than in the Army; in 10 of the last 12 years, at least 92 percent of Navy contract obligations with Canadian vendors were for products. The surge-related procurement of ground vehicles accounted for over half of total spent from 2000–2015—USD $2.5 billion of USD $4.6 billion. No other category of products exceeded USD $200 million over the period, but the next group of top items (between USD $100 million and USD $200 million for the period) includes night vision equipment, communications equipment, jet and gas turbine engines, and various airplane and helicopter parts (including landing equipment and drive mechanisms for helicopter rotors). When isolating ground vehicle contract obligations, a significant share of total Navy obligations to Canadian vendors were related to aircraft components and subsystems—over 30 percent and five of the top 10 products—which reinforces the relatively higher level of cooperation and industrial integration supporting air platforms, including maritime patrol aircraft and antisubmarine warfare helicopters (versus naval platforms).

Services accounted for just 5 percent of Navy contract obligations in the 2000–2015 period. While that share was as high as 22 percent in 2002, it exceeded 5 percent only once between 2007 and 2015. The low level of service contract obligations was less surprising for Navy, as defense trade is limited in this area due to U.S. legislation—for example, Jones Act and Byrnes-Tollefson Amendment, which restricts both the transport of goods between U.S. ports and the foreign construction of naval vessels or major components of hull or superstructures of naval vessels. Similar to products, aircraft-related services account for a sizable share of Navy service contract obligations. Approximately 30 percent of total service-

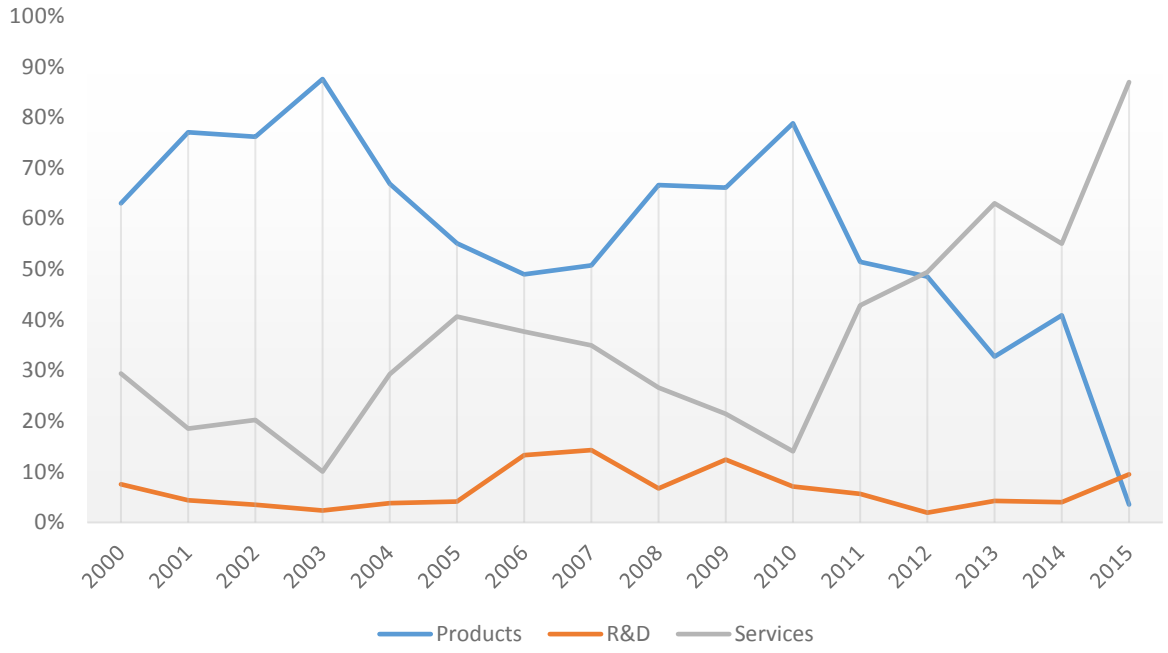
related obligations were tied to maintenance and repair of aircraft and aircraft-related components and another 15 percent tied to "education and training."

R&D, meanwhile, accounted for only 1 percent of Navy contract obligations to Canadian firms between 2000 and 2015, and has not accounted for more than 1 percent since 2006.[10]

Air Force

As shown in Figure 4, Air Force contract obligations to Canadian vendors were less volatile than either Army or Navy with fewer surge-related contracts, but overall spend levels were lower comparatively throughout the period and still fell steeply after 2011. Air Force contract obligations nearly tripled between 2000 and 2007, from USD $73 million to USD $201 million. After 2010, however, Air Force obligations fell to USD $64 million in 2013, the lowest total in the entire 2000–2015 period. Since 2013, obligations have remained at roughly the same level, with USD $69 million in Air Force contract obligations to Canadian vendors in 2015. Since 2000, 10 percent of overall DoD obligations to Canadian vendors have been from the Air Force. Air Force accounted for between 12 percent and 18 percent in all but one year between 2001 and 2009, but fell to between 5 percent and 8 percent from 2010–2013. Air Force has grown as a share since, to 14 percent in 2015.

Figure 4: Air Force Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

[10] The same caveats made for the Army with respect to the limits of prime contract and R&D data also apply here.

In contrast to Army and Navy, the Air Force contracted for a notably mixed portfolio of products, services, and R&D from Canadian vendors, as shown in Figure 4. Since 2000, only 59 percent of Air Force obligations were for products, with that share ranging from a high of 88 percent in 2003 to a low of 4 percent in 2015—the previous low was 33 percent in 2013. Besides landing gear and related components, which accounted for 20 percent of total Air Force contract obligations and 34 percent of product-related Air Force obligations, no one product category was dominant; in fact, "miscellaneous aircraft accessories and components" accounted for 14 percent of total Air Force obligations and 24 percent of product-related Air Force obligations. Fixed wing aircraft and jet/gas turbine engines accounted for 5 and 4 percent, respectively, of total Air Force contract obligations.

Services, particularly maintenance and repair of engines, landing gear, and other aircraft components, tracked more closely in overall contract obligations with products in those same categories than the product-service ratio for either the Army or Navy. Services accounted for 34 percent of Air Force obligations since 2000, with that share ranging from a low of 10 percent in 2003 to a high of 87 percent in 2015—the previous high was 63 percent in 2013. Notably, services as a percentage of total Air Force obligations surpassed products in 2013, on the strength of maintenance and repair contracts and air charter/air passenger services (tied to Afghanistan). In 2015, maintenance and repair of aircraft was the top spend item, accounting for 37 percent of total Air Force obligations; with air passenger services, this figure climbs to 55 percent.

R&D has accounted for 7 percent of Air Force contract obligations to Canadian vendors, the highest relative share of all the major components. The vast majority—over 80 percent—of the contract obligations were related to early stage R&D, that is, either basic or applied research. The R&D share of total Air Force spend ranged from a low of 2 percent (in 2003/2012) to a high of 14 percent in 2007.[11]

DLA

DLA contract obligations to Canadian vendors increased over fivefold between 2000 and 2007, from just USD $49 million to USD $257 million. That total fluctuated over the next few years, but has fallen steadily since 2011, from USD $235 million to just USD $83 million in 2015, the lowest total since 2000. DLA has accounted for 12 percent of contract obligations to Canadian vendors in the 2000–2015 period.

Unsurprisingly, given DLA's contract portfolio, DLA contract obligations with Canadian vendors have been almost exclusively for products throughout 2000–2015. Top products varied widely year-to-year, but over the period, the highest cumulative DLA obligations went toward miscellaneous construction materials, liquid propellants, fuels and oils, jet and gas turbine engines, landing gear components, and drugs and biologicals.[12]

[11] The same caveats made for Army and Navy on the limits of prime contract and R&D data also apply here.
[12] The same caveats made for Army, Navy, and Air Force on the limits of prime contract and R&D data apply here.

Other DoD

"Other DoD" contracting entities include a spectrum of organizations that typically account for less than 5 percent of overall DoD contract obligations with Canadian vendors during the 2000–2015 period. The exceptional three years (2011–2013) are another example of the use of Canadian contracting as surge capacity: services contract obligations for air charter services related to Afghanistan through the U.S. Transportation Command (USTRANSCOM).

4.1.4 Trends by Canadian Industrial Sectors

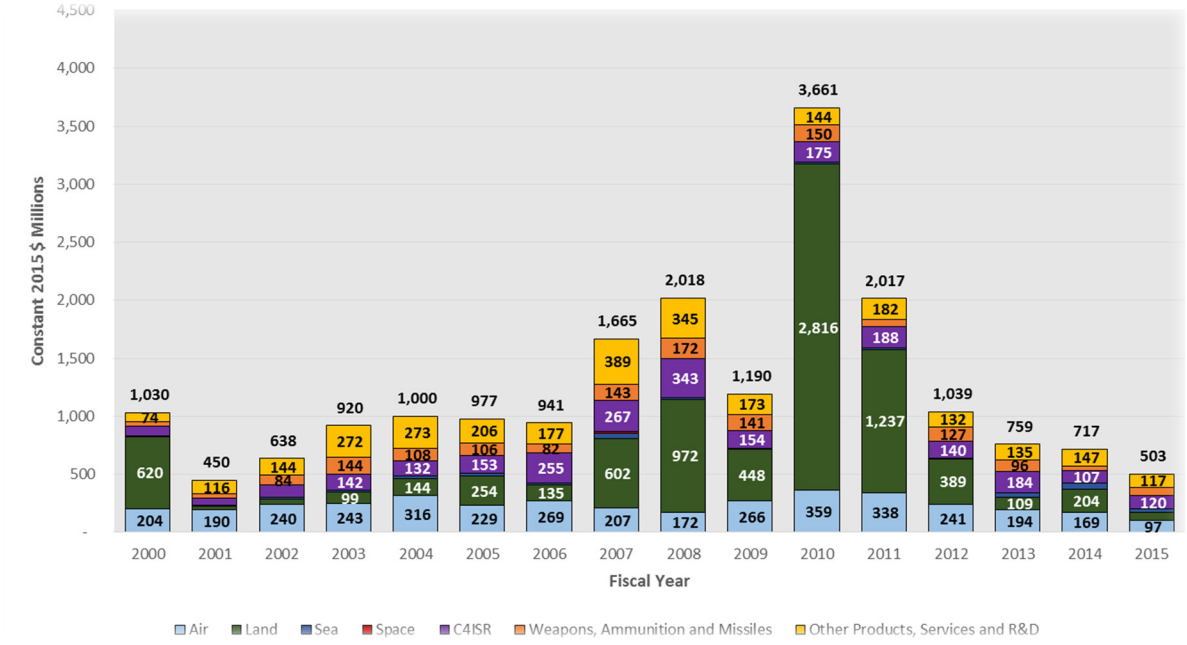
In addition to looking at which DoD components were awarding contracts to Canadian vendors, the study team examined the data to look at trends in what those contracts were for. To facilitate analysis, CSIS has grouped DoD contracts to Canadian vendors into six "major" industrial sectors where those vendors support DoD, as well as an "other" category for FPDS-labeled products, services, and R&D that did not cleanly fall into those sectors:[13]

1. Air
2. C4ISR
3. Land
4. Sea
5. Space
6. Weapons, Ammunition, and Missiles
7. Other (Products, Services, and R&D)

Each category captures all products, services, and R&D contracts related to that industrial sector. Figure 5 shows DoD obligations to Canadian vendors, broken down by those seven categories.

[13] See "Broad Description of Industrial Sectors" at the end of this section for more details on the definition and types of products, services, and R&D included in each sector category.

Figure 5: DoD Contract Obligations to Canadian Vendors, by Sector, 2000–2015



Source: FPDS; CSIS analysis.

Of the six major industrial sectors analyzed, land was the largest in absolute terms but also one of the most volatile and the least diverse with respect to its DoD contracting portfolio in products, services, and R&D. Additionally, land contract obligations have declined by 94 percent since 2011 and dropped to 15 percent of the DoD market share in 2015 relative to other sectors, half of its average market share for the 15-year period. These trends point to the fact that land contract obligations, more than any other major sector, were most closely tied to surge production requirements. It also highlights the overwhelming dominance of one category—ground combat assault vehicles—which reflects Canada's historical niche expertise in this area but also the vulnerability of industrial sectors in the DoD market in the absence of broader, more diversified cooperation (as seen in the air and C4ISR sectors).

Air was the second-largest sector in absolute terms, the most stable with respect to average annual fluctuations, and the most diverse in terms of the ratio of product-service-R&D. These trends reflect longstanding mil-to-mil cooperation under NORAD, which has fostered collaboration on a number of air programs—including fighter, maritime patrol, and rotary-wing programs—and has resulted in a high level of cross-border supply chain integration with Canadian industry specializing in a number of niche areas that feed the DoD market, including jet and gas turbine engines, landing gear, and other components and aerostructures. However, DoD obligations in these historically strong areas have declined in recent years and, while this trend is likely attributable in part to the decline in overall DoD obligations, the air sector's relative share of the DoD market only has been maintained by growth in air services in the last 5 years.

C4ISR was the third-largest sector in absolute terms, was relatively stable and diversified with higher levels of services than any other sector with the exception of the air sector, and

showed more years of positive growth during the 15-year period than any other sector. C4ISR is also one of two sectors to increase its relative share of the DoD market (to 17 percent) in the last five years over its 15-year average. These trends, again, reflect longstanding cooperation on electronics equipment for surveillance, communications (e.g., tactical radios), and command and control functions as well as recent growth in certain industries—for example, airborne multi-spectral sensors—in which Canadian industry has developed specialized technology and expertise. The relative stability of both the air and C4ISR sectors suggests less DoD spending tied to surge production. As noted earlier, DoD demand in these sectors is high and Canada possesses relevant engineering know-how and capability. Thus, the absence of surge production during periods of highest demand is a possible missed opportunity.

The two smallest sectors—by a wide margin—were sea and space, with just 2 and 0.1 percent, respectively, of total DoD obligations over the 15-year period, which reflects the comparatively stringent U.S. foreign acquisition restrictions, comparable restrictions on the Canadian side, foreign disclosure policies, and export controls that apply to these sectors. Due to the small size of these sectors, year-to-year DoD contract obligations fluctuated dramatically with the award or loss of contracts. Interestingly, space demonstrated an inverse of the trends seen across all other sectors with respect to product-service-R&D ratios, in that R&D was the dominant, and almost exclusive, contract type with over 90 percent of total space-related obligations. Given the exceedingly small amount of DoD obligations in the space sector, this finding speaks to the extent to which trade in space-related products and services is restricted, vice there being a more collaborative development environment.[14]

4.1.5 Trends in Canadian Vendor Base

This section examines trends within the Canadian vendor base that support DoD during the 2008–2015 timeframe. For each of the major industrial sectors (excluding space,[15] due to the low level of obligations), this section will look at three main questions:

- Which are the top vendors that support DoD within each sector?
- What is the level of consolidation of vendors that support DoD within each sector?
- To what extent are these top vendors Canadian vs. foreign-owned within each sector?

CSIS analysis on these questions found the following topline trends. The vendor bases that support DoD in all major industrial sectors are fairly concentrated with the top few vendors owning, on average, anywhere from 60 to 90 percent of the DoD market share. Land and weapons, ammunition, and missiles (WAM) sectors are most concentrated from a market share perspective with 90 and 80 percent, respectively, of total DoD obligations going to the top vendor alone. In the case of land, this data is somewhat skewed by the overwhelming

[14] Annex B provides further details on each sector's trends.
[15] Likewise, establishing useful trend analysis was difficult for the sea sector given the minimal amounts of DoD obligations. Year-to-year fluctuations were drastic due to the oversized impact of any individual contract.

dominance of LAV production, as previously highlighted. C4ISR and air were the least concentrated with 62 and 71 percent, respectively, going to the top five vendors (and just above 25 percent to the top vendor). The size of the broader base of suppliers beneath these dominant companies varies by sector, with C4ISR being broadly based (706 companies), air, land, sea being moderately diverse (230, 175, and 159 companies, respectively), and WAM being comparatively consolidated (64 companies).

Top vendors across all sectors were also characterized by the prevalence of foreign ownership, particularly by U.S. parent companies. In the case of Canadian-owned vendors, many have U.S. business operations or subsidiaries. The degree of foreign ownership and cross-border corporate structures and relationships among top vendors highlights the integrated nature of the defense industrial bases, as well as the correlation of these relationships to increasing access to the DoD market. Top vendors, especially large foreign-owned firms, also tended to have dominant industrial capabilities and DoD market access across sectors. For example, of the five major industrial sectors analyzed, General Dynamics was among the top five vendors in three of five sectors and the sector lead in two of those.

Finally, there was evidence across all sectors of substantial year-to-year fluctuations in the concentration of contract obligations among the top three to five vendors. This not only further supports qualitative evidence of the relatively prominent role larger firms play in export markets, but also substantiates that the award or loss of any one large DoD contract can have a significant impact on the defense industrial capabilities in that sector. Indeed, as previously discussed, Canadian firms have shielded themselves from this risk/vulnerability by tending toward more dual-use and commercially oriented business models. The level of vendor base diversity in the case of the air and C4ISR sectors suggests greater and more diversified access, including for smaller firms outside the top foreign-owned vendors, and slightly less vulnerability than other sectors to broader impacts resulting from the loss of any one major contract.[16]

4.2 Canadian Defense Procurement from U.S. Sources (2000–2015)

4.2.1 Canada's Position in Global Defense Trade vis-à-vis United States

CSIS reviewed Stockholm International Peace Research Institute (SIPRI) data from 2000–2015 to identify Canada's relative position in global defense trade.[17] In 2015, Canada ranked 17th in total military expenditures worldwide. These rankings are highly stratified, which is to say that the top importers dominate in dollar terms and that values dropped off quickly as you descend the rankings. Canada accounting for 1 percent of global defense imports.

Despite this fact, Canada is generally among the top 20 importers of defense-related goods from the United States. From 2000–2015, the largest importers of U.S. defense-related

[16] Annex B provides further details on vendor base trends within each sector.
[17] Information from the Stockholm International Peace Research Institute program on international arms transfers, https://www.sipri.org/research/armament-and-disarmament/arms-transfers-and-military-spending/international-arms-transfers.

products were South Korea (9.9 percent), the United Arab Emirates (7.11 percent), and Australia (5.72 percent). Canada was the 16th-largest importer of U.S. defense-related products during this timeframe, accounting for 2.3 percent of total U.S. arms exports. Canada maintained this relative position as a defense trade partner steadily throughout the period. In the last five years, Canada moved up to the 14th-largest importer of U.S. arms, accounting for 2.53 percent of total U.S. arms exports from 2011–2015.

As a percentage of total Canadian defense imports, the United States is Canada's top trading partner by a wide margin. From 2012–2016, 73 percent of Canada's total defense-related imports came from the United States. Likewise, the United States remains Canada's largest importer of defense-related exports.

4.2.2 Canadian Major Crown Projects and Role of United States[18]

The Canadian Department of National Defence (DND) categorizes its major ongoing equipment procurements into three areas: air, sea, and land. CSIS reviewed DND Major Crown Projects in these three areas over the past 15 years to examine the role of U.S. industry in recent major Canadian defense procurements.

4.2.3 Air Procurements

Major Crown Projects in the air sector over the past 15 years follow historical trends, whereby Canada procures the vast majority of its military aircraft from U.S. sources. As such, most prime contract awards were made to U.S.-based original equipment manufacturers (OEMs), while subcontractors were a mix of Canadian firms and subsidiaries of U.S. firms.

There were seven air-related Major Crown Projects over the period, six of which were related to the acquisition of new aircraft, and one of which was related to modernization of Canada's CP-140 Aurora maritime patrol aircraft (Canadian variant of the P-3 Orion). For the six aircraft acquisitions, five were awarded to one of three U.S. OEMs—Boeing, Sikorsky, and Lockheed Martin. Boeing was awarded three prime contracts to provide: 15 CH-147F Chinook tactical transport helicopters with an acquisition cost of CDN $2.3 billion; 5 CC-177 Globemaster strategic lift aircraft with an acquisition cost of CDN $1.8 billion; and most recently, 18 F/A-18 Super Hornet multirole fighter aircraft (cost TBD) as an interim solution for their Fighter Jet Replacement program. Sikorksy was awarded one prime contract to provide 28 CH-148 Cyclone maritime helicopters, with an acquisition cost of CDN $3.2 billion. Lockheed Martin was awarded one prime contract to provide 17 CC-130J Hercules tactical lift aircraft with an acquisition cost of CDN $3.1 billion. Altogether, these contracts total roughly CDN $10.4 billion, not including the cost of the Super Hornets (which is still being negotiated), of a total CDN $12.8 billion in acquisition costs related to aircraft procurements. The IRB commitments for three of the projects—the Chinook tactical transport helicopters, the CH-148 Cyclone

[18] For more information, see https://buyandsell.gc.ca/policy-and-guidelines/supply-manual/section/9/5, as well as the Canadian Department of National Defense website, http://www.forces.gc.ca/en/business-equipment/projects.page.

maritime helicopters, and the CC-130J Hercules tactical lift aircraft—totaled $4.72 billion, or just over half the value.[19]

While U.S. defense contractors dominated prime contracts for aircraft procurements, major subcontractors for these acquisitions—which perform a range of in-service support and subsystem modernization activities—are a mix of Canadian firms (CAE, Cascade Aerospace, IMP Aerospace, and others) and Canadian subsidiaries of U.S. firms (GD Canada, L-3 Communications, Pratt and Whitney Canada, and others). Altogether, these contracts total another CDN $11.6 billion in costs related to aircraft procurements.

Airbus Defence and Space was the only non-U.S. defense prime contractor to provide one of the six different airframes to Canada, and was awarded a CDN $2.4 billion contract for 16 C-295W search and rescue aircraft. For the CP-140 Aurora Modernization program, the prime contractor for the latest block of upgrades is General Dynamics Mission Systems; a mix of Canadian firms and subsidiaries of U.S. firms have won contracts for previous upgrade blocks and service life extension work under the multiyear modernization and life-extension programs.

4.2.4 Sea Procurements

Major Crown Projects in the sea sector over the past 15 years demonstrate the protected status shipbuilding holds, similar to the United States, where Canadian firms make up the majority of defense prime contractors.

There were only five sea Major Crown Projects noted by the Canadian government. Of the five sea-related Major Crown Projects, only one modernization contract held a U.S.-based defense contractor as a prime. In this specific case, the U.S. contractor was one of several prime contractors and not a standalone. Similar to the air-related Major Crown Projects, three of the five procurements were for new platforms.

However, unlike the air procurements, all three of the sea platform acquisitions were awarded to Canadian defense contractors. These contracts include the procurement of 6 Artic and offshore patrol ships, 2 joint support ships, and 15 Canadian surface combatants.

Irving Shipbuilding Inc, a Canadian-based defense firm, was awarded the prime contractor role for both the Artic and offshore patrol ships and the Canadian surface combatants. The joint support ships are to be procured from Seaspan's Vancouver Shipyards Company. Babcock Canada will be the prime contractor for the Victoria-class submarines maintenance contract. The four Victoria-class submarines were previously procured from the UK government.

The trend for major subcontractors holds true to the air procurements. Almost all major subcontractors on sea Major Crown Projects are Canadian-based defense firms. The only clear presence of a U.S. defense contractor is Boeing, in the Halifax-class modernization

[19] Canadian Department of National Defense, "Industrial and Regional Benefits: Procurement Projects," accessed June 5, 2017, http://www.ic.gc.ca/eic/site/042.nsf/eng/h_00017.html.

program. Boeing was awarded one of six prime contractor slots to provide the Advanced Harpoons Weapon Control System (AHWCS) to the Halifax-class frigate.

4.2.5 Land Procurements

When compared to the sea and air Major Crown Projects, the land procurements take on the characterization of a "mixed bag" of defense contractors. While air projects have significant presence of U.S.-based prime contractors and sea projects see limited access of U.S.-based contractors, land projects hold various prime and major subcontractors based in the United States, Germany, and Canada.

There are five Major Crown Projects related to land procurement projects. Four of these five are procurements of new land platforms. German-based defense contractors were awarded the Tank Replacement program and Force Mobility Enhancement procurement. The Tank Replacement program included the purchase of 200 Leopard 2 tanks, as well as modifications of the Leopard 2 platform. While multiple prime contracts were awarded under the replacement program, a majority went to German-based contractors with the remaining being awarded to Canadian-based contractors. The Canadian prime contractors provided the ammunition and repairs to the Leopard 2 tanks.

Textron Systems Canada was awarded the Tactical Armoured Patrol Vehicle Major Crown Project. This procurement acquires 500 Tactical Armoured Patrol vehicles at a cost of CDN $603.4 million. Although one of the four major subcontractors in this project is U.S.-based Textron Marine and Land Systems, the prime contractor and three other major subcontractors are all Canadian-based firms. In comparison, the Medium Support Vehicle System is supported by two U.S.-based prime contractors and one Canadian-based prime contractor.

The Medium Support Vehicle System project procures 2,837 Medium Support Vehicles in various forms at a cost of CDN $1.5 billion. U.S.-based contractors Navistar Defense and Mack Defense, provided all of the militarized commercial off-the-shelf trucks and standard military pattern trucks to Canada. The Canadian prime contractor, DEW Engineering, constructed the baseline shelters for the vehicles and modified the shelters.

General Dynamics Land Systems Canada was awarded the last Major Crown Procurement related to land projects. The cost is estimated to be over CDN $1 billion for 550 Light Armored Vehicle upgrades.

5 Case Studies

CSIS conducted case studies to provide more focused analysis across key segments of the Canadian defense industry. These key segments or key industrial capabilities (KIC) were selected during the course of the literature and data review process and aim to cover a cross-section of niche Canadian industrial capability areas within four major industrial sectors—air, space, C4ISR, and land.[20] The key industrial capability areas studied were:

Air: flight simulation systems and training; in-service support to fighter aircraft

Space: robotics

C4ISR: tactical communications; sensors

Land: light armored vehicles; armor/ballistics protection

To support this analysis, CSIS conducted interviews with U.S. and Canadian government and industry[21] stakeholders who engage in cross-border defense cooperation. In its selection of industry interviewees for each key segment, CSIS sought to achieve a mix of company profiles, including: 1) large vs. small firms; 2) U.S. vs. Canadian-owned firms; and 3) recent entrants vs. long-established incumbents in a particular industry. These interviews were conducted on a nonattribution basis, and substantiated through use of cited public documents to the extent CSIS was able to locate sources. Note that the industrial capability areas analyzed within each sector are not exhaustive, nor do they represent the entirety of industrial activities or specialized capabilities within each sector.

The purpose of the case study analysis was threefold: 1) evaluate the benefits of defense industrial cooperation; 2) assess the primary challenges encountered in cross-border cooperation; and 3) assess the nature of cross-border relationships, both government to industry and industry to industry. Following discussion of the specific case study areas, this section summarizes findings within each of these three areas of analysis.

5.1 Key Industrial Capability Case Studies

This section describes the technologies, development process, contracting arrangements, and the origins and evolution of U.S.-Canadian cooperation for each KIC studied. The amount of information for each KIC study varied depending on the availability of interviewees and open-source information.

[20] Due to the lack of interviewees, CSIS was unable to complete case study analysis for the marine sector.
[21] "Canadian industry" here includes all of the following: Canadian-owned firms and their subsidiaries operating in the United States as well as wholly owned subsidiaries and large divisions of U.S. firms operating in Canada.

5.1.1 Air

Defense aerospace is the largest and most mature sector of Canadian defense industry.[22] As previously covered, the Canadian air sector has been the most stable and consistent in terms of cross-border contracting of all industrial sectors examined due, in part, to military cooperation under NORAD. The United States and Canada have historically collaborated on air superiority, air defense and antisubmarine warfare capabilities, including multiple generations of fighter, maritime patrol, and antisubmarine aircraft.

The Canadian air industrial sector is composed of aerospace companies that are original equipment manufacturers (OEMs) for commercial and dual-use utility aircraft and Tier 1, 2, and 3 suppliers for U.S. military aircraft. While commercially focused, these companies possess specialized technologies and manufacturing and engineering capabilities that produce both dual-use and military hardware and software directly supporting U.S. production and sustainment of DoD military capabilities.

This sectoral case study focused on a few specialized niche areas in which Canadian firms have developed technology or industrial base capacity that is either unique or complementary to U.S. industry and that have been leveraged to support major U.S. programs. These niche areas are: 1) flight simulation products and services; and 2) in-service support for fighter aircraft, specifically engineering solutions related to maintenance and life-extension services.

5.1.1.1 Flight simulation systems and training

Simulation technology is a niche capability area where Canadian innovation and expertise have benefited U.S. and allied defense programs since the 1960s and that continues to expand its relevance and applications into present day. For the purposes of this case study, CSIS focused on flight simulator systems given the history of U.S.-Canadian cooperation in this area, as well as Canadian industry's particular strength in this segment.

Canadian industry began to develop flight simulation technologies in the 1950s, initially driven by Canadian government funding tied to its Avro Arrow fighter program.[23] Over the following five decades, these technologies were further developed to encompass a wide range of civil and military applications, leveraging growth in the commercial airliner market as well as public sector investment, including U.S.-Canadian joint R&D projects. An early example of this collaboration was the 1969 Army Tactical Aircraft Guidance System program for CH-47Cs, where Canadian simulation technology assisted in developing control systems to improve the stability of helicopters in flight.[24] The knowledge and capabilities gained by this project also helped bring about a substantial expansion of the Canadian industry's helicopter flight simulation systems, which grew through the 1970s and 80s to include a

[22] As such, the CSIS study team divided aerospace into air and space case studies to separately study each.
[23] Bertram C. Frandsen, "The Rise and Fall of Canada's Cold War Air Force, 1948–1968" (dissertation, Wilfrid Laurier University, 2015), http://scholars.wlu.ca/cgi/viewcontent.cgi?article=2857&context=etd.
[24] CAE, "About CAE," http://www.cae.com/about-cae/.

number of medium- and heavy-lift transport and antisubmarine warfare aircraft.[25] During this time, Canadian industry was also growing its flight simulator expertise and production for various variants of U.S. and European fixed-wing aircraft—including multirole fighter aircraft, maritime patrol aircraft, tactical airlift, and airborne warning and control aircraft[26]—and expanding its technologies and capabilities for full-mission flight and combat simulation.[27] Following Canada's procurement of the F/A-18 (CF-18 variant) in the late 1970s, the Canadian government funded development of advanced fighter training systems, which were stationed at training centers in Europe and Canada. The NATO Flight Training Center (NFTC) at Cold Lake still provides basic, advanced, and lead-in fighter training for the Canadian, allied, and other partner forces.[28]

Notwithstanding early U.S.-Canadian R&D collaboration on simulation technologies, major buyers of Canadian military flight simulators through the 1980s were primarily non-U.S. militaries—Canada, NATO/European nations, Australia, and others. Furthermore, the Canadian flight simulation industry was focused on the commercial market during this time, where it generated the majority of its revenue and was quickly growing its share in the global market. Major sales to the United States began in the 1980s and U.S. procurement of Canadian simulation products would increase over the 1990s and 2000s as Canadian industry significantly expanded its military flight simulation business and production to include a wide range of flight, tactical-mission, and full-mission simulators across a wide variety of rotary and fixed-wing aircraft.[29] This expansion is demonstrated in the global footprint of Canadian contractor-run training centers across the world, including the UK's Medium Support Helicopter Aircrew Training Facility.[30]

After establishing a U.S. subsidiary, CAE, Inc., Canada's largest firm in this technology area, expanded its provision of product and service support to U.S. programs substantially, leveraging decades of technology and systems development, generated by sales to Canada, NATO, and other allies, and the commercial market. Today, CAE USA, Inc. (a CAE subsidiary located in Tampa, Florida) provides flight simulator and training systems to the U.S. Air Force, Navy, Marine Corps, and U.S. OEMs across multiple major manned and unmanned fixed- and rotary-wing platforms.[31, 32] This advanced simulation capability has helped modernize and advance virtual training environments, including for some of the most sophisticated, complex U.S. military units. A recent example is the U.S. Army's Special Operations Forces Aviation

[25] CAE, "History," http://www.cae.com/about-cae/corporate-information/history/.
[26] Aircraft examples include multirole fighter aircraft (e.g., F-104, A-4S, F-5E, Tornado), maritime patrol aircraft (e.g., CP-140, P-3C), tactical airlift (e.g., C-130H), and airborne warning and control aircraft (E-3A).
[27] Robert. G. Blackburn, "The Role of the Canadian Government in Encouraging Innovation," *Canada-United States Law Journal* 15 (1989), http://scholarlycommons.law.case.edu/cuslj/vol15/iss/35.
[28] CAE, "NATO Flying Training in Canada," http://www.nftc.com/defence-and-security/training-and-services/training-centres/nato-flying-training-in-canada-nftc/.
[29] CAE, "History."
[30] CAE, "Medium Support Helicopter Aircrew Training Facility," http://www.cae.com/uploadedFiles/Content/BusinessUnit/Defence_and_Security/Media_Centre/Document/brochure.MSHATF.pdf.
[31] Platforms include MQ-1/MQ-9, KC-135, C-5, C-130J, C-130H, MH-60, P-8A, and KC-130J.
[32] CAE, "CAE wins defence contracts valued at more than C$120 million," September 2015, http://www.marketwired.com/press-release/cae-wins-defence-contracts-valued-at-more-than-c120-million-tsx-cae-2053682.htm.

Training and Rehearsal Systems (ASTARS) program initiated in the early 2000s. The Army's elite 160th Special Operations Aviation Regiment (SOAR, or "Night Stalkers") needed to update and integrate flight-training systems across its MH-6, MH-47, and MH-60 helicopter fleets. Leveraging the access of a local U.S. subsidiary, and the intellectual property and expertise of the parent company, CAE, USA won the ASTARS contract. Under multiple phases, CAE built the world's first MH-6 combat mission simulator (CMS),[33] built a new MH-47 CMS, refurbished existing MH-47 and MH-60 simulators, and designed a common avionics architecture system for all three. CAE also designed and developed an automated "common environment/common database" that could support rapid mission rehearsals.

The 160th SOAR conduct complex counterterrorism, intelligence, reconnaissance, and interdiction missions, including many nighttime operations, in a multitude of environments and under varied conditions, demanding a high level of technological expertise to construct realistic training scenarios and environments. In this case, the Army leveraged Canadian technology and expertise in modeling, simulation, displays, and instrumentation to achieve a high standard for precision and accuracy. Furthermore, the contractor drew on experience gained from establishing similar integrated systems for the UK medium support helicopter aircrew training facility. Technology development under this program was eventually used to develop an open industry standard for a common database system for geospatial data used in simulations. The Open Geospatial Consortium intends to "address the challenges of interoperability and reuse of geospatial data in a synthetic environment database." [34]

Most U.S. contracting with the Canadian simulation industry prior to 2000 was focused on products—hardware and software—and generally at the subcontract level by U.S. primes. Since the early 2000s, and after establishment of CAE USA, Inc. in 2001, Canadian flight simulation systems have been leveraged increasingly by U.S. services for more holistic, fully integrated longer-term training systems (products and services), to improve cost-effectiveness in maintaining preparedness.[35] Much of the recent growth has been due to increased interest in virtual (vs. live) training and in pursuing cost-saving and efficient integrated training solutions.[36] Canada, having contracted out much of its aircraft training and sustainment during the 1990s, grew an industry base that could meet the increased demand with advanced dual-use technologies, wide-ranging multimission products and capabilities, and already-practiced solutions for fully integrated training systems.[37]

[33] CAE, "CAE wins strategic contract with the U.S. Army," 2002, http://www.defense-aerospace.com/articles-view/release/3/9464/cae-wins-special-forces-contract-%28apr.-4%29.html.
[34] CAE, "CAE fully endorses Open Geospatial Consortium's approval of CDB as an OGC standard," October 2016, http://www.cae.com/CAE-fully-endorses-Open-Geospatial-Consortium-s-approval-of-CDB-as-an-OGC-standard/.
[35] CAE, "CAE USA wins U.S. Army contract to provide comprehensive training for fixed-wing pilots," June 2015, http://www.cae.com/CAE-USA-wins-US-Army-contract-to-provide-comprehensive-training-for-fixed-wing-pilots/.
[36] Daedal Research, "Global Civil Aviation & Military Simulation & Training Market (2016–2020), 2016.
[37] J. C. Stone and B. Solomon, "Canadian defence policy and spending," *Defence and Peace Economics* 16, no. 3 (2005), 145–169, https://doi.org/10.1080/10242690500123414.

5.1.1.2 In-Service Support (F/A-18 Hornets)

In-service support (ISS)—specifically maintenance, repair, overhaul (MRO) and service life extension for various advanced fighter, helicopter, maritime patrol, and transport aircraft—is a key Canadian industrial capability developed over decades but that only recently has been leveraged more extensively to support U.S. programs. For the purpose of this case study, CSIS focused on in-service support to the F/A-18 Hornet, although, as noted, there are various other fixed- and rotary-wing platforms for which the United States and Canada have common programs and for which there is some level of industrial cooperation.

In the late 1970s, Canada participated in the U.S. F/A-18 program and procured its own variant of the multirole fighter. Canada was the first to buy into the program and purchased the entire data package, allowing Canadian industry to advance its manufacturing and engineering capabilities to support sustainment of the aircraft.[38] Over the next 30 years, Canadian industry further developed its ISS expertise through management and maintenance of the Canadian CF-18 fleet, as well as through collaboration with and work for the Royal Australian Air Force, and other international users, in support of their F/A-18 fleets.

The Canadian-Australian industrial relationship began, in part, as result of follow-on testing of the F/A-18s under a bi-national collaborative project—the International Structural Follow-on Test Program (IFOSTP). The primary impetus for this combined test program was that the operational employment of F/A-18s by Canada, Australia, and other allied air forces would deviate from what it was originally designed for—flying off carriers. U.S. Navy airframe certification was therefore insufficient until Canada and other allies understood the structural integrity consequences and sustainment options for this different operational spectrum for land-based F/A-18 fleets. The IFOSTP examined those options and helped generate the relevant operational and engineering know-how present today.[39]

In addition to these early tests, Canada initiated its first 10-year life-extension program in the early 1990s, which drove a buildup in Canadian industrial facilities and grew ISS expertise and engineering capabilities.[40] Under this program, Canadian industry developed an overall approach that emphasized product life-cycle extension versus parts replacement as the most cost-effective method to extend the life of an aircraft. Preventative analysis methods (e.g., fatigue testing) and innovative engineering capabilities were developed to address aging-related structural issues before they became major problems.[41] One of the leading engineering innovations behind this approach is the use of robotics as a tool for maintenance, repair, and operations (MRO) processes. This includes a method called "robotic shot peening," which allows engineers to reach locations on the aircraft previously

[38] Office of Management and Budget, "F/A-18 Aircraft Sales to Canada, Australia, and Spain: A Case Study of Offsets," 1990, http://www.disam.dsca.mil/pubs/Vol%2013_1/OMB.pdf.
[39] D. L. Simpson et al., "The Canadian and Australian F/A-18 International Follow-On Structural Test Project," 2002, http://www.icas.org/ICAS_ARCHIVE/ICAS2002/PAPERS/6.PDF.
[40] L-3, "History of L-3 MAS," 2017, http://www.mas.l-3com.com/history.asp.
[41] Yool Kim, Stephen Sheehy, and Darryl Lenhardt, *A Survey of Aircraft Structural-Life Management Programs in the U.S. Navy, the Canadian Forces, and the U.S. Air Force* (Santa Monica, CA: RAND Corporation, 2006), http://www.rand.org/content/dam/rand/pubs/monographs/2006/RAND_MG370.pdf.

inaccessible to humans and to perform metal fatigue prevention processes in order to extend the life of aircraft materials and critical structural components. Robotics also enable engineers to conduct shot peening in a repeatable fashion with a high level of control and precision not possible when done manually, essentially creating a new life-extension engineering process previously unavailable. The first robotic shot-peening machine was designed and built in Canada.[42]

Canadian ISS know-how was first exported to Australia in support of the Australian Royal Air Force's F/A-18 fleet management. During this period, the Canadian ISS provider, L-3 MAS (which now reports to L3 Technologies Aerospace Systems Group, headquartered in Rockwell, Texas), participated in Australia's F/A-18 structural refurbishment project, which included work to extend the life of the center fuselage. This Center Barrel Replacement program involved major engineering and overhaul work and further developed Canada's unique ISS expertise.[43] This life-extension expertise was eventually exported to other allies, including Spain, Finland, and Switzerland.[44]

Canadian ISS support to U.S. F/A-18 Hornets, however, has been limited until more recently. L-3 MAS, under subcontract to Boeing, provided some component repair and engineering services in the mid-2000s to refurbish outer wing panels, but major MRO for U.S. F/A-18 Hornets had always been performed by the government depots and U.S. OEMs.[45] This dynamic began to change, incrementally, in the early 2010s, as the U.S. Navy became aware of and desired greater access to Canadian ISS engineering innovation. L-3 MAS worked as a subcontractor for Boeing for U.S. Navy F/A-18 repair and overhaul services after previous work with the Canadian and Australian version of those aircraft.[46] Subsequently, the Navy awarded a Depot-Level Maintenance (DLM) contract in 2016 to L-3 for structural life-extension modifications to the Navy's F/A-18 A/B/C/D fleet.[47] At the time, the U.S. Navy had a major F-18 refurbishment effort underway and was faced with a potential readiness problem, as the existing government and industry depot facilities did not have the capacity to finish the work on the required timeline. This is a straightforward example of Canada as surge capacity; L-3 MAS, with its previous work and demonstrated capabilities, offered the Navy a known, low-risk option to expand its industrial capacity and meet delivery timelines. It also provided the U.S. Navy with access to L-3 MAS's innovative approach to F/A-18 sustainment and life extension. It is notable that the U.S. Navy awarded this contract through L-3 Platform

[42] L-3 MAS Canada and Department of National Defence, "Evolution of Shot Peening on the Cf-18—From OEM to Robotic," 2003, https://www.shotpeener.com/library/pdf/2005048.pdf.
[43] L-3 Communications, "L-3 Communications MAS Awarded a CDN $20 Million (U.S. $17. 6 Million) Contract from the Australian Defence Materiel Organisation," 2009. http://www.defense-aerospace.com/article-view/release/67267/l_3-unit-to-refurbish-raaf-f_18s-(mar-10).html.
[44] Lyne Lortie, "L-3 MAS Completes Record Year in 2006," L-3 MAS Canada, March 2007, http://www.mas.l-3com.com/doc/Press_Release/03-Press_Release_2006_Summary_A.pdf.
[45] "L-3 MAS Receives Boeing Repair & Overhaul Contract," *Canadian Defence Review*, 2013.
[46] L-3 MAS, "L-3 MAS Selected by Boeing to Provide Component Repair and Overhaul Services for the U.S. Navy F/A-18 Program," 2013, http://www.mas.l-3com.com/doc/Press_Release/MAS_Boeing_F-18_OWP_Contract.pdf; and L-3 MAS, "L-3 MAS exports Canada's aerospace-unique know-how," http://www.mas.l-3com.com/doc/Press_Release/07-RAAF-CBR_SRP2_Contract_award.pdf.
[47] Department of Defense, "Department of Defense Contracts," 2016, https://www.defense.gov/News/Contracts/Contract-View/Article/648781.

Integration in Waco, Texas, L-3 MAS's U.S.-based sister division that also conducted a portion of the work directly.[48]

In the course of its engineering support work for the Navy, L-3 MAS has leveraged its robotic shot-peening processes to develop both repairs and modifications that can be used to extend the life of critical structural components and prevent further age-related damage.[49] This work has the potential to save the U.S. Navy a significant amount of money by avoiding the need for full center barrel replacements. The U.S. Department of Defense now reportedly considers L-3 MAS's MRO facility as one of four possible sources (two government and two industry) for collaborative F/A-18 depot-level maintenance.[50] The collaborative aspect of this arrangement is that DoD owns foreground intellectual property rights and engineering solutions shared rather than retained only in a single location. This means that L-3 MAS's engineering know-how, including its robotic-enabled modification and repair methods, will be available for use at the DoD and U.S. OEM depots.

5.1.2 Space

The space component of Canada's defense aerospace sector is relatively small, as much of Canadian space industrial activity has been commercially focused to date. U.S.-Canadian defense and industrial cooperation has been limited, in part due to differing policies on space-based defense programs, and in part due to U.S. national security and export controls. Where there have been mil-to-mil relationships, they have been limited primarily to sharing agreements for satellite data and communications, vice contracting for space hardware. This relative lack of cross-border contracting, particularly outside of R&D, was evident in CSIS data analysis.

Canadian space industry, however, has been a leader in satellite capabilities since the 1960s and has developed a number of dual-use space-based technologies, including space robotics, optical sensors and other space surveillance capabilities, and space-based synthetic aperture radar. U.S.-Canadian cooperation on the civil side has enabled valuable R&D collaboration, resulting in technology development that has spin-off military applications, as well as civil and commercial applications, and will likely continue to be a growth area for cooperation.

This sectoral case study focused on one of the specialized niche areas, space robotics, that grew out of early U.S.-Canadian civil space cooperation and is now being leveraged to support next generation space development programs.

5.1.2.1 Space robotics

Space robotics is a niche capability area where Canada has developed unique technology in large part due to U.S. and Canadian cooperation on civil space programs since the 1970s. More recently, this heritage in orbital space robotics has been leveraged for other

[48] Ibid.
[49] L-3 MAS, "Robotic Shot Peening," 2005, http://www2.l-3com.com/products-services/docoutput.aspx?id=389.
[50] L-3, "L-3 to Provide Depot-Level Maintenance for the U.S. Navy's F/A-18 A/B/C/D Fleet," March 2016, https://www.l3t.com/press-release/l-3-provide-depot-level-maintenance-us-navy's-fa-18-abcd-fleet.

developmental programs with military application, including to enhance on-orbit satellite-servicing capabilities. For the purposes of this study, CSIS focused on Canadian development of technologies that support the Defense Advanced Research Projects Agency's (DARPA) Robotic Servicing Geosynchronous Satellites program.

Canadian industry's advanced technology in space robotics finds its origins in the early years of the U.S. Space Shuttle program. NASA invited Canada to participate in the program and eventually signed an MOU with the Canadian National Research Council (NRC) to develop a "remote manipulator system," or remote-controlled robotic arm, that could extend from NASA shuttles to deliver and retrieve payloads and repair satellites in orbit. Nascent technologies within Canadian industry—including robotics used to load fuel into nuclear reactors and electronic displays and controls—well positioned Canada with the building blocks for designing such a system. NRC awarded a CDN $108 million development contract to Spar Aerospace, which leveraged the capabilities of its Robotics Division (now owned by MDA), as well as a wide-ranging industrial team that brought together the capacity of established U.S. and Canadian firms and engineering innovation of smaller firms for design and development of various subsystems.[51]

To serve its intended purpose, the Shuttle Remote Manipulator System (SRMS) had to be capable of dexterous and precise movement, while maintaining resiliency in harsh conditions, and the strength to handle payloads. At the time, there was little existing design or proven technology for operating machines in space in this manner. The project demanded innovation in design and engineering in a number of areas, including computer control and display systems, a multi-joint hardware system with six degrees of freedom and finely machined gears, and an "end-effector" (or hand) capable of "soft" capture and "hard" docking to retrieve payloads from free-flying satellites in orbit. The docking system, and its robotic interfaces, would become the standard for both the Shuttle and International Space Station programs. Finally, the project leveraged Canadian industry's strength in simulation systems to enable testing of and training on the robotic arm, a challenge given that the system was designed for micro-gravity and unable to bear its own weight on earth. Canadian industry ultimately built five arms, the first of which was delivered in 1981, and which altogether flew 91 missions until the program close in 2011.[52]

The SRMS design was so successful it eventually served other applications, including assisting with the repair of the Hubble telescope and construction of the International Space Station (ISS). A second generation of the SRMS was developed and built by MDA in the 1990s to assist with the on-orbit construction and assembly of the ISS. The second-generation SRMS—essentially a larger, "smarter," more flexible version—used the same design principles but integrated advanced sensors to provide a sense of touch, new robotic interfacing subsystems to allow data and power transfer at "grapple points," and a new space vision

[51] Government of Canada, "Canadian Space Agency: Historic First Moves," 2011, http://www.asc-csa.gc.ca/eng/canadarm/beginning.asp.
[52] D. Glenn Cook, "The Canadian Designed and Built SPAR/MDA Canadarms: Canada's Contribution to Space Exploration," April 2015, https://documents.techno-science.ca/documents/CASM-Aircrafthistories-SparMDACanadarms.pdf.

system.[53] The second-generation SRMS was delivered in 2001 and, since performing its original ISS assembly role, continues to provide ongoing maintenance, transport, and vehicle capture functions for the ISS.[54]

Each of these successive generations of technology development produced new advancements that serve as the foundation for more recent research focused on autonomous satellite-servicing capabilities. A series of NASA, Air Force, and DARPA-funded developmental programs carried out throughout the 2000s have applied and expanded these space robotics technologies to develop systems capable of tracking, docking, refueling, reconfiguring, and repairing satellites in orbit. In many of these cases, Canadian industry participated on the industrial teams, under subcontract with the U.S. prime, and provided the robotic components of these systems.[55] This includes the DARPA Orbital Express program, which launched two satellites into low-earth orbit (LEO) in 2007 to demonstrate autonomous on-orbit satellite rendezvous and servicing capabilities.[56] In this case, MDA provided the "manipulator system" that enabled a servicer satellite to track, capture, and transfer components to a client satellite.[57]

The ultimate objective of this satellite-servicing research is to develop the capability to drastically reduce the cost of operating in space and to increase the tactical agility of satellites. On-orbit servicing can refuel, relocate, and upgrade satellites with the latest technology, all of which serves to expand the capabilities of, and extend the life of, existing and future satellites.[58] It also reduces the weight and cost of future satellites by alleviating the requirement for stored fuel and backup systems. The latest and most advanced iteration of this research is the DARPA-led Robotic Servicing of Geosynchronous Satellites (RSGS) program, which seeks to bring together the previously mentioned technologies to enable satellite servicing in geosynchronous earth orbit (GEO), where many military, government, and commercial satellites are in orbit today.[59]

The RSGS program will design and develop a robotic toolkit that can integrate with a privately developed and commercially operated servicer spacecraft. A critical component of

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[53] Marc Boucher, "Neptec to Develop a New Advanced Space Vision System for the International Space Station," SpaceRef Canada, January 2016, http://spaceref.ca/missions-and-programs/canadian-space-agency/neptec-to-develop-a-new-advanced-space-vision-system-for-the-international-space-station.html.
[54] Cook, "The Canadian Designed and Built SPAR/MDA Canadarms."
[55] Space Systems Loral, "SSL Selected for NASA Project to Develop Robotic On-Orbit Satellite Assembly," December 10, 2015, http://www.sslmda.com/html/pressreleases/pr20151210.html; Caleb Henry, "NASA's Restore-L contract nudges SSL closer to in-orbit servicing," *Space News*, December 2016, http://spacenews.com/nasas-restore-l-contract-nudges-ssl-closer-to-in-orbit-servicing/.
[56] Defense Advanced Research Projects Agency, "Orbital Express Fact Sheet," March 2007, http://archive.darpa.mil/orbitalexpress/pdf/oe_fact_sheet_final.pdf.
[57] Andrew Ogilvie, Justine Allport, Michael Hannah, and John Lymer, "Autonomous Satellite Servicing Using the Orbital Express Demonstration Manipulator System," DARPA, 2008, http://robotics.estec.esa.int/i-SAIRAS/isairas2008/Proceedings/SESSION%2014/m113-Ogilvie.pdf; Manny Leinz, "Fostering Sustainable Satellite Servicing Orbital Express Program Summary," Boeing, 2012, https://swfound.org/media/87149/leinz-orbital_express_summary.pdf.
[58] Hannah Thoreson, "On-Orbit Servicing Will Lower Costs and Increase Satellite Life Spans," American Institute of Aeronautics and Astronautics, September 2016, http://space.aiaa.org/On-OrbitServicing/.
[59] Gordon Roesler, "Robotic Servicing of Geosynchronous Satellites (RSGS)," DARPA, http://www.darpa.mil/program/robotic-servicing-of-geosynchronous-satellites.

this service vehicle is the multi-joint dexterous robotic arms that would enable automated satellite rendezvous and servicing, including for satellites not designed for docking.[60] In 2016, Space Systems Loral (SSL), a U.S. subsidiary of MDA, won the contract with the Navy Research Laboratory to develop the robotic arm systems for the RSGS program, building off of previously contracted work in space robotics to develop on-orbit satellite assembly capabilities.[61]

After final assembly, the RSGS combined servicing vehicle will launch and conduct an on-orbit demonstration, including capabilities for inspection, repairs, relocation, payload installation, and refueling of satellite in GEO. Assuming a successful demonstration, the capability could be made commercially available for cooperative servicing to government and commercial customers.[62] DARPA, using its other transaction authority, established a public-private partnership agreement with SSL to provide the satellite bus, integrate the servicing payload, and launch the demonstration spacecraft. Under this agreement, DARPA and SSL share the cost of development and the U.S. government would receive preferential servicing once the RSGS-developed capability is demonstrated and commercialized in order to recoup its cost.[63] Once fully developed and commercialized, this GEO satellite servicing capability is envisioned to facilitate the next generation of space architecture to be more sustainable, capable, and resilient.

5.1.3 C4ISR

Like air, Canada's C4ISR is one of its more diversified sectors in defense industrial capability due in part to a history of collaboration in support of NORAD-related requirements. In particular, Canada has developed key industrial capabilities in surveillance, communications, and command and control technologies to support air defense and other mission areas. Canada's C4ISR sector is composed of a few large dominant firms but with a broad base of smaller firms focused in niche areas. In addition to longstanding cross-border relationships founded in NORAD-related work, the C4ISR sector has emerged as a growth sector within the DoD market in the last 10 to 15 years, including by new entrants supporting U.S. military requirements.

This sectoral case study focused on two specialized areas—one longstanding and the other more recently established—which have been leveraged to support major U.S. programs. These niche areas are: 1) tactical radio communications; 2) electro-optical/infrared (EO/IR) sensors.

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[60] Defense Advanced Research Projects Agency, "Program Aims to Facilitate Robotic Servicing of Geosynchronous Satellites," March 2016, http://www.darpa.mil/news-events/2016-03-25.
[61] Space Systems Loral, "SSL to Provide Robotic Arms to DARPA for Satellite Servicing," July 2016, http://sslmda.com/html/pressreleases/pr20160721.html.
[62] Colin Clark, "OSD to Review DARPA Sat Robot Program," *Breaking Defense*, February 2017, http://breakingdefense.com/2017/02/osd-to-review-darpa-sat-robot-program/.
[63] Space Systems Loral, "SSL selected to partner with DARPA to develop satellite servicing business," *PR Newswire*, February 2017, http://www.prnewswire.com/news-releases/ssl-selected-to-partner-with-darpa-to-develop-satellite-servicing-business-613312253.html.

5.1.3.1 Tactical radio communications

Tactical radio communications, like simulation technologies, is a key capability area of Canadian industry where the United States and Canada have had longstanding mil-to-mil and industrial relationships dating back to the 1960s. For the purposes of this study, CSIS focused on high-capacity line-of-sight tactical radios, as this is a niche where Canadian industry has supported U.S. and allied militaries with multiple generations of equipment and that found its origins in joint R&D under the U.S.-Canada Defense Development Sharing Program.

Canadian research and development of wireless communications technology dates back to the early 1900s and accelerated during World War II and under NORAD.[64] U.S.-Canadian air defense cooperation through the 1950s and 1960s drove R&D collaboration on communications systems, including development of early warning systems.[65] Under the U.S.-Canadian Defense Development Sharing Program, Canadian industry designed the first long-range point-to-point digital tactical radio relay set.[66] Ultra TCS (then Canadian Marconi Company until purchased in 2002), the leading producer of tactical radios in Canada, came under contract with the U.S. Army for full-scale production of this first generation of digital radios beginning in the late 1960s, with over 20,000 produced for U.S., Canadian, NATO, and other allied forces.[67] According to industry interviews, the Canadian Marconi Company and later Ultra TCS won and delivered tactical radios to the U.S. Army through three successive generations of technology and modernization efforts to continually enhance the U.S. Army's high-capacity line-of-sight radio network. With each successive generation, Ultra TCS renewed the fleet of technical networks with the latest technology while integrating the capability to connect with prior generation systems for continuity and interoperability within the U.S. Army and among allies that employ earlier generations of equipment. More recently, this technology includes software-defined high-capacity line-of-sight radios, using the Software Communications Architecture, to allow flexibility and innovation in waveforms.

Both the Army and U.S. Marine Corps (under contract with the Navy) procured Ultra TCS software-defined radios in the 2000s to modernize their tactical communications systems.[68] For the Army, these radios are a major component of the tactical communications network under the Warfighter Information Network-Tactical (WIN-T) program, enabling data-based

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[64] Ultra Electronics TCS, "Ultra TCS—Canadian Marconi History," 2016, http://ultra-tcs.com/files/Marconi_Radio_History_LV.pdf.
[65] North American Aerospace Defense Command, "A Brief History of NORAD," December 2013, http://www.norad.mil/Portals/29/Documents/A%20Brief%20History%20of%20NORAD%20(current%20as%20of%20March%202014).pdf.
[66] U.S. Congress, Office of Technology Assessment, *Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base* (Washington, DC: Government Printing Office, 1991), https://www.princeton.edu/~ota/disk1/1991/9134/9134.PDF.
[67] Ultra TCS, "Company Information," http://ultra-tcs.com/about-us/company-information/.
[68] North American Aerospace Defense Command, "A Brief History of NORAD"; Ultra TCS, "Ultra awarded contracts totaling US$100m for battlespace IT radios," https://www.ultra-electronics.com/uploads/PressRelease/TCS_$100m_Orders_in_2008_140708.pdf; and Ultra TCS, "Ultra Electronics Canada Defence Inc. Tactical Communication Systems Division," 2009, http://www.wirelessinnovation.org/assets/documents/news_499465Ultra_Electronics_TCS_PR_2-09.pdf.

communications, including voice, video, and email, for transmission over wide-area networks to enhance the Army's battlefield awareness.[69]

The most recent fourth-generation radio was procured in 2013 as part of the Army's signal modernization effort. The radios provide the high-capacity backhaul for the tactical network connecting various C4ISR systems and boosts its capacity and range to support increasing bandwidth demands.[70] Ultra TCS has also used this latest generation of technology to support modernization of air defense communications systems, including for the Army's Patriot system as well as for other allied forces through FMS.[71] Beyond production, Ultra TCS has leveraged its expertise in meshing systems (new and old) to help Army upgrade legacy radios to enhance interoperability and compatibility with Internet Protocol-based networks, in effect extending the life of deployed legacy radios under the Army's everything-over-internet protocol model.[72]

According to information provided during interviews, much of the technology development used in these radio communication systems was a result of internally funded R&D as well as collaboration with and continual feedback from the Army. In more recent years, Canadian government-led R&D—that is, the Build in Canada Innovation Program (BCIP), which helps companies transition pre-commercial technologies into federal government testing—has supported Ultra TCS product innovation and further development of capabilities that can be added to its latest generation of radios. These investments have supported technologies leveraging 4G for mobile overwater radio links and other "mission adaptive" radios.[73]

5.1.3.2 Electro-optical/infrared (EO/IR) sensors

Sensor technology, specifically advanced EO/IR sensors, is an area that more recently has emerged as a specialized niche capability of Canadian industry and whose origins derive from commercially driven innovation now leveraged for military application to the benefit of U.S. and allied defense programs. EO/IR sensor technology is an area of continuing development and likely growing cooperation, as requirements emerge for enhancing multi-domain awareness.

Canadian industry began developing optical sensor technologies as early as the 1970s to meet commercial demand, that is, camera lens for personal use, broadcast and entertainment, and other commercial sectors. The demands of the film industry in particular drove technological advancements in imaging due to the high cost of production and

[69] Ultra TCS, "Annual Report and Accounts 2016," https://www.ultra-electronics.com/uploads/business-documents/investors/Ultra_AR_A_2016.pdf.
[70] Ultra TCS, "Ultra Electronics, TCS Receives Order from US Army WIN-T for GRC-245C Radio Systems," October 2013, *PR Newswire*, http://www.prnewswire.com/news-releases/ultra-electronics-tcs-receives-order-from-us-army-win-t-for-grc-245c-radio-systems-227216541.html.
[71] Ultra TCS, "Ultra Electronics, TCS Receives [USD] $ 1.18M Order from the U.S. Government," 2013, http://ultra-tcs.com/news-events/press-releases/ultra-electronics-tcs-receives-733k-order-from-the-us-government/.
[72] Ultra TCS, "Ultra Electronics, TCS Tailors the CGM for USAF," November 2013, http://ultra-tcs.com/news-events/press-releases/ultra-electronics-tcs-tailors-the-cgm-for-usaf-theater-deployable-communica/.
[73] Government of Canada, "BCIP Pre-qualified Innovations," https://www.tpsgc-pwgsc.gc.ca/app-acq/picc-bcip/prequalifiee-prequalified-eng.html.

therefore high standard for reliability and quality.[74] These standards for imaging resolution, magnification, stabilization, and reliability under multiple environmental conditions, over land and water, set up Canadian industry with the technical know-how and capabilities to meet military requirements for sensing systems, and by the mid-1990s, Canadian industry recognized the potential for military applications.

In the late 1990s, Wescam developed a more direct relationship with the U.S. Navy in order to offer a solution for day and nighttime sensing requirements. The U.S. Navy was modernizing its P-3 maritime patrol aircraft fleet at the time, which used two different sensor systems to allow for day and nighttime surveillance.[75] Wescam had developed a single multi-sensor, multi-spectral product that integrated multiple capabilities, including day and nighttime sensing. Years of development in image processing and gyro-stabilization had also optimized their long-range imaging capabilities. Given the range of high-quality capabilities within one integrated system, the Navy selected Wescam as the most cost-effective solution and brought them under subcontract to the OEM for the P-3.[76]

After Wescam's acquisition by L-3 Communications in 2002, Wescam's presence and products expanded exponentially in the U.S. market, and sensors were installed on multiple U.S. surveillance, maritime patrol, close air support, and precision strike platforms operating in Iraq and Afghanistan. Wescam sensors now support major air, ground, and sea-based platforms (although primarily airborne) for the U.S. Navy, Air Force, and Army, as well as for other systems of U.S. homeland security, government agencies, along with state and local law enforcement agencies.

Variants of the sensor technology have also been exported under license to NATO and other allies in the Middle East and Asia. Proliferation of the technology did not appear to be tied to a deliberate U.S. or Canadian government strategy or coordinated security cooperation effort but rather a pull from allies that desired to increase interoperability and parity in capability with the United States. Compatible sensor systems have allowed allies and partners to communicate more effectively and share information and intelligence quickly in support of coalition operations, and to exchange feedback and best practices.[77] Military cooperation between the U.S., Canadian, French, and Emirati forces in Africa was highlighted as a recent example of the value of compatible sensor systems, with participating operators enabled to network information and plan and execute missions in short order.

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[74] Mike Lewis, "Stabilization, Steering, and Gimbal Technology as It Relates to Cinematography," Proprietary PV Labs, 2008, 1–8, http://www.pv-labs.com/wp-content/uploads/2014/12/Stabilization-Steering-and-Gimbal-Technology.pdf.
[75] Department of the Navy, "P-3C Orion Long Range ASW Aircraft," May 2016, http://www.navy.mil/navydata/fact_display.asp?cid=1100&tid=1400&ct=1.
[76] Defense-Aerospace.com, "Wescam Awarded C$19 Million Follow-On Order from Lockheed Martin for U.S. Navy P-3C Contract," March 2000, http://www.defense-aerospace.com/article-view/release/1951/wescam-awarded-order-for-p_3c-upgrade-%28mar.-31%29.html; Naval Technology, "P-3C Orion Maritime Patrol Aircraft," accessed June 21, 2017, http://www.naval-technology.com/projects/p3-orion/.
[77] National Research Council, *Realizing the Potential of C4I* (Washington, DC: National Academies Press, 1999), https://doi.org/10.17226/6457.

5.1.4 Land

Land capabilities make up Canada's second-largest defense industrial sector. As previously covered, land is the largest sector in terms of sales to DoD and has played a critical innovation and production role for the United States during its military engagements in Iraq and Afghanistan. Cross-border relationships, however, extend well before the 2000s, in support of both U.S. requirements and those of allies and partners abroad. 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.

This sectoral case study focused on both longstanding and more recent industrial capabilities, both of which provided adaptive, innovative technology, and industrial capacity to quickly respond to emerging (and urgent) U.S. military requirements. These areas are: 1) light armored vehicles; and 2) armor/ballistics protection.

5.1.4.1 Light armored vehicles

Design and production of light armored vehicles is an industrial capability where the United States and Canada have had relatively long-established mil-to-mil and industrial relationships since the 1980s, but which has grown exponentially since 2000 due to high demand for medium-weight protected mobility. For the purposes of this case study, CSIS focused on the LAV III family, including design, engineering, and production support to the U.S. Army's Stryker program, as well as recent U.S.-Canadian cooperation on foreign military sales to the Saudi Arabian National Guard.

While Canadian defense industry has a long history of producing various types of armored vehicles, it began developing specific niche expertise in the design and manufacture of light armored vehicles in the late 1970s. Under tight budget constraints and amidst a reorganization of the Canadian military toward a lighter, more flexible force, the Canadian government initiated the Armored Vehicle General Purpose program, which solicited bids for light, multipurpose air-transportable wheeled vehicles to support training and UN peacekeeping operations.[78] Canadian industry did not have indigenous capacity at the time, but a partnership emerged between Ontario-based General Motors Diesel Division (now General Dynamics Land Systems) and a Swiss firm MOWAG. After winning the contract, GM Diesel Division carried out licensed production of the first-generation LAV I based on the Swiss six-wheeled Piranha I. The AVGP series included three armored fighting vehicles—the Cougar (reconnaissance and fire support), the Grizzly (infantry carrier), and the Husky (recovery vehicle). This family of vehicles was only intended for training and low-intensity operations but ultimately supported UN peacekeeping operations in Somalia and the Balkans.[79]

With this early success, GM Diesel Division began to export variants of the LAV I family, including to the U.S. Marine Corps in the early 1980s. The USMC, seeking to improve

[78] Frank Maas, "The Success of the Light Armoured Vehicle," *Canadian Military History* 20, no. 2 (Spring 2011): 27–36.
[79] Ibid.

mobility, was drawn to the LAV design for its multirole capabilities, including the combination of maneuverability and firepower, and saw it as a cheaper, easier-to-maintain solution than other alternatives. The LAV-25 eight-wheeled amphibious reconnaissance vehicle was designed by GM Diesel Division, entered USMC service in the mid-1980s, and was employed in the Gulf War by both the USMC and U.S. Army (on loan).[80] With just a few other competitors worldwide producing eight-wheeled light armored vehicles, GM Diesel Division emerged as an industry leader and began designing and developing the second-generation LAV II for the Canadian armed forces (Bison infantry carrier and Coyote reconnaissance vehicle) and later variants for Australia, after its forces conducted initial testing using LAV-25s loaned by the USMC. Canada's Light Armored Vehicle Project, initiated in the 1990s, led to the development of the LAV III, the third-generation and heaviest of LAV families. LAV IIIs began production for Canadian armed forces at the end of the 1990s and licensed production in Australia for multiple variants with multiple roles.[81]

The Canadian LAV IIIs were in production and already entering service when a U.S. Army initiative developed in 1999, led by Chief of Staff General Eric Shinseki, to transform the Army from a "Legacy Force" into an "Objective Force" that could deploy as rapidly as light forces but with the "staying power"—that is, lethality, mobility and survivability—of heavier forces.[82] Thus, a new protected mobility requirement emerged for an infantry carrier configuration not yet fully developed or produced in the United States at that time. This program—eventually named the U.S. Army Stryker program—began concept evaluation testing in 1999 at Fort Knox with an assortment of medium-weight vehicles.[83] The U.S. and Canadian governments signed an agreement to facilitate the loan of 32 LAV IIIs to assist with this testing.[84]

At the time of the contract competition, General Dynamics Land Systems (GDLS), with its work in the 1990s under the Light Armored Vehicle Project, had already developed design and manufacturing know-how for a fast-response, medium-weight capability that could be adapted to U.S. Army requirements. From a cost and schedule perspective, GDLS was advantaged in that production and supply lines were already established and active for the Canadian order of 650-plus LAV IIIs. The gestation period, therefore, to configure a U.S. Army variant was short, allowing GDLS to offer a solution that could reach full-rate production quickly with the ability to deliver the first order within 11 months. GDLS formed a joint

[80] James D'Angina, *LAV-25: The Marine Corps' Light Armored Vehicle* (New York: Bloomsbury Publishing, 2011).
[81] S. J. Cimpoeru, "Project Land 112 Phase 4: ASLAV Enhancement Technical Risk Assessment," Australian Government, November 2010, http://www.defence.gov.au/FOI/Docs/Disclosures/084_1415_Documents.pdf.
[82] Alan Vick, David Orletsky, Brice Pirnie, and Seth Jones, *The Stryker Brigade Combat Team* (Santa Monica, CA: RAND, 2002), http://www.rand.org/content/dam/rand/pubs/monograph_reports/2005/MR1606.pdf.
[83] Mark J. Reardon and Jeffrey A. Charlston, *From Transformation to Combat: The First Stryker Brigade at War* (Washington, DC: U.S. Army Center of Military History, 2007, http://www.history.army.mil/brochures/Stryker/Stryker.pdf.
[84] U.S. Department of State, "Treaties in Force: A List of Treaties and Other International Agreements of the United States in Force on January 1, 2016," https://www.state.gov/documents/organization/267489.pdf.

venture with U.S.-based GM Defense and ultimately won the Stryker vehicle contract[85] in November 2000.[86]

While the Stryker LAV family was based on Canadian design and manufacturing know-how, production was shared between GDLS and GM Defense, as the initial order was the largest GDLS had ever received—over 2,000 vehicles would begin delivery by March 2002.[87]

As the Stryker vehicles were employed in Iraq and Afghanistan, modifications were made to the size and design of the hull for mobility and survivability upgrades. One of the most substantial technological developments during this time was the double V-hull design, which GDLS engineered to improve protection against the improvised explosive device (IED) threat—the double V-hull design improved survivability by channeling blasts away from the vehicle. Once designed, the new hull was retrofit to older vehicles and served as the new base variant for later production.[88] Over 4,400 LAV IIIs known as Stryker are now in service with the U.S. Army.[89]

Beyond support to U.S. military requirements, the United States and Canada have also partnered to export LAVs, including the latest LAV III generation to allies and partners. Australia and New Zealand maintain LAV fleets, and most recently the UN and smaller militaries, including a number of countries in South America and Africa, maintain tailored variants.[90] The most notable area of cooperation on foreign military sales (FMS) has been to Saudi Arabia. Canadian industry cooperation on FMS with the Army's Program Manager (PM) office and the Defense Security Cooperation Agency (DSCA) dates back to the late 1980s, in support of the U.S. military's modernization program for the Saudi Arabian National Guard (SANG). After witnessing USMC operating LAVs during the Gulf War, Saudi Arabia began procuring its own fleet of LAVs for its SANG brigades. These have been delivered as part of a coordinated effort between the Canadian Commercial Corporation, GDLS, the Army PM office and the Office of Program Manager (OPM) SANG.[91]

5.1.4.2 Armor/ballistics protection

Armor technology is an area where Canadian industry has developed expertise many years, tied in part to it production of LAVs, but which more recently has been a source of innovation and adaptiveness to enhance the survivability systems of Canadian, U.S., and allied platforms. CSIS also elected to study this capability area given evidence of smaller firms innovating in

[85] The project was originally named "Interim Armored Vehicles" before being renamed to Stryker in 2002.
[86] Brent Coryell, "Performance-Based Logistics, Contractor Logistics Support, and Stryker," U.S. Army Command and General Staff College, 2007.
[87] Stockholm International Peace Research Institute, *SIPRI Yearbook 2005* (New York: Oxford University Press, 2005).
[88] Director, Operational Test & Evaluation, "FY 2012 Annual Report," 2013, http://www.dote.osd.mil/pub/reports/FY2012/pdf/other/2012DOTEAnnualReport.pdf.
[89] International Institute for Strategic Studies, "Military Balance: Chapter Three, North America," February 2017, https://www.iiss.org/en/publications/military%20balance/issues/the-military-balance-2017-b47b/mb2017-03-north-america-744e.
[90] SIPRI, "SIPRI Arms Transfers Database," accessed June 21, 2017, https://www.sipri.org/databases/armstransfers.
[91] For a discussion of one such proposed sale, see Anthony Cordesman, *Saudi Arabia: National Security in a Troubled Region* (Santa Barbara, CA: Praeger Security International/CSIS, 2009), 181.

armor technologies, offering an opportunity for closer study of the role of small businesses in cross-border defense industrial cooperation.

With Canada's early involvement in coalition operations in Afghanistan, Canadian industry recognized a need for enhanced ballistics protection and began testing survivability solutions for the Canadian armed forces' personnel carriers.[92] During this early testing period, Armatec, a recently established small business, was leveraging technology from the aerospace industry to innovate applications for military vehicles and began designing and developing protected seats and armored panels to upgrade Canadian equipment.

When an urgent operational need emerged in 2004 within the U.S. Marine Corps (USMC) to upgrade the survivability of their LAV family against IEDs and other threats, Armatec had recently developed and tested solutions directly relevant to USMC's LAV survivability shortfalls.[93] Specifically, the USMC LAV-25 variant was configured with light-gauge steel armor to preserve its mobility and only intended to protect against small-caliber machine gun fire.[94] Armatec had developed a system of modular armor panels that could be "added on" to a base hull, providing a quick solution once the panels were designed to the specifications of the specific variant of vehicle, and ultimately a plus for the USMC given the urgency of the requirement.[95]

USMC initiated a survivability program in 2005 and released a request for proposals (RFP).[96] As part of the contract competition, Armatec participated in a "shoot-off" at the Aberdeen ballistics range together with two U.S. companies. Armatec won the competition and ultimately the Ballistics Protections Upgrade Package (BPUP) contract on a sole-source basis, given the urgency of the requirement.[97]

As a result of this initial work to support the Canadian and U.S. militaries, and as knowledge of the threat environment in places of conflict increased and evolved, cross-border industrial collaboration on ballistics testing and advancements in survivability technology continued, including to the benefit of other allies. Through a preexisting forum—the Light Armor Vehicle User Nation Group—solutions and technical exchanges occurred to improve survivability systems for a broader community of global partners.[98] Canadian industry continued as a

[92] General Dynamics, "Government of Canada Awards LAV III Upgrade Definition Contract to General Dynamics Land Systems-Canada," July 2010, http://www.generaldynamics.com/news/press-releases/2010/07/government-canada-awards-lav-iii-upgrade-definition-contract-general.
[93] Director, Operational Test & Evaluation, "FY 2013 Annual Report," 2014, 193–194, http://www.dote.osd.mil/pub/reports/FY2013/pdf/other/2013DOTEAnnualReport.pdf; Armatec, "Company History," http://www.armateconline.com/index.php/about-us/company-history.
[94] Martin G. H. Wells, Rebecca K. Weiss, Jonathan S. Montgomery, and Thomas G. Melvin, *LAV Armor Plate Study* (Watertown, MA: U.S. Army Materials Technology Laboratory, April 1992), http://www.dtic.mil/dtic/tr/fulltext/u2/a257674.pdf.
[95] Armatec, "Armor mounting system: Patent US20090133571 A1," May 2009, https://www.google.com/patents/US20090133571.
[96] D'Angina, *LAV-25*.
[97] GovTribe, "Federal Contract Opportunity: LAV Armor and Ballistic Protection Upgrade Packages," 2013, https://govtribe.com/project/23-lav-armor-and-ballistic-protection-upgrade-packages.
[98] Foreign Affairs, Defence and Trade Select Committee, "2007/2008 Financial Review: New Zealand Defence Force," 2009, https://www.parliament.nz/resource/en-NZ/49SCFDT_EVI_00DBSCH_FIN_8721_1_A45888/

leader in LAV-related technology and industrial capability, developing additional technologies for mine blast and rocket-propelled grenade protection, and other survivability systems, which it exported to other allied countries.

Additionally, similar to findings in the air sector, CSIS noted the role Canadian industry played in offering alternative equipment modernization and life-extension solutions for allies and partners. With design and engineering that allowed for additive protective equipment on older vehicles, the service life of legacy equipment could be extended significantly for countries desiring enhanced protected mobility, up to 20–30 years in some cases. Users of legacy equipment, therefore, were afforded options beyond full-fleet replacement, a valuable proposition particularly for smaller military partners. Armatec performed this type of work in Europe, the Middle East, and most recently for SAIC's Assault Amphibious Vehicle upgrade for the U.S. Marine Corps.[99]

92279ea55b24e96fdb6cc877e11e6164a13c5c2c; and Robert Nutbrown, "LAND 400 contenders manoeuvre at Land Forces exhibition," *Australian Defence Business Review*, December 1, 2014, http://adbr.com.au/land-400-armoured-vehicles-project-contenders-manoeuvre-at-land-forces-exhibition/.

[99] For a discussion of the SAIC contract that does not directly explore the role played by specific contractors, see James Bach, "SAIC unveils newest amphibious vehicle with eyes on expanded role in military transport," *Washington Business Journal*, February 1, 2016, http://www.bizjournals.com/washington/blog/fedbiz_daily/2016/02/saic-unveils-newest-amphibious-vehicle-with-eyes.html.

6 Case Study Findings

CSIS consolidated findings from across its case studies into two categories:

- Findings on the **benefits** of U.S.-Canadian industrial cooperation
- Findings on the **challenges** of and barriers to U.S.-Canadian industrial cooperation

6.1 Findings on Benefits of U.S.-Canadian Industrial Cooperation

The case studies highlight the value of U.S.-Canadian defense industrial cooperation to achieve a wide range of technology and capability development, production, and training and sustainment objectives. As is shown in Chapter 2, the United States and Canada have continued to expand and institutionalize the bilateral agreements since 1950. While efforts are often reactive or sporadic, the sustained interest reflects the value seen in the national technology industrial base in both countries. These cases look at where and how the aspirations of bilateral cooperation translate into practical and concrete benefits.

To discuss the findings in greater detail, CSIS broke down the benefits into the following topline categories:

- Increased access to unique design and product innovation
- Increased production and advanced manufacturing capacity
- Enhanced training and sustainment support
- Enhanced international armaments cooperation with allies and partners

Broadly speaking, the benefits accrued by U.S.-Canadian cooperation improve technology and industrial base preparedness, adaptability, responsiveness, and capacity. Leveraging a broader base of suppliers and engineering, manufacturing, and sustainment capabilities improves the quality, schedule, and cost-effectiveness of defense innovation, production, and sustainment. Additionally, while not the primary focus of analysis, the case studies also highlight the benefit of U.S.-Canadian cooperation and coordination in support of global allies and partners.

6.1.1 Increased Access to Unique Design and Product Innovation

One of the strongest themes to emerge from across the case studies was the significant role that unique design and innovation played in driving cross-border cooperation and contracting. In most of the cases analyzed, Canadian industry already possessed unique or comparatively advanced technology, and was able to demonstrate those capabilities at U.S.-

hosted demonstrations, during combined operations or exercises, or through other exchange programs, forums, or informal mechanisms. Overall, this increased access to unique design and product innovation brought a number of benefits, including affording the United States the ability to leverage higher returns from "pooled" resources and commercial innovation, to achieve faster integration of innovative solutions, and to build longer-term industrial capacity for transformational capabilities.

The first and most self-evident benefit is the value of leveraging a broader pool of R&D investment. In many of the case studies, innovation derived from Canadian government or industry R&D funding, as often as from the U.S. or joint U.S.-Canadian development programs. In one interview example, internal funding continued long after the company had a steady contract, and guided by collaboration and continual feedback from the customer. Canadian government and industry R&D investments often targeted areas of mutual benefit, with an eye toward direct participation in U.S. defense or civil programs, as was the case with many of the air, space, and C4ISR examples. According to the original U.S.-Canadian bilateral agreement on defense economic cooperation, one of the six overarching principles is to "achieve the most economical use of R&D and production resources."[100] From this perspective, the cross-border relationships seem to be working as intended in achieving cost-savings by tapping into a broader pool of publicly and privately funded development to benefit mutual programs (although the level "coordinated effort" toward this end is unclear).

Relatedly, Canadian industry's commercial orientation and specialization in dual-use technologies enhanced opportunities to leverage privately funded, commercially driven R&D for military capability development. As demonstrated by the flight simulation and sensor case studies, in particular, Canadian defense industry grew its capacity to support complementary military systems for both the United States and Canada, building off of innovation and advancements in the commercial sector. Indeed, in many cases, it was Canadian industry's proactive recognition of the military application of dual-use technologies that promoted their eventual integration into U.S. systems. Canadian industry's demonstrated ability to successfully maneuver in both the commercial and military markets, therefore, they will continue to be valuable in an environment where the United States is trying to increase its ability to harness commercial innovation.

Increased access to innovation also enabled the United States to identify solutions faster to address either emerging requirements or urgent operational needs. This value was seen most evidently in the land sector case studies. In the case of LAVs, the United States had an emerging requirement for medium-weight protected mobility and GDLS was able to leverage prior Canadian LAV design and development as a starting point for testing concepts and eventually for meeting the requirements. The valuable feedback loop of Canadian R&D investment was evident here, as the technical jump from the LAV II to the LAV III was enabled by the Canadian LAV III Project and allowed for successful development of design elements used to support the Stryker program. In the case of survivability systems, the United States was able to leverage Canadian innovation in hull and armor design to quickly respond with solutions to urgent operational needs from Iraq and Afghanistan. These examples highlight

[100] U.S. Department of Defense, "Exchange of Notes between Canada and the United States of America Giving Formal Effect to the Statement of Principles for Economic Cooperation," October 26, 1950.

the value of broader industrial base capacity in providing not just readily available alternative sources of supply in short order but also in improving the quality of systems on an urgent basis. Indeed, as discussed in Annex A's literature review, Canadian defense industry has been conditioned to remain adaptable in fulfilling its role as an alternative, complementary source of industrial capacity based on temporal, urgent operational requirements.

Finally, increased access to innovation also provides a source of complementary longer-term development, particularly in specialized areas. The simulation technology case study highlights this value. Canadian industry developed sophisticated niche expertise over the course of decades, harnessing growth in the commercial market to drive innovation in dual-use digital simulation technologies and production of a range of different systems. This, together with U.S.-Canadian military cooperation on multiple generations of fighter, maritime patrol, antisubmarine, tactical and strategic lift, and other utility aircraft, led to the development of an advanced, adaptable Canadian industrial base for simulation products compatible with U.S. weapons systems. The space robotics case study highlights the value of continued longer-term development of high-technology areas. Multiple generations of space robotics technologies have been incorporated into U.S. civil space programs and more recently into military developmental capabilities that could provide a wide range of benefits to U.S. defense programs. Canadian industry's advancements in these specialized technology areas, therefore, provide a long-term trusted and reliable source of innovation.

Taken together, this results in a national technological industrial base that can be greater than the sum of its parts. The CSIS study team noted the value of a "multiplier effect" in innovation created by cross-border cooperation. International joint development programs or even smaller service-level collaborative R&D created cross-border industrial teams that brought together a range of specialized skills and capabilities. Discovery of spin-off technologies or new applications appeared to result from this collaboration. For example, U.S.-Canadian R&D collaboration on flight simulation technologies—that is, visual, motion, and command and control systems—spawned progress in these areas with many applications. The 1960s tactical guidance system program mentioned earlier helped Canada further develop technology for hand controllers that was eventually leveraged to support development of the Space Shuttle Remote Manipulator System. Likewise, as demonstrated by the space robotics case study, R&D collaboration in support of the Space Shuttle robotic arm spawned development of numerous technologies—that is, space-based optical sensing, autonomous docking and satellite rendezvous, and in-orbit servicing—now being leveraged for new applications.

These findings illuminate the short- and long-term benefits to innovation of cross-border collaboration, but also raise questions regarding how and where to shape future cooperation. Of the case studies analyzed, many of the longer-term high-technology areas grew out of Cold War-era collaboration. The United States and Canada will need to identify the next generation of transformational technologies on which it should collaborate, which areas Canada should engender unique or complementary development capacity, and what, if any, international programs should be established to facilitate a more collaborative environment. Likewise, if the United States continues to pursue mechanisms to leverage commercial innovation, it should seek to replicate some of the recent successes with Canadian industry,

including by identifying those technology areas where commercial sectors are likely to continue to drive innovation, like space and electronics.

6.1.2 Increased Production and Advanced Manufacturing Capacity

The second broad area of benefit that the CSIS study team identified from across the case studies was increased production and advanced manufacturing capacity. This increased capacity does not just refer to the sum of U.S. and Canadian industry. For example, in one case U.S. production capability was increased over the course of a program thanks to the engineering and technical support of support by field service representatives from a Canadian division of a larger firm. Canadian defense industry possesses both complementary and specialized industrial capacity that feeds directly into the U.S. system to, again, achieve "the most economical use of . . . production resources."[101] In addition to economies of scale, the case studies demonstrated how Canadian defense industry could also surge this capacity for urgent U.S. production needs as required.

The land sector case studies best demonstrated this value. When the U.S. Army began its transition to a more rapidly deployable, lighter force, and when mobility requirements to fulfill this new role emerged on a more urgent basis as a result of the Afghanistan and Iraq wars, the specialized Canadian industrial capability for medium-weight protected mobility could be accessed immediately. Further, the existing production lines and cross-border supplier networks established to support the Canadian and Australian armies enabled the U.S. Army to access new material solutions on a faster schedule and cheaper pricing basis. The history of production for the U.S. Marines on earlier generations of the equipment helped build up LAV production capacity and, again, built confidence in the reliability of this alternative source of production. As noted in the case study, this industrial capacity has ultimately supported production of the entire fleet of Stryker vehicles (over 4,400 carriers) and multiple retrofit upgrades for survivability. This case demonstrates the value of having a trusted alternative source to offset underdeveloped U.S. industrial areas, including on an urgent basis, at optimal cost.

Additionally, CSIS noted the value of complementary production capacity for U.S. systems, including those that require high-technology manufacturing processes. The air sector case studies highlight this value best given the history of common air programs between the United States and Canada. As noted in the previous section, Canadian defense industry developed a sophisticated industrial base and production capacity for a range of military flight simulation systems—both hardware and software—that complemented U.S. systems given the commonality in platforms used by the U.S. and Canadian militaries. Additionally, while not included as a specific case study, CSIS also conducted interviews with firms that had performed work on both the F/A-18 and F-35 programs. In each case, Canadian defense industry brought valuable industrial capacity, not just in workshare but in advanced engineering and manufacturing capabilities, to contribute to the production of U.S. advanced weapons systems. This includes advanced machining for small hard metal components (e.g., titanium), as well as engineering capacity to work with complex composite material and meet challenging "tolerancing" standards required for stealth technology. Again, these

[101] Ibid.

complementary, advanced industrial base capacities promote a more capable broader industrial base, able to offer the benefits of competition for various subsystems and components.

As with innovation, CSIS findings suggest that it would be beneficial for the United States and Canada to cooperatively identify future areas of potential production or advancing manufacturing needs to ensure equivalent complementary capacity in areas of mutual interest. Emerging requirements for Arctic navigation, domain awareness, and communication, as well as the likely surge in use of unmanned systems, for example, are areas where U.S.-Canadian cooperation would continue to promote economical, scalable, and sustainable industrial capabilities to meet production needs.

6.1.3 Enhanced Training and Sustainment Support (in-Service Support)

Apart from product design and innovation, the other strongest theme to emerge from the case studies was the value added by Canadian industrial capability and capacity for in-service support (ISS). This was, again, particularly the case in the air sector due to common air programs and capabilities. The value of Canadian ISS industrial capability derived primarily from Canada's domestic budget environment. While the Canadian military employs similar systems to the United States for air superiority, maritime patrol, and transport, the defense budget allocated to procure and sustain such systems is magnitudes smaller than the U.S. defense budget. As such, Canadian defense industry has developed unique technologies, methods, and engineering solutions to promote cost-efficiencies in training and sustainment. These efficiencies improve readiness while driving down cost, the benefits of which the United States has just recently started to take advantage of, demonstrated most clearly in the air sector case studies.

The F/A-18 Hornet case study highlighted both the value of accessing Canadian industry's ISS expertise, as well as the value of having the ability to leverage additional capacity for maintenance and repair when needed. With respect to the former, as described in the case study, Canada developed unique robotic engineering capabilities for sustainment of fighter aircraft through its own life-extension programs and investments. These engineering solutions were leveraged to offer potential cost savings for the U.S. Navy by employing methods for product life-cycle extension versus full replacement of parts during F/A-18 Hornet maintenance and repair work. Furthermore, under the depot-level maintenance contract, these engineering capabilities will be transferred to other U.S. depots, effectively enhancing the collective engineering know-how of U.S. and Canadian MRO facilities to the benefit of both the U.S. and Canadian fleets. Finally, in the case of F/A-18 Hornets, Canada's complementary industrial capacity provided an invaluable alternative source of sustainment capacity under urgent circumstances where the U.S. Navy required additional industrial capacity to meet delivery timelines and maintain fleet readiness.

From a training perspective, the flight simulation case study similarly demonstrated the value of Canadian industry's role in identifying cost-effective, efficient solutions to maintain readiness.

As discussed in the case study, in the 1990s, the Canadian military started contracting out much of its air training support. This, together with a budget-constrained environment, drove Canadian defense industry to develop its capacity and expertise for fully integrated, long-term training services delivery. In recent years, DoD has been able to leverage this niche Canadian industrial capacity as greater emphasis has been placed on virtual training environments as a safe, cost-effective way of conducting flight training and crew readiness.

Notwithstanding the value highlighted in these case studies, in-service support is an area of industrial base capacity that appears relatively underutilized when compared to other cross-border activities in support of R&D and production. The F/A-18 Hornet case study highlights the potential benefit of more proactive cooperation on fleet management, vice waiting to the point of a readiness crisis. Additionally, it seems likely that other underutilized "turn-key" solutions for sustainment exist among close allies, and particularly between the United States and Canada among common air platforms. Broader cooperation in fleet management could be applied to other programs to promote more efficient and cost-effective sustainment, as has been the case with F/A-18 Hornets. The CSIS study team also noted that some ISS-related processes and training methods are likely platform agnostic (e.g., interactive technical manuals and augmented reality solutions for engineers). Broader ISS cooperation would promote freer exchange of transferable solutions that save money, time, and risk and that enhance collective technical know-how across capabilities and domains.

Likewise, new applications for simulation technologies are likely to bring cost-effective solutions to both training as well as experimental testing and evaluation of new operational concepts. Modeling and simulation were used to great effect in developing aircraft subsystems—visual, motion, command and control, etc.—and could be equally leveraged as the United States and key allies explore new concepts for unmanned systems, human-machine teaming, and networked operations. Similarly, networked simulation training would allow for testing and exercising coalition operations and interoperability in a more cost-effective manner than live environments.

6.1.4 Enhanced International Armaments Cooperation with Allies and Partners

The final overarching area of benefit identified in the case studies is the ability to enhance international armaments cooperation with allies and partners. These enhancements fall broadly into two categories: 1) helping improve compatibility of advanced U.S. systems with other key allies; and 2) enhancing partnership capacity building by providing alternative tailored solutions for smaller partner militaries.

Beyond the complementary industrial capacity that common air programs promote, the case studies showed that Canadian industry further leveraged their capacity to contribute to allied "user groups" to assist with modifying the operational employment and sustainment of advanced U.S. systems to better align with other allies' force structure and needs. The follow-on operational testing and evaluation of F/A-18s flying off land (versus carriers) best illustrates this point. Canadian industrial capacity and engineering know-how, therefore, can act as a useful supplemental to help the United States successfully integrate its systems across militaries with varying force sizes and structures.

The case studies also demonstrated how Canadian industrial capacity developed to support U.S. and Canadian military requirements can be further leveraged to provide tailored alternatives for other smaller partner militaries. In particular, Canada's life-extension and modernization expertise assisted in multiple instances to either identify a nonstandard solution or cost-saving engineering solution to upgrade or extend the life of legacy equipment. Although not specifically mentioned in the above case studies, the sale of maritime helicopters to the Peruvian navy is an illustrative example. In this instance, U.S. and Canadian industry partnered to modernize and extend the life of legacy maritime helicopters, arriving at a solution more suitable for the Peruvian military.[102] Likewise, both the F/A-18 Hornet and armor case studies demonstrated how Canadian engineering solutions provided alternatives to the more expensive practices of parts replacement (in the case of the F/A-18s) or full fleet replacement (in the case of armor upgrades).

In the course of interviews, it became apparent that with the exception of a few large programs—that is, LAV sales to Saudi Arabia—many of the industrial partnerships formed in support of international sales were fairly ad hoc. In particular, the need for "sun-down plans" for partner militaries using legacy equipment (and in need of supply and sustainment support) was raised on a number occasions as a potential area for closer and more deliberate coordination.

6.2 Findings on Challenges/Barriers

The case studies also facilitated a closer look at challenges encountered in cross-border cooperation and the specific market access barriers that can make it difficult for Canadian firms to compete and provide support to U.S. defense programs.

To discuss findings in greater detail, CSIS broke down these challenges into the following topline categories:

- Restrictions on Foreign Acquisition
- Export Control/International Traffic in Arms Regulations (ITAR)
- National Security/Foreign Disclosure
- Cultural Barriers
- Institutional Barriers

6.2.1 Restrictions on Foreign Acquisition

As a starting point, there are areas where Canadian industry is ineligible to compete for U.S. defense work due to restrictions codified in U.S. law and regulations that limit foreign

[102] Kaman, "Kaman awarded [USD] $39.8M Contract to Commence Implementation Phase of Peru SH-2G Super Seasprite Program," July 2016, http://www.kaman.com/news/kaman-awarded-398m-contract-commence-implementation-phase-peru-sh-2g-super-seasprite-program.

acquisition.[103] These restrictions have been passed in U.S. legislation incrementally since World War II. The most limiting restriction—the Buy American Act—is waived under the U.S.-Canada Defense Production Sharing Agreement, as it is for most other key defense trade partners under reciprocal defense procurement (RDP) agreements. However, several other restrictions remain in place and impact market access. The most prominent are: 1) the Berry Amendment, which restricts purchasing of food, clothing, fabrics, specialty metals,[104] and measuring tools; 2) the Byrnes-Tollefson Amendment, which restricts contracting for construction or repair of vessels in foreign shipyards; and 3) Small Business Act (SBA) set-asides and preferences.

Of these foreign acquisition restrictions, small business set-asides and targets were raised in interviews as a particularly high market access barrier, due in part to the market share covered by small business goals and in part to the uneven playing field created by the U.S. definition of small business under SBA provisions. Although Canada is defined as part of the U.S. National Technology and Industry Base in U.S. Code, Canadian firms cannot qualify for SBA preferences, as small business concerns are defined under the Federal Acquisition Regulations (FAR) as only those entities located in and operating primarily from within the United States.[105]

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.[106] 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 subcontracts.[107] According to OSBP's latest Scorecard, 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.[108]

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[103] Foreign acquisition regulations are enumerated in the Defense Acquisition Regulations, Subpart 225.70, "Authorization Acts, Appropriations Acts, and Other Statutory Restrictions on Foreign Acquisitions," http://www.acq.osd.mil/dpap/dars/dfars/html/current/225_70.htm.
[104] 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 DFARs 225.7002-2, http://www.acq.osd.mil/dpap/dars/dfars/html/current/225_70.htm#225.7002-2.
[105] For a full list of small business concern categories and definitions, see 10 U.S. Code §2505; FAR Part 19, http://www.acq.osd.mil/dpap/cpic/cp/docs/Government_contracting_-_the%20Basics_-_June_2011.pdf.
[106] See FAR 19.502-2—Total Small Business Set-Asides, https://www.acquisition.gov/far/html/Subpart%2019_5.html.
[107] U.S. Department of Defense, Office of Small Business Programs, "Small Business Program Goals," http://www.acq.osd.mil/osbp/statistics/sbProgramGoals.shtml.
[108] U.S. Department of Defense, "FY2015 Small Business Procurement Scorecard," 2016, http://www.acq.osd.mil/osbp/gov/resources/FY15_DOD_SB_Procurement_Scorecard_Public_View_FINAL.pdf.

These set-asides do not just exclude the Canadian small business sector. There is a marked discrepancy between standards used by the U.S. Small Business Administration to define "small" and Canadian standards. Size standards to qualify as small business are based either on the average number of employees or average annual revenue. These standards vary industry by industry, but generally the Small Business Administration size standard for the number of employees ranges from 500 to 1,500 personnel.[109] As a point of comparison, a recent Industry Canada survey showed that 95 percent of Canadian defense firms reported having fewer than 500 employees, below even the lower-end threshold of the U.S. Small Business Administration size standard for small business.[110] Thus, the comparatively smaller size of Canadian defense industries, combined with ineligibility to compete against similar U.S. companies for contracts with a small business set-aside, places the vast majority of Canadian defense firms at a competitive disadvantage in the U.S. market.

Interviewees pointed out that these small-business-targeting policies have trickle-down effects as well. For example, U.S. OEMs, upon which smaller Canadian firms tend to rely for access to the U.S. market, will select preferred suppliers specifically to meet small business targets. Notably, the case studies found that in multiple domains, even larger Canadian firms first established their bona fides by working with a U.S. OEM as a subcontractor. 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. While this issue was raised in the context of small business access, it is likely that membership limitations for consortiums and other technical exchanges are tied to export control and foreign disclosure policies vice small business policies. Regardless, the net effect is that the mechanisms used to improve DoD access to small business innovation preclude participation of non-U.S. entities in some cases.

Currently, the only exception made for Canadian industry to the SBA restrictions under the Defense Federal Acquisition Regulations Supplement (DFARS) is a provision tied to the original Defense Development Sharing Agreement (DDSA), which says that no defense supplies developed in whole or part under the DDSA may be set aside in the future.[111] In recent years, however, the DDSA has not been used often, and the preferred Canadian business strategy to increase access to smaller contracts is to pursue partnerships or joint

[109] U.S. Small Business Administration, "Table of Small Business Size Standards Matched to North American Industry Classification System Codes," https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf; and U.S. Small Business Administration, "Summary of Size Standards by Industry Sector," 2016, https://www.sba.gov/contracting/getting-started-contractor/make-sure-you-meet-sba-size-standards/summary-size-standards-industry-sector.
[110] Government of Canada, "State of Canada's Defence Industry, 2014," https://www.ic.gc.ca/eic/site/ad-ad.nsf/eng/h_ad03978.html.
[111] See Subpart 219.5 "Set-Asides for Small Business," http://www.acq.osd.mil/dpap/dars/dfars/html/current/219_5.htm.

ventures with U.S. small businesses. Though, where there is a high U.S. content requirement in the set-aside contracts, these partnerships or joint solutions are not generally competitive.

6.2.2 Export Control/International Traffic in Arms Regulations (ITAR)

Challenges related to U.S. arms export control policy, law, and regulations were also raised in several contexts during interviews. These challenges affect both bilateral trade as well as bilateral cooperation in support of foreign military sales to partners. This section covers findings from each perspective.

Bilateral Trade

Canada has unique status in terms of receiving an "exemption" from U.S. export control licensing regulations under ITAR.[112] The exemption allows license-free U.S. export to and temporary import from Canada for many categories of unclassified defense articles, services, and technical data, but excludes certain items from the U.S. Munitions List (USML).[113] Among others, items that are not eligible for license-free export and temporary import include:

- All classified defense articles, services, and technical data;
- All nuclear, strategic delivery, MTCR, and missile technology;
- All defense services and technical data related to applied research, design methodology, engineering analysis, and manufacturing know-how, 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 know-how related to aircraft and inertial navigation systems;
- All manufacturing know-how related to radar systems and electronic combat equipment;
- All defense articles and services specific to spacecraft and satellites (except commercial communications satellites);

[112] Canada is the only country given an exemption from the requirement to enter into a bilateral before receiving exemptions. The United Kingdom and Australia receive exemptions, provided they meet the terms of the bilateral. See Annex A: Literature Review for the history of the exemption.
[113] For a description of Canada-specific exemptions to ITAR requirements, see ITAR section 126.5, https://www.pmddtc.state.gov/regulations_laws/documents/official_itar/ITAR_Part_126.pdf.

- All designed and modified systems, components, parts, accessories, attachments, and associated equipment of spacecraft/satellites;

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

Additionally, Canada operates under a modified set of ITAR rules since 2001, following a temporary revocation of its exemption due to concerns over technology diversion through dual-nationals and unlicensed reexport of U.S.-origin defense articles. These rules require Canadian defense firms to be registered with the Canadian Controlled Goods Program (CGP), a compliance program established to strengthen and coordinate defense trade controls with the United States and to regulate access to controlled goods and technologies, including ITAR-controlled goods. The modified rule also restricted access of dual and third-party nationals to ITAR-controlled goods, although the scope of this change is limited because most dual citizens fall under the §126.5(a) definition of being a "Canadian-registered person."[114] Following an internal review of industrial security procedures, Canada implemented an Enhanced Security Strategy (ESS) and negotiated new ITAR rules with the United States to permit access for dual and third-party nationals to ITAR-controlled goods within registered companies under new CGP procedures for screening, clearance, and other industry security measures.

Industry interviewees generally characterized ITAR regulations as an "accepted part of the business" and more of an administrative hurdle than an actual barrier to cooperation. ITAR regulations create delays but do not necessarily prevent Canadian firms from competing and conducting work for the DoD. After an initial "learning curve," companies became familiar with the system and institutionalized export compliance and security procedures; that said, the administrative adjustment was relatively more difficult for smaller companies. At the industry-to-industry level ITAR provided an easy excuse to say no, but companies that wanted a Canadian partner would find a way. Within certain sectors, companies reported widely using the country exemption, and many items had been moved over to the Commerce Control List as part of the Export Control Reform effort, such as F/A-18 Hornets. Canada's geographic proximity also allows companies greater freedom to navigate around ITAR difficulties. For instance, Canadian firms can send engineers down to U.S. facilities for design or engineering purposes in cases where they are performing work on components of a larger U.S. system that cannot be exported due to export controls.

There were three exceptions to this above generalized view, where specific concerns were raised:

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

According to interviewees, ITAR primarily impedes company-to-company exchange of knowledge and ideas, frustrating cross-border industrial teams and joint development work. §126.5(b) allows for the license-free export of unclassified defense articles and defense services, which does not exclude technical data. Nonetheless, while technical data is not

[114] For guidance on modified ITAR rules, see http://pmddtc.state.gov/licensing/documents/exports_canada.pdf.

excluded as a category, companies reported that engineers are often unable to exchange information freely without a Technical Assistance Agreement (TAA), which can take up to two to three months to process. Canadian companies build in lead time for TAA licensing, but the greater time intensity may make a cross-border partnerships less appealing to U.S. firms than partnering with another U.S. firm that has greater flexibility, particularly if the Canadian company had not seen a particular opportunity coming. Such disincentives also impact the selection of sub-tier suppliers, with already existing licensing acting as a discriminator, although discussions with government officials suggest that retransfer revisions should assist with sub-tier issues for companies registered under the CGP. The effects of the rules are magnified depending on the interpretation of ITAR by U.S. companies, which varies widely. Generally, issues revolving around technical data and access to information or facilities were focused on industry-to-industry relationships. No company reported being unable to get a TAA license in time to compete for a U.S. government contract or visit a U.S. government facility.

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

The space sector and submersibles have relatively stronger export controls (where the Canadian exemption doesn't apply), exacerbating the challenges described above with respect to license delays and communication challenges. For the marine sector, ITAR has "catchalls" for underwater equipment multiplying the licensing burden for cross-border cooperation in all underwater technologies. For space, while there is nuance to restrictions, U.S. export controls have historically been tight, as both the United States and Canada see a strategic interest in the space domain and in the need to maintain industrial base capacity to access space. As a result, U.S. acquisition of Canadian space hardware has been limited and exports controlled to preserve industrial capacity. Likewise, the Canadian government denied a 2008 attempt by U.S. industry to acquire its largest space firm, MDA, Inc., acting to protect Canada's indigenous space industrial capacity.[115]

3. Secondary effects on the commercial operations of companies.

The most significant issue for most Canadian companies was the impact of ITAR on their commercial operations. Canadian defense industry specializes in dual-use technologies and relies heavily on commercial revenue, primarily in export markets. Given their commercial and export orientation, Canadian firms cannot afford to have preexisting products "controlled" by the U.S. system and limited in the global market—an effect commonly called "ITAR contamination." Industry interviews cited examples of items being integrated with U.S. defense articles or modified at the request of a DoD customer. In one case, a Canadian company described creating a separate product line for sale to DoD to ensure that the main product line avoided becoming ITAR-controlled. Outside of NATO and other close U.S. allies, licensed sales of ITAR-controlled equipment can be difficult, and many countries will request "non-ITAR" solutions. Accordingly, most Canadian firms maintain discrete lines of operation when doing business with the DoD, such that they have high-end ITAR-controlled products (which require U.S. and Canadian export permits), ITAR-free but still controlled items (which

[115] CBC News, "Govt. confirms decision to block sale of MDA space division," May 9, 2008, http://www.cbc.ca/news/technology/govt-confirms-decision-to-block-sale-of-mda-space-division-1.698584.

require Canadian export permits), and commercial items. Challenges associated with "ITAR contamination" varied company by company depending on the commercial versus. defense orientation of its business.

Notwithstanding the above three issues, Canadian companies universally stated that ITAR challenges were generally manageable and worth gaining access to the DoD market.

Foreign Military Sales

The CSIS study team also looked at the extent to which Canadian industry cooperates with the United States on foreign military sales to allies and partners. Generally speaking, as discussed above, Canadian companies prefer to keep discrete lines of production for U.S. military end-items and those produced for world markets due to the relatively strict U.S. export controls. Some firms did report exporting ITAR-controlled items, but generally preferred to do so commercially, with State Department authorization and licensing, versus working through the U.S. foreign military sales (FMS) system. The reasoning for this was twofold.

First, Canadian industry primarily produces components and subsystems for the DoD market. As such, Canadian firms may provide components to U.S. primes that are integrated onto U.S. platforms destined for export via FMS (i.e., sensors on an air platform), but will rarely sell those products individually through FMS. Furthermore, for smaller export markets, companies found it more efficient to work through the Canadian Commercial Corporation (CCC) to sell directly to the purchasing country due to the costly and time-intensive requirements FMS places on both the supplier and customer. These requirements include U.S. testing and certification, which in the case of non-U.S. content and technology can take longer. Smaller markets also tend to seek nonstandard solutions more often, which again are easier to process outside of FMS and via CCC channels. In cases where Canadian firms sell full systems as part of large FMS cases (e.g., LAVs), cooperation on FMS was more prevalent and successful due to close relationships with U.S. program manager offices and the Defense Security Cooperation Agency (DSCA). In these cases, however, companies had to build a larger network of U.S.-based suppliers to drive up U.S. content in their systems in order to avoid trouble with the U.S. Arms Export Control Act.

This latter point is the second reason why Canadian companies found cooperation on foreign military sales to be challenging. The U.S. Arms Export Control Act (AECA) emphasizes procurement from U.S. sources and applies restrictions on the use of FMS financing for non-U.S. sources.[116] Use of Foreign Military Financing (FMF), which provides repayable loans and nonrepayable grants to partners for the purchase of products or services, is restricted for offshore procurements and funding of non-U.S. content. DSCA guidelines require that FMF-funded purchases only be made from U.S. prime contractors, that the end-item be manufactured and assembled in the United States, that the end-item consist of at least 51 percent U.S.-origin content, and that only the U.S. content of the end-item may be funded with FMF. Waivers to the offshore procurement limitation are provided at the request of the

[116] See 22 U.S..C. § 2791, General Provisions, http://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title22-section2791&num=0&edition=prelim.

purchasing country but only on an exceptional basis. Exceptions to fund non-U.S. content are granted in limited cases of mixed content end-items; however, the requirements for manufacturing and assembly in the United States as well as the 51 percent U.S. content threshold still apply. Products and services provided by foreign subsidiaries of U.S. prime contractors, including those in Canada, do not qualify as U.S. content.[117]

As a result of these limitations, it is difficult for Canadian companies to operate in support of the U.S. FMS system. These challenges can be overcome where close cross-border relationships exist. Having a U.S. parent company, U.S. subsidiary, or other cross-border industrial partnership arrangement appeared necessary. Additionally, CSIS found that, except in those limited cases of long-established cross-border relationships (e.g., LAVs), there did not appear to be a larger DoD strategy for U.S.-Canadian cooperation to enhance equipment support to partners.

6.2.3 National Security/Foreign Disclosure

Classification and foreign disclosure policy were also raised as areas that pose challenges to cross-border cooperation, particularly in sectors or technologies considered vital to U.S. national security interests. The United States has historically considered defense technology to be a "valuable, limited national security resource"[118] and has established various policies and regulations to protect it. Under U.S. National Disclosure Policy-1, it is DoD policy that "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."[119] Exceptions to policy, as well as planning and procedures for disclosure of classified military information, are strictly controlled and overseen by the National Military Information Disclosure Policy Committee (NDPC), in accordance with DoD Directive 5230.11.

To facilitate the exchange of information and material while safeguarding protected and classified military information, the United States and Canada have negotiated numerous bilateral agreements establishing common industrial security procedures and technology controls, dating back to 1952.[120] In accordance with these agreements, the Canadian government assists defense contractors, under its Contract Security Program, in establishing the standards required to obtain personnel and facility clearances for protected and classified material and information, which facilitates bidding on Canadian, NATO, and other foreign classified contracts.[121] Almost all of the companies interviewed for this study had performed classified work for DoD under these arrangements. While a separate 30- to 90-day approval process is required for Canadian firms to access U.S. classified information, including

[117] Defense Security Cooperation Agency, "Guidelines for Foreign Military Financing of Direct Commercial Contracts," August 2009, http://www.dsca.mil/sites/default/files/2009_guidelines_for_fmf_of_dccs_0.pdf.
[118] See Department of Defense, Directive 2040.2—"International Transfers of Technology, Goods, and Services, and Munitions," January 1984, http://www.dtic.mil/whs/directives/corres/pdf/204002_2014.pdf.
[119] See Department of Defense, Directive 5230.11—"Disclosure of Classified Military Information to Foreign Governments and International Organizations," June 1992, http://www.dtic.mil/whs/directives/corres/pdf/523011p.pdf.
[120] Public Works and Government Services Canada, "Joint Certification Program," March 2016, http://iss-ssi.pwgsc-tpsgc.gc.ca/msi-ism/ch10-eng.html.
[121] Public Works and Government Services Canada, "Handling and Safeguarding of Classified and Protected Information and Assets," March 2016, http://iss-ssi.pwgsc-tpsgc.gc.ca/msi-ism/ch5-eng.html.

classified annexes of contract solicitations and facilities, no company reported issues with gaining access so long as they were cleared at the appropriate level by the Canadian government. U.S. OEM facilities, on the other hand, were much harder to access and were more variable in reciprocity of security clearances.

Notwithstanding U.S.-Canadian security agreements, the United States restricts access to its most sensitive defense programs by classifying information with national caveats—that is, "NOFORN" or "U.S.-only." NOFORN restrictions are also sometimes applied by default to less sensitive programs. U.S. government officials cited that discrepancy as an area where contracting officer education was needed and a challenge that could be overcome on a case-by-case basis. Of the Canadian firms interviewed, those operating in air and space sectors appeared most impacted by sensitivity-driven caveats, including programs where there is ongoing U.S.-Canadian military-to-military cooperation. Fortunately, there has been some progress in this arena, where interviews reported that a program that was previously classified U.S.-only was declassified and an obstacle to closer cooperation thus removed.

National caveats for sensitive technologies and programs also impacted access to contract solicitations in areas where Canadian industry was already performing work for DoD. The F/A-18 depot-level maintenance case best illustrates this point. 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. This case also demonstrates the challenges encountered by Canadian firms that support components or subsystems of U.S. weapons systems that are restricted at the platform level due to classification.

To help address some of these difficulties, Canadian firms, particularly those operating in sensitive technology areas, will establish U.S.-based operations, either through a local subsidiary, business unit, or contractor footprint. Establishing a U.S. subsidiary has allowed some Canadian firms to leverage U.S.-based operations to gain access to U.S.-only contracts while leveraging Canadian-based technology to perform the work. However, in this latter case, the proxy arrangements under which U.S. subsidiaries operate, in accordance with U.S. Foreign Ownership, Control, or Influence (FOCI) mitigation instruments, can negatively impact company operations.[122] In one case, a Canadian-owned U.S. subsidiary converted from a Special Security Agreement, where the company board consists of both local U.S. and parent company members, to a Proxy Agreement, which expands access to classified work but operates under a U.S.-only, U.S. government-approved board. In this case, 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.

6.2.4 Cultural Barriers

A theme consistent across all interviews was the challenge posed by skepticism by default and inertia. Even though Canada is defined as part of the U.S. national technology and

[122] U.S. Department of Defense, Defense Security Service, "FOCI Mitigation Instruments," http://www.dss.mil/isp/foci/foci_mitigation.html.

industrial base, Canada is still considered a "foreign source." As such, Canadian firms have to incrementally build trust and confidence with U.S. service components when there is not already a government-level joint development project to facilitate cooperation or where longstanding relationships don't already exist as a result of prior joint development initiatives.

As a result of this dynamic, accessing the DoD market at the prime contract level can be challenging. Canadian firms often enter the DoD market first as a subcontractor, and even after demonstrating its expertise in a technology or industrial area, may remain as a subcontractor to maintain the bidding advantage of having a U.S. firm as the prime. 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.

The case studies clearly demonstrated this dynamic across all five domain areas. In one case, a joint venture with a major U.S. company was necessary to win a large production contract, and even after the joint venture ended, cross-border cooperation was enabled by a U.S. parent company and U.S.-based facilities. In another case, engineering know-how and industrial capacity could best be leveraged once its U.S. sister division was established as the prime. In a third case, working through a U.S. subsidiary became necessary, even after decades of U.S.-Canadian cooperation in the domain in question, in order to facilitate DoD access to advanced technology. Likewise, when dealing with services and subsystems, despite having demonstrated comparative advantage in the commercial market for their technology areas, only after vendors establishing U.S.-based parent or subsidiary company arrangements were their products and services broadly integrated with U.S. systems.

While these challenges were universal, the CSIS study team noted that they seemed most pronounced for service-related industries. 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.

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 competition where the incentive structure is perverse, for example, when a supplier brings a product or engineering solution that eats into the OEM's allowable costs. Both the F/A-18 Hornet and sensor case

studies highlight this dynamic. In the F/A-18 case, a Canadian firm had identified a cost-saving engineering alternative to the previous practice of parts replacement. In the sensor case, a Canadian firm had developed a product that integrated multiple capabilities previously sold as separate products, in effect streamlining systems and reducing costs. In these instances, there is not a formal government or institutional "barrier" per se, but rather a bias in the acquisition process that can limit opportunities and competition.

These challenges, when combined with the fact that Canadian industrial capability often needs to be test driven before being able to compete with long-established incumbents, can create a tough market environment and challenges for entry and access. From an incentives perspective, the cultural bias also creates additional risk. A company may engage in development work with U.S. industry or directly with the U.S. government in order to share unique technology or capability, but ultimately may face an environment where it cannot win awards in the production phase as a result of preference for U.S. sources.

6.2.5 Institutional Barriers

As discussed in the Chapter 2, while the bilateral industrial relationship has been remarkably adaptable, resilient, and cooperative, inconsistency in implementation has always been a recurring feature of cross-border defense economic integration. Consistent with this theme, interviewees raised various issues associated with lack of awareness or alternative interpretations of bilateral agreements, as well as variances in standards that created challenges or delays.

Industry reported mixed experiences with the U.S. procurement system based on varying interpretations of or levels of familiarity with U.S.-Canadian bilateral agreements and associated provisions in the U.S. Federal Defense Acquisition Regulations. As discussed in Annex A: Literature Review, these agreements cover and aim to facilitate a broad range of activities from R&D and precertified exchange of unclassified technical data, to production and testing and evaluation. One interview with industry illustrated the importance of this familiarity. The interviewees never had a concern or issue being a Canadian firm. U.S. contract officers seemed generally in tune with bilateral agreements, and competitions were technical "bake-offs" focused on which solutions best meet technical requirements in an RFP at the lowest price. However, they were nervous moving forward because they noticed a shift in recent years where U.S. counterparts seem less aware of bilateral agreements, perhaps due to high turnover in contracting office personnel. They suspected that the cause might be a decline in training at contract commands on how to do business with Canada. The practical effect of these changes is that the contractor needs to request CCC and the U.S. Defense Contract Management Agency's involvement more often to ensure contracting officers are aware of rules and agreements.

Unfamiliarity with agreements appeared most prevalent in cases of new programs or program offices and contract officers that had little prior work with Canadian industry. 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.

According to the interviews, most of the issues cited were ultimately surmountable after adjudication by CCC or U.S. Defense Contract Management Agency and created only delays. The U.S. Defense Acquisition University offers training modules to procurement officials on the carve-outs made for Canada, but CSIS was unable to determine how often this training is given. Additionally, there is department-wide policy guidance—DoD Instruction 2035.01 "Defense Economic Cooperation with Canada"—that reinforces DoD policy and applicability of U.S.-Canadian bilateral arrangements, but how widely it got circulated was unclear, particularly at the service component level.

While the instruction may not be widely known, it received a recent endorsement from the House of Representatives Committee on Armed Services. The Fiscal Year 2016 National Defense Authorization Act committee report highlighted the importance of "a cost-effective, healthy [defense industrial] base that is responsive to U.S. military requirements is essential to achieving U.S. national security objectives." Given the volume of U.S.-Canadian trade, shared interest in continental defense, and status as the only two North American members of NATO, the committee expressed its support for "the strong, integrated, and widely dispersed industrial base in North America reflecting the economical use of research, development, and production resources, as laid out in the Department of Defense Instruction 2035.01."[123]

Interestingly, issues of unfamiliarity with bilateral agreements and programs were not limited to government officials. Industry also appeared to have variable knowledge and understanding of the agreements and pre-vetting programs. 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.

[123] House Armed Services Committee, Report 114-102, committee report together with dissenting reviews to accompany the National Defense Authorization Act for Fiscal Year 2016 (H.R. 1735), May 5, 2015, 175, https://www.congress.gov/congressional-report/114th-congress/house-report/102/1.

7 Recommendations

CSIS drew on the findings from the case studies, interviews, and workshops, supplemented by the broader data and literature review, devise the recommendations listed below. They are grouped in three categories based on the relevant actors and subject matter:

- High-level Government-to-Government Initiatives
- Export Control and Acquisition Regulations
- Agreements/Institutions

7.1 High-level Government-to-Government Initiatives

The first category focuses on areas where broader strategic guidance is paramount. While economic and efficiency considerations are significant benefits of bilateral U.S.-Canadian defense industrial cooperation, the cornerstone of the relationship remains the totality of overlapping strategic interests and priorities. One pattern shown throughout this report is that cooperation efforts: (1) are often driven by a clear operational need and then (2) build upon past success. Cultural and institutional barriers, as addressed in Sections 6.2.4 and 6.2.5, channel most cooperative efforts into areas in which there has been past success or in which an overwhelming need has been demonstrated. The bottom-up foundation of experienced contracting officers and established relationships are key to the sustainability of industrial cooperation. However, at regular intervals, top-down identification of focus areas is necessary to keep cooperation forward looking and address emerging opportunities and threats.

With recent changes of political leadership in both the United States and Canada, this is natural time to look at the common interests of the two countries and plan next steps. To assist in that effort, CSIS has identified three areas where government-to-government cooperative efforts directly support national security priorities and also take advantage of the comparative industrial advantages of the two nations.

Recommendation 1: The CSIS study team recommends DoD and DND seek to intensify and formalize government-to-government cooperation on the following potential initiatives:

- **Recommendation 1A: Enhancing RDT&E Cooperation in the Arctic Region**

North America's northern border, the Arctic, has long been an area of concern to both countries, whether related to Cold War concerns or the impact of climate change on the region's geography. More recently, the U.S. Congress demonstrated renewed interest in this area by mandating in the National Defense Authorization Act for Fiscal Year 2016 that the

secretary of defense develop a new strategy to respond to Russia's growing presence in the Arctic.[124]

Canada's specialization in cold weather technologies comes as no surprise and applies across multiple domains. The United States and Canada should therefore explore possible areas for RDT&E collaboration, including but not limited to developing and testing communications, maritime navigation, patrol aircraft, unmanned underwater surveillance, and other cold weather technologies.

As addressed in Section 4.2.4, both Canada and the United States have taken steps to protect the capabilities and capacities of their domestic shipyards, but the impact of the operating environment (e.g., effect of cold temperatures on batteries) means that collaboration and cooperation touches not just on platforms like icebreakers but also on systems, subsystems, and emerging technologies like underwater drones.

- Recommendation 1B: Prioritizing air and missile defense, maritime domain awareness, and cybersecurity capability development and equipment modernization efforts

Defense of the continent using cutting-edge technology has continued to be a priority for both the United States and Canada. For example, the case studies on air (Section 5.1.1) and C4ISR (Section 5.1.3) both speak to the importance of NORAD in developing technologies in these sectors. The importance of these areas goes beyond the changing Arctic environment. Both the United States and Canada have major procurement decisions coming up, and effective collaboration can provide systems that could be more than the sum of their parts.

Specifically, funding decisions impacting the North Warning System, the next-generation Sapphire satellite, and the new Canadian surface combatants are all on the horizon. These programs offer opportunities for RDT&E cooperation and enhanced interoperability between the United States and Canada. In parallel, the NORAD Next effort offers the two governments a significant opportunity to reexamine military-to-military cooperation in maritime and cyber domains. Even though several of these areas have existing institutions and proven results, high-level attention would result in great benefit. As addressed in Sections 6.2.2 and 6.2.3, many high-technology domain areas are subject to higher barriers to entry (e.g., export controls, "no foreign" disclosure restrictions). These technologies can indeed be sensitive, but at the same time, the quality and interoperability of sensors in Canada is vital for early warning in the United States.

- Recommendation 1C: Accelerating and aligning innovation initiatives

Looking further ahead, how the United States and Canada can most effectively align their efforts across a range of next-generation investments is part of a larger question confronting both nations on innovation. The Third Offset strategy was the Obama administration's

[124] Office of the Under Secretary of Defense (Policy), "Report to Congress on Strategy to Protect United States National Security Interests in the Arctic Region," 2016, https://www.csis.org/events/defense-arctic-assessing-us-security-concerns.

approach to innovation, led by U.S. Deputy Secretary for Defense Robert Work. The impulse driving the strategy was summarized in a recent CSIS report:

> Technological superiority has been a foundation of U.S. military dominance for decades. However, the assumption of U.S. technological superiority as the status quo has been challenged in recent years as near-peer competitors have sought a variety of asymmetric capabilities to counter the overwhelming conventional military advantages possessed by the United States. As Deputy Secretary Work stated in the opening plenary session, while previous technological advantages gained by the United States have endured for significant periods, the pace of technological innovation, and the pace at which new technology diffuses across the world, means that most new technological advances will provide DoD with only a temporary advantage, assumed to be no more than five years.[125]

While the strategy's name or focus areas may change, Deputy Secretary Work's continuation in that position suggests that DoD's focus on innovation will likely continue in one form or another in the future. To help highlight possible areas for collaboration, the United States and Canada should conduct a comparative assessment on relevant technologies to allow for more explicit guidance and identified areas and communities of interest.

Of course, the challenges and emerging threats that are the focus of this approach include some topics already discussed. When looking at countries—such as Russia and China—that the United States may consider to be "near-peer," the issues of Arctic security, maritime security/domain awareness, and European security come to the fore. When considering Iran and North Korea, countering intercontinental ballistic and cruise missiles are areas of shared concern. Finally, across the board, cybersecurity is a subject of considerable interest. With regard to North America, these technologies could be applied to existing capability gaps, such as High North sensors, communications, navigation systems, and infrastructure.

The Third Offset strategy is already a high-level government initiative, but follow-through is critical to its success. A key challenge of the strategy is the limitation on DoD's ability "to find and acquire new and innovative capabilities from the commercial sector, either domestically or internationally." [126] In Canada's case, the entire range of limitations discussed in Section 6.2 is relevant, but it may be worth giving extra attention to the limitations facing small businesses discussed in Section 6.2.1. Smaller, agile, commercial firms may be the source of DoD's next big technology needs. However, in the United States, most of the programs targeted at smaller entities do not extend to the entire national technology and industrial base. DND may find it easier to access those technologies but, given classifications involved, may not have a clear idea as to what is most of interest to the United States. A sense of common goals, in addition to targeted innovation initiatives, would be vital in light of the existing barriers to cooperation.

[125] Kathleen Hicks, Andrew Hunter, Jesse Ellman, Lisa Samp, and Gabriel Coll, *Assessing the Third Offset Strategy* (Washington, DC: CSIS, March 2017), 1, https://www.csis.org/analysis/assessing-third-offset-strategy.
[126] Ibid., 6.

7.2 Export Control and Acquisition Regulations

The next set of recommendations focus on regulations, the agencies charged with implementing them and in some cases the legal statues that mandate them. Recommendation 2 focuses companies that currently have a minimal presence among the Canadian vendors selling to the United States. As Section 6.2.1 discussed, the market many of these vendors might hope to address may be inaccessible to them, because it is highly targeted toward the U.S. companies that the U.S. Small Business Administration can categorize as small businesses. That legal distinction is unlikely to change, but there may be other means for DoD to gain more reliable institutionalized access to these companies.

Recommendation 2: The CSIS study team recommends DoD revise its acquisition regulations to improve and institutionalize small business and nontraditional supplier access mechanisms for Canadian industry, including by:

- **Recommendation 2A: Specifying eligibility in DFARs of Other Transaction Authority (OTA) agreements to better access the broader national technology and industrial base**

As explained by the U.S. Government Accountability Office, OTAs "allow an agency to enter into agreements other than traditional mechanisms, such as contracts. As a result, agencies can customize their other transaction authority agreements to help meet project requirements and mission needs."[127] OTAs focus on research, development, and demonstration, and DoD has specific authority to use them for prototypes. This mechanism would not bypass all contracting rules, but would make it easier to access commercial sources of new technology, such as those discussed in recommendation 1C. Experience has also shown that agencies use this approach in moderation rather than bypassing traditional contracting when it is inappropriate:

> Compared to traditional mechanisms, most agencies used other transaction authority agreements sparingly, according to officials. Most agencies had a small number of other transaction authority agreements—75 or fewer—in fiscal year 2010, and the number of agreements generally remained low by the end of fiscal year 2014.[128]

Many of the barriers and challenges discussed in Section 6.2 are not statutory but instead undermine the national technology and industrial base due to a lack of familiarity on the part of the contracting officer or because of interaction with other contracting rules).[129] OTAs could be a means of overcoming this challenge by creating preestablished consortiums that can provide access to nontraditional suppliers of research and development and prototypes. This approach builds on the lesson of past success; once the barriers to cooperation have

[127] U.S. Government Accountability Office, "Use of 'Other Transaction' Agreements Limited and Mostly for Development Activities," January 2016, http://www.gao.gov/assets/680/674534.pdf.
[128] Ibid.
[129] Increasing awareness among contracting personnel is discussed in greater detail in recommendation 6B.

been initially overcome, the sustaining cross-border cooperative effort has proven to be a far easier task.

- Recommendation 2B: Extending Small Business Innovation Research to the broader national technology and industrial base (may require legal change)

This approach is a natural follow-on to recommendation 1C because it seeks to overcome an obstacle to DoD gaining access to innovative technologies in other countries. U.S. rules on intellectual property and export controls can create an environment where a company may be hesitant to sell to the U.S. government even when it is allowed to. The Small Business Innovation Research program has had some success as a means of overcoming those concerns.

Recommendation 3 focuses specifically on one of the challenges raised by Section 5.2.2, namely that a range of excluded categories result in the diminishing relevance of Canada's ITAR exception to a range of the priority areas discussed under Recommendation 1.

Recommendation 3: The CSIS study team recommends that the U.S. Department of State, together with DoD and the U.S. Department of Commerce, update export control regulations and rules/procedures for Canada, including but not necessarily limited to:

- Recommendation 3A: Revising the Canadian technology exclusion list for updates, in light of U.S. Export Control Reform and Canadian Controlled Goods Program and Enhanced Security Strategy.

A 2009 U.S. review "determined that the current export control system is overly complicated, contains too many redundancies, and, in trying to protect too much, diminishes our ability to focus our efforts on the most critical national security priorities."[130] In keeping with that finding, in 2010, the Obama administration launched an Export Control Reform Initiative to steadily update, streamline, and standardize export control lists (i.e., the U.S. Munitions List administered by the U.S. Department of State and the U.S. Commerce Control List administered by the U.S. Department of Commerce) in an attempt to put "higher walls" around truly sensitive technologies. That approach of "steady rather than revolutionary" reform has reduced export control caseloads, retained the confidence of Congress, and not required new laws to date. This approach, however, has not addressed Canada's ITAR exception where revisions could be beneficial.

One critical factor for this review are the Canadian Controlled Goods Program and Enhanced Security Strategy, which contain measures to increase U.S. confidence in Canadian export controls, in keeping with the historically reciprocal nature of the national technology and industrial base. One factor that should certainly be considered during such a review is the extent to which steps Canada has already taken address concerns among the relevant U.S. stakeholders for any given control list. Interviews with some U.S. officials also warned that any update to the Canadian technology exclusion could involve stricter controls in certain especially sensitive areas. In those areas where the U.S. export control community is not yet

[130] International Trade Administration, "About Export Control Reform," 2015, http://2016.export.gov/ecr/.

satisfied with Canadian measures, this process could be an opportunity to make suggestions that would further harmonize the two systems.

- **Recommendation 3B: Establishing pre-cleared vetting process for Technical Assistance Agreements (TAAs)/licenses for Canadian registered firms, particularly for those already engaged under program MOUs**

This recommendation gets to the finding in Section 6.2.2, that the two to three months required to achieve a TAA may exclude a Canadian company from a competition. Based on interviews with industry and U.S. government sources, the scope of this problem is bounded. None of the Canadian companies interviewed reported to the study team a case where an inability to get a TAA in a timely manner prevented them from competing directly for a U.S. government contract. The challenge instead for Canadian suppliers is seeking to partner with U.S. prime contractors.

Technical data, when it is not classified or related to an excluded area, is covered under Canada's ITAR exemption. Interviews found that in some cases, primes may set a higher bar than the law requires or intends. The challenge is not evident among U.S. primes motivated to work with a Canadian firm, in those cases the partners have been able to put in the time and effort to make the relationship work. Instead, the challenge is those prime vendors willing to consider Canadians firms, but that lose interest when they encounter barriers to cooperation.

Building on U.S. export control reforms and the CGP to simplify the TAA process could help address this problem. This approach might prove particularly valuable when the challenge is reassuring U.S. primes that working with Canadian firms will not subject them to unacceptable business risk as a result of process hurdles. In addition, when TAAs are required because of a relevant exclusion to the ITAR exemption, pre-clearances given to Canadian firms already engaged under a program MOU would similarly reduce business risks. Once a company is cleared to work with a specific technology in a specific context, expediting similar requests is a practical time-saving measure. As recent export reform efforts in both countries continue to mature, surveying second- and third-tier companies about their difficulties working with U.S. primes for TAA-related reasons can help further address this problem.

7.3 Agreements/Institutions

The final set of recommendations focuses specifically on bilateral agreements and institutions.

Recommendation 4: The CSIS study team recommends DoD and DND modernize its framework agreements, by:

- **Recommendation 4A: Updating and reaffirming the terms of the DDPSA MOU, to include renewing the bilateral security agreement and codifying export control procedures in an annex to the MOU**

- Recommendation 4B: Formalizing an agreement for cooperation on foreign sales, outlining terms and conditions for collaboration in areas that bring mutual benefit (e.g., nonstandard items, life-extension and sun-down plans for global partners using old equipment)

Both recommendations attempt to ensure the applicability of agreements to an evolving, dynamic international security environment. One direct benefit of updating current agreements for both countries would be a simplified process by which the vendors within the national technology and industrial base can partner with one another to sell abroad.

The agreement discussed in recommendation 5B would assist with sales of nonstandard items better suited to smaller militaries. Beyond sales, the agreement would address sustainment of equipment already sold, particularly life-extension and "sun-down" plans (the latter referring to partner militaries using equipment that is no longer produced in the United States). In all of these cases, U.S.-provided equipment is often in demand, but the Canadian industrial base may at times be better suited to providing smaller quantities or to extending the life of legacy equipment. Finding ways to support other countries, even as the United States and Canada stop using a platform, requires identifying sources and alternative approaches. Better service to this niche market is mutually beneficial for the United States and Canada, but requires advanced planning.

This area is also one in which the Canadian Commercial Corporation (CCC) may be well-suited to support efforts. CCC has worked with U.S. government agencies, to include the Defense Security Cooperation Agency, to facilitate contracts between Canadian firms and the U.S. DoD and as a government-to-government mediator for standards and guarantor for quality, price, and delivery. CCC could assist in creating value within foreign sales markets in which Canadian companies can provide equipment and services.

Recommendation 5: The CSIS study team recommends DoD and DND reinvigorate existing institutions, by:

Recommendation 5A: Strengthening the connection between the agenda at NATIBO and high-value initiatives identified by DoD leadership in order to promote national technology and industrial base-wide access to technology interchange/exchange through mutual communities of interest.

This recommendation gets to the core strength of having a national technology and industrial base: ensuring the sharing of technology and industrial capacity between the United States and Canada in areas where this cooperation truly matters. At times, as covered in Section 6.2.5, the failure to provide adequate access to information about capability gaps and industrial shortfalls has proven an obstacle to cooperation. The study team's interviews found examples of the benefit this sort of information sharing can provide. For example, in one case where a Canadian firm was providing services as part of a pool of competitors, all participants shared among themselves new approaches to a common problem. As a result, including a Canadian firm in the process meant that the U.S. depots became better at performing their jobs. This level of coordination is most important when applied to high-value proposition initiatives identified by DoD leadership potentially including those identified

in recommendation 1. By identifying these high-level initiatives, DoD leadership may both set an agenda that sets priorities for proactive steps that could be undertaken by the North American Technology and Industrial Base Organization (NATIBO) in addition to the role of responding to implementation challenges. It can also help other DoD stakeholders build relevant communities of interest around these priorities. The Canadian government can contribute both to collaborating with priority setting discussions and by encouraging participation in communities of interest. In addition, in both countries, priority setting also has the potential to serve as a guide for what parts of the industry and the acquisition community should be targeted for raising awareness.

- Recommendation 5B: Improving awareness of key industrial capabilities (product and service support) and small business clusters among technology and procurement officials in the NTIB through proactive dissemination of this information coordinated by NATIBO.

Smaller businesses are a great source of innovation but have a harder time working across borders, particularly given U.S.-only small business set-asides. The United States, Canada, and prime contractors from both countries could benefit from being more aware of small business capabilities and clusters in the NTIB, such as those identified in the sector case studies in Chapter 5. NATIBO can undertake some of this information sharing directly in cooperation with its partners on both sides of the border. One possible additional avenue for awareness raising would be the Defense Acquisition University, which is a key educational institution for U.S. contracting officers and already has an online course on doing business with Canada. Further courses may also prove valuable as well as incorporation of information about the NTIB and key industrial sectors where relevant in existing required coursework. On the Canadian side of the border, while key industrial capabilities are well understood, promoting use of cross-border small business clusters may aid in identifying sources of innovation that may go overlooked when possessed by a small or medium enterprise on the other side of the boarder.

Recommendation 6: The CSIS study team recommends DoD or DND make better use of existing tools, by:

- Recommendation 6A: Improving awareness and understanding in DoD program offices and among contract officers of framework agreements and of existing eligible instruments to promote collaboration, including Other Transaction Authority (OTA) agreements and the Rapid Innovation Fund, as part of broader innovation initiatives in both nations.

Interviews found that often contracting officers were simply unaware of tools available to them, even when they sought to take advantage of firms in the NTIB. The simplest step in this process is not to apply the "No Foreign" restriction when it is not necessary or appropriate. Recommendation 2A suggests specifying in regulations that OTAs are eligible for use with the NTIB. OTAs already have more entries on the DAU website than does the NTIB. This disparity in references suggests that while a new course on the NTIB may be helpful, awareness raising could be served by integrating references and instructions relating to the NTIB into existing DAU curriculum. That said, the limited usage of OTAs in the DoD writ large

suggests that raising awareness may not be sufficient and that contracting offers need a better understanding of how to use these tools with the NTIB. Fortunately, fostering a higher level of awareness and understanding of the NTIB is relevant not just to high-level government-to-government initiatives, but also to efforts to encourage innovation coming out of both DoD leadership and Congress discussed in recommendation 1C.

- **Recommendation 6B: Leveraging OTAs to form consortiums (inclusive of U.S. and Canadian industry) in priority mutual communities of interest and to better access small business and nontraditional suppliers.**

Consortiums are already an effective approach used in the United States to allow a variety of different specialty vendors to overcome barriers to entry to sell to the U.S. government. The U.S. Army and DARPA house DoD's most extensive repositories of expertise on OTAs and would be logical partners for working with counterparts in DND to develop and expand such consortiums. Creating multinational consortiums is an opportunity for both the United States and Canada. As was covered in recommendation 1C, both countries have an interest in innovation initiatives to ensure access to technology from small businesses and nontraditional suppliers. Interviews have shown that Canadian firms often find it challenging to partner with U.S. small businesses, which suggests that even if regulatory barriers are lowered, practical impediments to cooperation may persist. Pathways provided by consortiums can greatly facilitate cooperation in such instances.

7.4 Final Thoughts

In conclusion, each of these three sections of recommendations has a different but ultimately complementary area of focus. The recommendations in Section 7.1: High-level Government-to-Government Initiatives cover areas of interest to both countries, but as is shown by recommendation 1C's reference to the Third Offset Strategy, the market power of the United States often means that collaboration is framed by finding common interest within larger U.S. endeavors. By comparison, the recommendations in Section 6.2: Export Control and Acquisition Regulations focus on the U.S. system because in no small part, both interviews and the research shown in Sections 4.2 and 6.1.2 show that with the case study areas, the Canadian system has already enabled significant sales from U.S. vendors. Instead, as the Canadian CGP and ESS show, the iterative process of updating Canadian export control restrictions is often driven by harmonization with the U.S. system and reciprocity rather than the lower barriers and higher walls on the U.S. side.

Finally, in Section 7.3: Agreements/Institutions the study provides recommendations for both sides on how, at the tactical level, the national technology and industrial base could be more effectively employed with special regard to parts of the industrial base that may be overlooked in the partner country. The national technology and industrial base is not a symmetrical partnership. The United States has a greater ability to set the demand and sell the goods of its primes, while Canada has a comparative advantage in systems and subsystems and benefits from being part of a much larger industrial base. As shown in Section 6.1, this asymmetrical relationship has nonetheless been balanced and mutually beneficial for both nations.

Annex A: Literature Review

The United States and Canada share a long history of economic relations and a volume of cross-border trade, in goods and technology, unmatched by any other two trading partners in the world.[131] Despite this, and the fact that it has been 75 years since the first formalized defense industrial agreement between the United States and Canada, literature addressing the topic remains relatively sparse. The relative lack of literature is in some ways a reflection of the ad hoc nature of U.S.-Canada defense industrial cooperation. Much of the progression in U.S.-Canada defense industrial cooperation occurred outside of the public eye at a bureaucratic versus treaty level. Consequently, there is not a wide array of literature and much of what is available is focused on specific subsets of issues, or offers a broad historical overview with little critical analysis.

Yet, in viewing the literature as a whole it is possible to identify certain themes, trends, and critical milestones in the evolution of the U.S.-Canada defense industrial base. Ultimately, the available literature depicts that the joint U.S.-Canada defense industrial base has been built incrementally and largely on an ad hoc, informal, and reactive basis. Success of integration efforts often fluctuated in effectiveness depending on domestic politics and the imminence of military threats or operational needs. Still, despite fluctuations and at times differing strategic calculations or policies in Washington and Ottawa, the U.S.-Canada defense relationship, and associated cross-border industrial ties, has shown remarkable resilience and adaptability as a result of strong mil-to-mil cooperation and shared national goodwill and desire for cooperation.

Origins and Evolution of U.S.-Canadian Defense Industrial Cooperation (1940–2000)

According to existing literature on the evolution of U.S.-Canadian industrial cooperation, the institutional framework that enables that cooperation was built and modified over the course of almost six decades. Milestones in that evolution were largely driven by world events and economic circumstances that gradually compelled the United States and Canada to pursue policies of closer cooperation and integration. The following section reviews those milestones and places them in historical context in order to make explicit the original intent and purpose of the framework.

World War II: Laying Foundation for Defense Cooperation and Industrial Base Integration

U.S.-Canada defense cooperation and industrial integration originated in the World War II period, a context that drove the United States and Canada to view their military and economic interests as closely linked. The issuance of two declarations within one year, while

[131] Jonathan T. Fried, "The Impact of U.S. Export Controls on Trade between Canada and the United States," *Canada-United States Law Journal* 11 (January 1986): 185.

initially serving an immediate wartime need, signaled broader shifts in the two nations' relationship that would lay the foundation for the close military and industrial cooperation that exists today.

In August 1940, amid German air bombardment of the United Kingdom, Canadian Prime Minister Mackenzie King and American President Franklin Roosevelt met in Ogdensburg, New York, to discuss concern over the struggling war effort and its implications for the defense of North America. The resulting Ogdensburg Declaration formed the basis for mutual commitments toward the common defense of North America. It recognized the need for closer military ties and joint planning orchestrated through the Permanent Joint Board on Defense (PJBD).[132] To date, the PJBD serves as the primary high-level bilateral forum to ensure coordination in defense planning for North America. Although only an informal executive agreement, the Ogdensburg Agreement had substantial political significance for the future of U.S.-Canada defense relations. Alistair Edgar and David Haglund state, "…for Canada, it was a recognition that this country was part of North America, with vital interests linked to continental defence and cooperation with Washington; for the United States, it marked an awareness of Canada's importance as an element in continental military and industrial preparedness."[133]

Furthermore, it represented a fairly significant policy shift vis-à-vis traditional alliances. Despite robust economic ties with the United States, Canada—as a dominion of the United Kingdom—had before World War II relied predominantly on the UK for defense collaboration. Defense ties between the United States and Canada were so limited up to that point that Stanley Dziuban noted, "As late as the beginning of 1940, with World War II several months old, military liaison between Canada and the United States was so scant that they had not even exchanged service attaches."[134] Effectively, the Ogdensburg Agreement marked the U.S. rejection of isolationism and Canada's shift toward the United States as a principal alliance for national defense. Dziuban noted the foundational nature of the agreement as it established "the spirit under which virtually all other security treaties, executive agreements, various understandings, and cooperation relative to or affecting North American security are authorized."[135] The changing political circumstances brought forward by the Ogdensburg Agreement, therefore, set the groundwork for the United States and Canada to move forward on defense industrial mobilization and integration.

The first agreement on defense industrial cooperation quickly followed in form of the Hyde Park Declaration in 1941. In his essay "The Road from Hyde Park," Dan Middlemiss states the Declaration "was the logical economic corollary to Ogdensburg."[136] The most immediate

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[132] John Herd Thompson and Stephen J. Randall, *Canada and the United States: Ambivalent Allies* (Athens: University of Georgia Press, 2002), 152–153.
[133] Alistair D. Edgar and David G. Haglund, *Canadian Defence Industry in the New Global Environment* (Montreal: McGill-Queen's University Press, 1995), 62.
[134] Ibid., vii.
[135] Ibid., 3.
[136] Dan Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," in *Fifty Years of Canada-United States Defense Cooperation: The Road from Ogdensburg*, ed. Joel J. Sokolsky and Joseph T. Jockel (Lewiston, NY: Edwin Mellen Press, 1992), 175–206.

need for the agreement was Canada's balance-of-payments crisis that had resulted from a trade imbalance with the UK and other European partners. This deficit was exacerbated by the U.S. Lend-Lease Act with the UK, which allowed for the provision of war materials to allied countries on loan or credit.[137] Under the declaration, the United States would purchase $200–300 million of defense articles from Canada, and Canadian purchases of components from the United States would be integrated into finished goods provided to the UK under the Lend-Lease Act. In effect, the United States and Canada recognized the inherent link between national security and economic security and the collective benefit of working together to secure both.[138]

More broadly, the Hyde Park Declaration called for joint mobilization and coordination of strategic materials and war production to enhance productivity and efficiency, both for the defense of North America and to aid the UK and allied partners. As with the Ogdensburg Agreement, it promoted and recognized the mutual benefit of an integrated continental, vice national, approach supporting "a general principle that in mobilizing the resources of this continent each country should provide the other with the defense articles which it is best able to produce, and, above all, produce quickly, and the production programmes should be coordinated to this end."[139] This principle would establish precedent for future defense economic cooperation and integration on the basis of "complementarity, competitive advantage, and specialization."[140] The Hyde Park Declaration represented, therefore, a fundamental shift in U.S.-Canada defense industrial cooperation relations, acknowledging a shared interest in the joint mobilization of resources in support of mutual interests, leveraging the respective strengths of each country.

As a result of this agreement, and once the United States entered the war in December 1941, the two economies would become enmeshed as legislative and administrative barriers in both countries were relaxed to allow the license and permit free flow of goods.[141] Trade grew exponentially, reaching "nearly $4 billion (US) between 1941 and 1945."[142] This increased defense trade enabled Canada to rebuild and further develop the "nucleus" of defense industry capability to meet Canadian, U.S., and UK defense requirements.[143]

An additional corollary benefit of this agreement were the cross-border bureaucratic and political relationships that developed and evolved, in a somewhat ad hoc manner, during implementation of joint planning and production. Middlemiss notes that the Hyde Park Declaration "established the basic pattern of bilateral interaction on these matters which would characterize this relationship in the future," and while it "provided no machinery for its

[137] Thompson and Randall, *Canada and the United States*, 155.
[138] Lawrence Aronsen, *American National Security and Economic Relations with Canada, 1945–1954* (Westport, CT: Praeger Publishers, 1997), 17.
[139] W. L. Mackenzie King, "The Hyde Park Declaration: Cooperation in Economic Defense" (Ottawa: Director of Public Information, 1941), 9, http://wartimecanada.ca/document/world-war-ii/economy-and-trade/hyde-park-declaration-statement-william-lyon-mackenzie-king.
[140] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," OTA-ISC-500 (Washington, DC: U.S. Government Printing Office, July 1991), 108.
[141] Fried, "The Impact of U.S. Export Controls on Trade between Canada and the United States," 189–190.
[142] Thompson and Randall, *Canada and the United States*, 169.
[143] Middlemiss, "The Road from Hyde Park," 178.

implementation," it succeeded through "close cooperation, goodwill, and problem-solving ingenuity of administrative officials . . . on both sides of the border."[144] While much of the wartime committees would later be disbanded, the linkages built in this collaborative environment would endure, permitting reestablishment of similar structures in the near future.[145]

Thus, the World War II period and two foundational bilateral agreements signed during this timeframe "laid the foundation for joint defense planning and implementation that continued in the following years . . . and created the realization within the publics of both the United States and Canada that in matters of defense, the common border joined, rather than separated, their two nations; never again could either nation pursue entirely independent defense policies."[146] Still, as World War II drew to a close, there was very little in terms of a binding framework to ensure cooperation would continue. Much of the support for the continental framework had been couched in terms of defeating "the worst threat ever faced by Western civilization."[147] The interwar period and onset of Cold War relations, however, would ultimately transform these bilateral arrangements set up for wartime purposes into a more enduring framework.

Post–World War II/Early Cold War Period: Formalizing a New Framework

The immediate decrease in defense industrial cooperation at the end of World War II raised concerns as to how permanent the wartime agreements would be. Middlemiss states, "urgency gave way to war-weariness, joint agencies were disbanded, and the key administrative personnel were dispersed; as a result, the will to continue this collaborative approach to defense economic matters eroded."[148] This marked an initial indication that U.S.-Canadian defense industrial cooperation would ebb and flow in response to the presence of a military threat, a trend that does bear some evidence in the following decades. Ultimately, however, incremental steps were taken over a six-year period to formalize the framework laid out in both agreements.

The postwar environment created a favorable setting for an extension of the principles contained in these agreements. The geopolitical context had changed, and the United States and Canada "shared a strong new commitment to internationalism, a stable world order, and the economic restructuring and collective security that were essential to this new international order."[149] Both countries were involved in building the international organizations (e.g., UN, NATO, International Monetary Fund, World Trade Organization) that would promote multilateralism and the stabilization of the global economy.[150] Further, growing East/West tensions heightened U.S. interest in accelerating allied economic recovery

[144] Ibid., 177.
[145] Thompson and Randall, *Canada and the United States*, 170.
[146] Douglas J. Murray, "Canada," in *The Defense Policies of Nations: A Comparative Study*, 3rd ed., ed. Douglas J. Murray and Paul R. Viotti (Baltimore, MD: Johns Hopkins University Press, 1994), 58–93.
[147] Thompson and Randall, *Canada and the United States*, 172.
[148] Middlemiss, "The Road from Hyde Park," 179.
[149] Thompson and Randall, *Canada and the United States*, 179.
[150] Aronsen, *American National Security and Economic Relations with Canada, 1945–1954,* 17.

and in improving continental planning and preparedness. Canada, likewise, viewed collaboration and reciprocal defense procurement with the United States as critical for continental defense and avoiding the equipment and foreign exchange difficulties experienced in World War II.[151]

In this context, the United States and Canada released a Joint Statement on Defense Cooperation in 1947 reaffirming the Ogdensburg Agreement and "reiterating that the wartime cooperation between the armed forces of the two countries should continue to the extent authorized by law through the postwar period in the interest of efficiency and economy for joint security."[152] At the time, the Truman administration was pressing hard on Prime Minister Mackenzie King to expand joint training, basing in Canadian territory and standardization of arms and equipment.[153] The Military Cooperative Committee, recently formed to link U.S. and Canadian military staffs, began joint planning to improve continental air defense, but it would be 10 years before the United States and Canada would sign the North American Air Defense Agreement (NORAD).[154]

Despite shared acknowledgement of the continued importance of joint defense cooperation, defense economic integration did lapse for a period. Continuation of Hyde Park principles met initial resistance, particularly in the U.S. Congress. Postwar demobilization and declining defense budgets returned both countries to favoring domestic industries and protectionist policies. The U.S. Department of Defense preserved some allowances; as Crosby notes, "…the Pentagon, recognizing the strategic benefits of integrating defense planning with defense production, acted on its own to improve Canada's access to the U.S. market. The U.S. Air Force, for example, exempted Canada from the Buy American Act in its procurement plans."[155] However, broader political support would not materialize until the need for economic integration was placed in the context of a foreign policy strategy to counter the Soviet threat by building up mutual defenses of the "free world" and to better enable mobilization and preparedness.

The Truman administration's 1948 Marshall Plan initiated momentum to reintegrate economically, as the case was made to Congress that the United States should purchase needed commodities from foreign markets when not "readily available" in the United States; "the real benefit, it was noted, was that such purchases would strengthen the supplier's economy, which would then have an overall positive effect on the world economy."[156] The same rationale was used to defend reciprocal defense procurement with Canada, together with an argument for working "towards common equipment, structures, and doctrine."[157] By

[151] Middlemiss, "The Road from Hyde Park," 179.
[152] U.S. General Accounting Office, "Defense Trade: Lessons to be Learned from the Country Export Exemption," Report to the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate, March 2002, 19, http://www.gao.gov/assets/240/234158.pdf.
[153] Thompson and Randall, *Canada and the United States*, 182.
[154] Ann Denholm Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96* (New York: St. Martin's Press, 1998), 23–25.
[155] Ibid., 109–110.
[156] Randall Wakelam, *Cold War Fighters: Canadian Aircraft Procurement, 1945–54* (Vancouver: UBC Press, 2011), 9.
[157] Ibid., 10.

1949, the Permanent Joint Board on Defence (PJBD) initiated a "mutual procurement program"[158] that reinforced Hyde Park principles by promoting a "dispersal of North American industrial capacity to reduce vulnerability," some specialization in production and standardization in equipment, and a balance in defense trade.[159] During this period, the United States also renewed its interest in ensuring access to strategic resources in Canada for U.S. stockpiling and rearmament.[160] Joint planning for industrial preparedness was reestablished under the Joint Industrial Mobilization Planning Committee in 1949, which "provided a link between the U.S. National Security Resources Board and Munitions Board and the Canadian Industrial Defence Board."[161]

Ultimately, the start of the Korean War in 1950 provided the final impetus to formalize U.S.-Canadian defense industrial integration. As with World War II, rapid industrial mobilization and rearmament drove increased defense economic cooperation. Again, there was general consensus that the United States and Canada needed a "coordinated program of requirements, production, procurement, distribution and other controls, and exchange of technical knowledge."[162] That same year, the United States and Canada gave "formal effect" to the Hyde Park principles in an exchange of notes titled the "Statement of Principles for Economic Cooperation," a framework that outlined six overarching goals:

> 3.1.1. Promote a strong, integrated, and more widely dispersed defense industrial base in North America.
>
> 3.1.2. Achieve the most economical use of research and development (R&D) and production resources.
>
> 3.1.3. Foster greater standardization and interoperability of military equipment.
>
> 3.1.4. Remove obstacles to the free flow of defense equipment trade.
>
> 3.1.5. Remove obstacles to the exchange of information and technology.
>
> 3.1.6. Give equal consideration to the offers of sources in both countries for defense procurement.[163]

In the wake of this agreement, the United States recognized Canada as part of a single, integrated national technology and industrial base in Section 2500(1) of title 10, United States Code, and a flurry of legislation on both sides of the border expanded and formalized the bureaucratic linkages between their respective supply, production and procurement agencies, and processes. The governments set up administrative bodies to implement coordination of industrial mobilization and preparedness, and reciprocal agreements helped to synchronize reporting, auditing, and standards. One of these agreements—the 1952 U.S.-

[158] Crosby, *Dilemmas in Defence Decision-Making*, 110.
[159] Middlemiss, "The Road From Hyde Park," 180.
[160] Aronsen, *American National Security and Economic Relations with Canada, 1945–1954,* 20–21.
[161] Wakelam, *Cold War Fighters,* 9–10.
[162] Middlemiss, "The Road From Hyde Park," 180.
[163] U.S. Department of Defense, "Exchange of Notes between Canada and the United States of America Giving Formal Effect to the Statement of Principles for Economic Cooperation," October 26, 1950.

Canada Industrial Security Agreement—included setting standards for industrial security and safeguarding classified information and materials. Canada also began participating in the U.S. defense production priority rating and materials allocation system, established under the 1950 U.S. Defense Production Act, to coordinate and ensure timely delivery of defense orders. The United States and Canada would also once again reduce trade barriers by allowing exemptions to protectionist legislation (e.g., Buy American Act) and custom duty regulations.[164]

Importantly, during this timeframe, the United States and Canada had also begun to align their regulatory regimes on the export of military-related and strategic goods, a necessary step to provide assurances that integration would not undermine national security objectives by diverting resources and technologies to adversaries (i.e., Russia). At the passing of its first Export and Import Permits Act in 1947, the Canadian control list contained all of the items on the U.S. commerce list and was adjusted again when the United States adopted an Export Control Act in 1949 to ensure coverage for additional sensitive items and to include a provision restricting the reexport of U.S.-origin items. Aronsen notes Canadian efforts to create parallel controls: "Canada follows a security export control policy identical with that of the United States, and has effectively supported the U.S. position in meetings of the Paris Consultative Group on security export controls applied to the Russian bloc."[165] As result of these efforts and to promote defense industrial integration pursuant to 1950 agreement, Canada was granted an exemption to the licensing requirements under U,S, export control policy, the only such exemption to be granted to another country including to present day. The scope of this exemption, however, would evolve over time and is discussed in later sections.[166]

The formalization of the Hyde Park principles would not only prove successful in promoting closer integration to enable rearmament programs for the Korean War, but would also serve as the basis for many implementing arrangements introduced over the coming decades. Notwithstanding the value of a more formalized framework, U.S. and Canadian defense economic integration up this point had been characterized by a pattern of cyclical and reactive integration in wartime settings. Post–Korean War, the United States and Canada would again confront questions regarding how to evolve the bilateral relationship. These discussions would focus on identifying a longer-term, sustainable model for cooperation in relative peacetime.

Post–Korean War: Restructuring and Institutionalizing Defense Development and Production Sharing

During the Korean War, the United States and Canada again collaborated successfully to increase production sharing to support mutual military requirements and interests. Yet, after the Korean War ended, the United States and Canada reverted to protectionist tendencies

[164] Middlemiss, "The Road From Hyde Park," 181.
[165] Aronsen, *American National Security and Economic Relations with Canada, 1945–1954,* 20.
[166] U.S. General Accounting Office, "Defense Trade: Lessons to Be Learned from the Country Export Exemption," 3.

amidst declining budgets. This cyclical retreat again raised questions regarding how to maintain critical industrial capacity and cooperation in a sustainable and equitable manner that accounted for both U.S. and Canadian domestic—political and budgetary—contexts.[167]

As a result of its rapid expansion during the Korean War, the Canadian defense industry in the mid-1950s "was producing a greater quantity and wider range of sophisticated military equipment than ever before, especially in the electronic and aviation fields." [168] Production continued even after postwar demobilization, primarily for export to European allies.[169] The Canadian government set up programs to sustain specialized production in the aircraft, electronics, and shipbuilding sectors. The pressure of Cold War competition and shared concern for long-range Soviet bombers via the Arctic route provided a strategic imperative for continued U.S.-Canadian military and economic cooperation, particularly in air defense. Accordingly, the United States and Canada collaborated on the electronic equipment for and construction and operation of the Pinetree and Distant Early Warning (DEW) radar lines that extended across large swathes of Canadian territory.[170]

However, a structural problem emerged by 1958 for the now well-developed Canadian defense industry—a "collision between the spiraling costs of advanced-technology weapons platforms and a limited domestic market."[171] The culmination of this tension was the cancellation of a jet interceptor program known as the Avro Arrow, the "most ambitious defense R&D effort in Canadian history," due to cost overruns, program mismanagement, and lack of export potential.[172] This event is considered a turning point in many scholars' view, whereby Canada recognized it "could no longer afford to develop advanced weapons systems and platforms unless it became a major arms exporter, which would have conflicted with its foreign-policy goals."[173]

These events coincided with U.S.-Canadian bilateral discussions over how to operationally integrate continental air defense forces, discussions that eventually led to the establishment of the binational North American Air Defense Command (NORAD) in 1958. In this context, the United States recognized the importance of a healthy Canadian industrial base for joint defense cooperation and of having "alternate sources of both resources and finished products as well as dispersed production sites." [174] Likewise, Canada was interested in a solution that sustained indigenous defense production capacity, both for economic benefits and to meet collective security commitments under NORAD and NATO. Canada also recognized that this capacity would be contingent on closer integration with U.S. production programs.[175] However, reduced defense budgets and protectionist policies on both sides of the border made the current North American industrial complex unsustainable. New

[167] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 179–183
[168] Ibid., 183.
[169] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 63.
[170] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 181–184.
[171] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 63.
[172] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 184.
[173] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 108.
[174] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 111–112.
[175] Ibid.

cooperative arrangements were needed to restructure the industrial base while maintaining joint capacity to meet Cold War requirements.

This confluence of events led the United States and Canada to establish the Defense Production Sharing Arrangements (DPSA), formalized in 1959, by an exchange of notes between the U.S. secretary of defense and the Canadian minister of defense. The DPSA not only again reinforced Hyde Park principles, but also codified specific measures to remove barriers to reciprocal procurement and integration of defense production. An equitable "quid pro quo" arrangement resulted.[176] On the U.S. side, the Buy American Act was waived and domestic price preference and import duties were removed for Canadian defense goods produced for the Department of Defense and U.S. prime contractors. Canadian industry would compete on "an equal basis" as U.S. firms when bidding on U.S. defense contracts.[177] For the Canadians, the DPSA was understood to establish "the US as producer of major defence systems and Canada as the producer of subsystems and components for the US market."[178] This "tacit division of labor," inextricably linking U.S. and Canadian production capacity and supply chains, would be one of the defining features of the joint industrial base.[179] A Senior Policy Committee and Steering Group were set up to monitor and coordinate production-sharing activities under these arrangements.

As with previous agreements, however, implementation of the DPSA was slowly institutionalized over a number of years. Initially, the terms of the DPSA were applied selectively on a case-by-case basis by procurement officials who over time became frustrated with the variances in standards and practices of cross-border industries.[180] Further, U.S. firms lacked the necessary knowledge of relevant Canadian industrial capabilities to promote cross-border contracting. In response to these challenges, a number of steps were taken to promote and institutionalize cross-border relationships.

On the Canadian side, the Canadian Commercial Corporation (CCC), originally established post–World War II to assist with reconstruction efforts in Europe, was given the mandate to act as an interlocutor between DoD and Canadian industry. In this role, CCC would not only serve as a "conduit" for contracts between Canadian firms and DoD, but also as a government-to-government mediator for standards and guarantor for quality, price, and delivery, assuming liability for all contracts above a certain threshold. CCC would conduct audits of Canadian firms according to "uniform auditing standards and rules worked out with DoD," an arrangement which ensures Canadian industry "meets all the terms and conditions of the U.S. contract" while also allowing them to "use normal business practices" and "meet

[176] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 108.
[177] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 183.
[178] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 112–113; and U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 108–109.
[179] Middlemiss, "The Road From Hyde Park: Canada-U.S. Defense Economic Cooperation," 186–189.
[180] Ibid., 188.

the labor and environmental laws of Canada."[181] CCC continues to function in this role to present day.

On the U.S. side, DoD would take steps to institutionalize procurement practices and enable more open communications between U.S. and Canadian industry. In 1960, DoD released its first internal directive—DoD Directive 2035.1, "Defense Economic Cooperation with Canada"—which reinforced the 1950 "Statement of Principles for Economic Cooperation" as the economic policy of the department and instructed that the DPSA terms be incorporated into DoD acquisition regulations, supporting a "policy of maximum production and development program integration."[182] Bilateral agreements were signed on product qualification and renewed for industrial security procedures (i.e., the U.S.-Canadian Security Agreement of 1962).[183] Finally, in an effort to address perennial trade balance concerns, Canadian Minister of National Defense Drury and U.S. Defense Secretary McNamara agreed to an additional DPSA provision committing that "each side should seek to maintain 'a rough long-term balance in reciprocal defence procurement at increasing levels'" under the program.[184]

The final step in formalizing this set of arrangements was establishing a complementary agreement to promote cross-border collaborative R&D, which was occurring only on an ad hoc basis at the service level, but not fully or uniformly across DoD. The United States and Canada "recognized that for the production sharing arrangements to remain viable, the Canadian defense industry would need to retain an indigenous development capability."[185] From both a funding and access perspective, the resulting Defense Development Sharing Agreement (DDSA) was designed to help Canadian industry "take part in the early stages of new systems development aimed at meeting future Pentagon requirements."[186] In retrospect, this was a critical requirement if Canadian firms were to have equal access and make meaningful contributions to the production phase of major U.S. weapons systems. As Crosby notes, without such an agreement, "Canadian industry could not enter the bidding competition on the ground floor"[187]; furthermore, there was a need for "uniform agreements regarding Canadian access to U.S. military specifications and other classified data."[188]

The DDSA, signed in 1963, established that Canadian firms should be considered on an equal basis as U.S. firms for U.S. R&D contracts. It authorized Canadian R&D funding for the purpose of satisfying U.S. DoD requirements and further outlined terms for jointly funded

[181] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 109.
[182] Department of Defense, "Directive 2035.1, Defense Economic Cooperation with Canada," February 2006, http://www.dtic.mil/whs/directives/corres/pdf/203501p.pdf.
[183] Middlemiss, "The Road From Hyde Park: Canada-U.S. Defense Economic Cooperation," 186–187.
[184] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 64.
[185] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 109.
[186] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 64.
[187] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 113.
[188] Middlemiss, "The Road From Hyde Park: Canada-U.S. Defense Economic Cooperation," 190.

R&D projects undertaken by Canadian industry to meet DoD requirements.[189] For joint R&D projects, the United States would contribute no less than 25 percent of the cost—a provision aimed not just at achieving equity in investment but to maintain incentives for procurement officials to control standards and costs.[190] It further stipulated that Canadian firms should be allowed to compete for follow-on work related to jointly funded development, and that these follow-on contracts should not be "set aside" for small business or labor surplus areas. To increase confidence and effect, the DDSA reinforced previous industrial security agreements and outlined joint procedures for information disclosure, technology transfer, and the sale of data or items developed under DDSA projects. Importantly, it further granted that "subject to U.S. law and national policy," the Canadian government would have access to information on future DoD requirements and R&D programs, and Canadian firms would have equal access to R&D program information as U.S. firms.[191]

Even with the Defense Development and Production Sharing Agreements (DDPSA) in place, the Canadian government recognized that Canadian industry would need assistance to develop and sustain industrial capabilities necessary to compete for U.S. contracts. In 1959, the Defence Industry Productivity Program (DIPP) was established to provide R&D funds for "modernizing plants and acquiring advanced production equipment," other production start-up costs, and "re-tooling for firms competing for US contracts."[192] In effect, Canada was subsidizing industrial capacity in technology areas and manufacturing sectors necessary to complement and compete with U.S. industry. This program, together with the DDPSA arrangements, additionally incentivized U.S. industry to invest in Canada and made it "increasingly attractive for U.S. firms to establish subsidiaries in Canada."[193]

Middlemiss states that these agreements, together with the efforts to institutionalize their implementation, signaled that the United States and Canada had "entered a new peacetime defense economic relationship." Indeed, an early sign of this special consideration was Canada's exemption from executive directives in the early 1960s, including the 1963 Interest Equalization Tax, intended to reduce the U.S. general balance of payments deficit.[194] Collaborative projects and production sharing would be initiated on missiles, communications, and radar development programs in support of joint air defense interests, and the Canadian defense industry would continue to develop specialized capabilities and advanced technology in the aerospace, defense electronics, and light armored vehicles.[195] This collaborative environment was furthered buoyed in the early 1960s by President

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[189] Charles M. Drury and Robert McNamara, "Memorandum of Understanding between the Department of Defense of the United States and the Department of National Defence of Canada Concerning the Procurement of Defense Supplies Cite," 1963, http://www.acq.osd.mil/dpap/Docs/mou-canada.pdf.
[190] Middlemiss, "The Road From Hyde Park: Canada-U.S. Defense Economic Cooperation," 190.
[191] Drury and McNamara. "Memorandum of Understanding Between the Department of Defense of the United States and the Department of National Defence of Canada Concerning the Procurement of Defense Supplies Cite."
[192] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 113.
[193] Ibid., 127.
[194] Bruce Muirhead, *From Special Relationship to Third Option: Canada, the U.S., and the Nixon Shock* (American Review of Canadian Studies, 2004), 439.
[195] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 187; and Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 66.

Kennedy's adoption of a "flexible response" defense strategy to respond to Soviet military threats, which required a "more flexible, diversified, dispersed and viable North American defence industrial base."[196]

Defense development and production sharing would, however, continue to face challenges at the bureaucratic and political levels. Not all "barriers" were removed under the DDPSA. Canadian tariffs and a 10 percent domestic price preference remained in place initially, and U.S. defense acquisition regulations continued to protect small businesses and stressed industries as well as restrict foreign procurement of some raw materials (e.g., Berry Amendment) and strategic resources.[197] Further, procurement officials continued to show domestic preferences. At the political level, trade balance and divergences in foreign policy would emerge as the greatest sources of tension.[198] These challenges persisted and evolved in the first two decades of DDPSA implementation in response to world events, political leadership and domestic policies. Defense procurement during this period would become more politicized.

1960s, 1970s: Divergence of Defense Policies and Politicization of Defense Procurement

Under the terms of the DDPSA, and with U.S. escalation in Vietnam during the 1960s, the trend toward closer integration of the U.S. and Canadian industrial bases accelerated. Canada's defense sales to the United States doubled from 1964 to 1966, with their defense industry becoming "increasingly export-oriented and concentrated on producing sub-assemblies, components and parts mainly for U.S. defense contractors."[199] Canadian industry was already involved in U.S. mobilization production planning, but a 1970 MOU formalized the procedures for Canadian firms to register under the U.S. Industrial Preparedness Production Planning Program as "planned producers" for specialized components, assemblies, and parts.[200] This MOU afforded Canadian industry unique status that was not extended to other allies and guaranteed registered producers the ability to bid on restricted U.S. mobilization contracts over USD $10,000 on an equal footing with U.S. firms and granted them exemption from small business set-asides.[201] Canada, in turn, removed customs duties on "certified" U.S. defense supplies and tariffs for other defense imports, so that "by 1970, Canadian tariff provisions for defense imports closely paralleled those of the U.S. DoD."[202] Despite these steps toward closer integration, a "serious threat to the fledging production sharing program arose from the apparent diminution of Canadian support for U.S. foreign and defense policies in the early 1960s."[203]

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[196] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 120.
[197] Ibid., 112–113.
[198] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 188.
[199] Ibid., 192.
[200] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 111–112
[201] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 192.
[202] Ibid., 191.
[203] Ibid., 188.

The first signal of dissonance was debate over Canada's role as a partner in protecting the U.S. nuclear deterrent. While not a producer of nuclear weapons itself, Canada had agreed under the recent NORAD agreement to acquire and host nuclear weapons, including nuclear-capable interceptors at facilities on its territory.[204] At the time of the 1958 NORAD agreement signing, however, the Canadian political establishment was not fully aware of the implications for participation in U.S. nuclear, ballistic missile, and space programs. Canadian policy preference for disarmament and arms control options were in tension with these programs, which came to a head in 1962 during the Cuban Missile Crisis when Canada denied U.S. requests for permission to disperse U.S. nuclear-armed inceptors on and overflight over Canadian territory.[205] Canada ultimately publicly accepted a nuclear weapons role in 1963, but tension remained regarding the extent to which Canada would participate in active ballistic missile defense and space programs.[206] Air defense capabilities—the centerpiece of U.S.-Canadian defense cooperation to date—had reduced in relative importance, as Soviet military threats evolved from the traditional bomber to intercontinental and sea-launched ballistic missiles and antisatellite capabilities. NORAD shifted its emphasis to building space-surveillance and missile-warning systems, while Canadian participation remain limited to hosting Baker-Nunn space surveillance cameras on its territory.[207] Canada maintained this general policy of limited involvement and in 1968 inserted an "antiballistic missile (ABM) clause" into the NORAD renewal agreement, making explicit that its role in active ballistic missile and space-based defense programs would be restricted.[208]

Foreign policy differences heightened during the U.S. escalation in Vietnam, generating the most direct criticism of U.S.-Canadian defense economic cooperation since the signing of the DDPSA. Concerns had already been raised regarding the dependencies that DDPSA created; as Crosby notes: "the terms of defence production sharing, together with US procurement in Canada during the Vietnam War, contributed to the stability of the Canadian defence production industry" but also "served to entrench the industry's dependence upon the US market, upon US weapons designs and specifications, and ultimately upon US defence policy."[209] These dependencies took on greater significance in the context of policy differences at the height of the Vietnam War. Canadian critics claimed that U.S. export market dependency and continued participation in U.S. military programs (a prerequisite for industrial integration) compromised independent Canadian foreign policymaking.[210] In war critics' views, arms sales to the United States during this period amounted to "indirect Canadian complicity in the war effort."[211] Canadian prime minister Pearson ultimately rebuked calls for an arms embargo and termination of the DDPSA on the basis that it would have "far-reaching consequences" and "be interpreted as a notice of withdrawal on our part

[204] Matthew Trudgen, "A Canadian Approach: Canada's Cold War Grand Strategy, 1945 to 1989," *Journal of Military and Strategic Studies*, Vol. 14, Issues 3 & 4, 2012, 14, http://jmss.org/jmss/index.php/jmss/article/viewFile/489/487.
[205] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 53.
[206] Ibid., 53.
[207] North American Aerospace Defense Command, "A Brief History of NORAD," History Office, 2013, 6–7.
[208] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 3.
[209] Ibid., 114.
[210] Ibid., 116.
[211] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 192.

from continental defence and even from the collective defence arrangements of the Atlantic Alliance."[212] Public furor would diminish as the United States withdrew involvement in Vietnam, but these events highlighted what would be a recurring challenge for Canada: balancing decisions among sometimes competing foreign, economic, and collective defense policies.

Notwithstanding these policy divergences, the most powerful forces acting on U.S.-Canadian defense industrial cooperation by the 1970s would result from changes in domestic economic and industrial base policies on both sides of the border, but particularly driven by the United States. At the time, the United States had a worldwide balance-of-payments problem that prompted a comprehensive review of trade policy under the Nixon administration. Defense trade had heavily favored Canada during the Vietnam War with "a cumulative favorable balance of almost USD $500 million under the DDPSA between 1965 and 1971," and for the first time, the DDPSA was reviewed in the context of broader U.S. bilateral trade policy, which had a number of consequences.[213]

First, Canadian defense trade was not exempted, as it had been previously, from U.S. Treasury Department's recommended tax measures—for example, a temporary 10 percent surcharge on imports—enshrined in President Nixon's "New Economic Program."[214] As a result of these protectionist measures, Canada began considering anew alternatives to diversify engagement and trade with other global partners, particularly the European Economic Community, including for major weapons systems. This shift in defense trade resulted in Canada's acquisition of the German Leopard I tank and the Italian 127mm naval gun for their destroyers.[215]

Second, whereas previously U.S. defense trade issues were typically left to the Defense Department, the Commerce and Treasury Departments now played a greater role, resulting in more politicized defense procurement as "considerations of economic development, trade, defence production, and strategic planning were becoming more interdependent in the US."[216] In this context, the DDPSA would be recast as a U.S. "trade irritant," on account of the trade imbalance, the 10 percent price preference Canada afforded domestic suppliers, and the Canadian tariffs levied on some defense goods. The issue became less politicized by the mid-1970s, in part because of large Canadian defense purchases from the United States as part of Prime Minister Trudeau's equipment modernization program.[217] However, Edgar and Haglund highlight that the linkage of reciprocal defense procurement to high-level bilateral trade policy signaled that these arrangements might be more "vulnerable to modification" or political bargaining in the future. Middlemiss also notes it was the first time

[212] Ernie Regehr, "Arms Canada: The Deadline Business of Military Exports," James Lorimer & Company, 1987, 49.
[213] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 191.
[214] Muirhead, *From Special Relationship to Third Option: Canada, the U.S., and the Nixon Shock,* 439.
[215] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 110.
[216] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 117
[217] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 194.

the United States approached defense trade from an economic perspective first and military perspective second, contrary to previous practice.[218]

While the DDPSA was not ultimately rescinded, largely due to the advocacy efforts of the DoD and State Department, the United States did enact a new round of protectionist and export control legislation during this timeframe that would impact its implementation. These changes included restrictions on foreign procurement for R&D contracts (Bayh Amendment) and of specialty metals (added as a provision to the Berry Amendment). Additionally, the United States tightened restrictions on defense exports and technology transfer with the enactment of the Arms Export Control Act (AECA) and the International Traffic in Arms Regulations (ITAR) in 1976. The "country exemption" remained in place for Canada under ITAR regulations, but certain sensitive technologies were now excluded under U.S. law and national security policy. The modified ITAR regulations also had implications for Canadian reexport and transfer of U.S.-origin defense goods and technology, which raised areas of extraterritoriality including in areas of diverging foreign policy (e.g., exports to Cuba). With respect to technology security, differences in definitions of technical data emerged, with the U.S. definition applying more broadly to "design, process, know-how, and other tangible and intangible forms of technical data."[219] The United States also began to charge administrative fees on Canadian goods used in U.S. arms exports.[220]

The above policy changes were accompanied by a decline in U.S. defense spending—U.S. procurement from Canada was cut in half from 1969–74[221]—as well as reduced defense spending in Canada as it underwent a defense policy review. Canadian industrial capabilities were again beginning to deteriorate. Canada would ultimately restructure defense procurement policies and practices that continue to shape reciprocal defense procurement today. As Edgar and Haglund state, the late 1960s to mid-1970s period was "noteworthy because two 'givens,' or parameters, of future [Canadian] procurement policy became established: tight budget constraints accompanied by vacillating government direction; and the requirement that offset provisions be attached to all major equipment purchases from foreign sources (including the United States)."[222]

The Canadian defense funding increases that followed Prime Minister Trudeau's "Defence Structure Review" in 1975 "proved invaluable for the rebuilding or expansion of what had since 1959 become the major elements of the Canadian defence manufacturing base—aircraft components, defence electronics (especially systems integration), ships, small arms, and light armoured and other vehicles."[223] However, it was also determined that a stronger, more direct Canadian government role was needed to ensure the continued competitiveness

[218] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 65; and Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 194.
[219] Dorinda G. Dallmeyer, "Foreign Policy and Export Controls: How Will the Canada-United States Free Trade Agreement Accommodate the Extraterritorial Application of the United States Laws to Canadian Exports of Goods and Technology?," *Georgia Journal of International and Comparative Law*, Vol. 19, No. 3, University of Georgia School of Law, 1989, 578.
[220] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 120.
[221] Ibid., 117.
[222] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 66.
[223] Ibid., 66.

of Canadian industry—specifically, a policy that would leverage government contracting to accrue broader economic and technological benefits. As Middlemiss notes, "Until the mid-1970s, Canada had relied upon the market access afforded by the DDPSA coupled with government financial and marketing assistance to sustain an export-oriented defense industry. This approach was not entirely satisfactory owing to the competitive advantages enjoyed by larger, better established firms in the United States, and because of increased legislative and administrative protectionism in U.S. defense contracting."[224]

As such, Canada adopted a new offset policy, eventually named the industrial and regional benefits (IRB) program, to act as the primary mechanism, in addition to the DIPP program, to protect and expand critical industries and advanced technologies. Canada would leverage its equipment-modernization effort during the mid-1970s to implement this policy, including large weapons procurements from the United States—the CP-140 Aurora long-range patrol aircraft in 1976 and the CF-18 fighter in 1977. This offset policy went beyond traditional "content provisions" and further obligated foreign firms to invest in local procurement, production, or other spending in amounts that "approached or exceeded 100 percent of the value" of the weapons procurement contract.[225] The intent was to take advantage of large discretionary defense spending—which represented more than a third of total federal discretionary funds—to direct expenditures to achieve broader economic and industrial objectives.[226]

The IRB policy had a number of offshoot consequences. First, the Canadian defense procurement process became further politicized, as the government sought to use the policy as a tool to distribute economic benefits as equitably as possible across provinces—"the issue of industrial benefits to Canada from weapons procurements emerged, and was to remain, as a primary political and economic consideration in defence decision-making."[227] Noting the significance that offsets assumed in the bidding process, Crosby surmises that McDonnell-Douglas won the Canadian fighter contract "primarily for its offset package," which included investments amounting to 120 percent of the price of the fighters that would go toward the Canadian aerospace industry, other defense production industry, and nondefense related sectors over ten years.[228] McDonnell-Douglas awarded Litton Canada, for example, a production contract for cruise missile guidance systems as part of its offset arrangements tied to Canada's F/A-18 purchase.[229] For industry, the offset policy "served to reinforce the preexisting trend towards integration of Canadian defence companies into the U.S. defence market as specialized subcontractors."[230] It also accelerated cross-border corporate investments as "U.S. prime contractors intensified their relationships with Canadian suppliers and in some cases established subsidiaries in Canada" in order to fulfill the new offset requirements.

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[224] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 195.
[225] Ibid., 195.
[226] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 70–71.
[227] Ibid., 67.
[228] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 119.
[229] Ibid., 120.
[230] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 68.

The offset policy would become a central friction point for the U.S. DoD, Treasury, and Congress, as it was viewed as taking "two bites at the apple" given allowances already granted under DDPSA.[231] Canada, conversely, argued that it promoted a more equitable balance given the advantages accrued to U.S. industry—as evidenced in the fact that many of the continental defense-related prime contracts for aerospace, electronics, and communications equipment modernization were awarded to U.S. industry, leaving opportunities for Canadian firms only at the subcontract level.[232] The offset policy served as a "guarantee" for return on large offshore contracts with U.S. industry in order to sustain domestic industrial capabilities and maintain support from its public and political establishment.[233] Canada was also facing increased competition from other allies and partners during the 1970s, as the United States pursued a policy of enhanced material standardization and interoperability within NATO and began signing reciprocal defense procurement (RDP) MOUs and expanding information exchange agreements. As a form of compromise, Canada agreed in 1980 to count offsets toward the "rough balance" of trade provision under DDPSA.[234] Notwithstanding the new offset policy, the trade balance tipped in favor of the U.S. throughout most of the 1970s and 1980s, primarily as a result of Canada's aircraft procurements.[235]

1980s: Defense Policy Reconvergence and Shamrock Summit Recommitment

By the late 1970s to early 1980s, U.S. and Canadian defense policies started to reconverge, again organized around continental defense. This convergence, together with increased U.S. and Canadian defense spending, enabled a collaborative environment for joint military and industrial cooperation and set the stage for the establishment of the last set of framework agreements and organizations related to U.S.-Canadian industrial cooperation.

On the Canadian side, with the breaking of defense procurement logjams in the late 1970s, the Trudeau government continued its equipment-modernization program and additionally began to invest in rebuilding domestic industrial base capacity "with the goal of restoring selective capability for the design and production of weapons systems."[236] These investments "revitalized" certain industries and manufacturing capabilities, including flight simulators, naval shipbuilding and naval electronics subsystems, production facilities for military trucks, utility vehicles, and light armored vehicles; the capability to manufacture small arms such as the M-16; the phased development of a light to medium helicopter industry; continued expansion of the design and production of small gas-turbine engines; and a significant

[231] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 119.
[232] Ibid.,118.
[233] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 67–68.
[234] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 120.
[235] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 194; and U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 110.
[236] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 107.

improvement in ability of the defense industry to undertake large-scale integration projects."[237]

On the U.S. side, President Reagan initiated a Strategic Modernization Program in 1981, which called for USD $222 billion in spending over five years on strategic weapons, delivery systems, and command, control, and communications systems and renewed emphasis on strengthening North American strategic defenses.[238] Industrial cooperation expanded under these modernization programs, not only in support of continental air defense but also U.S. ballistic missile and space-based defense planning and programs.[239] The NORAD agreement had been adjusted in 1975 to expand the mission to include warning and assessment of air, missile, or space attacks on North America. In 1981, the command's name was changed to the North American "Aerospace" Defense Command,[240] and the "ABM clause" of the NORAD agreement—which previously restricted Canadian involvement in U.S. ballistic missile programs—was removed.[241] Canadian industry had already been involved in air defense and cruise missile programs initiated in the 1970s as part of "flexible response" planning, but the Canadian government would take steps to more formally and publicly support expanded Canadian military and industrial engagement in these programs.[242] An early indication of this increased cooperation was reflected in Prime Minister Trudeau's decision to authorize U.S. testing of air-launched cruise missiles (ALCM) over Canadian territory in 1983,[243] despite the domestic political controversy it stirred up. This decision also coincided with the signing of an umbrella agreement—the Canada-U.S. Testing and Evaluation Program (CANUSTEP)—which allowed for the United States and Canada to use each other's defense facilities for military technology testing and evaluation. This agreement continues to exist today and has facilitated joint testing on a range of technologies, including sonobuoys, munitions, and F/A-18 aircraft.[244]

While the Canadian government would not ultimately accept a formal government-to-government role in President Reagan's Strategic Defense Initiative (SDI), which sought to develop ground and space-based ballistic missile defenses, Prime Minister Mulroney endorsed university and industry engagement in SDI research and supported government R&D funding (e.g., DIPP) to support those efforts.[245] Indeed, Canadian firms were already engaged in SDI-related technology areas and stood to benefit technologically and economically from participation in these high-tech programs.[246] These decisions

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[237] Ibid., 107–108.; and Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 77.
[238] Jeffrey Richelson, "PD-59, NSDD-13 and the Reagan strategic modernization program," *Journal of Strategic Studies*, Vol. 6, Issue 2, 1983, 125.
[239] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 3.
[240] North American Aerospace Defense Command, "A Brief History of NORAD," 6–7.
[241] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 3.
[242] Brian Tomlin and Maureen Molot, "Canada among Nations 1985: Conservative Agenda," Lorimer, 1986, 66.
[243] Trudgen, "A Canadian Approach: Canada's Cold War Grand Strategy, 1945 to 1989," 24–25.
[244] National Defence and the Canadian Armed Forces, "Canada-United States Defence Relations," Government of Canada, July 27, 2006, http://www.forces.gc.ca/en/news/article.page?doc=canada-united-states-defence-relations/hnocfojt.
[245] Tomlin and Molot, *Canada among Nations 1985: Conservative Agenda,* 66; and Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 140.
[246] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 140.

represented a shift in Canadian policy whereby the government supported increasing defense cooperation and industrial engagement to strengthen deterrence capabilities, while also continuing to emphasize arms control in international forums and support for the ABM, SALT II, and Intermediate-Range Nuclear Forces (INF) treaties.[247]

Notwithstanding these policy adjustments, modernization of NORAD's air defenses remained the area of closest cooperation during this timeframe. Concerns surrounding new Soviet bombers and the cruise missile threat renewed interest in air defense capabilities. A joint planning process within NORAD was initiated in 1979, in response to an order from U.S. Congress, to design plans for air defense modernization. These plans formed the basis for negotiation of the NORAD Modernization Agreement signed by President Reagan and Prime Minister Mulroney at the 1985 Shamrock Summit. The NORAD Modernization Agreement outlined plans and cost-sharing arrangements to replace the Distant Early Warning (DEW) radar line with an improved system dubbed the North Warning System (NWS), as well as the deployment of over-the-horizon radar and greater use of surveillance (AWACS) and fighter aircraft.[248] Upgrades and transition to the new system would be carried out through the early 1990s. This agreement also sparked joint R&D work by consortiums of U.S. and Canadian industry in advanced surveillance and communications technologies, including space-based radar surveillance systems. To facilitate effective industrial cooperation, a new round of department-level agreements were signed, including MOUs for the exchange of high-technology defense information[249] and a Joint Certification Program (JCP) "to certify contractors of each country for access, on an equally favorable basis, to unclassified technical data disclosing critical [controlled] technology."[250]

At the Shamrock Summit, President Reagan and Prime Minister Mulroney also recognized the continued importance of defense industrial preparedness and recommitted to strengthen the North American defense industrial base and flow of defense goods under the DDPSA. The leaders pledged to "reduce barriers and stimulate the two-way flow of goods" and to enable a "free exchange of technology, knowledge and skills involved in defense production."[251] Two years later, this commitment was institutionalized with the establishment of the North American Defense Industrial Base Organization (NADIBO), a joint organization charged with "the development and administration" of U.S. and Canadian defense industrial base programs.[252]

NADIBO, in effect, became the new clearinghouse coordination mechanism between the various U.S. and Canadian departments and agencies involved in industrial base planning and programs. A Steering Committee utilized biannual meetings among procurement managers, industrial planners, and industry to raise specific areas of concern to be assigned to task

[247] Tomlin and Molot, *Canada among Nations 1985: Conservative Agenda,* 65–66.
[248] North American Aerospace Defense Command, "A Brief History of NORAD," 7.
[249] Crosby, *Dilemmas in Defence Decision-Making: Constructing Canada's Role in NORAD 1958–96*, 141.
[250] Defense Logistics Agency, "Joint Certification Program (JCP)," Logistics Information Services, https://www.dlis.dla.mil/jcp/.
[251] NATIBO, "North American Technology and Industrial Base Organization (NATIBO) 2007 Annual Report," (January 1, 2008), 1, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA486574.
[252] Middlemiss, "The Road from Hyde Park: Canada-U.S. Defense Economic Cooperation," 197–198.

forces for resolution. A few early examples of collaborative work included identifying solutions for ammunition supply shortages and for cross-border manufacturing capability to supply components for the M1A1 Abrams tank, as well as surge production of precision-guided munitions. However, NADIBO's effectiveness was initially criticized as being "limited by its lack of executive authority and financial resources and the participation of a large number of government agencies with divergent interests."[253] Additionally, momentum was curbed by the end of the Cold War and a refocus on leveraging a "peace dividend."[254]

1990s to Present: ITAR Changes and NORAD Updates

The NADIBO Charter was revised a number of times in the 1990s to broaden the organization's scope of mission and was eventually formalized under a 2001 MOU for North American Technology and Industrial Base Activities (NATIBO).

This period—through the 1990s and early 2000s—was also a time of change for NORAD.

As the Cold War ended, NORAD undertook a strategy review in 1992 to assess the changed security environment. Emerging from that report were NORAD's next areas of focus: "air sovereignty, warning, and assessment, as well as the potential need to better integrate a ballistic missile defense mission."[255] Focusing on the cruise missile threat, NORAD sought enhancements to ground-based radar and space surveillance, as well as USAF AWACS and air defense fighters to aid in missile detection and defeat. Canada and the United States renewed the NORAD agreement in 1991, 1996, and 2000. "The 1996 renewal was especially significant because it redefined the command's mission as aerospace warning and aerospace control for North America."[256]

The 9/11 terrorist attacks again brought changes to NORAD's mission. This included the air patrol mission Operation Noble Eagle, which as of 2014 had responded to "2,100 potential airborne threats in the continental United States, Canada, and Alaska."[257] The United States stood up a new Northern Command (USNORTHCOM) and together with Canada created a Bi-National Planning group that focused on the NORAD-USNORTHCOM relationship. Emerging from those discussions, the 2006 renewal of NORAD added the maritime-warning mission.[258]

While changes in NORAD were largely cooperative evolution in response to external events, the turn of the century involved consequential changes for Canadian-U.S. cooperation that involved Canada's ITAR country exemption. That exemption was called into question because of mistakes made during this period and then restored thanks to effective cooperation. After an investigation, "[i]n April 1999, State revised its regulations to clarify

[253] U.S. Congress, Office of Technology Assessment, "Redesigning Defense: Planning the Transition to the Future U.S. Defense Industrial Base," 112.
[254] Edgar and Haglund, "Canadian Defence Industry in the New Global Environment," 68.
[255] North American Aerospace Defense Command, "A Brief History of NORAD," 7.
[256] Ibid., 8.
[257] Ibid.
[258] Ibid., 9.

when the exemption could be used and limited the defense items that could be exported under the exemption. Nineteen criminal investigations and seizure cases related to the Canadian exemption were identified, including 3 diversions to China, Iran, and Pakistan and 16 attempted diversions to these and other nations of concern or technical regulatory violations. . . . In addition, State received 23 voluntary disclosures from exporters who inappropriately used the Canadian exemption." [259] State revised the regulations to improve the clarity. In 2002 State recognized the difficulty in interpreting regulations and held in-house workshops to help disseminate the proper information to companies involved.[260]

In response, Canada changed its export control laws and regulations to reflect everything covered in the U.S. Munitions list and created an organization, known as the Controlled Goods Program, that required Canadian companies to register through in order to be able to apply to the exemption between the United States and Canada.[261] The Controlled Goods Program was a way to ensure compliance with export control regulations and compliance with all articles under ITAR-controlled articles.[262] The Controlled Goods Program implemented the Controlled Goods Regulations that provided the rules and conditions for registering to access controlled goods.[263]

There has been an ongoing controversy regarding updated U.S. policy regarding the conditions under which dual citizens and third-country nationals needed to work or be involved with the companies that can hold exemptions to ITAR.[264] While most dual citizens do not fall under this change because they fall under the §126.5(a) definition of being a "Canadian-registered person," this modified policy nonetheless created a source of conflict in Canada. Canadian law prohibits discrimination in hiring or work policies for or against dual or third-country nationals.[265] Talks began regarding this policy in 2007, with changes resulting in 2011.[266]

Recent years have seen greater harmonization. In 2008 Canada engaged in a risk assessment of the Controlled Goods Program and sought to implement improvements to close any gaps in security or operational capability.[267] During 2011 Canada, in response to the Threat and Risk Assessment of the Controlled Goods Program, enacted a new Enhanced Security

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[259] U.S. Government Accountability Office, "Defense Trade: Lessons to Be Learned from the Country Export Exemption."
[260] Ibid.
[261] Jennifer Stewart, "Canada's Controlled Goods Program and U.S. Export Control Reform" (presentation at the Canada-Australian-UK-U.S. Quadrilateral Conference, May 27, 2014), https://www.ndia.org/-/media/sites/ndia/meetings-and-events/3187-sullivan/divisions/international/recurring-events/quadrilateral-conference/3---jennifer-stewart.ashx.
[262] Ibid.
[263] Public Works and Government Services Canada, "Key Events that Shaped the Controlled Goods Program," 2016, http://ssi-iss.tpsgc-pwgsc.gc.ca/dmc-cgd/ei-ke-eng.html.
[264] R. Luc Beaulieu, Paul D. Conlin, Sebastien Beauregard, and Richard A, Wagner, "A Measure of Relief: US Amends ITAR Export Controls for Dual Nationals and Third-Country Nationals," Norton Rose Fulbright Canada, August 15, 2011, http://www.mondaq.com/unitedstates/x/142502/International+Trade/A+Measure+Of+Relief+US+Amends+ITAR+Export+Controls+For+Dual+Nationals+And+ThirdCountry+Nationals.
[265] Ibid.
[266] Public Works and Government Services Canada, "Key Events that Shaped the Controlled Goods Program."
[267] Ibid.

Strategy that would work to develop new tools and methods to conduct security assessments and ensure proper control of goods in a uniform manner to meet industrial security needs.[268] In response, the United States has worked to redesign ITAR regulations to ensure their clarity and offer training and access to guides that help further explain regulations.

[268] Ibid.

Annex B: Supplementary Information on Trends

Additional Details on Trends by Canadian Industrial Sectors

Land

While the largest sector in absolute terms—accounting for 42 percent of total DoD obligations—contract obligations for land have been highly volatile, fluctuating by an average of 118 percentage points from year-to-year in the 2000–2015 period. This is primarily driven by huge increases in 2003 (111 percent), 2007 (346 percent), and 2010 (528 percent), all due to spikes in obligations for either "combat assault and tactical vehicles" (in 2003 and 2007) or "trucks and truck tractors, wheeled" (in 2010). Even excepting those three massive spikes, however, land contract obligations fluctuated by an average of 65 percent year-to-year, which would still be the highest average annual rate of any industrial sector with significant obligations.

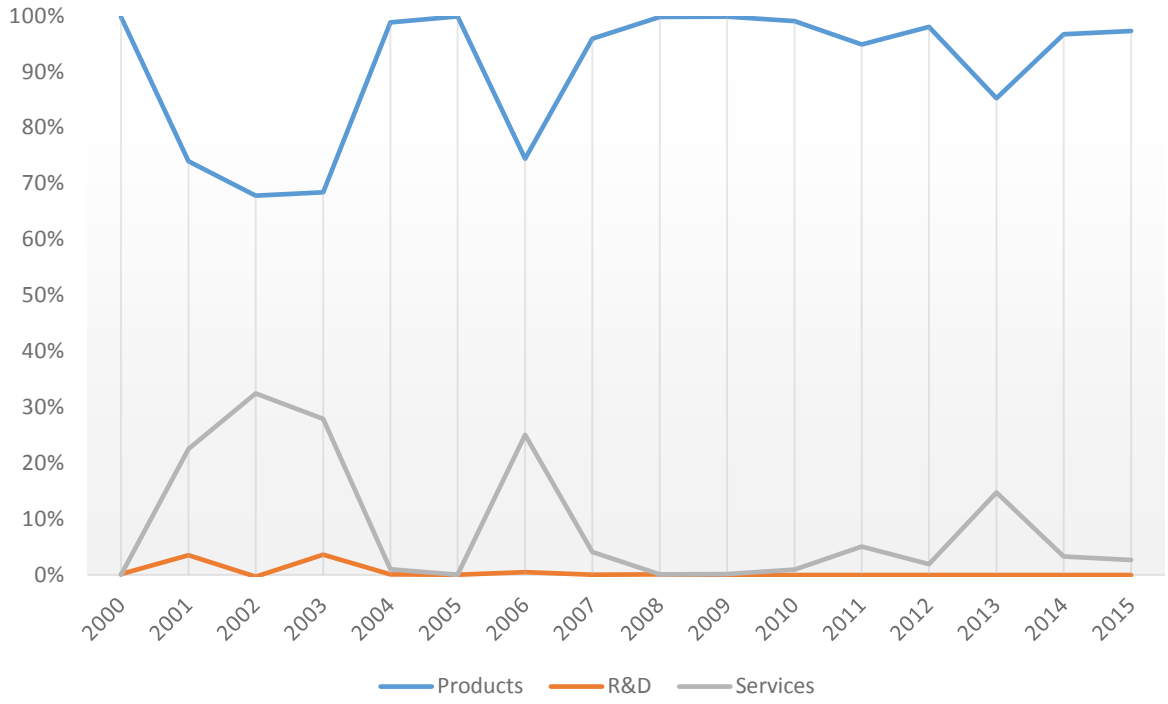
As might be expected given the volatility in DoD contract obligations for land, land's share of the overall DoD contracting portfolio with Canadian vendors has fluctuated significantly throughout the period. Though land has accounted for an average of 31 percent of DoD contract obligations from 2000 to 2015, those shares have ranged from as low as 7 percent in 2001 and 2002 to 77 percent in 2010. Since its peak in 2010, land's market share relative to other sectors has declined fairly consistently (except for 2014) to just 15 percent in 2015.

As shown in Figure 6, land has had the least diverse DoD contracting portfolio, overwhelming dominated by products. Over the 2000–2015 period, products have accounted for 97 percent of land contract obligations and were the primary driver of growth in all years but 2001 and 2002 when logistics support services exceeded all other categories by a fairly wide margin. Aside from the above-mentioned ground vehicles, which accounted for 75 percent of total land product contract obligations, the largest shares went for vehicular "miscellaneous components," "body frame structural components," and interior "furniture and accessories." Outside of vehicular products, special-purpose clothing and personal armor accounted for the next-largest share, notable given Berry Amendment restrictions—although altogether these two products accounted for less than 0.5 percent of total land products. Interestingly, despite the drop-off in overall land contract obligations after the drawdown from Iraq and Afghanistan, combat assault vehicles remained the top land item from 2011 to 2015.

Services accounted for just 3 percent of total land contract obligations, with significant shares only in a few years in the early to mid-2000s, as well as in 2013. Growth drivers in those years varied, with the early 2000s driven by logistics support and vehicle modification contracts, the middle of the decade by inspection services, and the last five years by engineering and technical representative services. Overall, the categories that accounted for

the largest shares over the 15-year period were "automotive production engineering services (including design)" and "technical representative services—vehicles/trailers," which together accounted for over 50 percent. As noted, previously maintenance contracts were limited, suggesting that most overhaul and repair work for Canadian ground vehicles was done in the United States and assisted by Canadian engineering know-how and technical representatives as necessary. R&D accounted for less than 0.1 percent for the period.

Figure 6: Land Sector Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

Air

As a share of the overall DoD contracting with Canadian vendors, air has accounted for an average of 23 percent of total obligations from 2000 to 2015, the second highest of any sector. DoD contract obligations to Canadian vendors for air have also been the most stable of any of the seven categories, fluctuating by an average of 23 percentage points from year-to-year from 2000 to 2015, roughly half the average yearly change of overall DoD obligations to Canadian firms.

Obligations for Air have waxed and waned over the 2000–2015 period, rising from 2001–2004, falling back to prior levels by 2008, peaking in 2010, and then falling consistently since, to USD $97 million in 2015, by far the lowest level of the entire period. Though total contract obligations for air have declined drastically since 2010, air still accounted for 22 percent of total DoD obligations to Canadian vendors from 2011 to 2015, suggesting that this decline may simply be tied to reductions in the topline DoD budget. The growth in the early 2000s was primarily the result of rising obligations for aircraft engines, landing gear components,

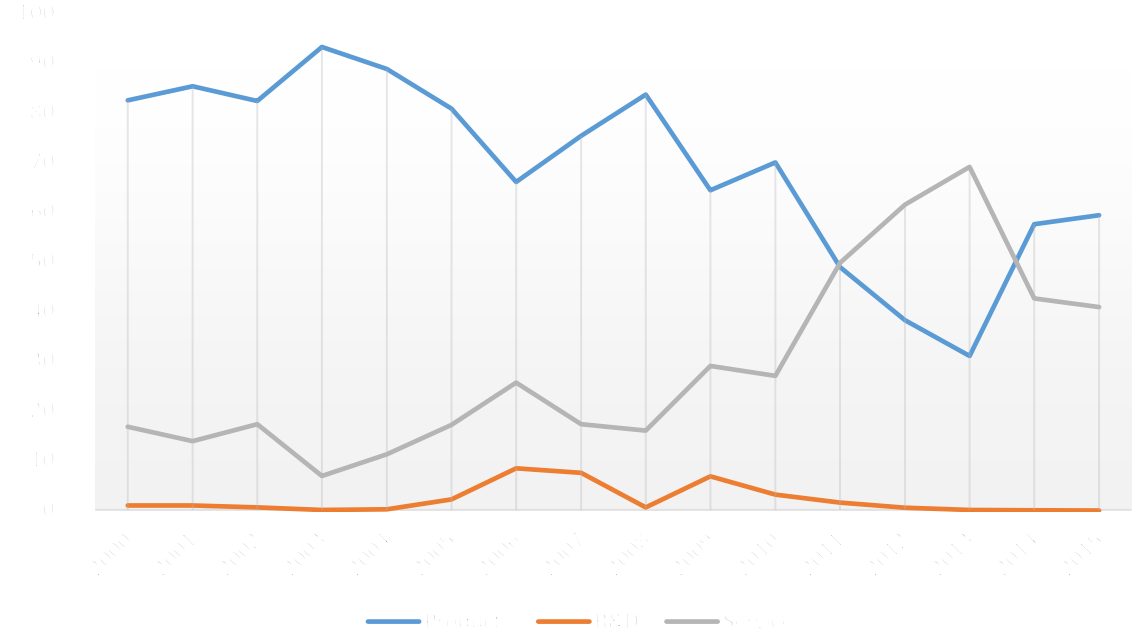
and fixed-wing aircraft, while growth in the late 2000s and early 2010s was primarily the result of increased obligations for air charter services in Afghanistan, for maintenance of the North Warning System, and increased obligations toward maintenance and repair of aircraft and aircraft components.

As shown in Figure 7, relative to other sectors, DoD contract obligations for air also comprised the most diverse mix of products, services, and R&D. Still, products accounted for 68 percent of overall air contract obligations between 2000 and 2015, and that masks the degree to which products dominated the air sector prior to 2009; in all but one year from 2000 to 2008, at least three-fourths of air contract obligations were for products. Aircraft landing gear and components, jet and gas turbine engines, and miscellaneous aircraft accessories and components are, overwhelmingly, the largest categories of air products from 2000–2015, but all have seen declines in recent years.

Services accounted for 30 percent of air contract obligations over the 15-year period, but only exceeded 17 percent in one year prior to 2009. Since 2010, however, as total air product contract obligations have fallen by nearly four-fifths, air services rose as a relative share of total air contract obligations, ranging from 50 to 70 percent of total Air spending from 2011 to 2013. This growth in recent years was driven by rising obligations for air charter services and aircraft maintenance and repair contracts. In 2015, aircraft maintenance and repair was the lead item for the first time in the 15-year period.

R&D accounted for 2 percent of total Air contract obligations and the highest percentage of total DoD obligations of any major sector; however, 96 percent of these obligations went toward early-stage basic or applied research, suggesting limited cooperation in later stage development.

Figure 7: Air Sector Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

C4ISR

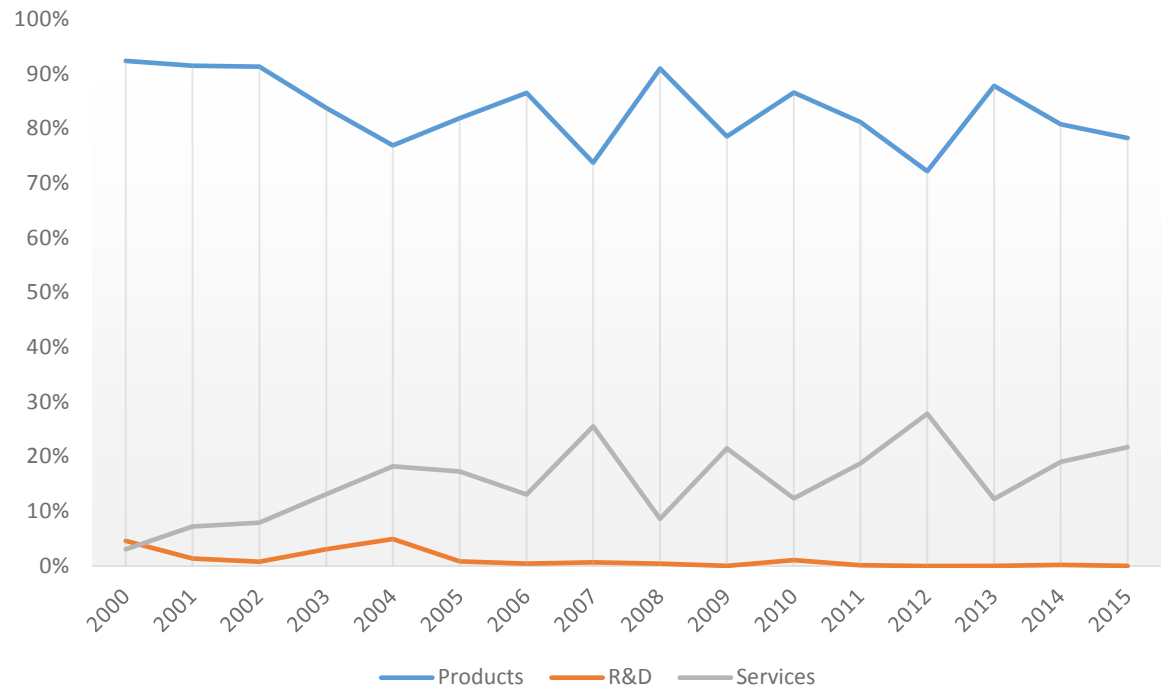
As a share of the overall DoD contracting with Canadian vendors, C4ISR has accounted for an average of 15 percent from 2000 to 2015 and growing to 17 percent in the 2011–2015 period. Like air, DoD contract obligations to Canadian vendors for C4ISR have been relatively stable year-to-year through the 15-year period, fluctuating by an average of 28 percentage points, notably less volatile than the year-to-year change for overall obligations to Canadian vendors.

Obligations grew most significantly from 2002 to 2008, with a spike in 2002 and 2006 driven primarily by nonairborne "radio and television communications" equipment, optical sighting and ranging equipment, and night vision equipment, as a well as growth in engineering and various professional and management services. After a steep decline in 2009, obligations rebounded the next year and sustained positive growth in three out of five years from 2010 to 2015, while most other major sectors were in decline. Obligations in these later years were sustained by the above categories of products, together with a variety of other airborne and nonairborne communications equipment, most prominently "antennas waveguides, and related equipment" and "visible and invisible light communications equipment," as well as growth in services contracts, primarily for maintenance of communications equipment and information and telecommunications management services.

Over the 2000–2015 period, 83 percent of C4ISR contract obligations were for products, while 16 percent were for services. As shown in Figure 8, this distribution is fairly representative of the mix throughout the period, although services as a ratio of products gained relative strength in the middle to latter half of the 15-year period. The largest categories of C4ISR products over the 2000–2015 period were those already mentioned above; though, with the exception of tactical radios, which accounted for 26 percent of total C4ISR product obligations, no one category of equipment was dominant. A diverse range of electronics equipment were purchased each year, much of which supported ground or airborne capabilities; obligations for underwater acoustics equipment grew considerably, however, particularly in the last two years.

For services, the largest categories over the course of the period have been engineering and technical services and "operation of government radar and navigation facilities," but with information and telecommunications management and communications equipment-related services surging their relative share of total C4ISR services in the last two to three years. R&D, as a share of total C4ISR obligations, only rose above 1 percent in three years—2000, 2003, and 2004; however, relative to other sectors, C4ISR R&D was the third highest against total DoD obligations. Additionally, two-thirds of these obligations went toward later-stage development and commercialization, a deviation from trends in most other major sectors.

Figure 8: C4ISR Sector Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015



Source: FPDS; CSIS analysis.

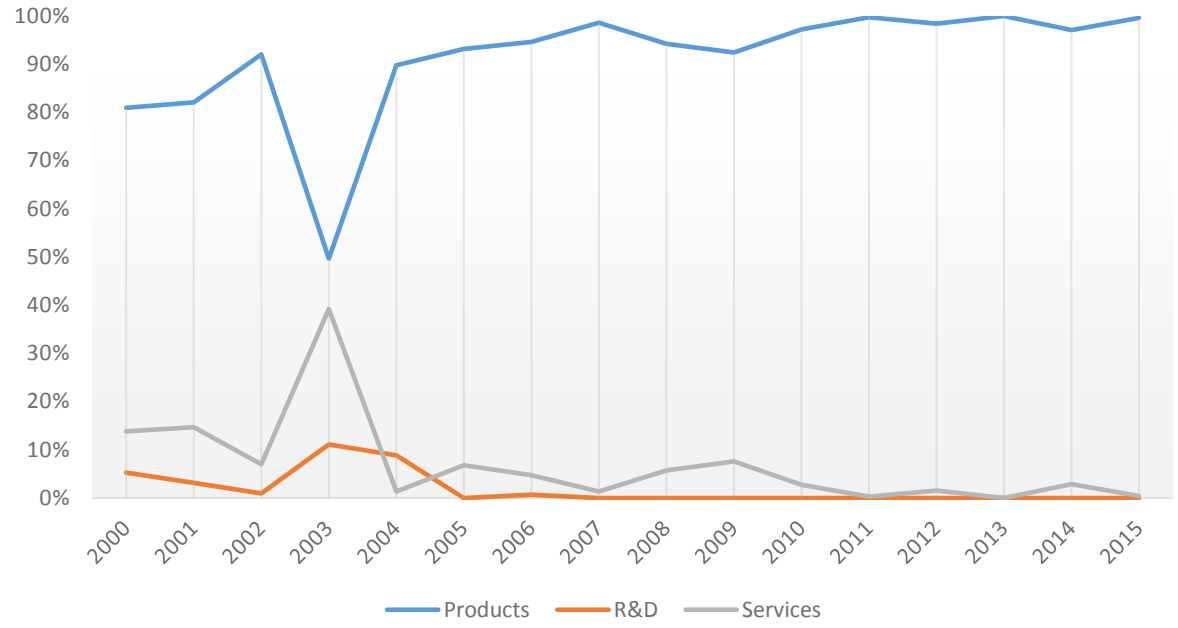
Sea

For the 2000–2015 period, sea has accounted for only 2 percent of total DoD contract obligations to Canadian vendors, the smallest among the major sectors, next to space, by a fairly wide margin. This small market size drove volatility in year-to-year trends, although less dramatically than land, fluctuating by an average of nearly 64 percentage points between 2000 and 2015, and increasing to 82 percent average annual change from 2011 to 2015 due to surges in spending in recent years. Sea never accounted for more than 3 percent of obligations between 2000 and 2012, but rose to account for between 5 percent and 7 percent from 2013 to 2015, increasing its relative DoD market share above its 2 percent annual average for the 15-year period. This increase in market share, however, is equally attributable to the fairly consistent decline in contract obligations for the land and air sectors.

Obligations grew steadily between 2000 and 2007, largely on the strength of increasing obligations for "marine lifesaving and diving equipment" and "special service vessels," doubled between 2006 and 2007 due to a spike in obligations for "gas turbines and jet engines," and fell back to early 2000s levels from 2008 to 2012. Obligations nearly quadrupled between 2012 and 2013, however, and reached a new high for the period in 2014, primarily driven by obligations for "ship and boat propulsion equipment" and "gas turbines and jet engines" before dropping by nearly half in 2015.

As shown in Figure 9, products have accounted for 94 percent of sea contract obligations over the 2000–2015 period, over 70 percent of which is accounted for by the above-mentioned items. A fairly wide range of miscellaneous ship and marine components and accessories make up the remaining product obligations. Services accounted for nearly 5 percent of sea contract obligations, the third-largest relative share among the sectors; however, this was largely driven by pre-2007 maintenance and repair contracts. R&D, which accounted for just 1 percent of total sea contract obligations, was likewise driven by early-2000s investments; in fact, no R&D contracts were awarded after 2006.

Figure 9: Sea Sector Contract Obligations, Market Share of Products, Services, and R&D, 2000–2015

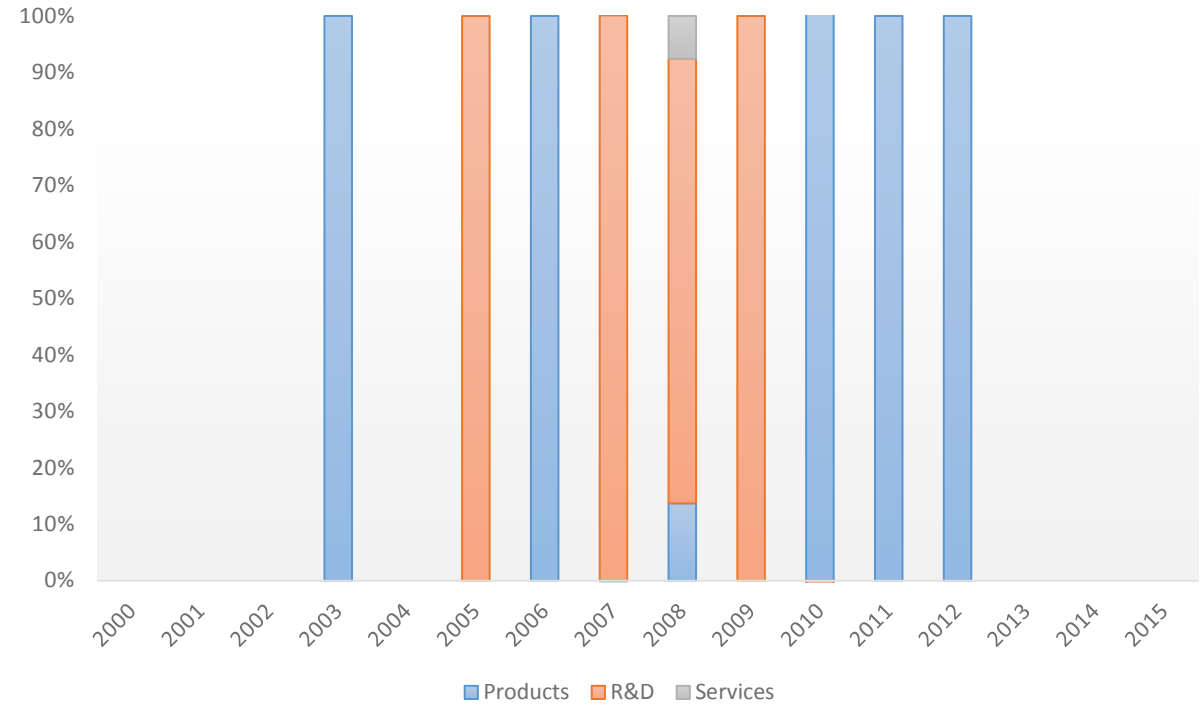


Source: FPDS; CSIS analysis.

Space

Space is, by far, the smallest sector with just USD $11.5 million in DoD contract obligations over the entire 15-year period; as a point of comparison, the next-smallest sector, sea, had USD $294.5 million in DoD obligations over the period. Converse to other sectors' trends, 94 percent of space contract obligations went toward R&D, the bulk of which were tied to a three-year contract for basic research related to the Space Station. Products accounted for 5 percent of total DoD obligations to space, the majority of which is accounted for in the 2010–2012 period with obligations toward space vehicle components and remote control systems. After 2012, there were zero prime contract obligations for space. The extreme year-to-year fluctuations, as shown in Figure 10, are the result of this exceedingly small market. The minimal DoD obligations, together with the overwhelming dominance of R&D, speaks to the level of DoD market access barriers in the space sector.

Figure 10: Space Sector Contract Obligations, Market Share of Products, Services, R&D, 2000–2015



Source: FPDS; CSIS analysis.

Weapons, Ammunition, and Missiles

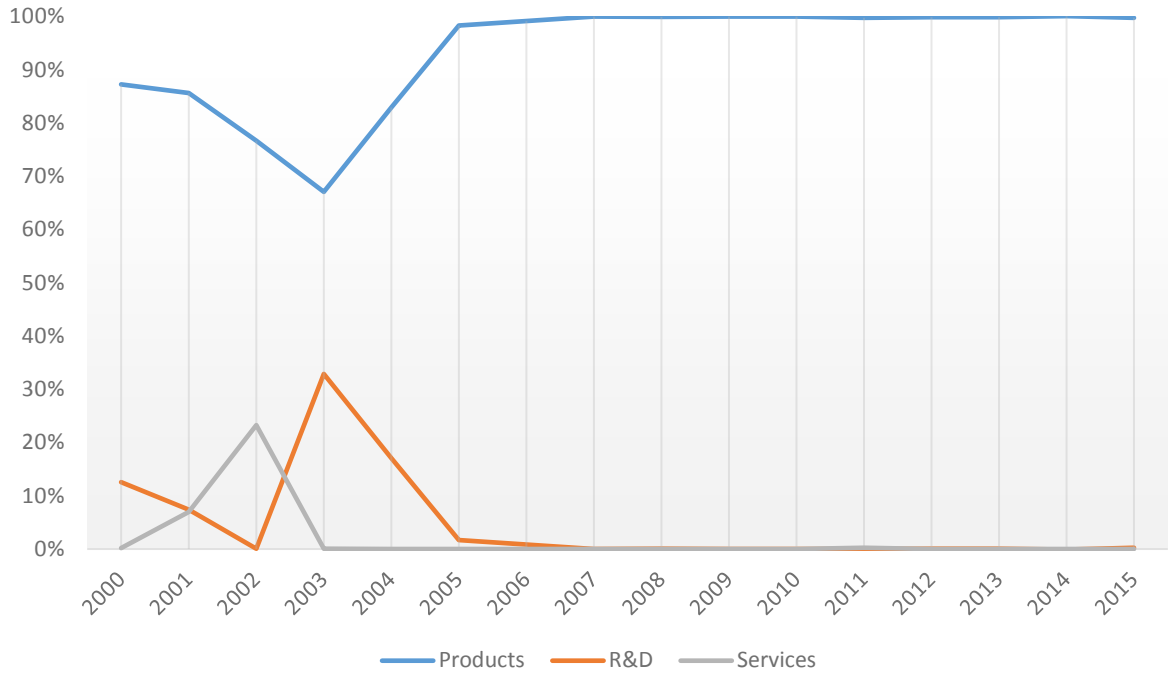
As a share of overall DoD obligations to Canadian vendors, weapons, ammunition, and missiles (WAM) has on average accounted for 9 percent over the 2000–2015 period. These obligations have fluctuated by an average for 50 percentage points from year-to-year, roughly in line with the variation in overall DoD obligations to Canadian vendors. WAM obligations have been notably more volatile since 2011—however, averaging a 68-percentage point change from year-to-year, more than double the magnitude of the average change for overall obligations. WAM accounted for between 9 percent and 16 percent of total obligations between 2002 and 2009, but has accounted for less than 5 percent of DoD obligations to Canadian vendors in three of the last six years.

Obligations increased nearly fivefold between 2001 and 2003, driven by increasing obligations for ammunition, then gradually declined from 2003 to 2006. Obligations then more than doubled between 2006 and 2008, fluctuated significantly over the next several years, and then fell to USD $37 million by 2014, the lowest level of obligations since 2001. In 2015, however, obligations nearly doubled again, to USD $67 million.

Various categories of ammunition, ranging from 30mm to over 125mm, have accounted for nearly two-thirds of DoD obligations to Canadian vendors. As shown in Figure 11, products have accounted for 95 percent of WAM obligations over the period and for over 98 percent in every year since 2005. The vast majority—99.4 percent—of R&D and service contract

obligations to Canadian vendors for WAM occur prior to 2007, much of which is related to ammunition.

Figure 11: WAM Sector Contract Obligations, Market Share of Products, Services, R&D, 2000–2015



Source: FPDS; CSIS analysis.

Other Products, Services, and R&D

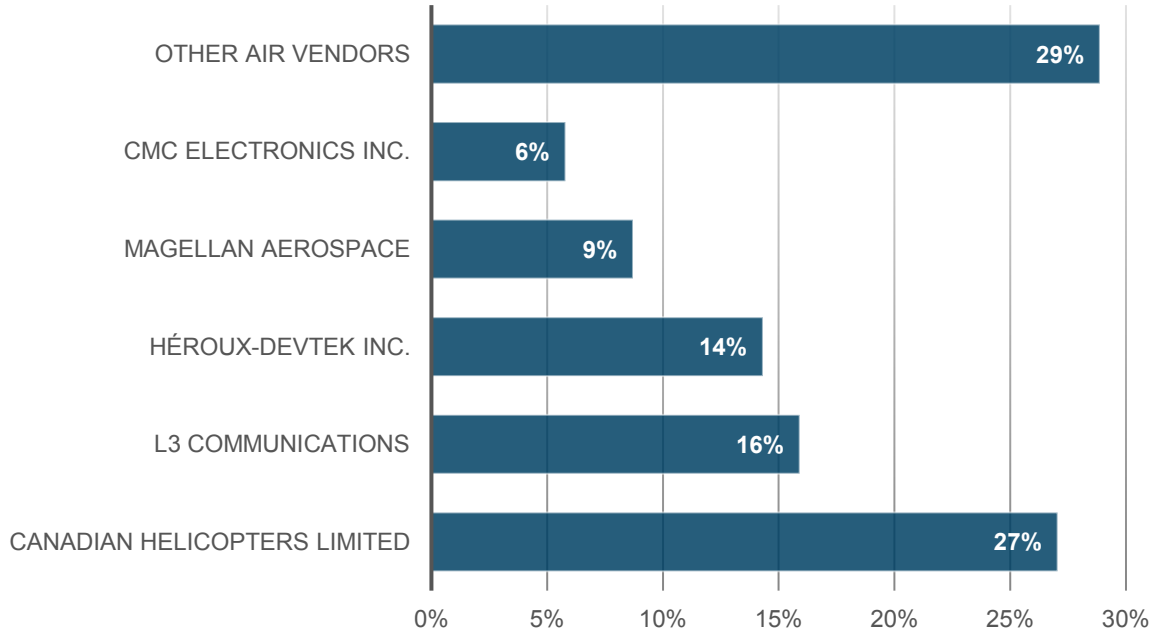
DoD contract obligations to Canadian vendors for all products, services, and R&D not captured by the preceding six categories have been relatively stable throughout the 2000–2015 period, fluctuating by an average of 33 percentage points from year-to-year, notably lower than the magnitude of year-to-year fluctuation for overall DoD obligations to Canadian vendors. Similarly, since 2011, obligations to Canadian vendors in this category have fluctuated by an average of only 17 percentage points from year-to-year, making "other products, services, and R&D" the most stable category in the 2011–2015 period. As a share of total DoD contract obligations to Canadian vendors, "other products, services, and R&D" has accounted for 18 percent over the 2000–2015 period, and has maintained that share in the 2011–2015 period.

Products have accounted for 77 percent of "other products, services, and R&D" contract obligations to Canadian vendors since 2000, with services accounting for 10 percent and R&D accounting for 13 percent. The largest categories of products have been "miscellaneous construction equipment" and "liquid propellants—petroleum base"; for services, "construction of dams" and "education/training—training/curriculum development"; and for R&D, "biomedical (advanced research)" and "construction (basic research)."

Additional Details on Trends in Canadian Vendor Base

Air Procurements

Figure 12: DoD Contract Obligations, Market Share of Top 5 Air Vendors, 2008–2015



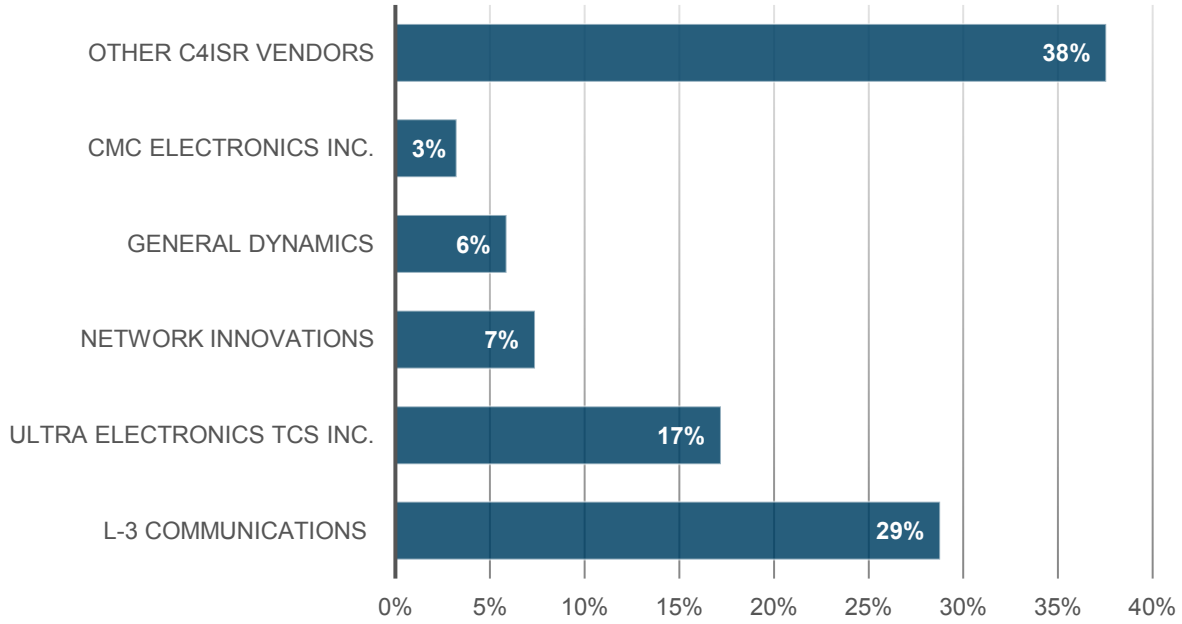
Source: FPDS; CSIS analysis.

DoD contract obligations to Canadian vendors for air have been fairly concentrated, although less so than all other sectors except C4ISR. As shown in Figure 12, the top five vendors received 71 percent of total obligations over the 2008–2015 period. Between 2008 and 2014, this share fluctuated significantly from year-to-year, ranging from a high of 80 percent in 2009 to a low of 64 percent in 2014. However, the 2015 decline in air contract obligations, by over USD $70 million, was primarily borne by Canadian Helicopters Limited, which saw prime contract obligations fall from USD $41 million in 2014 to USD -$3 million, due to deobligations; and by L3 Communications, which saw prime contract obligations fall from USD $36 million in 2014 to USD $9 million. This resulted in these top five vendors' share of air contract obligations falling to just 48 percent in 2015.

Of the five top Canadian vendors for air, three are Canadian-owned, while two—L3 Communications and CMC Electronics (Esterline)—are Canadian subsidiaries of U.S. vendors. Notably, Magellan Aerospace, while Canadian-owned, also has U.S. subsidiaries.

C4ISR Procurements

Figure 13: DoD Contract Obligations, Market Share of Top 5 C4ISR Vendors, 2008–2015



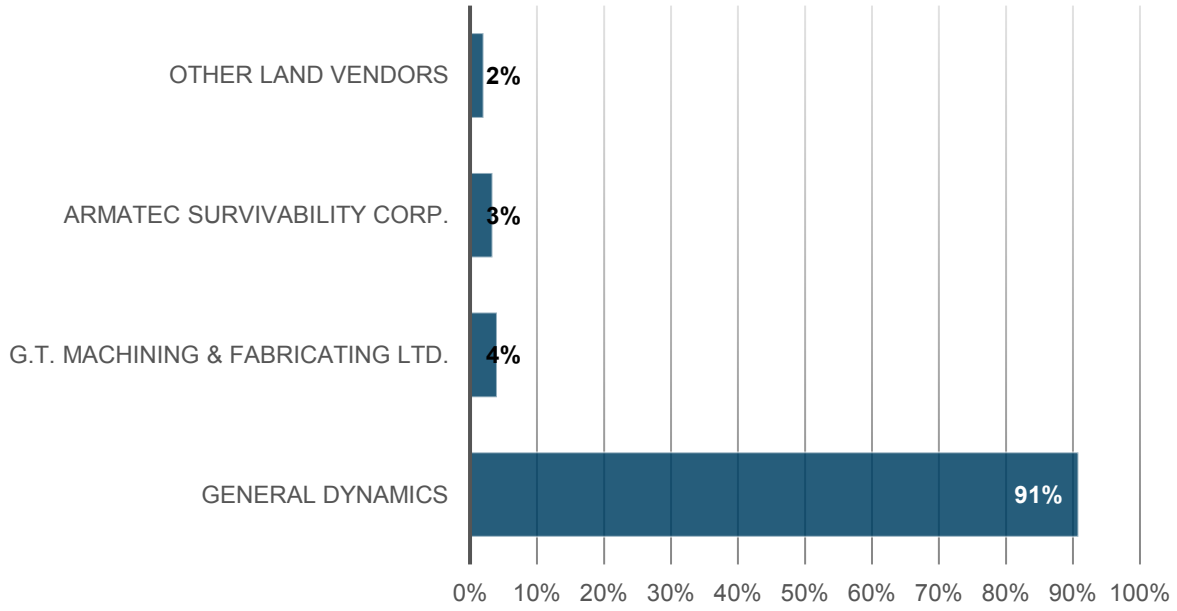
Source: FPDS; CSIS analysis.

DoD contract obligations to Canadian vendors for C4ISR, shown in Figure 13, have been notably less concentrated than for air, with 62 percent of obligations going to the top five vendors over the time period. As recently as 2009, only 48 percent of C4ISR obligations went to the top five; however, significant increases in obligations going to both L-3 Communications and Ultra Electronics TCS resulted in increasing concentration within the C4ISR sector, with 73 percent of obligations going to the top five in 2013. All of the top five vendors have seen significant drops in prime contract obligations between 2013 and 2015, with all but L-3 Communications seeing declines of over 80 percent. As a result, by 2015 the share of obligations going to those top five vendors declined to just 53 percent.

Of the top five C4ISR vendors, Network Innovations is the only Canadian-owned vendor, but also has a U.S. subsidiary. L-3 Communications, CMC Electronics (Esterline), and General Dynamics are U.S.-owned Canadian subsidiaries, while Ultra Electronics TCS is a Canadian subsidiary of a UK vendor. Both CMC Electronics and the Canadian subsidiary of Ultra Electronics had their origins in the Canadian Marconi Corporation, which had been a subsidiary of General Electric before going their separate ways in the early 2000s.

Land Procurements

Figure 14: DoD Contract Obligations, Market Share of Top 3 Land Vendors, 2008–2015



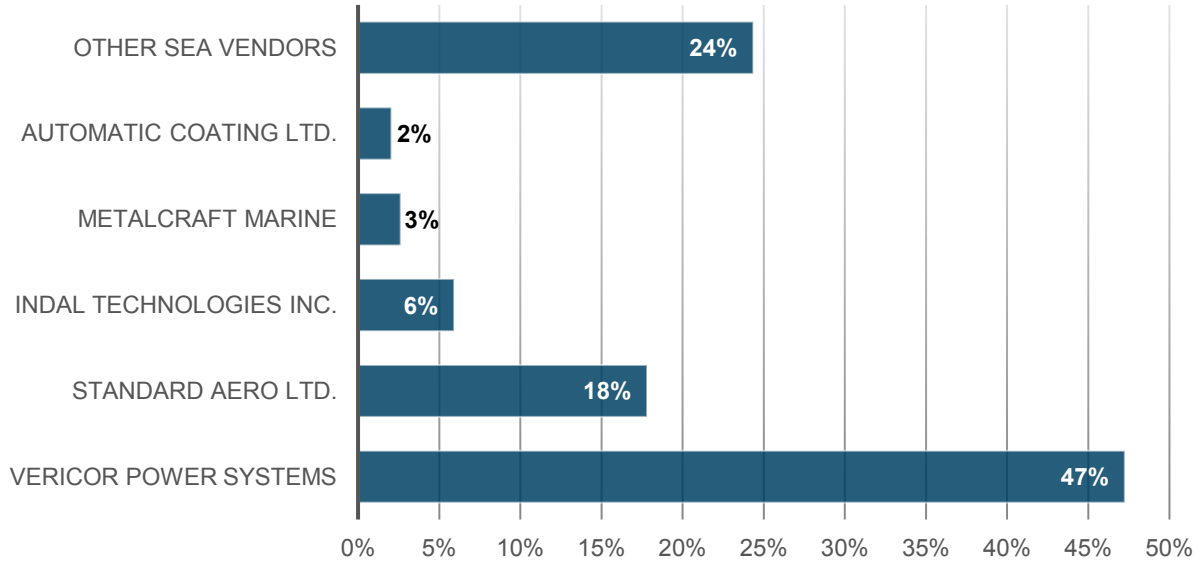
Source: FPDS; CSIS analysis.

Shown in Figure 14, DoD contract obligations to Canadian vendors for land have been dominated by General Dynamics, with 91 percent of obligations since 2008 going to that single vendor. Procurement of GD Land System's light armored vehicles was a major factor, but even since 2013, over three-quarters of land obligations went to General Dynamics. In only three years did another vendor account for even 10 percent of total land obligations: Armatec Survivability in 2009 and 2013 (10 percent and 18 percent, respectively), and G.T. Machining & Fabricating in 2014 (38 percent). Similarly, 2015 was the only year where vendors outside the top three accounted for more than 8 percent of land contract obligations (12 percent in 2015).

G.T. Machining and Fabricating Ltd and Armatec Survivability Corporation are Canadian-owned, while General Dynamics is a U.S.-owned Canadian subsidiary.

Sea Procurements

Figure 15: DoD Contract Obligations, Market Share of Top 5 Sea Vendors, 2008–2015



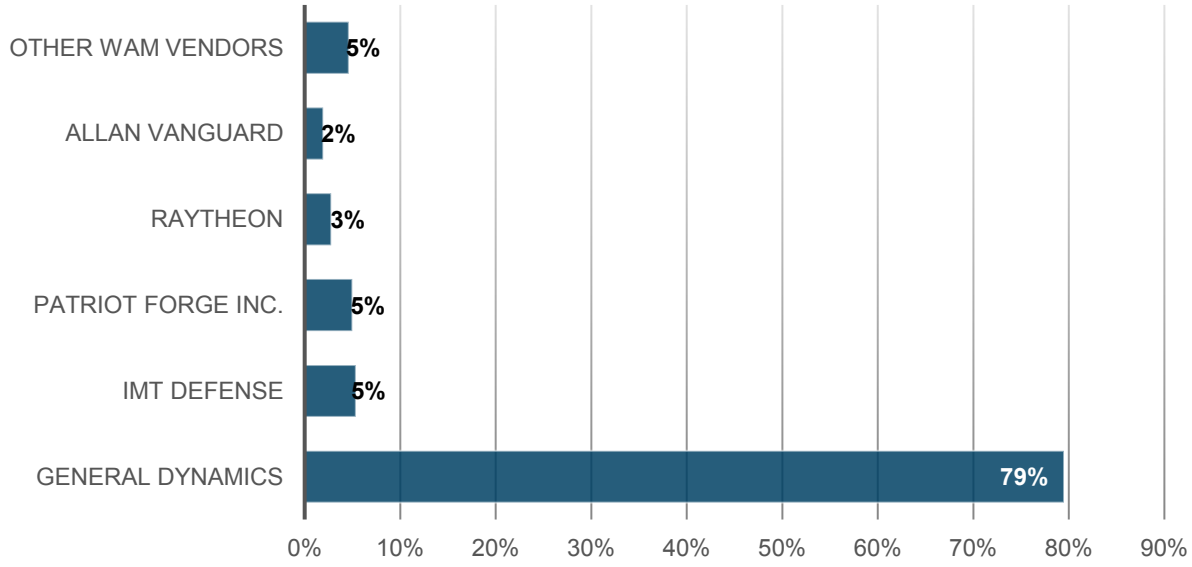
Source: FPDS; CSIS analysis.

For the 2008–2015 period, 76 percent of DoD contract obligations to Canadian vendors for sea have gone to the top five vendors, but that level of concentration was not the norm until recent years. As shown in Figure 15, Only 10 percent of obligations went to those top five vendors in 2009, and as recently as 2011, that figure was 48 percent. The share captured by the top five vendors rose to 65 percent in 2012, and has been above 85 percent from 2013 to 2015, largely on the strength of increased contract obligations to Vericor Power Systems over those three years.

Two of the top five sea vendors are Canadian-owned: Metalcraft Marine and Automatic Coating. Vericor Power Systems is a U.S. subsidiary of a German vendor that has business operations in Canada, while Indal Technologies is a business unit of a U.S. vendor (Curtiss Wright Defense Solutions) and Standard Aero is a U.S. vendor with business operations in Canada. Metalcraft Marine also has a U.S. subsidiary.

Weapons, Ammunition, and Missile Procurements

Figure 16: DoD Contract Obligations, Market Share of Top 5 WAM Vendors, 2008–2015



Source: FPDS; CSIS analysis.

As with land, DoD contract obligations to Canadian vendors for WAM have predominantly gone to General Dynamics, as shown in Figure 16. This trends also holds on an annual basis, with over 80 percent of WAM obligations going to that single vendor in all but two years during the 2008–2015 period. Also similarly to land, in only three years did any other single vendor capture even 10 percent of total WAM obligations: IMT Defense in 2011 and 2013 (22 percent and 13 percent, respectively) and Patriot Forge in 2015 (12 percent). WAM vendors outside of the top five accounted for more than 6 percent of obligations in only one year, capturing 10 percent in 2008.

Two of the top five vendors for WAM are Canadian-owned: IMT Defense and Patriot Forge. General Dynamics, Raytheon, and Allen Vanguard are U.S.-owned Canadian subsidiaries.

Other Products, Services, and R&D Procurements

Unsurprisingly, the vendor base for Other Products, Services, and R&D is highly decentralized, with only 40 percent of obligations between 2008 and 2015 going to the top 5 vendors. "Other" was more highly concentrated earlier in the period, with the top five vendors accounting for 59 percent of obligations in 2008. Since 2011, however, the top five vendors have accounted for less than 30 percent of obligations in all but one year (41 percent in 2013).

Three of the top five "Other" vendors are Canadian-owned: AirBoss–Defense, Advanced Construction Techniques, and Tekmira Pharmaceuticals. HESCO Bastion and Emergent Protective Products are both U.S.-owned firms with business operations in Canada.

Note about Definition of Canadian Vendor

The CSIS approach focuses on contracting with ties to firms and divisions based in Canada. The criteria were broad, including vendors performing work in Canada, that are themselves Canadian, or that provide products originating in Canada. However, this approach leaves out U.S. subsidiaries of Canadian firms—a large dataset. CSIS did a case study of large firms, with known subsidiaries in the United States, from each sector to sample order-of-magnitude and assess trends. This study added about a tenth to total spending of the sample, with higher proportional market share for services.

Note about U.S. Federal Procurement Data

CSIS data analysis is focused at the prime contract level due to lack of consistent reporting at the subcontracting level within the U.S. Federal Procurement Data System. CSIS notes that evidence from both interviews and qualitative research suggests that prime contract data may provide a somewhat narrow view given the sheer volume of cross-border activity that occurs at the sub-contract and commercial level.

Due to the level of supply chain integration as well as the nature of U.S. contracting practices, there are numerous complex cross-border contractual relationships and supplier networks at multiple sub-tier levels, many of which would not be captured at the prime contract level. Furthermore, Canadian firms with a U.S. parent company or U.S. sister division may not have a direct prime contract relationship with DoD, even while they perform most of the work or retain the intellectual property. The industrial sectors with the highest degree of cross-border corporate relationships and supply chain integration—particularly the air sector—have the highest margin of error with respect to capturing a full picture of defense trade.

CSIS estimates, based on a sample rough order of magnitude, that as much as two-thirds of total cross-border defense trade may occur at the sub-tier levels and therefore would not be captured in our analysis. CSIS was able to establish trends within the prime contract data that corroborated data from qualitative research and interviews, but notes that this represents only a sample of the full cross-border defense industrial relationship.

Broad Description of Industrial Sectors

Air – includes aircraft (manned), aircraft components, specialized flight clothing, related facilities and construction, and related R&D and services (no C4ISR)

Sea – includes ships/small crafts/subs (manned) and components, related facilities and construction, and related R&D and services (no C4ISR)

Land – includes vehicles (manned), components, armor (personnel), related facilities and construction, and related R&D and services (no C4ISR)

Space – includes space vehicles (including communications/observation satellites), components, launch, and related R&D and services (**includes** space-based C4ISR)

C4ISR (air/land/sea-based and cross-domain; no space-based) – drones/unmanned systems, all fire control equipment, all communication, detection, radiation, electrical/electronic, fiber optic equipment and components, related facilities and construction, operational training aids, simulation systems and services, and related R&D and services

Weapons, Ammunition, Missiles – self-explanatory

Other – Facilities, Construction, Manufacturing and Testing Equipment; and "Other Products, Services, and R&D"

About the Project Director and Authors

Andrew Hunter is a senior fellow in the International Security Program and director of the Defense-Industrial Initiatives Group at CSIS. He focuses on issues affecting the industrial base, including emerging technologies, sequestration, acquisition policy, and industrial policy. From 2011 to November 2014, Mr. Hunter served as a senior executive in the Department of Defense (DoD). Appointed as director of the Joint Rapid Acquisition Cell in 2013, his duties included fielding solutions to urgent operational needs and leading the work of the Warfighter Senior Integration Group to ensure timely action on critical issues of warfighter support. From 2011 to 2012, he served as chief of staff to Ashton B. Carter and Frank Kendall, while each was serving as under secretary of defense for acquisition, technology, and logistics. Additional duties while at DoD include providing support to the Deputy's Management Action Group and leading a team examining ways to reshape acquisition statutes.

From 2005 to 2011, Mr. Hunter served as a professional staff member of the House Armed Services Committee, leading the committee's policy staff and managing a portfolio focused on acquisition policy, the defense industrial base, technology transfers, and export controls. From 1994 to 2005, he served in a variety of staff positions in the House of Representatives, including as appropriations associate for Representative Norman D. Dicks, as military legislative assistant and legislative director for Representative John M. Spratt Jr., and as a staff member for the Select Committee on U.S. National Security and Military/Commercial Concerns with the People's Republic of China. Mr. Hunter holds an M.A. degree in applied economics from the Johns Hopkins University and a B.A. degree in social studies from Harvard University.

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Gregory Sanders is deputy director and fellow with the Defense-Industrial Initiatives Group at CSIS, where he manages a research team that analyzes data on U.S. government contract spending and other budget and acquisition issues. He employs data visualization and other

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