



THE SCHOOL OF PUBLIC POLICY

MASTER OF PUBLIC POLICY CAPSTONE PROJECT

CF-39 Arrow II: A Swedish Solution to the CF-18 Replacement Problem

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Capstone Executive Summary

Prime Minister Pierre Trudeau ordered 138 CF-18 fighter jets in 1980. As of September 2018, 76 modernized CF-18s remain in service. Over the past two decades, four different Prime Ministers have been involved in selecting a replacement for the CF-18. With a purchase price of over \$16 billion and a potential total lifetime cost of over \$40 billion, the CF-18 replacement will be the second most expensive military procurement in Canadian history. Not only will the CF-18 replacement program have to fight for funding against the general austerity and easy riding nature of Canadians, but it will also be running concurrently with the largest military procurement in Canadian history: The National Shipbuilding Strategy.

This paper reviews the history of Canadian military procurement, with emphasis on the successful New Fighter Aircraft (NFA) program of the 1970s that selected the CF-18, and how those lessons should be applied to the CF-18 replacement. This paper argues that, absent the political will to provide considerably more than 1.15% of GDP in defence spending, the Canadian Forces can no longer afford to be a modern multipurpose force and should instead move to a Navy centric force structure. By reviewing how the CF-18 serves at home on the NORAD mission, in Europe on NATO air policing missions, and as part of coalition combat missions; the minimum requirements for the CF-18 replacement are identified.

This paper recommends employing the NFA methodology to design a defence policy for easy riders. Such a defence policy will meet military objectives with best value, state-of-the-art technology that also offers full industrial offsets for Canadian industry. The best value solution to the CF-18 replacement is the least expensive jet in the competition: the Saab Gripen.

Introduction

Canada's CF-18 fighter jets were purchased by Prime Minister Pierre Trudeau in April 1980 upon the completion of the New Fighter Aircraft (NFA) program that commenced in 1977.¹ A total of 138 F/A-18A/B jets were delivered by McDonnell Douglas between 1982 and 1988.² As of September 2018, 76 modernized CF-18 jets remain in service.³

The NFA program was considered a model procurement method both at the time and in retrospect.⁴ Prime Minister Stephen Harper and Prime Minister Justin Trudeau both aborted attempts to sole source a replacement fighter and both eventually promised an open and transparent competition that closely resembled Pierre Trudeau's NFA program. Long term planning to replace the CF-18 began in earnest in 1998 under the Liberal government of Prime Minister Jean Chrétien when Canada contributed \$10 million (USD) to join the American led Joint Strike Fighter (JSF) program as an information partner during the concept development phase.⁵ The JSF would eventually become the Lockheed Martin F-35.

Defence policy expert Dr. Philippe Lagassé observed that four catchphrases summarize the history of Canadian defence policy since the end of the Second World War: that Ottawa always aims to get "a seat at the table" (Lieutenant-General Burns); that Canadian politicians always ask, "how much is just enough?" (Sokolsky); that the stated defence ambitions of Canadian politicians almost always lack the commitment to adequately fund those projects thereby creating a "commitment-capability gap" (Byers); and that Ottawa's relationship with the United States and approach to North American security is one of "defence against help" (Ørvik).⁶ The combination of these apt descriptors has led multiple Canadian public policy experts to paint Canadians as not quite free riders but "easy riders" when it comes to defence spending and our NATO and NORAD commitments.⁷ The literature review section will summarize and explain these concepts. The findings and policy recommendations sections will outline how the next-generation Saab Gripen E/F is the ideal policy solution for a nation of easy riders.

¹ Kim Richard Nossal, "Late Learners: Canada, the F-35, and Lessons from the New Fighter Aircraft Program," *International Journal* 68, no. 1 (2012): 169, <http://www.jstor.org/stable/42704966>.

² Nossal, "Late Learners," 168.; Canada, "CF-188 Hornet," Accessed September 3, 2018, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cf-188.page>.

³ Canada, "CF-188 Hornet."

⁴ Michael M. Atkinson and Kim Richard Nossal, "Bureaucratic Politics and the New Fighter Aircraft Decisions," *Canadian Public Administration* 24, no. 4 (Winter 1981): 531-58, <http://dx.doi.org/10.1111/j.1754-7121.1981.tb00348.x>; Nossal, "Late Learners," 169.

⁵ John Birkler, John Graser, Mark V. Arena, Cynthia R. Cook, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, Fred Timson, Obaid Younossi and Jon Grossman, "Assessing Competitive Strategies for the Joint Strike Fighter: Opportunities and Options," *The RAND Corporation*, 2001: 18.

⁶ Philippe Lagassé, "Nils Ørvik's 'defence against help'," *International Journal*, Vol. 65, No. 2, Annual John W. Holmes issue on Canadian foreign policy (Spring 2010): 463, <http://www.jstor.org/stable/25681122>.

⁷ Kim Richard Nossal, *Charlie Foxtrot* (Toronto: Dundurn, 2016), 109.

As “gripen” is Swedish for “griffon” and the Royal Canadian Air Force (RCAF) already fly the CH-146 Griffon helicopter, the RCAF should rename the Gripen “Arrow II” should it replace the CF-18. Both the Gripen and the historic CF-105 Avro Arrow have a delta wing, a single vertical tail, and twin rectangular intakes on either side of the nose. To the lay observer, a Gripen would appear to be a modern, albeit smaller, single-engine version of the cancelled Avro Arrow. Saab has offered full technology transfer as well as assembly in Canada for a Canadian order.⁸ Canadian assembly would likely be completed by Bombardier as an expansion of the existing Saab/Bombardier GlobalEye airborne radar jet and Saab/Bombardier Swordfish maritime patrol jet partnerships.⁹ This would mirror how Saab won Brazil’s fighter competition in part by partnering with Embraer for domestic assembly of Brazilian Gripen E/F jets.¹⁰

This would not be the first time the RCAF renamed a European aircraft. Canada’s CH-149 Cormorant helicopter is a search and rescue version of the EH-101 Merlin helicopter flown by the British Royal Navy.¹¹ Building a state of the art, supersonic fighter jet in Canada under the Arrow II name would be a boon to national pride. That said, this paper focuses exclusively on the Swedish Saab JAS-39 Gripen E/F jet being rebranded and assembled in Canada as the “CF-39 Arrow II.” The proposal by a Canadian company to build modern Avro Arrow jets based on surviving blueprints of the original was rightly dismissed by the Canadian Government as not being a viable option.¹² For simplicity, the JAS-39 Gripen E/F will be referred to as “Gripen” throughout this paper.

Purpose of Study

The CF-18 replacement program has been overseen by four different Prime Ministers and gone through multiple iterations. It has become a case study in Canada’s dysfunctional military procurement system. With an estimated initial total purchase price of between \$16 and \$19 billion for 88 jet fighters (between \$181.8 million and \$215.9 million per jet), and a potential total lifetime cost of over \$40 billion, the CF-18 replacement

⁸ Canada, House of Commons, Standing Committee on National Defence, *Meeting 38 Evidence*, 40th Parliament, 3rd Session, December 7, 2010, <http://www.ourcommons.ca/DocumentViewer/en/40-3/NDDN/meeting-38/evidence>.

⁹ Bombardier, “Rollout of Elite GlobalEye Surveillance Solution Solidifies the Bombardier Global 6000 Aircraft as the Platform of Choice for Special Missions,” February 26, 2018, https://www.bombardier.com/en/media/newsList/details.bba_20180226_rollout-of-elite-globaleye-surveillance-solution-so.bombardiercom.html.; Saab, “Swordfish Maritime Patrol Aircraft,” Accessed August 3, 2018, <https://saab.com/air/airborne-solutions/airborne-surveillance/swordfish-maritime-patrol-aircraft/>.

¹⁰ Saab, “Saab Brings Gripen Technology Transfer Programme to Brazil,” November 23, 2016, <https://saab.com/air/gripen-fighter-system/gripen/gripen/proud-to-be-brazilian/gripen-updates/gripen-stories-updates/saab-brings-gripen-technology-transfer-programme-to-brazil/>.

¹¹ Canada, “CH-149 Cormorant,” June 22, 2017, <http://www.rcf-arc.forces.gc.ca/en/aircraft-current/ch-149.page>.; United Kingdom, “Merlin Mk2,” Accessed August 3, 2018, <https://www.royalnavy.mod.uk/the-equipment/aircraft/helicopters/merlin-mk2>.

¹² The Canadian Press, “Avro Arrow redesign pitched as alternative to F-35 stealth fighter jets,” *The National Post*, September 9, 2012, <https://nationalpost.com/news/canada/avro-arrow-redesign-pitched-as-alternative-to-f-35-stealth-fighter-jets>.

will be one of the largest military purchases in Canadian history.¹³ Moreover, the CF-18 replacement program will have to run concurrently with the National Shipbuilding Strategy, by far the largest military purchase in Canadian history with procurement estimates as high as \$40 billion and 30 year total cost estimates over \$64 billion.¹⁴ The current reality is exactly the worst case predictions of defence policy scholars from the turn of the 21st century: that over the next decade the Canadian Forces will be forced to modernize or replace a significant portion of the military's existing capabilities with little to no political will to provide adequate funding.¹⁵

Long term defence spending commitments from the Liberal Government's 2017 Strong Secure Engaged Defence Policy are outlined in Appendix A of this paper and show defence spending remaining relatively flat until 2020. From \$21.7 billion in 2019, defence spending will grow to a high of \$32.7 billion in 2026. This represents only a modest increase from around 0.94% of GDP in 2019, to a high of just under 1.15% in 2024, back down to 1.1% in 2026.¹⁶ It is also worth noting that like the long term defence spending plans of previous Canadian governments, the bulk of new spending is scheduled for after the next election.

Prime Minister Justin Trudeau made the Navy the top priority when he made the 2015 election promise to buy fighter jets that are less expensive than the F-35A in order to free additional funds for the Navy's National Shipbuilding Strategy.¹⁷ This focus on the Navy combined with the Harper Government's 2010 slowdown of defence spending, and 2012 cuts to balance the budget by 2015, have made Jones' and Lagassé's affordable policy option of a Navy-centric force prescient.¹⁸

If policy makers fail to recognize budget limitations, fail to remember the successful NFA program that purchased the CF-18s, and continue with dysfunctional military procurement structures; then the RCAF could be left either with a shrinking fleet of antiquated CF-18s or with an overbudget boondoggle too expensive to adequately meet operating requirements. This paper aims to provide an accurate overview of the significant procurement problem and a framework for a policy solution.

¹³ Lee Berthiaume, "New fighter-jet competition to have national 'economic interest' requirement," *The National Post*, December 12, 2017, <http://nationalpost.com/pm/news-pmn/canada-news-pmn/newsalert-new-fighter-jet-competition-to-have-economic-interest-requirement>.

¹⁴ Murray Brewster, "Ottawa facing decisions on the frigate replacements for navy," *Global News*, March 20, 2016, <https://globalnews.ca/news/2589029/ottawa-facing-decisions-on-frigate-replacements-for-navy/>.

¹⁵ Peter Jones and Philippe Lagassé, "Rhetoric versus reality: Canadian defence planning in the time of austerity," *Defense & Security Analysis* 28, no. 2 (June 2012): 141, <https://doi.org/10.1080/14751798.2012.678160>.

¹⁶ Canada, "Strong Secure Engaged Canada's Defence Policy," 2017, 43, <http://dgpapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf>.

¹⁷ Daniel Leblanc, "Canada Needs New Fighter Jets 'Now,' Defence Minister Says," *The Globe and Mail*, May 26, 2016, <https://beta.theglobeandmail.com/news/politics/canada-needs-new-fighter-jets-now-defence-minister-says/article30172969/?ref=http://www.theglobeandmail.com&>.

¹⁸ David McKie, "Government gets poor grade for military spending," *CBC*, April 14, 2015, <https://www.cbc.ca/news/politics/government-gets-poor-grade-for-military-spending-1.3030862>; Jones and Lagassé, "Rhetoric," 147.

Good research exists for the history of the problem but is complex and dispersed. A modern summary for policy makers is lacking. Regarding the CF-18 replacement itself, the bulk of the research is focused on the American F-35 and Super Hornet. There is little contemporary public policy work comparing Canadian military needs and budget limitations with the available options from European manufacturers. This paper focuses on the CF-18 replacement problem and how the inexpensive multirole Saab Gripen is the best solution for the military needs and financial constraints of the Canadian Forces.

Literature Review

A Seat at the Table & Defence Against Help

Canadian politicians, regardless of political party, have always pushed for Canada to have “a seat at the table” on almost all issues of global politics.¹⁹ Since the end of the Second World War, a bi-partisan consensus has existed in Canada supporting shared security principles.²⁰ These principles include the belief that Western allies have similar values, that the East-West conflict can be deescalated through diplomacy and arms agreements, and that Canada’s interests require a seat at the NATO table with the requisite roles for the Canadian Forces.²¹ Canadian policy has thus long been linked towards this goal of participating in world events in order to ensure international peace and security.²² Historians point out that it is a positive that Canadian governments have made defence policy subordinate to well-articulated foreign policy objectives, however multiple successive governments have consistently failed to articulate a detailed defence policy.²³ As such, much defense policy has been ad hoc in service to Canadian foreign policy while also emphasizing domestic industrial policy.²⁴

Four long-term international defence obligations have historically earned Canada a seat at the table: to contribute to the collective defence of the NATO alliance; to defend North America as part of NORAD; to participate in international UN peacekeeping missions; and to protect the sovereignty and independence of Canadian territory.²⁵ First outlined in the 1959 Conservative Defence White Paper, these responsibilities have been reiterated and reinforced in multiple Liberal and Conservative Defence White Papers since the 1960s.²⁶ During the Cold War, there were issues of allocating the limited available funds between these responsibilities as the manpower and equipment optimal for the defence of North America were distinct from what was required to defend Western Europe from a Soviet invasion. This balancing act continues to be an issue as different branches of the military and various politicians push for spending on equipment optimized for a RCAF capable of a sustained peer-state conflict, a Navy with both coastal and blue-water (open

¹⁹ E.L.M. Burns, *A Seat at the Table: The Struggle for Disarmament*, (Toronto: Clarke Irwin, 1972).

²⁰ R.B. Byers, "Canadian security and defence: The legacy and the challenge," *Adelphi Papers* 214 (1986): 5, <https://doi.org/10.1080/05679328608448759>.

²¹ Ibid.

²² Ibid.

²³ Ibid.

²⁴ Byers, "Canadian security and defence," 9.

²⁵ Byers, "Canadian security and defence," 6.

²⁶ Ibid.

ocean) capabilities, and an Army capable of both peer-state armoured warfare and UN peacekeeping. The key Canadian mission commitments to NATO and NORAD were summarized by Byers in the 1980s as falling into six key areas:²⁷

1. To provide surveillance of strategic submarine forces in the Atlantic and Pacific that threaten North America.
2. To prevent an enemy nation-state from invading and establishing a beachhead on Canadian soil.
3. To protect commercial sea-lanes between Canada and alliance members.
4. To protect North America from Soviet bomber attacks.
5. To maintain an army and air force presence in Western Europe able to help NATO counter a Soviet invasion.
6. To be ready to provide reinforcements to aid in the defence of Europe.

These six Cold War priorities have evolved since the fall of the Soviet Union. While Russia and China have military capabilities that can threaten Canada and its allies, the top security concern in 2018 is from terrorism and violent extremism.²⁸ In 2016 Stephen Burt, the Assistant Chief of Defence Intelligence at the Canadian Forces Intelligence Command, told the Standing Committee on National Defence (NDDN) that the Canadian Armed Forces (CAF) “do not see a state actor that has both the capability and the intent to harm Canada militarily.”²⁹ Mr. Burt explained:

“Tracking or predicting changes in capability is sometimes challenging, but is usually possible within a reasonable margin of error. Gauging current and evolving intent is more complicated but still possible. However, predicting future intent is highly risky. Where a state may not exhibit hostility while it is developing a capability, once acquired, that capability remains in its arsenal whatever changes happen in its political calculus and intent.”³⁰

Counter-terrorism efforts are primarily the domain of civilian government agencies, with the US Department of Homeland Security coordinating with the Royal Canadian Mounted Police (RCMP) and Canadian Security Intelligence Service (CSIS).³¹ NORAD considers terrorist threats less dangerous than potential threats from other states but considers the terrorist threat as more probably because “terrorists have demonstrated capability and intent.”³² To prevent another 9/11-type scenario NORAD maintains a robust air defence over Canada and the United States.³³ In February 2015 Major-General D.L.R.

²⁷ Byers, “Canadian security and defence,” 7.

²⁸ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” *Report of the Standing Committee on National Defence*, September 2016: 16, <https://www.ourcommons.ca/Content/Committee/421/NDDN/Reports/RP8406082/nddnrp02/nddnrp02-e.pdf>.

²⁹ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 6.

³⁰ *Ibid.*

³¹ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 16.

³² Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 10.; NORAD, “NORAD Operations,” brief to NDDN by Major-General Christopher J. Coates (Director of NORAD Operations), NORAD Headquarters, Colorado Springs (Colorado, U.S.), 2 May 2016.

³³ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 10.

Wheeler, Commander 1 Canadian Air Division and Canadian NORAD Region, told the NDDN that NORAD had “responded to more than 3,500 possible airborne threats and intercepted more than 1,400 aircraft” over Canada and the U.S. since the September 11, 2001 terrorist attacks.³⁴

The threat from Russian long-range military aviation still exists but the primary nuclear threat shifted from bombers to ballistic missiles in the mid-1960s.³⁵ The number of Russian bomber intercepts dropped off in the 1990s at the end of the Cold War but began to increase again in 2007.³⁶ Since 2007, NORAD fighters have conducted an average of five intercepts per year of Russian military aircraft in the Canadian or American Air Defence Identification Zone (ADIZ).³⁷ Russian intercepts peaked in 2014 with ten interception flights, this is similar to the average number of intercepts during the high point of the cold war.³⁸ RCAF Lieutenant-General St-Amand explained to the NDDN that none of these Russian aircraft penetrated NORAD airspace but instead entered the international airspace approaching North America that makes up the ADIZ without filing a flight plan, thus necessitating an intercept flight.³⁹

One of the more recent intercept missions flown by the RCAF involved two CF-18s intercepting a Russian Tu-95 Bear bomber in April of 2017.⁴⁰ This was the first RCAF intercept of a Russian aircraft in more than 2 years.⁴¹ The 1950s era turboprop Russian bomber was first tracked by US Air Force (USAF) F-22 stealth fighters based in Alaska.⁴² A similar intercept occurred in February 2009 with USAF and CF-18 jets intercepting a pair of Russian Tu-95 bombers 190 km northeast of Tuktoyaktuk, NWT just hours before President Obama arrived in Ottawa for his first foreign visit.⁴³ RCAF CF-18s are often photographed intercepting Russian Tu-95 bombers equipped with three external fuel tanks, a pair of AIM-9M infrared guided missiles, and two AIM-120 radar guided missiles.⁴⁴ USAF F-22s are often photographed intercepting Russian Tu-95 bombers equipped with two external fuel tanks, Luneburg lenses, and an unknown internal armament of at most two AIM-9M/X infrared missiles and six AIM-120 radar guided missiles.⁴⁵ The

³⁴ Ibid.

³⁵ Byers, “Canadian security and defence,” 7.

³⁶ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 12.

³⁷ Ibid.

³⁸ Ibid.

³⁹ Ibid.

⁴⁰ The Canadian Press, “Canadian jets intercept Russian bombers for first time in 2 years,” *The Star*, April 21, 2017, <https://www.thestar.com/news/canada/2017/04/21/canadian-jets-intercept-russian-bombers-for-first-time-in-2-years.html>.

⁴¹ Ibid.

⁴² Ibid.

⁴³ Allan Woods, “Russian bombers intercepted on eve of Obama visit,” *The Star*, February 27, 2009, https://www.thestar.com/news/canada/2009/02/27/russian_bombers_intercepted_on_eve_of_obama_visit.html.

⁴⁴ Ibid.; Canada, “Royal Canadian Air Force Image Gallery,” July 26, 2013, <http://rcaf-arc-images.forces.gc.ca/gallery/caf/search/>.

⁴⁵ Stephen Dowling, “Russia’s Bear: The old-fashioned plane still thriving,” *BBC*, February 26, 2015, <http://www.bbc.com/future/story/20150225-the-worlds-noisiest-spyplane>.; Ami Dombe, “China’s Radars

combination of radar reflecting Luneburg lenses and external fuel tanks intentionally ruin the passive stealth of the F-22 so as to deny the Russians the opportunity to test their radars against a stealth jet in a stealth configuration.⁴⁶

While the primary threat to Canada and the United States from ballistic missiles remains Russia's considerable inventory, the US Army Space and Missile Defense Command report that 30 countries possess some ballistic missile capability.⁴⁷ Of those with ballistic missiles China, France, India, Israel, North Korea, Pakistan, Russia, the United Kingdom, and the United States also possess nuclear weapons.⁴⁸ Russia, North Korea, Libya, and Syria are also known to have chemical and biological weapons.⁴⁹ Stephen Burt stressed to the NDDN that the threat of weapons of mass destruction reaching North America on ballistic missiles is "worrisome" but that "only states can master the complexities of ballistic missile delivery systems."⁵⁰

Stephen Burt elaborated to the NDDN that North Korea and Iran will continue to develop their ballistic missile systems and nuclear weapons programs.⁵¹ Iran currently lacks the ability to attack North America with ballistic missiles.⁵² North Korea has publicly stated the goal of building a ballistic missile able to attack North America with a thermonuclear weapon.⁵³ Mr. Burt told the NDDN in March 2016 that "North Korea's recent claim of successfully testing a thermonuclear weapon or H-bomb is unsubstantiated."⁵⁴ However, USAF General John E. Hyten, commander of Strategic Command, told reporters that he assumed that North Korea had tested a thermonuclear bomb on September 3rd, 2017 based on the size of the explosion.⁵⁵ US Defense Secretary Jim Mattis later commented that the explosion was more than 100 kilotons and thus could have been an H-bomb.⁵⁶ A few months later in November 2017, North Korea successfully tested the Hwasong-15 missile that Secretary Mattis reported likely had the ability to hit anywhere in the continental United States.⁵⁷

Christopher Sands, the Director of John Hopkins University's Center for Canadian Studies, told the NDDN that Russian and China are responsible states unlikely to start a

Tracked the US Stealthy F-22 Raptor," *Israel Defense*, February 22, 2016, www.israeldefense.co.il/en/content/chinas-radars-tracked-us-stealthy-f-22-raptor.

⁴⁶ Ibid.

⁴⁷ Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 12.

⁴⁸ Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 13.

⁴⁹ Ibid.

⁵⁰ Ibid.

⁵¹ Ibid.

⁵² Ibid.

⁵³ Ibid.

⁵⁴ Ibid.

⁵⁵ The Associated Press, "U.S. nuclear commander assumes North Korea tested H-bomb Sept. 3," *CBS News*, September 15, 2017, <https://www.cbsnews.com/news/u-s-nuclear-commander-assumes-north-korea-tested-h-bomb-sept-3/>.

⁵⁶ Ibid.

⁵⁷ Zachary Cohen, Ryan Browne, Nicole Gaouette, and Taehoon Lee, "New missile test shows North Korea capable of hitting all of US mainland," *CNN*, November 30, 2017, <https://www.cnn.com/2017/11/28/politics/north-korea-missile-launch/index.html>.

nuclear war by launching a missile at North America while North Korea and Iran are more worrisome and untrustworthy.⁵⁸ While the United States would be the likely target of any rogue Korean or Iranian ballistic strike, Canada would be closely involved as part of NORAD's role in tracking incoming ballistic missiles.⁵⁹ A missile strike aimed at the US could cause massive Canadian casualties from a missile accidentally landing in Canada or from radioactive fallout spreading into Canada from targeted American cities near the border.⁶⁰

A new threat of concern to NORAD stems from recent advancements in the speed and sophistication of advanced cruise missiles.⁶¹ These new missiles increase the threat from submarines, surface ships, and military aircraft as they have enhanced range, higher speeds, and are harder to detect than the legacy weapons they replace.⁶² Of particular concern are the conventionally-armed Russian Kh-101 and nuclear-armed Kh-102 cruise missile twins.⁶³ These weapons have an estimated intercontinental range of "between 3,000 and 5,000 km."⁶⁴ Russian cruise missile strikes against targets in Syrian included successful launches of Kh-101 missiles from Tu-160 Blackjack supersonic strategic bombers, as well as similarly capable naval cruise missiles launched from warships and submarines.⁶⁵ Lieutenant-General St-Amand outlined to the NDDN the threat to North America from these new cruise missiles in April 2016:

"The advanced long-range cruise missiles that we have observed are not only still a threat in the aerospace domain but also in the maritime domain, because they are now being launched from submarines and surface vessels. So the maritime domain now is becoming a domain of interest that is really challenging us to think in terms of continental defence, as opposed to only from a perspective of U.S. or Canadian defence."⁶⁶

While the primary nuclear threat has shifted to ballistic missiles, the next generation of advanced Russian and Chinese cruise missiles have reinvigorated the need for Canada to fulfill the old cold war obligations of contributing to the defence of North America from the threats from submarines and bombers flying over the Arctic. The former demands a return to the Cold War joint efforts between the Royal Canadian Navy and the RCAF CP-140 Aurora long-range maritime patrol aircraft.⁶⁷ The latter demands a fast CF-18 replacement that's capable of operating from existing Forward Operating Locations in Iqaluit, Inuvik, Rankin Inlet, and Yellowknife.⁶⁸

⁵⁸ Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 14.

⁵⁹ Ibid.

⁶⁰ Ibid.

⁶¹ Ibid.

⁶² Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 15.

⁶³ Ibid.

⁶⁴ Ibid.

⁶⁵ Ibid.

⁶⁶ Ibid.

⁶⁷ Byers, "Canadian security and defence," 7.

⁶⁸ Canada, "RCAF MAP," July 19, 2013, <http://www.rcf-arc.forces.gc.ca/en/rcf-map.page>.

The \$2.2 billion CP-140 Aurora fleet modernization and life extension programs are currently ongoing and should be completed in December 2020.⁶⁹ These programs include an upgrade to key mission systems and sensors as well as replacing the wings and horizontal stabilizers on 14 CP-140 Aurora aircraft.⁷⁰ This will extend the life of the CP-140 fleet to the year 2030.⁷¹ As 18 CP-140 Aurora aircraft were ordered by Prime Minister Pierre Trudeau before his government ordered the CF-18, replacing the CP-140 Aurora is an urgent requirement for the RCAF.⁷² The Liberal government's 2017 Strong Secure Engaged Defence Policy announced that the CP-140 would be primarily replaced by the Canadian Multi-Mission Aircraft (CMA) program in the early 2030s and may be augmented by a future Intelligence, Surveillance and Reconnaissance (ISR) program aircraft to support the Special Operations Forces.⁷³ The CMA must function as "a long-range manned Command, Control, Communications and Computers (C4) and Intelligence, Surveillance and Reconnaissance (ISR) and Anti-Submarine Warfare (ASW) aircraft," capable of long loiter times to support Canada's NORAD mission at home and NATO missions abroad.⁷⁴ In February 2017 Lieutenant-General Mike Hood, commander of the Royal Canadian Air Force, announced that for the CMA and ISR programs he had instructed the Department of National Defence "to imagine how we continue to develop the world-leading anti-submarine warfare capability and put that into a Canadian platform."⁷⁵ General Hood elaborated, "I want to be working with Canadian industry, favouring Canadian industry, and I want to create that innovation culture to maybe get the RCAF back to where it was at one point in time, where it drove a lot of the innovation."⁷⁶

Ørvik's idea of "defence against help" was to provide a fourth answer to the question: "What does a country do when it becomes obvious that its defence forces are unable to resist successfully an attack by the superior forces of a neighboring state?"⁷⁷ The three contemporary strategies available to small states were: Self-Help, a significant increase in their own military strength (ex: Israel); Borrowed-Help, a reliance on alliances to bolster the limited capabilities of the domestic military (ex: Luxembourg via NATO); or Helplessness, a purely ceremonial and symbolic military (ex: Gambia).⁷⁸ Ørvik argued that a defence against help strategy in the Canadian context would be one where the Canadian military possessed the capability to credibly and independently defend Canada from the Soviet Union.⁷⁹ This self defence capability was critical so that the Americans would see us

⁶⁹ Canada, "CP-140 Aurora fleet modernization and life extension," June 6, 2018, <http://www.forces.gc.ca/en/business-equipment/procurement-projects/aurora-cp-140.page>.

⁷⁰ Ibid.

⁷¹ Ibid.

⁷² Canada, "CP-140 Aurora," November 28, 2017, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cp-140.page>.

⁷³ Canada, "Strong Secure Engaged," 65.

⁷⁴ Canada, "Canadian Multi-Mission Aircraft," May 30, 2018, <http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=975>.

⁷⁵ Chris Thatcher, "Operation Innovation," *RCAF News Article*, February 28, 2017, <http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=operation-innovation/izkjrliv>.

⁷⁶ Ibid.

⁷⁷ Nils Ørvik, "Defence against help: A strategy for small states?" *Survival* 15, no. 5 (1973): 228.

⁷⁸ Lagassé, "Nils Ørvik's 'defence against help'," 465.

⁷⁹ Lagassé, "Nils Ørvik's 'defence against help'," 467-468.

as partners in the defence of North America.⁸⁰ A purely symbolic Canadian Forces would be blatantly and utterly dependent on American borrowed-help and would invite the Americans to “help” defend Canada with or without our consent thereby eroding our sovereignty, international standing, and self-respect.⁸¹ Applying Ørvik’s idea to Canadian history shows numerous examples of Canadian politicians being worried about unsolicited help from the Americans and employing a defence against help strategy.⁸² During the Second World War Prime Minister Mackenzie King made it clear that Canada would adequately defend itself from the Germans and Japanese without relying on assistance from the United States.⁸³

Joel Sokolsky outlined to the NDDN in 2016 that the modern defence of North America is intertwined between Canada and the United States and that “the defence of North America can’t be separated from [the] overall foreign and defence policy” of both nations.⁸⁴ Lieutenant-General St-Amand reinforced this point to the committee, “it’s very difficult to isolate a threat to the United States from a threat to Canada, and vice versa.”⁸⁵ This inability to separate threats forces Canada to adopt Ørvik’s idea of defence against help to guarantee a seat at the table lest the Americans feel the need to subsume Canadian defence responsibilities. Pulling our own weight is also key to maintaining good trade relations with the United States. The connection between trade and defence was outlined to the NDDN by David Drake, Director General of Global Affairs Canada’s International Security and Intelligence Bureau, when he emphasized that “the security of North America is the primary enabler for the close economic ties with the U.S. that underpin the prosperity of both Canada and the United States.”⁸⁶

The Modern NORAD Mission

The history of the North American Aerospace Defense Command (NORAD) began in 1957 when Canada and the United States agreed to establish a joint air defence command.⁸⁷ The official NORAD agreement was signed on the 12th of May 1958.⁸⁸ The NORAD agreement was “reviewed, revised, renewed, or extended” nine times between 1958 and 2006 when it was renewed in perpetuity.⁸⁹ The 2006 renewal also added a new maritime warning role.⁹⁰ The modern NORAD missions consist of:

⁸⁰ Ibid.

⁸¹ Ibid.

⁸² Lagassé, “Nils Ørvik’s ‘defence against help,’” 470.

⁸³ Ibid.

⁸⁴ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 8.

⁸⁵ Ibid.

⁸⁶ Ibid.

⁸⁷ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 18.

⁸⁸ Ibid.

⁸⁹ Ibid.

⁹⁰ Ibid.

Aerospace Warning: monitoring all man-made global aerospace movements and providing warning of any potential attack against North America from aircraft, missiles, satellites, or spacecraft.⁹¹

Aerospace Control: providing surveillance and exercising operational control of Canadian and American airspace. This includes the authority to coordinate and direct the activities of all Canadian and American military forces available to NORAD.⁹²

Maritime Warning: monitoring and distributing intelligence information pertaining to the maritime approaches to, and the internal waterways of, Canada and the United States. NORAD is to maintain a comprehensive understanding of all maritime activities, identify maritime threats to North America, and relay that information to the relevant national commands.⁹³

The Canadian and American militaries work together to fulfill the NORAD missions using a network of ground-based radars including the North Warning System, Airborne Warning and Control Systems (AWACS) aircraft, fighter jets, air-to-air refueling tankers, satellites, and other assets.⁹⁴ NORAD functions as “a system of systems” that critically relies on the interoperability of Canadian and American military hardware.⁹⁵ It is therefore critical that all RCAF purchases maintain support for NORAD interoperability. The two most pressing Canadian purchases in the NORAD context are the CF-18 replacement and the pending upgrade to the North Warning System. NORAD leadership explained to the NDDN in May 2016 that the future system should ideally extend the ADIZ farther north in response to the threat posed by modern long-range cruise missiles.⁹⁶ A map of the original 1987 North Warning System and NORAD radar array network is included in Appendix B.

[Charlie Foxtrot: Easy-Riding, Big-Eyed Politicians and Canadianizing Agents](#)

Dr. Kim Richard Nossal’s 2016 book *Charlie Foxtrot* is a catalog of dysfunctional Canadian military procurement. It includes case studies on the Sea King helicopter replacement program and the CF-18 replacement program, that serve as key examples of Canada’s procurement problems. Comparing these fiascos to the successes of the NFA program reinforces how the NFA program design got it right and should be the model of all future major procurements. This paper heavily references Dr. Nossal’s research and arguments pertaining to the CF-18 replacement program but deviates from his conclusion: that the F-35A would win a truly open and fair competition based on both price and capability.⁹⁷ The findings section will expand on the reasons for the different conclusion.

⁹¹ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 18-19.

⁹² Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 19.

⁹³ Ibid.

⁹⁴ Ibid.

⁹⁵ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 19-20.

⁹⁶ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 29.

⁹⁷ Nossal, *Charlie Foxtrot*, 81-83.

The 1987 defence white paper announcement included a proud proclamation that the government of Prime Minister Brian Mulroney was committed to purchasing twelve nuclear submarines for the Royal Canadian Navy.⁹⁸ Two years later, once the sizeable cost of such a purchase was itemized, the Mulroney government cancelled the program.⁹⁹ The cancellation was predicted by political scientist Norrin Ripsman in 1987 when he pointed out that such a grandiose purchase announcement was likely just the latest example of Canadian politicians having “big eyes” but “empty pockets” when it came to defence spending.¹⁰⁰ The Harper government, in the 2008 Canada First Defence Strategy, demonstrated big eyed thinking when it argued that Canada must have a “fully integrated, flexible, multi-role, and combat-capable military.”¹⁰¹ The strategy document was lambasted by many defence experts as little more than an aspirational “shopping list.”¹⁰² The fact that the stated budget was insufficient to purchase the equipment was another example of what Byers and Legassé call Canada’s “commitment-capability gap:” “the tendency of Canada’s defence ambitions to surpass the means allocated to the armed forces.”¹⁰³

Canadians have rarely worried enough about foreign aggression to demand lavish defence spending. As a result, politicians in Canada have enjoyed a permissive political environment for playing political games with relatively small defence budgets. David Mills, the Liberal MP for Bothwell, provided a timeless summary in an 1875 speech to the House of Commons: “In a country situated as we are, not likely to be involved in war, and having a large demand upon our resources for public improvements, it [is] highly desirable to have our military affairs conducted as cheaply as possible.”¹⁰⁴ Joel Sokolsky, former principal of the Royal Military College of Canada, postulated that Canadian politicians are not “free-riders” when it comes to our military treaty obligations, but “easy-riders” that carefully calculate the minimum amount of money we need to spend to avoid international scorn and domestic embarrassment.¹⁰⁵

Politicians of both major parties know that they can get positive press from proudly proclaiming their support for the troops and from announcing a new long-term defence plan with new spending priorities. Delivering on those promised procurements in a timely fashion, however, gains them little to no additional political rewards.¹⁰⁶ The aforementioned example of Mulroney’s submarines is a prime case showing positive press

⁹⁸ Nossal, *Charlie Foxtrot*, 55.

⁹⁹ Ibid.

¹⁰⁰ Norrin M. Ripsman, “Big Eyes and Empty Pockets: The Two Phrases of Conservative Defence Policy,” *Diplomatic Departures: The Conservative Era in Canadian Foreign Policy, 1984-93 ed.* (Vancouver: UBC Press, 2001), 100-112.

¹⁰¹ Canada, “Canada First Defence Strategy,” Accessed October 19, 2017, http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/CFDS-SDCD-eng.pdf.

¹⁰² Ferry de Kerckhove, “Foreword,” *Charlie Foxtrot* (Toronto: Dundurn, 2016), 14.

¹⁰³ Ibid; Philippe Lagassé “Nils Ørvik’s ‘defence against help’.” 463.

¹⁰⁴ House of Commons, *Debates*, February 21, 1875; quoted in Nossal, *Charlie Foxtrot*, 108.

¹⁰⁵ Joel S. Sokolsky, “Realism Canadian Style: National Security Policy and the Chrétien Legacy,” *Policy Matters* 5, no. 2 (June 2004), 11, <http://irpp.org/wp-content/uploads/assets/pmvol5no2.pdf>; Nossal, *Charlie Foxtrot*, 109.

¹⁰⁶ Ibid.

from the announcement with little to no negative press when the plan was eventually discarded.¹⁰⁷ The successful NFA program, praised by historians for successfully purchasing the CF-18s on time and on budget, gained Trudeau few political points in the 1984 election campaign that he lost to Brian Mulroney. Similarly, the Harper Government enjoyed no praise for the on time and on budget deliveries of C-17 Globemaster jets, M777 howitzers, and CH-47 Chinook helicopters during the 2015 election campaign.¹⁰⁸

Getting defence procurements right doesn't win many votes in Canada and being overtly critical of a sitting government's defence policy doesn't lose votes. The Sea King replacement program was an objectively well run, NFA style procurement, that started by the Pierre Trudeau government and was completed with an order placed by the Mulroney government.¹⁰⁹ Two versions of the winning EH101 helicopter would be purchased: a multipurpose version to replace the Sea King helicopters used by the Navy and a search and rescue version to replace the Labrador helicopters.¹¹⁰ With the cold war coming to an end both the NDP and the Liberal party seized the opportunity to criticize the Mulroney government and speciously painted the EH101 as an "attack helicopter."¹¹¹ Liberal leader Jean Chrétien claimed that it was "an obscene waste of tax dollars," that it was "un-Canadian," and promised to cancel the order if elected.¹¹² It became an election issue in 1993 and the Chrétien Liberals won a landslide victory.¹¹³

The EH101 order was cancelled by the Chrétien government at its first cabinet meeting in 1993.¹¹⁴ The next day 750 Canadians hired to deliver on the contract were laid off and in 1996 the Chrétien government admitted that it had cost \$478.3 million to cancel the contract.¹¹⁵ With the Labradors' age making continued operations unsafe for the crews, the Chrétien government was forced to launch a new search and rescue helicopter competition in 1995.¹¹⁶ In 1998 the Chrétien government formally announced that the EH101 had won, but the name was changed to CH-149 Cormorant.¹¹⁷

Unwilling to sufferer another embarrassment, the Chrétien government designed the subsequent Sea King replacement competition so that any helicopter but the EH101 would win. The initial list of 1,400 mandatory performance requirements was reduced to 475 by order of the Prime Minister's Office (PMO).¹¹⁸ The requirement that the winner be an off-the-shelf purchase of a helicopter currently in use and production was scrapped, allowing developmental aircraft to compete.¹¹⁹ Cabinet even violated standing Treasury Board contracting rules that required procurements secure "best value" by changing the

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

¹⁰⁹ Nossal, *Charlie Foxtrot*, 61.

¹¹⁰ Nossal, *Charlie Foxtrot*, 62.

¹¹¹ Nossal, *Charlie Foxtrot*, 64.

¹¹² Ibid.

¹¹³ Ibid.

¹¹⁴ Nossal, *Charlie Foxtrot*, 65.

¹¹⁵ Nossal, *Charlie Foxtrot*, 66.

¹¹⁶ Ibid.

¹¹⁷ Ibid.

¹¹⁸ Nossal, *Charlie Foxtrot*, 68.

¹¹⁹ Ibid.

criteria to “lowest-cost compliant” bid.¹²⁰ The political game worked, and the developmental Sikorsky CH-148 was announced as the winner in 2004.¹²¹ The CH-148 was supposed to be fully delivered and in service by 2011. Instead, the first helicopters were not delivered until 2015.¹²² Final deliveries are scheduled for 2021 at an estimated cost overrun of \$200 million.¹²³ The Liberals under Justin Trudeau employed a similar election strategy during the 2015 campaign by focusing on the Conservative’s F-35 boondoggle, promising to not purchase the F-35, and instead committing to start an “open and transparent competition” to replace the CF-18s.¹²⁴

The practice of formally requesting domestic economic benefits as a part of defence procurement bids can trace its origins back to the large procurements of the 1970s, including the NFA program that selected the CF-18.¹²⁵ Originally called “Industrial and Regional Benefits (IRBs)” the name was changed in 2014 by the Harper government to “Industrial and Technological Benefits (ITBs).”¹²⁶ The program still operates much the same way, requiring that all defence procurements worth over \$100 million generate “high value-added business activity for Canadian industry” equal to or greater than the value of the contract awarded by the government.¹²⁷ In 2014, the Harper government also added the requirement that bidders identify how they will support “Key Industrial Capability’s (KICs)” and that these would be considered in the evaluation.¹²⁸ With so much of the Harper government defence policy being focused on domestic industry, Canadian historian Jack Granatstein lamented, “it is becoming increasingly clear that the government has no defence policy. Nowhere has the government stated that it foresees threats or crises that might require Canadian intervention with this or that kind of forces.”¹²⁹

Many of the most successful defence acquisitions, such as the CF-18 jets, the M777 howitzers, and the C-17 Globemaster jets, were purchased off-the-shelf and imported with little to no modifications.¹³⁰ In each of these examples, this was against the self-interest of the bureaucrats who pushed for heavy customization, or “Canadianization.” Canadianization games were one of the defining characteristic of the LRPA acquisition that created so much principal-agent conflict during the procurement of the CP-140 aircraft.¹³¹ The LRPA procurement conflict escalated to the point where the minister responsible, Jean-Pierre Goyer, accused one of the senior civil servants on the project of “gross negligence” and said in the House of Commons that he had been routinely misinformed by the

¹²⁰ Nossal, *Charlie Foxtrot*, 69.

¹²¹ Nossal, *Charlie Foxtrot*, 70.

¹²² Nossal, *Charlie Foxtrot*, 71.

¹²³ *Ibid.*

¹²⁴ CBC, “Justin Trudeau Vows to Scrap F-35 Fighter Jet Program,” *CBC News*, September 20, 2015, <http://www.cbc.ca/news/politics/canada-election-2015-trudeau-scrap-f35-halifax-1.3235791>.

¹²⁵ Nossal, *Charlie Foxtrot*, 97.

¹²⁶ *Ibid.*

¹²⁷ *Ibid.*

¹²⁸ *Ibid.*

¹²⁹ J.L. Granatstein, “Delays, deficit fighting and no direction,” *Ottawa Citizen*, 6 December 2012.

¹³⁰ Nossal, *Charlie Foxtrot*, 101.

¹³¹ *Ibid.*

bureaucracy.¹³² The LRPA program became a case study in public choice theory and of the principal-agent problem in how an unconstrained bureaucracy will tend to advance their gold-plated policy preferences by claiming to minimize risk, taking shortcuts, and spinning cost estimates in a way that hides the true cost until it is too late to cancel or fix the project.¹³³

In a similar manner to how the Trudeau Liberals learned the importance of the principal overseeing the agent from the LRPA program, the Harper Conservatives would learn from the F-35 fiasco. When Defence Minister Peter MacKay announced the sole sourced purchase of 65 F-35 jets in July 2010, he fully trusted that the bureaucracy had followed best practice and was being completely forthright with all relevant costs. However, the F-35 cost scandal revealed that DND's estimated flyaway cost of \$75 million (USD) was irrationally optimistic when the Parliamentary Budget Officer (PBO) reported a flyaway cost estimate of \$148 million (USD) in 2011.¹³⁴ The scandal also highlighted that even if Canadian firms won all \$10.2 billion (USD) in eligible domestic component production contracts, the \$16 billion (USD) acquisition cost of 65 F-35 aircraft would mean that it would fail the 100% industrial offset requirement established by the NFA program.¹³⁵ The F-35 program shared a program structure, lack of oversight, and many of the failures of the LRPA program.¹³⁶

The Government of Canada devotes considerable time and resources to protecting against conflicts of interest in procurement matters and has rules to reduce the appearance of impropriety.¹³⁷ Public choice theory suggests that even excellent rules will not completely prevent the noblest of public servants from thinking of their own personal long-term interests and career prospects. Members of the RCAF and DND bureaucrats working on the CF-18 replacement currently are interacting with lobbyists who were recently their peers and leaders. Retired RCAF Lieutenant-General Charles Bouchard retired from the RCAF in April 2012 only to join Lockheed Martin Canada as Country Sales Leader in September 2013.¹³⁸ Retired RCAF Lt. Colonel Billie Flynn, a former CF-18 pilot, joined Lockheed Martin in 2003 and is currently an F-35 test pilot and is heavily involved in

¹³² Nossal, "Late Learners," 172.

¹³³ Nossal, "Late Learners," 180.

¹³⁴ Tolga R. Yalkin and Peter Weltman, "An Estimate of the Fiscal Impact of Canada's Proposed Acquisition of the F-35 Lightning II Joint Strike Fighter," Canada, March 10, 2011, 27, http://publications.gc.ca/collections/collection_2011/dpb-pbo/YN5-31-2011-eng.pdf.

¹³⁵ Daniel Leblanc, "Harper Bending to U.S. on Sole-Source Fighter Purchase, Documents Reveal," *The Globe and Mail*, June 10, 2010, <https://beta.theglobeandmail.com/news/politics/harper-bending-to-us-on-sole-source-fighter-purchase-documents-reveal/article4184697/?ref=http://www.theglobeandmail.com&>.

¹³⁶ Nossal, "Late Learners," 182.

¹³⁷ Canada, "Apparent Conflict of Interest," July 23, 2015, <https://www.canada.ca/en/treasury-board-secretariat/services/values-ethics/conflict-interest-post-employment/apparent-conflict-interest.html#a3>.

¹³⁸ Lockheed Martin, "Charles Bouchard To Lead Lockheed Martin Canada," September 24, 2013, <https://www.lockheedmartin.com/us/news/press-releases/2013/september/0924hq-bouchard-lm-canada.html>.

selling the F-35.¹³⁹ Retired RCAF Major Ricardo Traven, a former CF-18 pilot, joined Boeing in 1997 and is currently the chief test pilot on the Super Hornet program.¹⁴⁰ While none of the above have broken any rules, public choice theory suggests that even the most noble RCAF officer will subconsciously consider if they'd like to follow their colleagues' "retirement" career paths and allow that to influence their recommendations. This simple fact reinforces the need for the cabinet-principals to keep the public servant-agents on a tight leash with clearly defined objectives. Proper oversight, like that provided under the NFA program, solves many of the agent-related games that can plague military procurement.

Methodology and Data Collection/Analysis

This paper utilizes a combination of a qualitative case study approach that compares the potential future needs of the Canadian Forces next fighter aircraft to how the CF-18 was historically deployed. The qualitative analysis includes examinations of the academic literature, government documents, testimony before the Parliamentary Standing Committee on National Defence, industry publications, press releases, and publicly available program budgets.

This paper illustrates the different missions flown by the CF-18, how the Gripen can fly those same missions, and how valuable Canadian contributions are to multinational combat missions. In short, this paper is a recipe for a low-cost NATO air force optimized for NORAD air policing, support of Navy-centric overseas operations, and coalition air campaigns.

Findings

Austerity and the Need to Specialize

The 2010 NATO Strategic Concept advanced the idea that member nations should better coordinate defence spending to reduce overlapping capabilities while also prevent the loss of important niche capabilities.¹⁴¹ NATO Secretary General, Anders Fogh Rasmussen, encouraged members to "pool and share capabilities" as "not all nations can afford or need all capabilities."¹⁴² Jones and Lagassé emphasized that Canadian defence planners and politicians should take this advice to heart as they were rapidly approaching a point where "DND and the CF will be forced either to eliminate certain capabilities or

¹³⁹ Maryam Shah, "Test pilot makes F-35 pitch," *Toronto Sun*, June 17, 2016, <http://torontosun.com/2016/06/17/test-pilot-makes-f-35-pitch/wcm/4e877334-adf3-484d-9d0a-174a0a8a87c4>.

¹⁴⁰ Daniel Leblanc, "Dogfight," *The Globe and Mail*, November 12, 2017, <https://www.theglobeandmail.com/news/politics/breaking-down-the-dogfight-over-canadas-next-fighter-jet/article30495055/>.

¹⁴¹ NATO, Strategic Concept: Active Engagement, Modern Defence, 19 November 2010, para. 37.; Jones and Lagassé, "Rhetoric versus reality:" 140.

¹⁴² NATO Secretary General Anders Fogh Rasmussen, 'Building Security in an Age of Austerity' (keynote speech Munich Security Conference, Munich, Germany, February 4, 2011).; Jones and Lagassé, "Rhetoric versus reality:" 140.

curtail spending in other areas, such as operations and readiness, if they wish to preserve a semblance of the Canadian military's existing force structure."¹⁴³

The Chrétien Government's 1994 Defence White Paper assured that Canada would maintain a multi-purpose military able to meet all NORAD and NATO commitments despite the budget being cut by a third.¹⁴⁴ The capital equipment portion was consistently underfunded and operations consumed the bulk of the budget.¹⁴⁵ Personnel were pushed to the limit trying to patch old equipment; this had a negative impact on morale and retention rates.¹⁴⁶ In 2004 defence planners admitted that a multi-purpose force was not sustainable without a dramatic increase in the budget.¹⁴⁷ The Martin Government announced a shift to a more affordable and specialized army centric joint force structure in 2005.¹⁴⁸ This plan was abandoned when the Harper Government committed to replace the bulk of Army, Navy, and Air Force equipment over the next decade.¹⁴⁹ Numerous defence scholars agreed that there was a considerable gap between the budget and the actual cost of the equipment required.¹⁵⁰ In 2016 Ferry de Kerckhove lamented that the Canada First Defence Strategy was never more than a glorified "shopping list" that "was underfunded [from the beginning]."¹⁵¹

Jones and Lagassé argued that without a long-term bipartisan agreement to increase defence spending to 2% of GDP, specialization would be the only option for the Canadian Forces.¹⁵² They noted that the Conservative majority election win in 2011 gave DND planners optimism that increased spending was soon to follow but warned that if the funding didn't materialize the CF would lose or retain capabilities in an ad hoc fashion depending on the whims of political expediency.¹⁵³ Their warning would turn out to be prescient:

"Lastly, the Conservative government might disappoint the defence community by not augmenting defence expenditures to the degree required, once it has tackled the budget deficit. In fact, a Conservative government may prove less sympathetic toward the CF if its efforts to balance the federal budget take longer than expected. ...However tempting, simply muddling through could, in light of these considerations, result in a disjointed and far less capable CF."¹⁵⁴

¹⁴³ Jones and Lagassé, "Rhetoric versus reality:" 141.

¹⁴⁴ Jones and Lagassé, "Rhetoric versus reality:" 142.

¹⁴⁵ Ibid.

¹⁴⁶ Ibid.

¹⁴⁷ Ibid.

¹⁴⁸ Jones and Lagassé, "Rhetoric versus reality:" 143.

¹⁴⁹ Ibid.; Canada, "Canada First Defence Strategy."

¹⁵⁰ Jones and Lagassé, "Rhetoric versus reality:" 143.

¹⁵¹ "was underfunded ab initio," Ferry de Kerckhove, "Foreword," *Charlie Foxtrot*, 14.

¹⁵² Jones and Lagassé, "Rhetoric versus reality:" 145.

¹⁵³ Jones and Lagassé, "Rhetoric versus reality:" 149.

¹⁵⁴ Ibid.

The Harper Government would cut defence spending in the years between 2012 and 2015 in order to balance the budget.¹⁵⁵ David Perry calculated that between the operating fund cuts and departmental cuts from a government-wide strategic review, defence spending was cut by 11% in 2012.¹⁵⁶ In addition to budget cuts, the Harper Government allowed \$9.6 billion in budgeted defence spending to lapse during its tenure.¹⁵⁷ This led then-former Parliamentary Budget Officer Kevin Page to lament in 2015: “Parliament is authorizing the money, and the government is still not spending it... National Defence is becoming a source of funds to reduce the deficit. We're going to need a whole new capital plan for National Defence.”¹⁵⁸ The Liberal Government’s 2017 Strong Secure Engaged Defence Policy does outline a new capital plan, but with spending as a percent of GDP set to peak at only 1.145% in 2024 it is doubtful that there will be sufficient funding to maintain a multipurpose force.¹⁵⁹ The Government must thus choose a specialized niche force structure for the Canadian Forces.

Jones and Lagassé presented three options for a specialized niche structure: an army centric force, an air centric force, and a navy centric force.¹⁶⁰ The army centric force structure would maintain and expand the capabilities procured by the Harper Government for the Army’s Afghanistan mission.¹⁶¹ To fund the Army, the RCAF would need to settle on an inexpensive fighter jet capable of domestic air policing and the National Shipbuilding Strategy would have to be considerably scaled back to the point where the Navy becomes a coastal defence force.¹⁶² The air centric force structure would expand the existing C-17 and C-130 cargo fleet and would purchase 65 F-35A fighters for a niche stealth ground attack capability.¹⁶³ To afford the expansion in the RCAF, the army would be reduced to a homeland defence force with limited low-intensity peacekeeping capabilities while the Navy would have to focus on coastal defence.¹⁶⁴ The navy centric force structure would see the National Shipbuilding Strategy fully funded resulting in a Navy capable of both independent and coalition blue water operations.¹⁶⁵ To fund the Navy, the Army would be reduced to a homeland defence and low-intensity peacekeeping force while the RCAF would have to make do with low-cost replacements for the CF-18s and CP-140 maritime patrol aircraft.¹⁶⁶

At time of writing, the only major defence procurement program with bipartisan support is the National Shipbuilding Strategy (NSS). Since the 2015 election, both the Liberals and the Conservatives have argued that the Navy should receive additional funds

¹⁵⁵ David McKie, “Government gets poor grade for military spending.”

¹⁵⁶ David Perry, “DND will be doing less with less,” *iPolitics*, April 4, 2012, <https://ipolitics.ca/2012/04/04/david-perry-dnd-will-be-doing-less-with-less/>.

¹⁵⁷ Ibid.

¹⁵⁸ Ibid.

¹⁵⁹ Canada, “Strong Secure Engaged,” 43.

¹⁶⁰ Jones and Lagassé, “Rhetoric versus reality:” 146-148.

¹⁶¹ Jones and Lagassé, “Rhetoric versus reality:” 148.

¹⁶² Ibid.

¹⁶³ Jones and Lagassé, “Rhetoric versus reality:” 147.

¹⁶⁴ Ibid.

¹⁶⁵ Ibid.

¹⁶⁶ Ibid.

for additional ships to be built by the Davie shipyard in Quebec.¹⁶⁷ The Liberal Government recently clarified that they are fully committed to the NSS and that the new ships ordered from Davie would not cause any reduction in the size of the NSS order from Irving in Halifax or Seaspan in Vancouver.¹⁶⁸ When this bipartisan commitment is combined with Prime Minister Justin Trudeau's election promise to make the Navy the top priority, and to fund the Navy by purchasing a less expensive alternative to the F-35A, it becomes clear that the only politically supported and militarily viable force structure is a Navy centric niche force. Bezglasnyy and Ross reinforced this point in their 2011 paper writing, "The opportunity costs [of] the JSF option are simply dire. The JSF has the potential of becoming 'the plane that ate the Canadian Navy.'"¹⁶⁹

Jones and Lagassé argued that the Navy's ability to project force makes a Navy centric force the correct choice from a strategic and alliance perspective in many potential threat scenarios. They argued that if China's rise as a global power becomes more militant, then Navy power would be most valued by Canada's allies to respond to the potential conflicts in the South China Sea.¹⁷⁰ Blue water navy power would also be critical in any conflict where Canada is called to support South Korea or Japan. The Royal Canadian Navy has participated in numerous coalition anti-piracy missions off the coast of Africa that protect valuable shipping lanes and have been praised for the professionalism of its sailors.¹⁷¹ Task Force Vancouver made up of HMCS Vancouver and HMCS Charlottetown were an integral component in the 2011 coalition mission against Libya.¹⁷² The Navy's Maritime Command was put in command of Canada's contribution to the First Gulf War and the Navy's contribution of two destroyers and HMCS Protecteur to the Gulf War earned Canada praise from the United States and other allies.¹⁷³ A Navy centric force structure would allow Canada to continue to contribute to these highly valuable coalition blue water naval missions. It is therefore critical that the RCAF recapitalization is affordable.

¹⁶⁷ Tony Clement, "Liberals must change course on sinking approach to shipbuilding," *Toronto Sun*, April 17, 2018, <https://torontosun.com/opinion/columnists/guest-column-liberals-must-change-course-on-sinking-approach-to-shipbuilding>; Alexander Quon, "Ottawa reaffirms role of Halifax Shipyard in National Shipbuilding Strategy after company 'concerned' over remarks," *Global News*, August 14, 2018, <https://globalnews.ca/news/4387096/irvings-halifax-shipyard/>.

¹⁶⁸ Alexander Quon, "Ottawa reaffirms role of Halifax Shipyard in National Shipbuilding Strategy."

¹⁶⁹ Anton Bezglasnyy and Douglas Alan Ross, "Strategically Superfluous, Unacceptably Overpriced: The Case against Canada's F-35A Lightning II Acquisition," *Canadian Foreign Policy Journal* 17, no. 3 (2011), 243, <https://doi.org/10.1080/11926422.2011.638192>.

¹⁷⁰ Jones and Lagassé, "Rhetoric versus reality:" 148.

¹⁷¹ The Canadian Press, "Navy must still 'catch and release' Somali pirates," *CBC*, January 24, 2012, <https://www.cbc.ca/news/politics/navy-must-still-catch-and-release-somali-pirates-1.1210954>; Anna Cunningham, "Keeping pirates at bay: On board with the Canadian navy off the coast of Nigeria," *CBC*, March 29, 2018, <https://www.cbc.ca/news/world/keeping-pirates-at-bay-on-board-with-the-canadian-navy-off-the-coast-of-nigeria-1.4590286>.

¹⁷² CBC, "Canada's military contribution in Libya," *CBC News*, October 20, 2011, <https://www.cbc.ca/news/world/canada-s-military-contribution-in-libya-1.996755>.

¹⁷³ Major Jean Morin and Lieutenant-Commander Richard Gimblett, *Operation Friction 1990-1991 The Canadian Forces in the Persian Gulf*, Directorate of History of the Department of National Defence (Toronto: Dundurn, 1997), 18-19, 187, 219.

Pierre Trudeau's New Fighter Aircraft Program

The Liberal government of Prime Minister Pierre Trudeau set up the New Fighter Aircraft (NFA) program in March 1977 with the goal of selecting a single multi-role fighter to replace the bulk of Canada's mixed fighter fleet.¹⁷⁴ The NFA quickly shortlisted the American General Dynamics (now Lockheed Martin) F-16 Falcon and the McDonnell Douglas (now Boeing) F/A-18 Hornet over the British/Italian/German Panavia Tornado, French Dassault Mirage F1, American McDonnell Douglas (now Boeing) F-15 Eagle, and American Grumman (now Northrop Grumman) F-14 Tomcat.¹⁷⁵ Like a rematch of the US Air Force's 1972 Lightweight Fighter program, the F-16 and F/A-18 were shortlisted primarily based on their low upfront cost and low operating costs.¹⁷⁶ While the USAF choose the F-16 over the F/A-18, Canada announced the F/A-18 as the winner in April 1980 because of the greater reliability of a twin-engine jet over the single-engine F-16 and because the F/A-18 could carry a radar guided beyond visual range missile (BVR) at the time of purchase (the F-16 would gain this capability a few years later with the introduction of the F-16C/D).¹⁷⁷

The NFA program, launched by Prime Minister Pierre Trudeau in 1977, was praised as a model decision-making process for defence acquisition both at the time and in retrospect.¹⁷⁸ The NFA program was designed around two primary restrictions imposed by the Trudeau government: strict budget limits and a requirement that the purchase be fully offset with economic returns to domestic industry.¹⁷⁹ With those restrictions in mind, the Liberal cabinet made what Atkinson and Nossal categorized as four key sets of structural decisions. These decisions were designed to prevent the principal-agent problem that had plagued previous defence procurement programs.¹⁸⁰

The first set of decisions set a clear definition of the types of combat missions the fighter must be able to perform. To prevent the RCAF and Department of National Defence (DND) from creating inflated mission profiles that only a large and expensive fighter like the F-15 Eagle could perform, the aircraft favoured at the time by many RCAF generals, the government used the existing Cold War combat mission profiles flown by the jets the NFA

¹⁷⁴ Nossal, "Late Learners," 168.

¹⁷⁵ CBC, "Sky High: The search for a new Canadian fighter jet in the 1970s," *The Fifth Estate* (1978), https://www.youtube.com/watch?v=kTk-Z0Th_SA.

¹⁷⁶ Nossal, "Late Learners," 169.; Erik Simonsen, "Legacy of the Lightweight Fighter Competition," *Air Force Magazine*, February 2017, <http://www.airforcemag.com/MagazineArchive/Pages/2017/February%202017/Legacy-of-the-Lightweight-Fighter-Competition.aspx>.

¹⁷⁷ Ibid.; Eric Hehs, "History of the F-16 Fighting Falcon," *Code One Online*, February 19, 2014, http://www.codeonemagazine.com/article.html?item_id=23.

¹⁷⁸ Atkinson and Nossal, "Bureaucratic Politics and the New Fighter Aircraft Decisions.,"; Nossal, "Late Learners," 169.

¹⁷⁹ Nossal, 170.

¹⁸⁰ Atkinson and Nossal, "Bureaucratic Politics and the New Fighter Aircraft Decisions.,"; Nossal, "Late Learners," 171.

would replace: The North American air defence (NORAD) mission, the defence of Norway (NATO) mission, and the war on the central front in Europe (NATO) mission.¹⁸¹

The second set of decisions was a strict rule that the winning aircraft must be both operational, or nearly done development with another nation having already ordered the jet, and that the jet be purchased “off the shelf” with no customization or requirement to assemble them in Canada.¹⁸² The government did not want a repeat of the sizable cost overruns that plagued the CF-5 light fighter program, built in Canada under license by Canadair (now Bombardier), or the extensive Canadian customization of the American P-3 Orion under the Long-Range Patrol Aircraft (LRPA) program that resulted in Canada’s more expensive CP-140.¹⁸³

The third set of decisions imposed a firm budget of \$2.34 billion (CAD) and imposed the requirement for industrial offsets. Cabinet, weary of bureaucrats not including key costs in their estimates, mandated that the \$2.34 billion (CAD) cover all the related procurement costs including the flyaway costs of the aircraft, any R&D premium charged by the Government(s) of the manufacturer, the 12% sales tax the government would charge itself on the purchase, the full cost of air crew and ground crew training, all the costs of modifying airports and ground facilities, and the cost of a generous initial supply of ammunition for the aircraft.¹⁸⁴ For industrial offsets there were two simple conditions: that they be legally enforceable and be at least equal to the procurement cost.¹⁸⁵ This made costs and industrial offsets equal to military requirements in the purchase decision whereas Industry Canada requirements were secondary to DND requirements under the LRPA program.¹⁸⁶ It also further reduced the principal-agent problem by eliminating the risk of cost overruns related to domestic offsets becoming the responsibility of the government like they were in the CF-5 procurement.¹⁸⁷

The fourth set of decisions dictated the organization and reporting structures of the NFA Program Office (NFA/PO). The NFA/PO was set up as a new agency independent of National Defence (DND), the Department of Industry, and the Department of Supply and Services (now “Public Works”).¹⁸⁸ It was the primary point of contact for everyone in government involved in the procurement as well as the contractors submitting bids, interested lobby groups, and the media.¹⁸⁹ The NFA/PO consisted of a manager from each of the three key departments (DND, Industry, and PSPC) working as equals under a program manager appointed by DND.¹⁹⁰ The NFA/PO reported to a review board consisting of assistant deputy ministers from the three departments and observers from the Department of Finance, the Privy Council Office, the Treasury Board, and the

¹⁸¹ Nossal, “Late Learners,” 171; CBC, “Sky High.”

¹⁸² Nossal, “Late Learners,” 171.

¹⁸³ Ibid.

¹⁸⁴ Nossal, “Late Learners,” 172.

¹⁸⁵ Ibid.

¹⁸⁶ Ibid.

¹⁸⁷ CBC, “Sky High.”

¹⁸⁸ Nossal, “Late Learners,” 172.

¹⁸⁹ Ibid.

¹⁹⁰ Ibid.

Department of External Affairs.¹⁹¹ These checks and balances prevented a repeat of the self-interested bureaucratic misinformation problem that plagued the LRPA program.

In April 2012, on the same day that the auditor general report on the F-35 was released, the Harper Government announced that the F-35 acquisition was on hold and that Public Works would lead a new National Fighter Procurement Secretariat (NFPS).¹⁹² The NFPS adopted a nearly identical structure to the NFA program of the 1970s.¹⁹³ The new Trudeau Government's Future Fighter Capability Project would take over from the NFPS with a similar NFA style program structure.

Future Fighter Capability Project

The Future Fighter Capability Project (FFCP) commenced not long after the Liberals won the 2015 election. Spring and Summer 2016 were spent building on the options assessments previously conducted by the NFPS and consulting with allied governments and their domestic aviation companies.¹⁹⁴ In May 2016 Defence Minister Harjit Sajjan announced that the CF-18s need to be replaced as soon as possible and that the Liberal government would begin an open and transparent process to replace them.¹⁹⁵ The minister also announced that the current fleet of CF-18s were facing a "capability gap" in the years ahead, especially if the CF-18s are required to continue to serve into the 2020s.¹⁹⁶ This claim of a capability gap conflicted with the RCAF "CF-18 Hornet Estimated Life Expectancy" report that outlined how the 2014 CF-18 modernization work should be sufficient to keep the CF-18s flying to 2025.¹⁹⁷ The report did warn of a possible capability gap should the CF-18s be required to extend their life to 2030 as that would require another life extension program and a significant structural refurbishment.¹⁹⁸

In June 2016, the Liberals defined the "capability gap" as being the inability of the RCAF to meet both NATO and NORAD fighter commitments simultaneously.¹⁹⁹ The Conservative opposition countered that fulfilling both commitments simultaneously is a new requirement of the RCAF fighter fleet and quoted testimony from the Commander of the RCAF, Lt-Gen. Hood, that the RCAF does not need more than 65 fighters to fulfill Canada's commitments.²⁰⁰

On November 22, 2016 Public Works Minister Judy Foote announced that the government would conduct an "open and transparent competition" to replace the CF-18

¹⁹¹ Ibid.

¹⁹² Nossal, "Late Learners," 178.

¹⁹³ Ibid.

¹⁹⁴ Canada, "Future Fighter Capability Project," August 16, 2018, <http://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/spdgp-ffcp-eng.html>.

¹⁹⁵ Daniel Leblanc, "Canada Needs New Fighter Jets 'Now,' Defence Minister Says."

¹⁹⁶ Ibid.

¹⁹⁷ Canada, "CF-18 Hornet Estimated Life Expectancy," March 13, 2017, <http://www.forces.gc.ca/en/about-reports-pubs/next-gen-fighter-cf18-estimated-life-expectancy.page>.

¹⁹⁸ Ibid.

¹⁹⁹ Berthiaume, "Canada Doesn't Have Enough Fighter Jets."

²⁰⁰ Ibid.

fighters that would maximize economic benefits for Canadian industry.²⁰¹ The Government also announced the intention to purchase 18 new interim Super Hornet aircraft.²⁰² In January 2017, the government announced it had entered talks with the US State Department to arrange a sole-source purchase of 18 Boeing Super Hornet fighter jets.²⁰³ In early 2017 the Trump administration announced that the US Navy would be replacing 14 legacy F/A-18C/D fighters with 14 new Boeing Super Hornets at a cost of \$1.1 billion (USD, \$78.6 million/unit).²⁰⁴ These F/A-18 fighters were slated to be replaced with F-35C fighters, but the fighters were wearing out faster than expected due to increased use over Iraq and the Navy couldn't wait for the delayed F-35C.²⁰⁵ The State Department responded to Canada's request in early September with a price of approximately \$5.23 billion (USD, \$290.6 million/unit) for 18 Boeing Super Hornets and associated services, weapons, spare parts, software, and training.²⁰⁶

On June 7, 2017 the Trudeau Government released the Strong Secure Engaged defence policy that outlined how the RCAF would replace the CF-18 with 88 new fighter jets.²⁰⁷ The policy outlined how these 88 new jets would have to be fully interoperable with NORAD and NATO allies, as well as being capable of dealing with a wide range of threats including advanced fighters and anti-access area denial (A2AD) surface-to-air missile systems.²⁰⁸ On September 27, the US Department of Commerce announced its preliminary decision to side with Boeing and impose a 219.6% tariff on Bombardier's C-Series passenger jets.²⁰⁹ Boeing had filed a complaint with the US government over the sale of up to 125 C-Series passenger jets to Delta Airlines on the grounds of unfair trade.²¹⁰ Prime Minister Trudeau issued a statement that Canada would not move forward with a Super Hornet purchase saying, "We won't do business with a company that's busy trying to sue us and put our aerospace workers out of business."²¹¹ With a defined capability gap and a cancelled interim solution, the Canadian Government announced on December 12 the intention to purchase 18 used Australian F/A-18 aircraft that would be modified to CF-18

²⁰¹ Canada, "Canada announces plan to replace fighter jet fleet," November 22, 2016, <https://www.canada.ca/en/department-national-defence/news/2016/11/canada-announces-plan-replace-fighter-fleet.html>.

²⁰² Ibid.

²⁰³ Murray Brewster, "Stopgap Super Hornet Purchase Could have \$5B to \$7B Price Tag," *CBC News*, January 31, 2017, <http://www.cbc.ca/news/politics/fighter-jet-purchase-super-hornets-1.3956306>.

²⁰⁴ CNBC, "Under Trump, Super Hornet gets a Boost: Production set to Double," May 8, 2017, <https://www.cnb.com/2017/05/08/super-hornet-production-set-to-double-as-trump-gives-program-a-boost.html>.

²⁰⁵ Ibid.

²⁰⁶ Lee Berthiaume, "U.S. State Department OK with Sale of Super Hornets to Canada for Estimated at \$5.23B U.S.," *The Toronto Star*, September 12, 2017, <https://www.thestar.com/news/canada/2017/09/12/us-state-department-oks-sale-of-super-hornets-estimated-at-523b-us-to-canada.html>.

²⁰⁷ Canada, "Strong Secure Engaged," 38.

²⁰⁸ Ibid.

²⁰⁹ Alex Ballingall, "Boeing may have won a Battle, but not the war, says Quebec premier of Bombardier battle," *The Star*, September 27, 2017, <https://www.thestar.com/news/canada/2017/09/27/trudeau-disappointed-in-us-decision-to-slap-220-per-cent-duty-on-canadas-bombardier-jets.html>.

²¹⁰ Ibid.

²¹¹ Ibid.

standards and enter RCAF service in the early 2020s.²¹² The government also announced the start of an open competition to replace the CF-18 with 88 new jets with a procurement budget of between \$15 billion and \$19 billion (CAD).²¹³

The FFCP has adopted much of the successful procurement methodology of the NFA program. The competition was originally scheduled to evaluate submissions in 2018 and 2019, announce a winner in 2022, and have all 88 aircraft delivered by 2025.²¹⁴ The government has since pushed back the timeline. As of September 2018, the government plans to complete the formal engagement process, fairness monitor review, and legal review in 2018; to finalize and release the solicitation documents to the chosen suppliers in 2019; to evaluate initial proposals in 2020; to evaluate final proposals in 2021; to announce a winner in 2022; to take delivery of the first aircraft in 2025; to reach Initial Operational Capability in 2026; and to have all aircraft delivered by 2032.²¹⁵ The FFCP includes a requirement for industrial offsets equal to the procurement price and a Bombardier-friendly provision that the assessment process will evaluate the bidder's "impact on Canada's economic interests."²¹⁶

Public Works has formally invited the following governments and corporations to submit bids as the chosen suppliers of their respective fighter jets:²¹⁷

- France / Dassault Aviation: Rafale
- Sweden / Saab: JAS-39 Gripen E/F
- United Kingdom / Airbus Defence & Space: Eurofighter Typhoon
- United States / Lockheed Martin: F-35A
- United States / Boeing: F/A-18E/F Super Hornet

Lessons from the RCAF at War

The public debate over which of the five fighters is the right one to replace the CF-18 often devolves into which of the five fighters is the best overall multirole fighter, with little regard for total cost of ownership. What the government should do is remember the lessons of the NFA program and focus instead on finding the best value replacement for the CF-18. The CF-18 was selected based on how it could replace the CF-101 Voodoo jets that flew the North American air defence (NORAD) mission, the CF-5 Freedom Fighter jets that flew the defence of Norway (NATO) mission, and the CF-104 Starfighter that flew the

²¹² Canada, "Integrating Australian Jets into the Current Royal Canadian Air Force Fighter Fleet," December 12, 2017, <https://www.canada.ca/en/department-national-defence/news/2017/12/integrating-australianjetsintotheurrentroyalcanadianairforcefig.html>.

²¹³ Lee Berthiaume, "New fighter-jet competition to have national 'economic interest' requirement."

²¹⁴ Canada, "Government launches open and transparent competition to replace Canada's fighter aircraft," December 12, 2017, <https://www.canada.ca/en/public-services-procurement/news/2017/12/government-launchesopenandtransparentcompetitiontoreplacecanadas.html>.

²¹⁵ Canada, "Future Fighter Capability Project."

²¹⁶ Canada, "Replacing and Supplementing Canada's Fighters," December 12, 2017, <https://www.tpsgc-pwgscc.gc.ca/app-acq/amd-dp/air/snac-nfps/CF-18-eng.html>.

²¹⁷ Canada, "Future Fighter Capability Project - Suppliers List Invitation (W847A-180210/A)," September 7, 2018, <https://buyandsell.gc.ca/procurement-data/tender-notice/PW-NGF-002-26574>.

defence of central Europe (NATO) mission.²¹⁸ The CF-18 was neither the most expensive option nor was it the most capable, it was the best value.²¹⁹ As such, the government should measure the CF-18 replacement against the successful service history of the CF-18, the mission profiles it actually flew, and against the service history of similar allied light fighters such as modernized European F-16As.

Prime Minister Mulroney announced on September 14, 1990 that a squadron of CF-18 fighter jets would be deployed from CFB Baden-Söllingen, Germany to join the Royal Canadian Navy ships in the Persian Gulf participating in the coalition embargo of Iraq.²²⁰ Between September 20 and 24, 22 cargo trips were made to bring tools, spare parts, and equipment from Canada to Germany to support the deployment.²²¹ Starting on October 4, a fleet of 12 C-130 Hercules and 2 Boeing 707 cargo planes flew a 10 day “air bridge” mission delivering 700 tonnes of matériel and 600 passengers to Doha.²²² This deployment mission also involved Canada’s only available Boeing 707 air-to-air refueling tanker.²²³ By October 12, 18 CF-18s were in Qatar.²²⁴

As the CF-18 Hornets were nearly identical to US Navy and Marine Corps F/A-18 Hornets, they were integrated in the US Navy patrol circuits under American naval air control.²²⁵ While initial integration went well, there was concern over the how the CF-18 fighters lacked secure Havequick radios and Link-4 data links.²²⁶ This deficiency was partially addressed by rushing to secure Link-4 systems from the US and integrating them in January 1991.²²⁷ The CF-18s would fly 2,400 air defence patrols protecting US Navy aircraft carriers during the conflict.²²⁸ By taking over these air patrols, the CF-18 crews freed American F/A-18s to focus on combat missions over Iraq.²²⁹ While on air patrol, Canadian CF-18 pilots were called to intercept Iraqi jets penetrating the warning corridor.²³⁰ The Iraqis always turned around before they were intercepted but the fast response of Canadian pilots on their first intercept earned them a “Way to go, Canada!” radio message from the staff aboard the US Navy command ship USS LaSalle.²³¹ The participation of Canada’s Boeing 707 tanker for refueling of coalition air patrol fighters was also greatly appreciated by allied nations.²³²

The first shots of Operation Desert Storm didn’t come from stealth fighters, but from US Army Apache attack helicopters. At 2:36am on January 17, 1991, two groups of four

²¹⁸ Nossal, “Late Learners,” 171; CBC, “Sky High.”

²¹⁹ CBC, “Sky High.”

²²⁰ Morin and Gimblett, *Operation Friction*, 97.

²²¹ Morin and Gimblett, *Operation Friction*, 99.

²²² Morin and Gimblett, *Operation Friction*, 103.

²²³ Ibid.

²²⁴ Morin and Gimblett, *Operation Friction*, 104.

²²⁵ Morin and Gimblett, *Operation Friction*, 105.

²²⁶ Morin and Gimblett, *Operation Friction*, 131.

²²⁷ Morin and Gimblett, *Operation Friction*, 159.

²²⁸ Morin and Gimblett, *Operation Friction*, 132.

²²⁹ Morin and Gimblett, *Operation Friction*, 160.

²³⁰ Morin and Gimblett, *Operation Friction*, 110.

²³¹ Ibid.

²³² Morin and Gimblett, *Operation Friction*, 160

Apache helicopters launched a coordinated Hellfire missile strike on two Iraqi early warning radar sites.²³³ The Apache raid was a complete success, destroying both sites and every helicopter safely returned to base.²³⁴ At 2:50am, the US Navy launched a massive Tomahawk cruise missile strike soon followed by USAF F-117 stealth fighters and other coalition fighters.²³⁵ Canadian CF-18s were protecting the fleet at the most forward Whiskey-1 air patrol position and were thus tasked with the difficult job of intercepting any incoming fighter that didn't signal using a coalition Identification Friend-or-Foe (IFF) transmitter.²³⁶ The rules of engagement required the CF-18 pilots to visually identify incoming unidentified aircraft to prevent any friendly fire incidents.²³⁷ Between IFF technical issues and some pilots being so shaken up by Iraqi anti-aircraft artillery (AAA) and near misses from surface-to-air missiles (SAMs) that they forgot to turn on their IFF transmitter, the CF-18 pilots were busy with many "non-cooperative target recognition" intercepts.²³⁸ The professionalism of CF-18 pilots earned them considerable thanks from coalition pilots who made IFF mistakes and could have been shot down had the Canadians not remained calm.²³⁹ The Canadian 707 tanker also saved coalition lives that night, providing numerous US Navy F-14 Tomcat fighters with emergency refueling on their return flights.²⁴⁰

On January 24, CF-18s performed their first escort mission of USAF F-16s on a bombing mission.²⁴¹ These "sweep and escort" missions were flown with air-to-air weapons ahead of the F-16s, that were loaded with heavy bomb loads, to engage any Iraqi fighter jets and to spot any SAM sites that could then be engaged by F-4 Phantom Wild Weasel suppression of enemy air defence (SEAD) fighters equipped with antiradiation missiles.²⁴² The CF-18 pilots would also escort RAF Tornado fighter-bombers on some of their attacks near Baghdad.²⁴³ During the escort missions, CF-18 pilots never encountered an Iraqi fighter but they were constantly harassed by AAA and SAMs.²⁴⁴

In late February, the CF-18 pilots were given authorization to begin flying bombing missions.²⁴⁵ At the time, Canada had no laser targeting pods and the CF-18 fighters lacked the modernized equipment required to drop precision guided munitions.²⁴⁶ The CF-18 bombing missions were flown with each fighter carrying eight Mark 82 500lbs

²³³ Clarence A. Robinson Jr., "Gulf War 20th: Apache Raid," *Defense Media Network*, February 2, 2011, <https://www.defensemedianetwork.com/stories/gulf-war-20th-apache-raid/>.

²³⁴ Ibid.

²³⁵ Morin and Gimblett, *Operation Friction*, 162-163.

²³⁶ Ibid.

²³⁷ Morin and Gimblett, *Operation Friction*, 164.

²³⁸ Ibid.

²³⁹ Ibid.

²⁴⁰ Morin and Gimblett, *Operation Friction*, 165.

²⁴¹ Morin and Gimblett, *Operation Friction*, 169.

²⁴² Morin and Gimblett, *Operation Friction*, 167.

²⁴³ Morin and Gimblett, *Operation Friction*, 171.

²⁴⁴ Ibid.

²⁴⁵ Morin and Gimblett, *Operation Friction*, 174-175.

²⁴⁶ Ibid.; T.F.J. Leversedge, "McDonnell Douglas CF-188B Hornet," *Canada Aviation and Space Museum*, 22, <https://documents.techno-science.ca/documents/CASM-AircraftHistories-CF-18Hornet.pdf>.

conventional (unguided) bombs.²⁴⁷ Many of the early missions were accomplished thanks to “borrowed” American bombs, later missions employed bombs flown in from Canada.²⁴⁸ Over 56 missions, CF-18s dropped over 100 tonnes of ordinance.²⁴⁹

It was determined that CF-18s bore the brunt of coalition fleet defence during the critical early days of the war between the 16th and 19th of January.²⁵⁰ This was an incredibly important coalition mission that earned Canadian pilots high praise. It also demonstrates a key NATO coalition mission that the Gripen can perform perfectly well, even in high threat scenarios against militaries with modern aircraft and sophisticated A2AD systems and SAMs. The American Navy and Marines are transitioning to a future carrier fighter force composed of F/A-18 Super Hornets, EA-18 Growlers, and F-35Cs.²⁵¹ In future air operations, Canadian Gripen fighters could easily take up the brunt of fleet defence patrols thereby freeing the larger and more expensive American fighters to focus on bombing missions. The Gripen uses the same probe-and-drogue style aerial refueling system as the CF-18 and all future US Navy and Marine fighters, so it integrates perfectly with our American carrier-based allies and can receive fuel from US Navy tankers.²⁵²

Escort and patrol missions during the Gulf War were initially flown with 2x AIM-9 infrared (IR) missiles and 4x AIM-7 radar (BVR) missiles but by January the weapons load was changed to 4x AIM-9 and 3x AIM-7.²⁵³ As mentioned in the literature review, CF-18s routinely fly Arctic patrol missions with 3x fuel tanks, 2x IR missiles, and 2x BVR missiles. The Gripen has ten hardpoints and can fly escort and patrol missions with 2x fuel tanks, 3x BVR missiles, and 4x IR missiles; or 2x fuel tanks, 2x IR missiles, and 5x BVR missiles; or 3x fuel tanks, 2x IR missiles, and 2x BVR missiles. The Gripen can fly all the important air-to-air missions of the CF-18 with nearly identical weapons loads.

The Gripen is designed to use precision guided munitions including the Mark 82 based JDAM in twin store carriers just like the unguided Mark 82 bombs carried by the CF-18 over Iraq.²⁵⁴ The Gripen would fly this bombing mission with 8x 500lbs bombs, a single fuel tank, 2x IR missiles, and a targeting pod.²⁵⁵ The modernized CF-18 currently in service could fly a bombing mission with the same armament only with the addition of a single BVR missile. Alternatively, the Gripen could fly a similar bombing mission armed with 2x fuel tanks, 2x BVR missiles, 2x IR missiles; and 8x 250lbs Small Diameter Bombs (SDB), or 8x SPEAR missiles.²⁵⁶ Regardless of the configuration, a Gripen with precision guided munitions would have outperformed the CF-18 using unguided bombs against Iraqi

²⁴⁷ Morin and Gimblett, *Operation Friction*, 174-175.

²⁴⁸ Ibid.

²⁴⁹ Leversedge, “McDonnell Douglas CF-188B Hornet,” 22.

²⁵⁰ Morin and Gimblett, *Operation Friction*, 175.

²⁵¹ Kyle Mizokami, “The Navy’s Super Hornets Are Getting an Upgrade,” *Popular Mechanics*, March 22, 2018, <https://www.popularmechanics.com/military/aviation/a19563666/navys-super-hornets-block-iii/>.

²⁵² Saab, “Gripen E in brief,” <https://saab.com/globalassets/commercial/air/gripen-fighter-system/pdf-files-download-section/facts/gripen-e-fact-sheet-en.pdf>.

²⁵³ Morin and Gimblett, *Operation Friction*, 159.

²⁵⁴ Saab, “Gripen E/F,” Accessed September 4, 2018, <https://saab.com/air/gripen-fighter-system/gripen/gripen-ef/>.

²⁵⁵ Ibid.

²⁵⁶ Ibid.

vehicles. The Gripen would match the performance of modernized CF-18s employing precision guided munitions. An overview of the weapons and hardpoints of the Gripen can be found in Appendix C.

The final key lesson from the First Gulf War was in the importance of force multipliers. A force multiplier is commonly defined as a factor or technology that dramatically increases the effectiveness of a combat force. Aerial refueling tankers proved to be a considerable force multiplier. Readily available tankers allowed fighter jets to fly longer combat air patrols, fly strike missions deeper into enemy territory, fly with more weapons and fewer external fuel tanks, and they give pilots greater flexibility to use their afterburners to fly as fast as needed to evade enemy air defences. As mentioned above, the Canadian 707 tanker provided numerous US Navy fighters with emergency refueling on their return flights.²⁵⁷ The importance of tankers as a force multiplier needs to be considered in the CF-18 replacement selection. An inexpensive fighter, like the Gripen, frees up capital budgets to invest in more tankers. Tankers increase the effectiveness of coalition air power far more than a marginally more capable fighter would without tanker support.

The second key force multiplier was the value of training and interoperability. The ability to upgrade the CF-18s to support Link-4 and the ability of CF-18 pilots to integrate into US Navy carrier air patrol operations was critical for coalition operations. The multi-role training of the Canadian pilots before the war allowed them to rapidly move from air patrol, to bomber escort, to bombing missions over the course of the conflict.²⁵⁸ The inverse is also true. Military historians analyzing Iraqi tactics after the conflict concluded that even though some units were equipped with contemporary Russian aircraft and weapons, they were rarely employed effectively or in accordance with Russian best-practices.²⁵⁹ The Iraqis lacked adequate training and tactics to confidently make the most of their complex weapons systems.²⁶⁰ An expensive CF-18 replacement combined with insufficient funding for training could cause RCAF pilots to lose valuable combat skills. The affordable Gripen solves this potential problem.

The NATO missions over Kosovo during the 1990s reinforced many of the lessons learned over Iraq. The 18 CF-18s deployed to the Kosovo campaign were able to carry out 678 combat missions over 78 days largely thanks to the RCAF's ability to beg and borrow equipment and munitions from allies.²⁶¹ The CF-18 fighters once again lacked the secure Havequick radios.²⁶² Canadian pilots also lacked night vision goggles, GPS navigation, enough Nitehawk FLIR targeting pods, or enough precision guided bombs.²⁶³ The entire RCAF only had thirteen Nitehawk pods shared by 120 CF-18s and could only send six to Kosovo.²⁶⁴ The majority of the successful Canadian bombing missions would never have

²⁵⁷ Morin and Gimblett, *Operation Friction*, 165.

²⁵⁸ Morin and Gimblett, *Operation Friction*, 175.

²⁵⁹ Morin and Gimblett, *Operation Friction*, 243.

²⁶⁰ Ibid.

²⁶¹ Leversedge, "McDonnell Douglas CF-188B Hornet," 25.

²⁶² Leversedge, "McDonnell Douglas CF-188B Hornet," 26.

²⁶³ Leversedge, "McDonnell Douglas CF-188B Hornet," 26-28.

²⁶⁴ Leversedge, "McDonnell Douglas CF-188B Hornet," 28.

occurred if it wasn't for the willingness of the Royal Australian Air Force to lend the Canadians six of their FLIR pods.²⁶⁵ The other saving grace was that since Desert Storm the RCAF had continued to train closely with American pilots in joint exercises, so CF-18 pilots were able to overcome their technical shortcomings and integrate into NATO operations.²⁶⁶ While a Kosovo style lack of equipment should be discouraged, the Gripen supports a wide array of American and European NATO munitions and pods making it easy to beg and borrow from our allies.²⁶⁷

The Canadian deployment to Kosovo was made more difficult by the fact that the RCAF never replaced the Boeing 707 when it was retired from service and thus lacked strategic airlift and aerial tanker support.²⁶⁸ This lesson reinforces the force multiplying value of strategic airlift and aerial tankers. It is imperative that the CF-18 replacement is interoperable with our existing probe-and-drogue C-130 Hercules and C-150 Polaris tankers.²⁶⁹ The Gripen, Eurofighter, Rafale, and Super Hornet all use probe-and-drogue refueling.

The Kosovo campaign provided an example of the combat capability of light fighters equipped with modern missiles and radars, and the vulnerability of overconfidence in passive stealth. On March 24, 1999 a modernized Dutch F-16AM light fighter was warned by a NATO AWACS jet of an approaching Yugoslav Mig-29 fighter. The F-16AM pilot used his upgraded radar to lock on and fire an AIM-120 AMRAAM BVR missile, successfully shooting down the Mig-29.²⁷⁰ The modernized European F-16AM and the new Gripen-E are closely matched in size, empty weight, max takeoff weight, and weapons payload.²⁷¹ This air victory against a modern Mig-29 shows that a light fighter like the Gripen, equipped with a modern radar and modern missiles, can win air victories in NATO coalition engagements against contemporary Russian fighters.

On the night of March 27, 1999 Colonel Zoltán Dani, commander of a Yugoslavian air defence battalion, was able to track and successfully shoot down a USAF F-117 stealth fighter with a surface to air missile.²⁷² The success was attributed to American overconfidence in stealth technology, Yugoslavian intelligence knowing the F-117 was

²⁶⁵ Leversedge, "McDonnell Douglas CF-188B Hornet," 29.

²⁶⁶ Leversedge, "McDonnell Douglas CF-188B Hornet," 25.

²⁶⁷ Saab, "Gripen E/F."

²⁶⁸ Leversedge, "McDonnell Douglas CF-188B Hornet," 24.

²⁶⁹ Canada, "CC-130 Hercules," June 28, 2017, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-130.page>.; Canada, "CC-150 Polaris," June 28, 2017, <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-150.page>.

²⁷⁰ Eric Stijger, "Dutch Mig kill," *Code One Magazine*, July 31, 1999, <https://planken.org/balkans/allied-force/operations-day-day/dutch-mig-kill>.; Giovanni de Briganti, "First Technical and Operational Lessons from Kosovo Air Operations," *defense-aerospace.com*, Accessed September 4, 2018, <http://www.defense-aerospace.com/article-view/feature/19141/first-lessons-from-kosovo-ops.html>.

²⁷¹ Stephan Planche, "F-16 MLU," January 18, 2005, http://www.f-16.net/f-16_versions_article2.html.; Saab, "Gripen E in brief."

²⁷² Shahan Russell, "That Day The Serbs Did The Impossible And Shot Down An F-117 Nighthawk," *War History Online*, August 4, 2016, <https://www.warhistoryonline.com/history/that-day-the-serbs-did-the-impossible-shot-down-an-f-117-nighthawk.html>.

coming from intercepted communications, Colonel Dani's masterful use of short bursts of long wavelength radar to track the F-117, and waiting for the F-117 to open its bomb bay doors for a weapons lock.²⁷³ The F-117 pilot ejected safely and was rescued by helicopter.²⁷⁴ While the F-35 has more advanced early warning capabilities and countermeasures, all fighter sized stealth aircraft are similarly vulnerable to long wavelength tracking radars and to being targeted when the bomb bay is open. Stealth fighters are not invisible. The loss of an F-117 also reinforced the need to seek out and destroy enemy IADS and SAM sites early in any conflict.

The CF-18, due to politicians kicking the upgrade can down the road, went from a state-of-the-art fighter when it was introduced in the 1980s to the least advanced NATO jet over Kosovo.²⁷⁵ The Treasury Board approved the first phase of the CF-18 Modernization Project in August 2000 and the second phase in October 2004.²⁷⁶ Of the 120 CF-18s in service, only 80 would be upgraded (62 CF-18A, 18 CF-18B); the other CF-18s would be cannibalized for spares or given to museums.²⁷⁷ The Phase 1 (ECP 538) upgrades included the new AN/APG-73 radar required to support the AIM-120 AMRAAM, the latest NATO standard IFF system, new secure Havequick compliant radios, a new mission computer, the AN/AYQ-9 stores management system required to support the AIM-120 and JDAM family of GPS-guided bombs, and a modern GPS/INS navigation system.²⁷⁸ The Phase 2 (ECP 538 R2) upgrades included NATO Link-16 data links, the Joint Helmet Mounted Cueing System (JHMCS), an upgraded flight data recorder, and new EW suite.²⁷⁹ The total cost of the upgrade was \$2.65 billion (CAD) and Boeing committed to deliver \$515.7 million (CAD) in industrial and regional benefits.²⁸⁰ The final upgraded CF-18 was delivered in March 2010.²⁸¹ This successful upgrade brought the CF-18 fighters in-line with upgraded American and European NATO fighters, although a High-Off Bore-Sight (HOBS) missile capable of taking full advantage of the JHMCS was never purchased.²⁸² Swedish and Brazilian Gripen fighters will use the Targo helmet mounted display that supports a variety of HOBS missiles.²⁸³

In March 2011, within a few hours of Prime Minister Harper announcing Canada's participation in the UN sanctioned mission against Libya, seven CF-18s already prepared for a NATO air policing tour in Iceland departed CFB Bagotville for Italy.²⁸⁴ The RCAF also deployed two CP-140 Aurora patrol aircraft, two CC-150 tankers, one CC-130 Hercules

²⁷³ Ibid.

²⁷⁴ Ibid.

²⁷⁵ Canada, "CF-18 Hornet Estimated Life Expectancy."

²⁷⁶ Canada, "ARCHIVED - 2007-2008 DPRs - Status Report on Major Crown Projects," Accessed September 4, 2018, <https://www.tbs-sct.gc.ca/dpr-rmr/2007-2008/info/mcp-gpe-eng.asp#t5-07>.

²⁷⁷ Ibid.; Leversedge, "McDonnell Douglas CF-188B Hornet," 35.

²⁷⁸ Ibid.

²⁷⁹ Ibid.

²⁸⁰ Canada, "ARCHIVED - 2007-2008 DPRs - Status Report on Major Crown Projects."

²⁸¹ Ibid.

²⁸² Canada, "CF-18 Hornet Estimated Life Expectancy."

²⁸³ Saab, "Saab receives order from FMV for a new helmet mounted display system," November 7, 2016, <https://saabgroup.com/media/news-press/news/2016-11/saab-receives-order-from-fmv-for-a-new-helmet-mounted-display-system/>.

²⁸⁴ Leversedge, "McDonnell Douglas CF-188B Hornet," 30-31.

tanker, and one CC-130J Hercules cargo plane.²⁸⁵ The overall NATO commander was RCAF Lt-Gen Charles Bouchard.²⁸⁶ The CF-18s flew 946 combat missions, representing 10% of NATO strikes.²⁸⁷ The CF-18 fighters dropped 495x 500lbs and 188x 2,000lbs Paveway II bombs; and 11x 500lbs and 2x 2,000lbs JDAM bombs.²⁸⁸ For the first time, the RCAF didn't need to beg or borrow a single bomb from coalition partners.²⁸⁹ The modernized CF-18 performance was exemplary, the new Sniper FLIR pods were instrumental in the use of precision guided munitions, the secure communications and data links performed well and allowed for integration with coalition partners, and the night vision goggles allowed CF-18 pilots to perform night missions effortlessly.²⁹⁰

The Libya conflict saw the first deployment of Swedish Air Force fighter jets since the UN mission in the Congo in the early 1960s.²⁹¹ Sweden deployed eight Gripen-C fighter jets to Italy that were restricted to reconnaissance missions for internal political reasons related to Sweden's history of neutrality.²⁹² The Gripen-C jets flew with a state-of-the-art reconnaissance pod paired with a LITENING 3 FLIR pod that provided some of the most valuable recon data of the operation.²⁹³ The quality of Swedish reconnaissance earned Swedish officers invitations to "five eyes" alliance intelligence meetings (Australia, Canada, New Zealand, United Kingdom, United States).²⁹⁴ Swedish Gripen-C jets flew 570 recon missions, over 30% of total coalition recon missions, and were praised by Lt-Gen Bouchard, "The Gripens have a strategic importance for the operation. They have a spectacular capability."²⁹⁵ Initial issues integrating the Gripen Link-16 system with the rest of NATO were caused by bureaucratic delays in gaining authorization to access the NATO crypto key.²⁹⁶ Once the key was authorized, Swedish and Danish technicians quickly had the Gripen fully integrated with the rest of NATO forces.²⁹⁷ Canada, being a full NATO member, would not have crypto key authorization issues.

Recent conflicts like Libya also call into question the value of stealth fighters in coalition campaigns. No F-22 or F-35 stealth fighters participated in the Libya campaign.²⁹⁸ Most of Libya's IADS was destroyed in the initial salvo of 124 cruise missiles.²⁹⁹ On the

²⁸⁵ CBC, "Canada's military contribution in Libya."

²⁸⁶ Ibid.

²⁸⁷ Leversedge, "McDonnell Douglas CF-188B Hornet," 31-32.

²⁸⁸ Ibid.

²⁸⁹ Ibid.

²⁹⁰ Leversedge, "McDonnell Douglas CF-188B Hornet," 33.

²⁹¹ defenceWeb, "Swedish Gripens deliver 37% of Libyan reconnaissance reports," August 8, 2011, http://www.defencweb.co.za/index.php?option=com_content&view=article&id=17886:swedish-gripens-deliver-37-of-libyan-reconnaissance-reports&catid=35:Aerospace&Itemid=107.

²⁹² Robert Egnell, "The Swedish Experience in Operation Unified Protector," *USAF, RAND Corporation, Stockholm Center for Strategic Studies*, October 16, 2012, 10, http://media.wix.com/ugd//012b60_f1ddfb759804fe6809fb4f09f536405.pdf.

²⁹³ Robert Egnell, "The Swedish Experience in Operation Unified Protector," 16.

²⁹⁴ Robert Egnell, "The Swedish Experience in Operation Unified Protector," 25.

²⁹⁵ Robert Egnell, "The Swedish Experience in Operation Unified Protector," 11.

²⁹⁶ Robert Egnell, "The Swedish Experience in Operation Unified Protector," 26.

²⁹⁷ Robert Egnell, "The Swedish Experience in Operation Unified Protector," 24.

²⁹⁸ Bezglasnyy and Ross, "Strategically Superfluous, Unacceptably Overpriced," 248.

²⁹⁹ Bezglasnyy and Ross, "Strategically Superfluous, Unacceptably Overpriced," 247.

second day of the conflict American B-2 stealth bombers dropped 40 bombs on surviving defensive infrastructure.³⁰⁰ Then the legacy non-stealth coalition fighters went in to mop up the remaining air defences and to begin the largely uncontested bombing campaign in support of rebel forces.³⁰¹ Bezglasnyy and Ross argue that future conflicts will resemble Libya in that cruise missiles will be the preferred opening salvo and that expensive stealth fighters like the “F-35 will be in most cases, again, strategically superfluous.”³⁰² This is reinforced by the fact that the F-35A cannot carry the 2,000lbs Paveway II bomb internally, and thus must carry it on the wings in a non-stealth configuration.³⁰³

The Gripen can fly almost every single weapons configuration that the modernized CF-18 carries. The only exceptions are configurations that push the CF-18 to its limits. The CF-18 has a higher maximum take-off weight of 23,400 kg vs. the 16,500 kg for the Gripen.³⁰⁴ The Gripen however, thanks to its low empty weight and strong delta wing, has a similar maximum stores weight of 6,000 kg vs. 6,215 kg for the CF-18.³⁰⁵ That said, the Gripen max store weight comes with the caveat that to remain below max take-off weight with full stores the Gripen would need to take off with 900 kg less than a full internal fuel load (with full internal tanks, max stores are 5,100 kg).³⁰⁶ Modernized CF-18 fighters have flown combat missions armed with 3x 330 gallon tanks, 2x 2,000lbs bombs, 2x IR missiles, 1x BVR missile, and 1 FLIR pod.³⁰⁷ The closest equivalent Gripen armament is 2x 450 gallon tanks, 2x 2,000lbs bombs, 2x IR missiles, 2x BVR missiles, and 1x FLIR pod. The Gripen can fly the mission, it just would take off with less fuel and have a shorter range. Modernized CF-18 bombing missions against ISIS in 2014-2016 were primarily flown armed with 2x 330 gallon tanks, 3x GBU-12 500lbs bombs, 2x IR missiles, 1x BVR missile, and 1x FLIR pod.³⁰⁸ The Gripen can fly this counter-terrorism bombing mission with 2x 450 gallon tanks, 3x GBU-12 500lbs bombs, 2x IR missiles, 2x BVR missiles, and 1x FLIR pod.³⁰⁹ Of the five potential CF-18 replacements, the Gripen is the only fighter that does not represent a significant increase in size and cost. As the closest CF-18 equivalent, surpassing the CF-18 in some respects while not being able to perfectly match the maximum bomb load, the Gripen still represents the best value replacement. The

³⁰⁰ Ibid.

³⁰¹ Ibid.

³⁰² Bezglasnyy and Ross, "Strategically Superfluous, Unacceptably Overpriced," 248.

³⁰³ Amanda Macias, "Behold the most expensive weapons system ever and all of its ammunition in one photo," *Business Insider*, July 26, 2016, <https://www.businessinsider.com/lockheed-martin-f35-and-all-its-weapons-2016>.

³⁰⁴ Leversedge, "McDonnell Douglas CF-188B Hornet," 55.; Saab, "Gripen E in brief."

³⁰⁵ Leversedge, "McDonnell Douglas CF-188B Hornet," 55.; Dan Katz, "Specifications: JAS 39 Gripen," *Aviation Week Intelligence Network*, September 25, 2014, http://aviationweek.com/site-files/aviationweek.com/files/uploads/2014/09/asd_09_25_2014_jas7.pdf.

³⁰⁶ Saab, "Gripen E in brief."

³⁰⁷ Reuben F. Johnson, "Canada Ponders CF-18 Fighter Replacement," *AIN Online*, January 4, 2017, <https://www.ainonline.com/aviation-news/defense/2017-01-04/canada-ponders-cf-18-fighter-replacement>.

³⁰⁸ CBC, "ISIS mission: Canadian CF-18s drop laser-guided bombs over Iraq," *CBC News*, November 2, 2014, <https://www.cbc.ca/news/politics/isis-mission-canadian-cf-18s-drop-laser-guided-bombs-over-iraq-1.2821425>.

³⁰⁹ Saab, "Gripen E in brief."

statement of requirements for the CF-18 replacement should not disqualify any aircraft for falling slightly short of matching a niche armament rarely deployed by the RCAF.

Breaking the Cost Curve

The costs of operating and upgrading modern fighter jets often surpasses the upfront procurement costs. The F-16 and F/A-18 were finalists in the NFA program because they were the two most advanced affordable western light fighters of the era. Of the five aircraft being considered, only the Gripen falls into the light fighter category.

The Swedish Government began the Gripen program with the goal of “breaking the cost curve” of increasing operating and support costs that accompanied advances in operational fighter capabilities.³¹⁰ Saab achieved this goal and every version of the Gripen delivered to the Swedish Air Force has had lower operational and maintenance costs than the older and less capable Saab Viggen they replaced.³¹¹ The Gripen production and development program also cost less than the Viggen program.³¹² With the Swedish Government having already internalizing the costs of the Gripen program, export customers benefit from the lowest flyway cost of any modern fighter: around \$55 million (2010 CAD).³¹³

In March 2012 IHS Jane’s released a report on modern NATO fighter cost per flight hour (CPFH) based on fuel used, pre-flight preparation and repair costs, regular airfield-level maintenance costs, and personnel costs.³¹⁴ The report provide CPFH estimates for the F-35, Eurofighter, Rafale, Super Hornet, F-16, and Gripen; the graph of these findings is included in Appendix D.³¹⁵ The report emphasized that the CPFH represents the “opportunity cost of the maintenance personnel’s time as well as use of the limited stocks of spare parts, both large and small, in addition to aviation fuel,” therefore CPFH should not only be considered as a budgetary cost but also used to illustrate the effort required by ground crews to generate sorties during a conflict.³¹⁶ An expensive aircraft, with a high CPFH, may offer greater capability than a light fighter. However, this higher CPFH represents a greater strain on the time of ground crews and the inventory of spares and consumables.³¹⁷ If Air Force budgets are small and under pressure, then a high CPFH aircraft may have a reduced sortie rate relative to a less expensive light fighter. IHS Jane’s emphasized this point:

³¹⁰ Saab, “Gripen E: The Cost Edge,” May 8, 2017, <https://saab.com/region/india/gripenfor/gripen-updates/gripen-stories-updates/gripen-e-the-cost-edge/>.

³¹¹ Saab, “More than a fighter, a national asset: Gripen – the smart fighter,” March 2016, <https://saab.com/globalassets/gripen.com/downloads/gripen-brochure--en-.pdf>.

³¹² Ibid.

³¹³ Catherine Hoeffler and Frédéric Mérand, “Buying a fighter jet: European Lessons for Canada,” *Canadian Foreign Policy Journal*, 22, No. 3 (2016): 271. <https://doi.org/10.1080/11926422.2015.1083872>; Canada, Standing Committee on National Defence, *Meeting 38 Evidence*, December 7, 2010.

³¹⁴ Edward Hunt, “Fast Jet Operating Costs,” *IHS Jane’s*, March 13, 2012, 3.

³¹⁵ Edward Hunt, “Fast Jet Operating Costs,” 9.

³¹⁶ Edward Hunt, “Fast Jet Operating Costs,” 5.

³¹⁷ Ibid.

“IHS Jane’s has found the Saab Gripen and Lockheed Martin F-16 to offer the lowest CPFH which suggests that – everything else being equal – both types will therefore offer the highest serviceability and most economical cost per mission. While the larger Rafale, Eurofighter and [Super Hornet] are generally considered to offer high performance and capability, the types of operations flown by Western nations over the last decade have not shown the smaller F-16 or Gripen to be at a significant disadvantage compared to the larger, twin-engined types.”³¹⁸

The study argues that CPFH should be given a high consideration among nations looking to purchase new fighter jets, especially if that national budget is modest and under pressure.³¹⁹ The study also estimates that the CPFH of all F-35 variants will be more in line with the larger twin-engine fighters.³²⁰

Concerns about increasing F-35 sustainment costs have since been outlined by the United States Government Accountability Office (GAO). The GAO, in their October 2017 report, highlight a concern over a 23.9% increase in the program life-cycle operating and support cost estimates since 2012.³²¹ The report notes, “the annual F-35 operating and support costs were estimated to be considerably higher than the combined annual costs of several legacy aircraft, and according to DOD officials, the sustainment strategy was not affordable.”³²²

Some European fighter procurements give warning signals to Canada about not buying more fighter than you can afford to fly. Austria, a nation of 8.75 million people with military spending as a percentage of GDP that has been falling from a high of 0.75% in 2014 to 0.58% in 2018, set out to replace its Saab Draken fighters in the late 1990s with 24 new jets.³²³ In 2002, the Austrian government decided to purchase 18 Eurofighter Typhoons.³²⁴ To meet Austria’s limited budget, many advanced features were removed including IFF and night vision.³²⁵ After a change in Government, and a Eurofighter cost and corruption scandal, the order was reduced to just 15 of the most basic Tranche 1 Eurofighters.³²⁶ With little funds available for weapons, Austrian Typhoons only have a handful of IRST-T IR short range missiles at their disposal.³²⁷ The high CPFH of the Eurofighter consumes the

³¹⁸ Edward Hunt, “Fast Jet Operating Costs,” 5-6.

³¹⁹ Edward Hunt, “Fast Jet Operating Costs,” 6.

³²⁰ Edward Hunt, “Fast Jet Operating Costs,” 14.

³²¹ United States, “F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency,” *United States Government Accountability Office*, Report to Congressional Committees, October 2017: 33. <https://www.gao.gov/assets/690/687982.pdf>.

³²² United States, “F-35 Aircraft Sustainment,” 34.

³²³ United States, “The World Factbook: Austria,” *Central Intelligence Agency*, Accessed September 4, 2018, <https://www.cia.gov/library/publications/the-world-factbook/geos/au.html>; Hoeffler and Mérand, “Buying a fighter jet: European Lessons for Canada,” 267.

³²⁴ Hoeffler and Mérand, “Buying a fighter jet: European Lessons for Canada,” 267.

³²⁵ Ibid.

³²⁶ Hoeffler and Mérand, “Buying a fighter jet: European Lessons for Canada,” 268.

³²⁷ David Axe, “Austria Has No Business Flying These High-Performance Fighters,” *War is Boring*, November 2, 2014, <https://warisboring.com/austria-has-no-business-flying-these-high-performance-fighters/>.

bulk of operating funds leaving only enough in the budget for 12 pilots to share 1,070 annual daylight flight hours; Austrian Eurofighters do not fly at night.³²⁸ With inadequate training, no BVR missiles, no air-to-ground capabilities, and no funds to upgrade to Tranche 3 standards; the Austrian Eurofighters are considered a token force.

The Austrian example stands in stark contrast to their neighbours in the Czech Republic; a nation of 10.67 million people with military spending as a percentage of GDP ranging from 1.03% in 2012 to 0.98% in 2016.³²⁹ After joining NATO, the Czech government had an open fighter competition with considerable industrial offset requirements and an emphasis on selecting the lowest cost option.³³⁰ Saab won with a lease offer for fourteen Gripen C/D aircraft and industrial offsets reportedly worth between 110% and 150% of the contract.³³¹ The fighters were delivered between 2005 and 2006 at a cost of €100 million per year. Hoeffler and Mérand called the Czech lease “quite cheap” by “F-35 or Eurofighter standards.”³³² An advantage of the lease deal has been that Saab continues to provide service and upgrades that keep Czech pilots flying regularly. Czech Gripens have participated in various NATO training exercises and have performed NATO air-policing missions in Iceland and the Baltics; two missions the CF-18 regularly performs.³³³

Hoeffler and Mérand’s paper, “Buying a fighter jet: European Lessons for Canada,” concluded with this important insight on European fighter procurements:

“In all countries but Sweden, we saw that politics played a major role in determining how many aircraft would be bought. Usually prompted by an alarming report from the Court of Auditors on cost overruns, opposition parties turned against whatever program had been committed to and tried to make it a stake in partisan politics.”³³⁴

While Canada was resetting the CF-18 replacement, Brazil announced that the Gripen E/F had won over the Super Hornet and Rafale. Brazil is a relevant example for Canada as Brazil is the 5th largest landmass, it spends 1.4% of GDP on the military, and spends just shy of 50% more (in US dollar terms) than Canada does on defence.³³⁵ Brazil announced the \$4.5 billion deal for 36 Gripen jets (USD, \$125

³²⁸ Ibid.

³²⁹ United States, “The World Factbook: Czechia,” *Central Intelligence Agency*, Accessed September 4, 2018, <https://www.cia.gov/library/publications/the-world-factbook/geos/ez.html>.

³³⁰ Hoeffler and Mérand, “Buying a fighter jet: European Lessons for Canada,” 269.

³³¹ Ibid.

³³² Ibid.

³³³ AIRCOM, “Icelandic NATO Mission accomplished by Czech Gripen,” *NATO*, November 7, 2016, <https://ac.nato.int/archive/2016/icelandic-nato-mission-accomplished-by-czech-gripen->; Saab, “Czech Air Force Gripen Policing the Baltic Airspace,” *DefenceTalk*, May 26, 2009, <https://www.defencetalk.com/czech-air-force-gripen-policing-the-baltic-airspace-19207/>.

³³⁴ Hoeffler and Mérand, “Buying a fighter jet: European Lessons for Canada,” 272.

³³⁵ Nan Tian, Aude Fleurant, Alexandra Kuimova, Pieter D. Wezeman, & Siemon T. Wezeman, “Trends in World Military Expenditure, 2017,” *Stockholm International Peace Research Institute*, May 2018, https://www.sipri.org/sites/default/files/2018-05/sipri_fs_1805_milex_2017.pdf.

million / unit) in December 2013.³³⁶ Brazil admitted that while the Gripen was not as capable as the larger twin engine jets it offered the best value between full technology transfer, considerable domestic offsets with Embraer assembling most of the Gripens in Brazil, partnership in the development of a future Sea Gripen for Brazil's aircraft carrier, and by far the lowest total cost of ownership.³³⁷ It was reported that the Gripen total cost of ownership for the life of the jets was half the estimate for the Rafale.³³⁸ Brazil's order is expected to grow to a total of 108 Air Force Gripens and 24 Navy Sea Gripens.³³⁹ The Gripen will also flawlessly integrate with Brazil's Saab/Embraer E-99 Erieye AEW&C jets.³⁴⁰

Does Canada need a Fifth-Generation Fighter?

Proponents of the F-35 often claim that Canada needs to buy a fifth-generation stealth fighter, and thus the F-35A is the only option.³⁴¹ The term fifth-generation was first used to describe the F-22 Raptor and, while definitions vary slightly, generally a fighter is fifth-generation if it offers the following: advanced low observability (stealth), extreme agility, sensor fusion with advanced sensors, advanced data networks, and the ability to supercruise (fly supersonic without afterburners).³⁴²

The F-35A is unique among the fighters Canada is considering on the passive stealth metric. That said, low observability is a spectrum not a checkbox. The F-35A is often quoted as having the radar cross section (RCS) of a golf ball (0.001m²) but the Gripen and other options were also designed to minimize the RCS in affordable ways. While 1970s designs like the F-15 have reported RCSs of around 5m², the Gripen RCS is reportedly around 0.5m².³⁴³ The Gripen also employs state-of-the-art electronic warfare systems and countermeasures to jam enemy radars and evade enemy weapons, this is sometimes referred to as "active stealth."³⁴⁴ Based on the success of light fighters in recent conflicts, the improvement the Gripen offers over the CF-18 should be more than adequate for future conflicts.

³³⁶ Tim Logan, "Brazil snubs Boeing Super Hornets in big fighter jet buy," *St. Louis Post-Dispatch*, December 18, 2013, https://www.stltoday.com/business/local/brazil-snubs-boeing-super-hornets-in-big-fighter-jet-buy/article_38bebef5-72f0-5cde-a3eb-c4294bf81850.html.

³³⁷ Defense Industry Daily, "F-X2: Brazil's Saab Contract for Gripen's a Done Deal," December 19, 2016, <https://www.defenseindustrydaily.com/brazil-embarking-upon-f-x2-fighter-program-04179/>.

³³⁸ Ibid.

³³⁹ Ibid.

³⁴⁰ Saab, "Gripen Technology Hub in Brazil," Accessed September 4, 2018, <https://saab.com/air/gripen-fighter-system/gripen/gripen/proud-to-be-brazilian/>.

³⁴¹ Clare Clancy, "Former fighter pilot turned MP criticizes federal decision to buy Super Hornets," *Edmonton Journal*, November 24, 2016, <https://edmontonjournal.com/news/local-news/former-fighter-pilot-turned-mp-criticizes-federal-decision-to-buy-super-hornets>.

³⁴² Lockheed Martin, "F-22 Raptor," Accessed September 4, 2018, <https://www.lockheedmartin.com/en-us/products/f-22.html>.

³⁴³ Sebastien Roblin, "A 'Stealthy' F-15 'Silent Eagle': Smart Idea or a Waste of Money?" *The National Interest*, August 18, 2018, <https://nationalinterest.org/blog/buzz/stealthy-f-15-'silent-eagle'-smart-idea-or-waste-money-29127>.

³⁴⁴ Saab, "Gripen E/F."

When it comes to extreme agility the Euro-canards are generally considered to be the best in the world. Former Swedish Air Force fighter pilot and Saab chief test pilot Richard Ljungberg said of the Gripen's agility, "I have flown about 40 different fighters and none of them are as responsive and precise as Gripen."³⁴⁵

The Gripen offers leading sensor fusion capabilities. The Gripen combines an active electronically scanned array (AESA) radar, a state-of-the-art infra-red search and track (IRST) system, passive and active electronic warfare systems, and a large wide area touch screen display.³⁴⁶ The Gripen sensor fusion capabilities also include integration of targeting (FLIR) pod and reconnaissance pod information.³⁴⁷ With the targeting pod looking down and the IRST looking up and ahead, the Gripen has considerable passive detection capabilities. The Gripen AESA is also mounted on a repositioner, this allows the Gripen to gain an extra 40 degrees of scanning angle.³⁴⁸ The repositioner gives Gripen pilots the ability to lock onto an enemy fighter, fire a BVR missile, and turn 90 degrees away from the enemy while maintaining radar lock and 2-way data link with the missile. This increases the lethality of the missile while allowing the Gripen pilot to maintain distance from the target. A comparison of the F-35A and Gripen cockpits can be found in Appendix E.

Related to sensor fusion, and unique to the Saab Gripen, is how the Gripen avionics software architecture has separated flight critical systems from the tactical mission systems. This separation, combined with full technology transfer, will allow the RCAF to rapidly incorporate new capabilities without the need to re-validate all the flight-critical functions. Saab pioneered this software technology. The only other western aircraft with a similar capability is the Israel-exclusive F-35I that uses technology from Israel Aerospace Industries to create an add-on layer that separates the core F-35 flight systems so that Israel can more quickly make tactical software modifications and certify their own domestic weapons.³⁴⁹ This software is not available to other F-35 customers.

Saab has long been a leader in fighter data networks. The 1950s era Saab Draken employed one of the world's first data link systems.³⁵⁰ The first Gripen-A/B flew with a Saab specific Gripen data link (TIDLS). The latest Gripen is fully interoperable with NATO

³⁴⁵ Saab, "More than a fighter, a national asset: Gripen – the smart fighter."

³⁴⁶ John Belanger, "Saab Press Briefing CANSEC 2018," *Saab*, May 30, 2018, <https://saabgroup.com/globalassets/corporate/media-news-press-stories/event-press-kits/zip-folders/cansec/cansec-2018-press-brief-finalx.pdf>.

³⁴⁷ Ibid.

³⁴⁸ Tyler Rogoway, "SAAB's Gripen NG Fighter Has An Awesome Way To Make Its Radar More Capable," *Foxtrot Alpha*, November 21, 2015, <https://foxtrotalpha.jalopnik.com/saabs-gripen-ng-fighter-has-an-awesome-way-to-make-its-1743963539>.

³⁴⁹ Eric Adams, "Why Only Israel Can Customize America's F-35 (At Least for Now)," *WIRED*, May 10, 2016, <https://www.wired.com/2016/05/israel-can-customize-americas-f-35-least-now/>.

³⁵⁰ Saab, "Link 16 Added to Gripen's Datalink Systems," *defense-aerospace.com*, June 11, 2007, <http://www.defense-aerospace.com/article-view/release/83146/saab-adds-link-16-to-gripen's-datalink-systems.html>.

and NORAD systems including Link 16, Havequick radios, satellite communications, and IFF systems.³⁵¹

Lockheed Martin emphasized how supercruise was an important characteristic of fifth generation fighters when they were trying to stop the US Government from reducing the F-22 order. The USAF asked for 381 F-22s, but the program was terminated at 187 aircraft due to the high cost of the twin-engine stealth fighter.³⁵² Lockheed Martin has since downplayed this characteristic as the F-35 lacks the ability to supercruise. The Gripen demonstrator reportedly achieved a supercruise speed of Mach 1.2 in 2009.³⁵³ The Super Hornet also lacks the ability to supercruise.

Forward Operating Locations

Canada and Sweden are Arctic nations and, to paraphrase Frank Herbert, the Gripen is Arctic power. Knowing that in any war with Russia major Swedish Air Force bases would be attacked, the Gripen was designed to operate from dispersed bases with a minimal logistical footprint. The Gripen can operate from Swedish road bases designed around straight sections of rural highway 800m long and only 16m wide thanks to its low approach speed, carbon brakes, and because the canards function as airbrakes.³⁵⁴ A small team of technicians can perform an engine swap in a tent on the side of the road in under an hour.³⁵⁵ Saab even sells the deployable aircraft maintenance facility tents that can be packed inside a C-130 cargo plane.³⁵⁶ An air-to-air rearmament and refueling can be performed in 10 minutes using hand powered lifts.³⁵⁷ All of Sweden's major Air Force Bases are farther north than CFB Cold Lake, Alberta. The northernmost base is north of Alaska and home to 45 Gripen fighter jets.³⁵⁸ All of Canada's existing Forward Operating Locations could support the Gripen with no major changes.

The F-35A, on the other hand, requires a minimum runway length of 8,000 feet to operate safely for trained pilots and 10,000 feet for trainee pilots.³⁵⁹ Iqaluit is the only FOL with a runway suitable for the F-35A, at 8,605 feet. The cost of expanding these runways is unknown but should be fully included in any F-35A procurement cost calculation.

CP-140 and CC-144 Replacements that Complement the Gripen

As outlined in the Literature Review section of this paper the RCAF is currently planning to replace the CP-140 Aurora fleet with a new Canadian Multi-Mission Aircraft

³⁵¹ John Belanger, "Saab Press Briefing CANSEC 2018."

³⁵² General (Ret.) Norty Schwartz, *Journey Memoirs of an Air Force Chief of Staff*, (New York: Skyhorse, 2018), 256.

³⁵³ Saab, "Gripen NG: 2009 Milestones / Supercruise," August 16, 2009, <http://www.gripenblogs.com/Lists/Posts/Post.aspx?ID=177>.

³⁵⁴ Saab, "More than a fighter, a national asset: Gripen – the smart fighter."

³⁵⁵ Ibid.

³⁵⁶ Saab, "Deployable Aircraft Maintenance Facility," Accessed September 4, 2018, <https://saab.com/dam>.

³⁵⁷ Ibid.

³⁵⁸ Canada, Standing Committee on National Defence, *Meeting 38 Evidence*, December 7, 2010.

³⁵⁹ Australia, "Facilities Requirements for the New Air Combat Capability," *Statement of Evidence to the Parliamentary Standing Committee on Public Works*, June 2014: 7.

(CMA) and is considering a future Intelligence, Surveillance and Reconnaissance (ISR) program aircraft. As only 14 of the 18 CP-140 aircraft are being upgraded the RCAF should consider if all 18 original CP-140 aircraft should be replaced.³⁶⁰ In April 2018, the RCAF recommended replacing the two oldest CC-144 Challengers that were purchased in the early 1980s.³⁶¹ In the interest of reducing the number of different aircraft types in service, it would be optimal to fulfill all three potential roles with a single aircraft type: the Bombardier Global Express. The Bombardier Global Express platform, in partnership with Saab, fulfills all the roles required while meeting Lieutenant-General Mike Hood's desire to favour Canadian industry.³⁶²

The Saab GlobalEye airborne early warning and control (AEW&C) aircraft is based on the Bombardier Global Express 6000 and can fulfill the ISR requirements while also adding a state of the art powerful AEW&C capability to the RCAF. Currently RCAF personnel serve alongside USAF personnel on American E-3 Sentry AWACS aircraft based on the 1970s-era Boeing 707.³⁶³ By adding AEW&C aircraft to the RCAF, Canada would be adding capabilities to NORAD while demonstrating to the US Government a willingness to "pull our weight."

The first flight of a GlobalEye jet was on March 14, 2018 and three have been ordered by the United Arab Emirates Air Force.³⁶⁴ The GlobalEye comes equipped with the new Saab Erieye Extended Range (ER) Gallium Nitride (GaN) S-Band AESA radar.³⁶⁵ This state of the art radar can track targets 650 km away, supports sensor fusion, and is designed to detect low observable targets such as cruise missiles and stealth fighters.³⁶⁶ In addition to the Erieye radar GlobalEye aircraft are equipped with a Leonardo Seaspray 7500E AESA 360° multimode (air-to-air and air-to-surface) X-Band radar, a FLIR Star Safire 380-HD electro-optical/infrared (EO/IR) sensor turret, an Automatic Identification System (AIS), an IFF system, the Saab HES-21 electronic support measures (ESM) suite, and countermeasures.³⁶⁷ The GlobalEye is also equipped with all NORAD and NATO required communications including satellite communications, secured radios, and full NATO Link 11/16/22 support.³⁶⁸ From a surveillance equipment standpoint, the GlobalEye meets or exceeds the radar and EO/IR capabilities of upgraded CP-140s.³⁶⁹ The CP-140 and

³⁶⁰ Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 40.

³⁶¹ Chris Rands, "RCAF wants Ottawa to buy two used jets for the VIP fleet," *CBC*, April 27, 2018, <https://www.cbc.ca/news/politics/challenger-vip-jet-fleet-1.4636818>.

³⁶² Chris Thatcher, "Operation Innovation."

³⁶³ Captain Kevin McLaren, "35 years of Canadian participation in NORAD AWACS program," *Royal Canadian Air Force*, November 24, 2014, <http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=35-years-of-canadian-participation-in-norad-awacs-program/i2kafyfb>.

³⁶⁴ Gareth Jennings, "GlobalEye makes maiden flight," *IHS Jane's*, March 14, 2018, <https://www.janes.com/article/78582/globaleye-makes-maiden-flight>.

³⁶⁵ Ibid.

³⁶⁶ Ibid.

³⁶⁷ Ibid.; Selex, "Seaspray 7500E," 2014, http://www.leonardocompany.com/documents/63265270/65501186/mm07777_Seaspray_7500E_LQ_.pdf.

³⁶⁸ David Donald, "Saab launches GlobalEye for Swing-role Surveillance," *AIN Online*, February 16, 2016, <https://www.ainonline.com/aviation-news/defense/2016-02-16/saab-launches-globaleye-swing-role-surveillance>.

³⁶⁹ Canada, "CP-140 Aurora fleet modernization and life extension."

GlobalEye have comparable mission endurance of over 11 hours while the GlobalEye jet is slightly faster than the turboprop CP-140 with respective top speeds of 833 km/h and 750 km/h.³⁷⁰ The combination of sensor fusion and advanced data links allow GlobalEye aircraft to share target information with Gripen and NATO allied fighters, enhancing the fighter pilot's ability to counter enemy stealth aircraft. Saab promotional material illustrates how a GlobalEye AEW&C aircraft can assist a group of Gripen fighters to detect, track, and destroy a Chinese stealth J-20 fighter with a BVR missile.³⁷¹

NATO currently uses Boeing E-3 AWACS aircraft based in Europe and will be looking to replace them around 2035.³⁷² Saab and Bombardier have declared an interest in competing for that NATO business and would be better positioned to win if Canada already had four GlobalEye aircraft in service.³⁷³ The industrial export opportunity combined with the irresistible photo opportunity of a ribbon cutting ceremony at a Canadian Bombardier facility makes the Saab/Bombardier aircraft solution politically irresistible. Replacing the four CP-140 aircraft that are not being modernized with four Saab/Bombardier GlobalEye jets bundled with a Gripen fighter order would add capability to the RCAF while advancing the long-term interests of Canada's domestic aviation industry.

While the GlobalEye is an outstanding ISR and AEW&C aircraft, it lacks the maritime anti-submarine warfare (ASW) capabilities of the CP-140. The 14 upgraded CP-140s should therefore be replaced by the GlobalEye's ASW twin: the Saab/Bombardier Swordfish. The Swordfish is also based on the Global Express 6000 and shares many systems with the GlobalEye.³⁷⁴ The Swordfish trades the large Erieye ER radar of the GlobalEye for a magnetic anomaly detector (MAD) boom, rotary and fixed sonobuoy launchers, storage for around 200 sonobuoys, and four external weapon pylons.³⁷⁵ The external pylons can carry up to six MU90 Mk3 Eurotorp lightweight torpedoes (using twin store carriers on the in-board pylons), two Saab RBS15 anti-ship missiles and two MU90 torpedoes, or up to four survival kit air droppable (SKAD) pods.³⁷⁶ The CP-140 and Swordfish have comparable low altitude maritime mission endurance of over 11 hours, the Swordfish is faster with a top speed of 833 km/h, and the Swordfish has a far longer high altitude cruise range of 9,600 km vs. the CP-140's 7,400 km range.³⁷⁷ From a maritime ISR

³⁷⁰ Gareth Jennings, "GlobalEye makes maiden flight."; Canada, "CP-140 Aurora."

³⁷¹ Saab, "Gripen E/F Forever Ahead," Accessed September 4, 2018, <https://saab.com/gripen/our-fighters/gripen-fighter-system/gripen-e-series/gripen-e/#seetheunseen>.

³⁷² Craig Hoyle, "Saab has sky-high sales hopes for GlobalEye," *Flight Global*, February 28, 2018, <https://www.flightglobal.com/news/articles/saab-has-sky-high-sales-hopes-for-globaleye-446303/>.

³⁷³ Ibid.

³⁷⁴ Saab, "Swordfish MPA A New Era in Maritime Air Power," Accessed September 4, 2018, <https://saab.com/globalassets/commercial/air/airborne-solutions/airborne-surveillance/swordfish-maritime-patrol-aircraft/swordfish-datasheet.pdf>.

³⁷⁵ Ibid.; Saab, "Swordfish Redefines Tomorrow's Maritime Patrol Aircraft," February 5, 2018, <https://saabgroup.com/media/news-press/news/2018-02/swordfish-redefines-tomorrows-maritime-patrol-aircraft/>.

³⁷⁶ Air Forces Monthly, "Weapons boost for Swordfish," May 10, 2017, <https://airforcesmonthly.keypublishing.com/2017/05/10/weapons-boost-for-swordfish/>.

³⁷⁷ Canada, "CP-140 Aurora."; Saab, "Swordfish MPA A New Era in Maritime Air Power."

and ASW perspective, the Swordfish meets or exceeds the capabilities of the upgraded CP-140 aircraft.³⁷⁸

Equipped with Saab's latest RBS15 Mk4 anti-ship cruise missile, RCAF Swordfish jets would gain a powerful anti-surface warfare (ASuW) capability allowing them to engage modern warships from over 300 km away.³⁷⁹ The RBS15 also supports a land-attack capability that would allow RCAF Gripen and Swordfish aircraft to participate in cruise missile attacks similar to the 2018 cruise missile strike against Syria that saw British Tornado fighter bombers, French Rafale fighters, and American B-1B bombers launch cruise missiles from beyond the range of Syrian air defences.³⁸⁰ This would add a powerful coalition strike capability to the RCAF that would be highly valued by our allies.

At a reported flyaway cost of around \$236 million (USD) the Saab GlobalEye and Swordfish aircraft are less expensive than the larger and approximately \$355 million (USD) equivalent Boeing 737 based E-7 and P-8 aircraft.³⁸¹ The smaller Global Express based Saab aircraft should also have a far lower CPFH and thus a lower total cost of ownership.

The two older CC-144 aircraft, that the RCAF is currently looking to replace, have a range of only 4,074 km and are thus unable to fly non-stop from Ottawa to Europe.³⁸² The newer two CC-144 aircraft have a range of only 5,926 km and thus lack the range to reach Berlin or Rome direct.³⁸³ A new Bombardier Global Express 6000 has a range of 11,112 km allowing it to fly non-stop from Ottawa to anywhere in Europe, Japan, South Korea, and to most of the Middle-East.³⁸⁴ A map showing the ranges of these aircraft is included in Appendix F. These new transport Global Express 6000 aircraft could be equipped with the secure radios, satellite communications, and self defence suites as the Saab aircraft. The Global Express can carry up to 17 passengers vs. the Challenger only carrying 9.³⁸⁵ It is a waste of time and money to leapfrog the Prime Minister, Cabinet Ministers, and other officials across the Atlantic in antiquated CC-144 aircraft. The RCAF should thus consolidate the CC-144 and CP-140 fleets into a mix of Bombardier Global Express based aircraft.

³⁷⁸ Canada, "CP-140 Aurora fleet modernization and life extension."

³⁷⁹ Saab, "The RBS15 Family," Accessed September 4, 2018, <https://saab.com/air/weapon-systems/air-to-surface-missile-systems/rbs15-family/>.

³⁸⁰ Ibid.; Brad Lendon, "Weapons the US, UK and France used to target Syria," *CNN*, April 15, 2018, <https://www.cnn.com/2018/04/14/politics/syria-airstrikes-weapons-used-intl/index.html>.

³⁸¹ Jeremy Binnie, "IDEX 2017: UAE confirms order for third Saab GlobalEye," *IHS Jane's*, February 23, 2017, <https://archive.is/20170224024315/http://www.janes.com/article/68189/idx-2017-uae-confirms-order-for-third-saab-globaleye>; Rich Smith, "Britain Goes All In for Boeing's P-8A Poseidon," *The Motley Fool*, April 21, 2016, <https://www.fool.com/investing/general/2016/04/21/britain-goes-all-in-for-boeings-p-8a-poseidon.aspx>.

³⁸² Canada, "CC-144 Challenger," June 29, 2017, <http://www.rcf-arc.forces.gc.ca/en/aircraft-current/cc-144.page>; Chris Rands, "RCAF wants Ottawa to buy two used jets for the VIP fleet."

³⁸³ Ibid.

³⁸⁴ Bombardier, "Global 6000," Accessed September 4, 2018, <https://businessaircraft.bombardier.com/en/aircraft/global-6000#!#bba-pdp-section-1>.

³⁸⁵ Ibid.

Policy Recommendations

- 1) It is recommended that the government draft a well-defined Navy-Centric long-term plan for the Canadian Forces.
- 2) It is recommended that the government follow the recommendations from the “Canada and the Defence of North America: NORAD and Aerial Readiness” Report, included in Appendix F.³⁸⁶ Emphasis should be placed on the report’s first recommendation pertaining to the CF-18 replacement. The Gripen meets all the report’s conditions and would win a truly open and fair competition based on these criteria. Expanding on these criteria should be limited to a NFA style process, structured around the above mentioned NFA four key sets of structural decisions:
 - i. Clearly defined combat missions based on those currently flown by the CF-18. Mission profiles that demand capabilities far beyond what the CF-18 can perform should be discarded. As outlined above, the Gripen can replace the CF-18 on virtually all missions.
 - ii. That the winning aircraft must be operational or nearly done development with another nation having ordered the jet and that it be purchased “off the shelf.” Sweden and Brazil have ordered the Gripen and the production prototype first flew on June 15, 2017.³⁸⁷ Canada should follow Brazil’s example and have Bombardier assemble most of the Canadian Gripens. However, to avoid a repeat of the CF-5 scandal, the contract for the fighters should be with Saab at a fixed price. Both the Gripen and the Super Hornet use the American GE F414 engine. To guarantee a secure supply of spare parts, Canadian Gripen jets should use the same generation of the F414. At time of writing both jets use the same generation F414, however GE recently announced the new F414 Enhanced Performance Engine (EPE). The F414-EPE offers 18% more power with nearly identical fuel economy.³⁸⁸ Should the US Navy’s Block III Super Hornet upgrade program select the F414-EPE engine, then Canada should also select the more powerful engine to maintain commonality between the RCAF and US Navy.
 - iii. That the purchase price includes all related procurement costs including the flyaway costs of the aircraft, any R&D premium, the sales tax, the full cost of ground and air crew training, all the costs of airport and ground facility improvements, and a generous supply of ammunition. That the industrial offsets be enforceable and equal to the purchase price. The F-35 scandal highlighted that even if Canadian firms won all \$10.2 billion (USD) in eligible contracts, the \$16 billion (USD) acquisition cost of 65 F-35 aircraft would mean it would fail

³⁸⁶ Canada, “Canada and the Defence of North America: NORAD and Aerial Readiness,” 61.

³⁸⁷ Saab, “A Successful First Flight with Gripen,” June 15, 2017, <https://saab.com/gripen/our-fighters/evolution/first-flight/>.

³⁸⁸ GE Aviation, “The F414 Engine,” Accessed September 4, 2018, <https://www.geaviation.com/military/engines/f414-engine>.

- the industrial offset benchmark of the NFA program.³⁸⁹ Saab, on the other hand, has a proven track record of delivering on promised industrial offsets.
- iv. That the Future Fighter Capability Project continue to follow the best practices of the New Fighter Aircraft Program Office.
 - 3) It is recommended that the government sole-source two new Bombardier Global Express 6000 VIP jets to replace the aging CC-144 Challengers as outlined in the findings section. The RCAF Challengers lack the capability required of a modern VIP jet and the RCAF is currently engaged in a sole-source replacement project for those jets.
 - 4) It is recommended that the government sole-source four Saab/Bombardier GlobalEye AEW&C jets, as outlined in the findings section, if the Gripen wins the CF-18 replacement contract. If for some reason the Gripen is not selected, then the requirement for four affordable AEW&C jets should be included in the CP-140 replacement competition.
 - 5) It is recommended that the government accelerate the CP-140 replacement competition as outlined in the findings section above. Mission profiles that demand capabilities far beyond what the CP-140 and Swordfish can perform should be discarded.

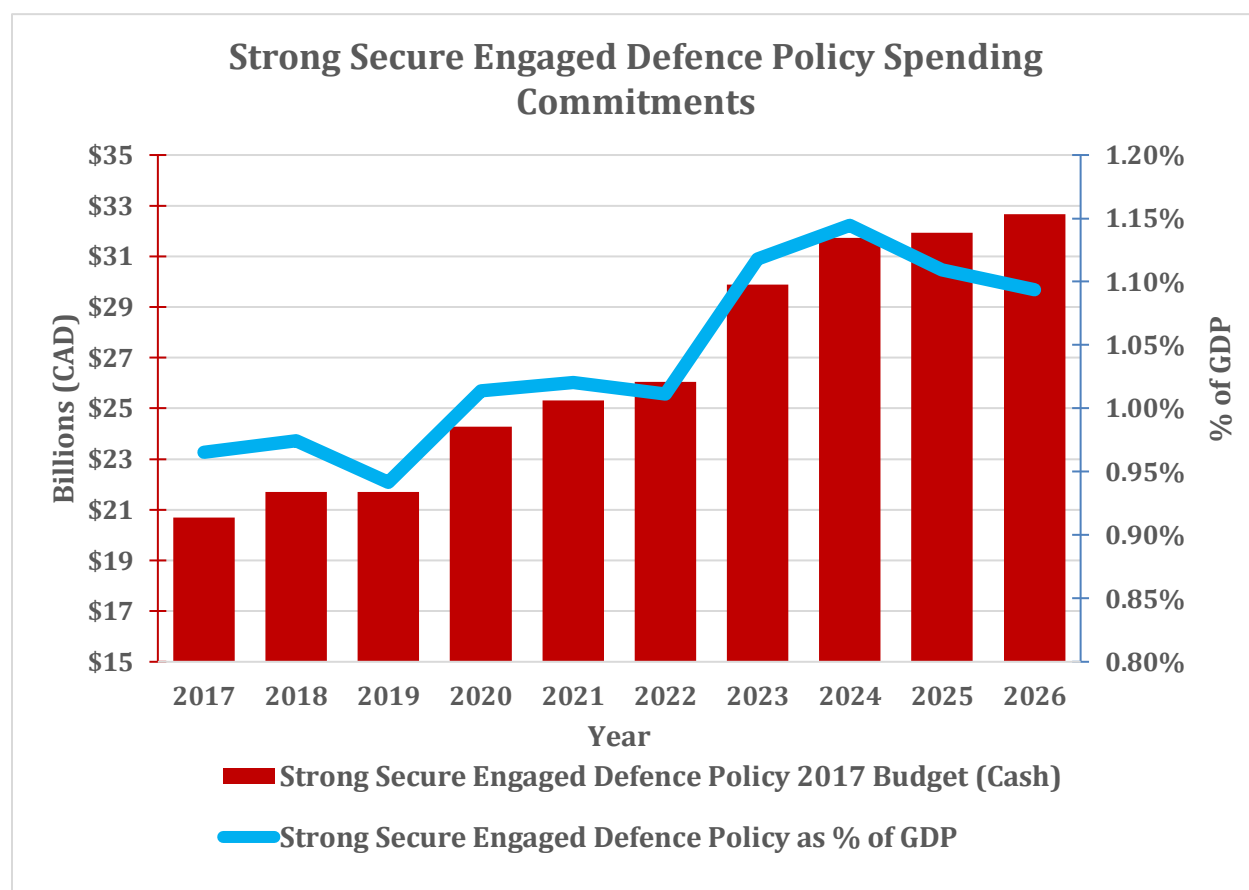
Conclusion

The CP-140 boondoggle inspired the Pierre Trudeau Government to create the NFA program and the F-35 boondoggle motivated the Harper Government to rediscover why the NFA process was so important. The NFA structure solves many of the administrative issues related to defence procurement, while also illuminating the importance of setting reasonable defence policy. Some argue that the solution to the easy rider problem is to show leadership and encourage Canadians to spend more. This goal of better leadership is as unlikely to be successful as it is unlikely to be seriously attempted. As Nossal emphasized, “Canadians have demonstrated quite consistently over many decades that they are profoundly unwilling to spend on defence.”³⁹⁰ Instead, politicians and public policy leaders should use the NFA methodology to design a defence policy for easy riders. Such a defence policy will meet military objectives with best value, state-of-the-art technology. The best value solution to the CF-18 replacement is the least expensive jet in the competition: the Saab Gripen.

³⁸⁹ Daniel Leblanc, “Harper Bending to U.S. on Sole-Source Fighter Purchase, Documents Reveal.”

³⁹⁰ Nossal, *Charlie Foxtrot*, 138.

Appendix A



Budget 2018 ³⁹¹	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026 ³⁹²
Nominal GDP (\$ Billions)	\$2,142	\$2,228	\$2,306	\$2,394	\$2,481	\$2,575	\$2,672.34	\$2,773.35	\$2,878.18	\$2,986.98

Strong Secure Engaged ³⁹³	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Budget (Cash) (\$ Billions)	\$20.683	\$21.714	\$21.714	\$24.276	\$25.315	\$26.048	\$29.879	\$31.741	\$31.931	\$32.673
% of GDP	0.966%	0.975%	0.942%	1.014%	1.020%	1.012%	1.118%	1.145%	1.109%	1.094%
Annual Increase (\$ Billions)		\$1.031	\$0.000	\$2.562	\$1.039	\$0.733	\$3.831	\$1.862	\$0.190	\$0.742

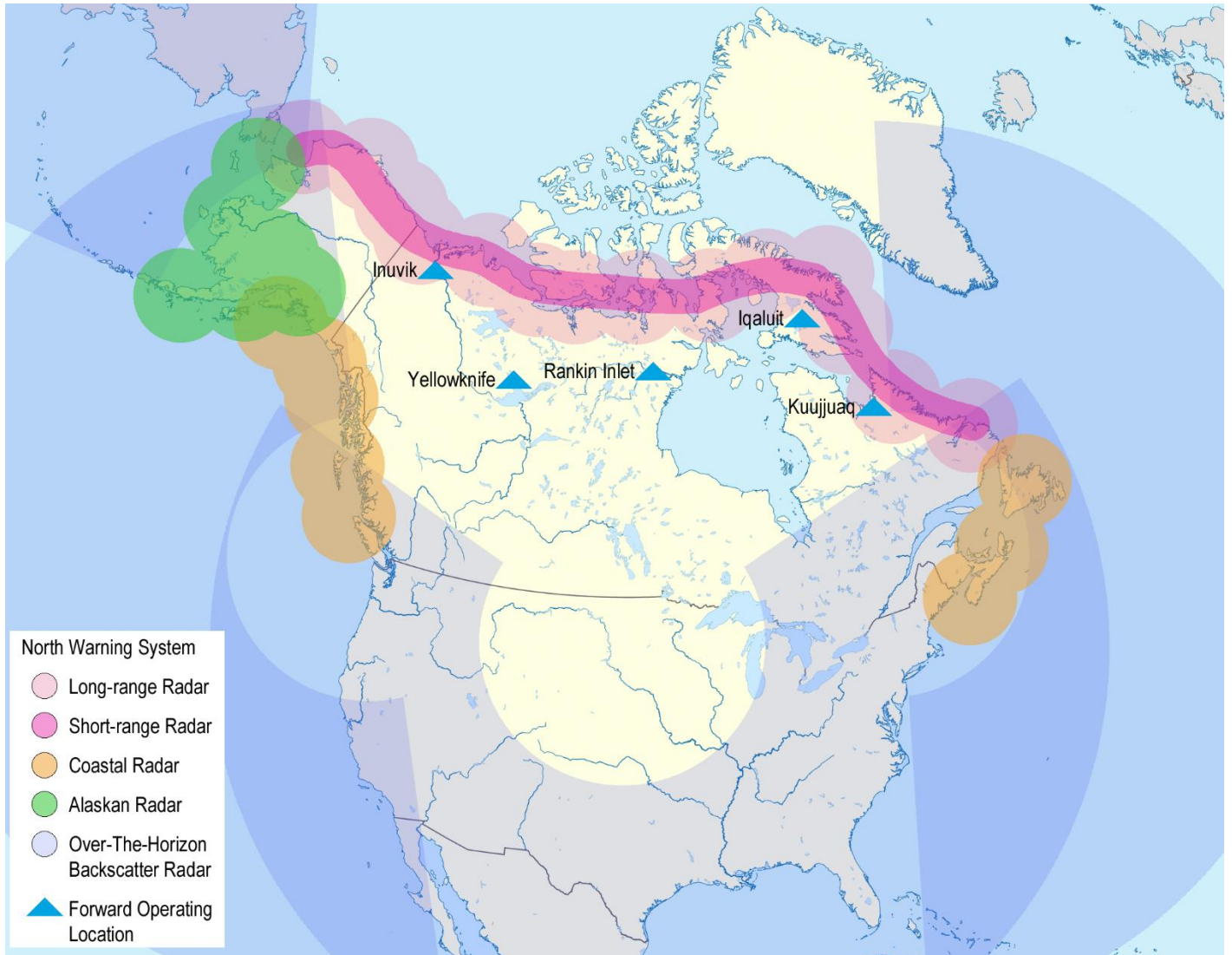
³⁹¹ Canada, "Budget 2018 Equality + Growth," February 27, 2018, 300, <https://www.budget.gc.ca/2018/docs/plan/budget-2018-en.pdf>.

³⁹² 2017-2022 Nominal GDP numbers are taken directly from Budget 2018. 2023-2026 Nominal GDP numbers are estimates based on 3.78% nominal GDP growth.

³⁹³ Canada, "Strong Secure Engaged Canada's Defence Policy," 43.

Appendix B

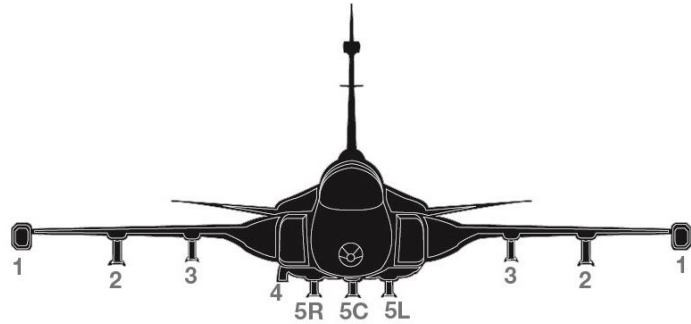
NORAD North Warning System³⁹⁴



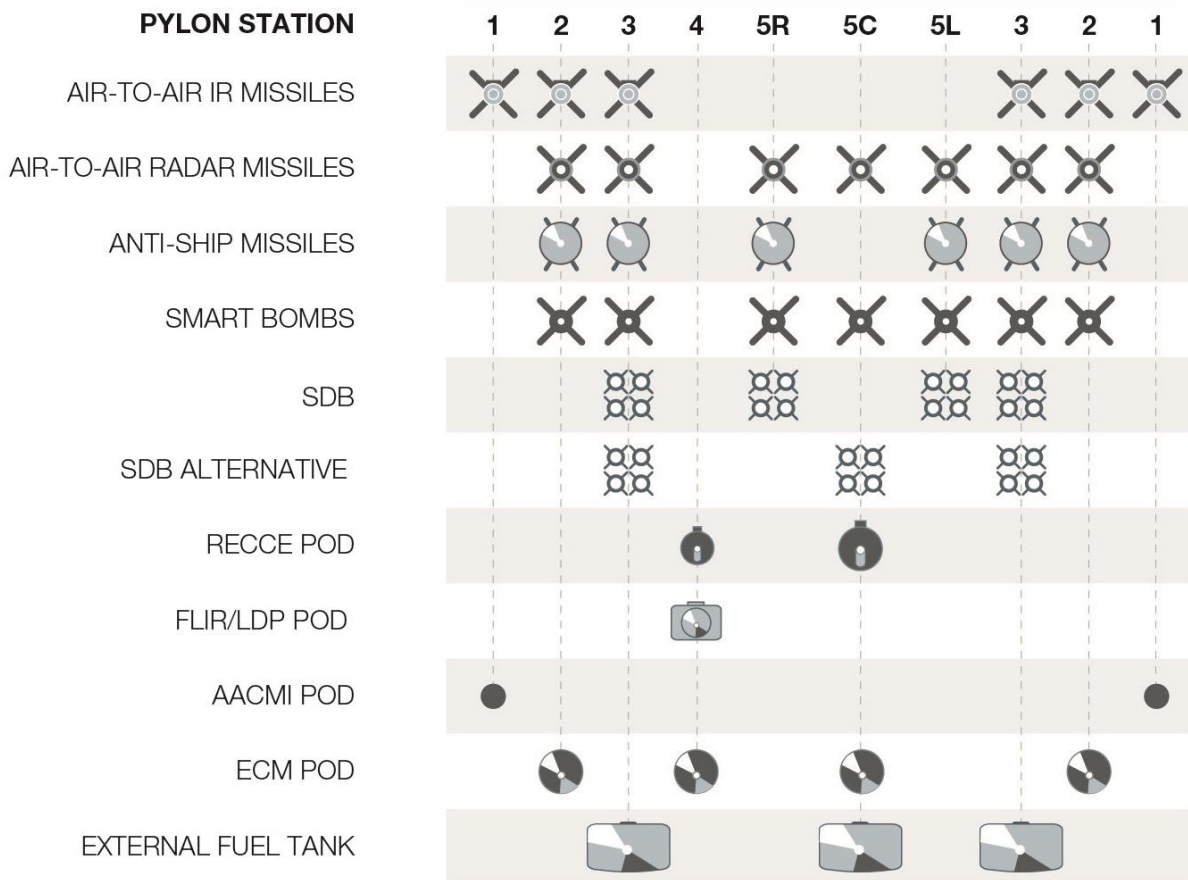
³⁹⁴ Wikimedia Commons, "The North Warning System as part of NORAD radar array as envisioned by Canada and the US in 1987," https://en.wikipedia.org/wiki/North_Warning_System#/media/File:North_Radar_System.png a high-definition recreation of the original map from: Canada, "Challenge and Commitment - A Defence Policy for Canada," June 1987, pg. 57, http://publications.gc.ca/collections/collection_2012/dn-nd/D2-73-1987-eng.pdf.

Appendix C

Saab Gripen-E Weapons and Hardpoints³⁹⁵



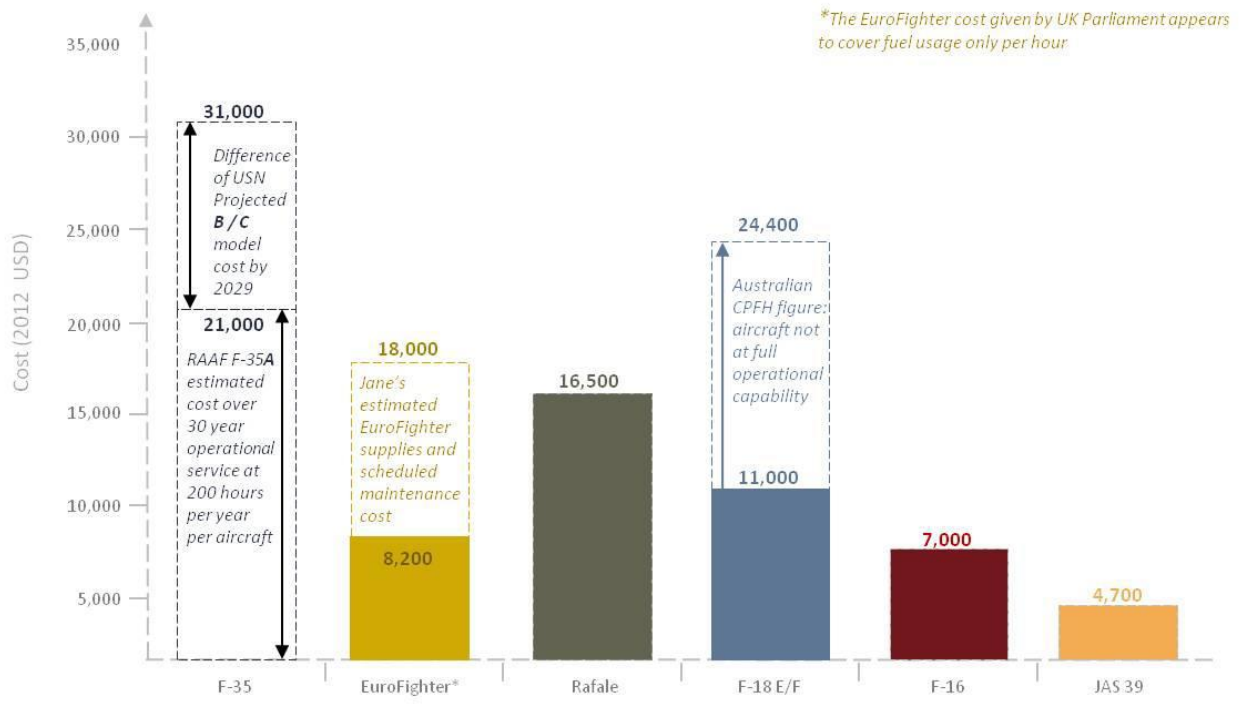
MULTI-ROLE CAPABILITY



³⁹⁵ Saab, "Gripen E/F."

Appendix D

IHS Jane's CPFH Core Findings³⁹⁶



³⁹⁶ Edward Hunt, "Fast Jet Operating Costs," *IHS Jane's*, March 13, 2012, 9.

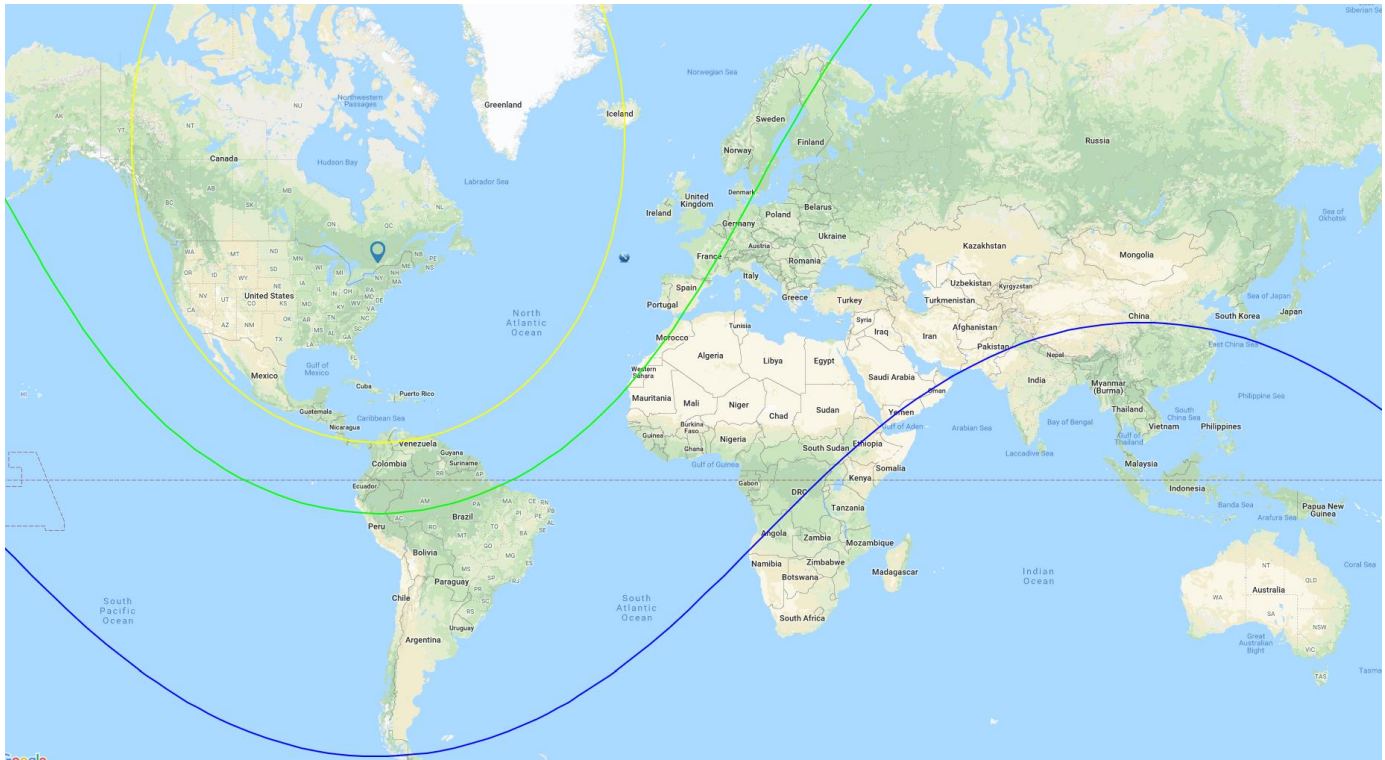
Appendix E
F-35 Cockpit (Top), Gripen E Cockpit (Bottom)³⁹⁷



³⁹⁷ Lockheed Martin, "The F-35 Cockpit," Accessed September 4, 2018, <https://www.f35.com/media/videos-detail/the-f-35-cockpit>; John Belanger, "Saab Press Briefing CANSEC 2018."

Appendix F

CC-144 Range vs. Global Express 6000 from Ottawa³⁹⁸



Yellow circle: 4,074 km radius (1980-era CC-144)
Green circle: 5,926 km radius (2000-era CC-144)
Blue circle: 11,112 km radius (Global Express 6000)

³⁹⁸ Map created using: <https://www.freemaptools.com/radius-around-point.htm>; Canada, “CC-144 Challenger; Chris Rands, “RCAC wants Ottawa to buy two used jets for the VIP fleet.”

Appendix G

Canada and the Defence of North America: NORAD and Aerial Readiness Report Recommendations:³⁹⁹

Recommendation 1

That the Government of Canada conduct a thorough review of Canada's international and domestic capability requirements for the replacement of the CF-18 fighter jets; that the Government select a replacement which satisfies both Canada's international and domestic needs by being capable of effectively exercising Canada's sovereignty in the high Arctic and remote regions of the country while remaining interoperable with our allies; and that the CF-18 replacement:

- a) Possess an active electronically scanned array (AESA) radar and beyond line of sight communication equipment;
- b) Work to a high degree with Canada's existing infrastructure;
- c) Be interoperable with the United States of America's NORAD assets;
- d) Provide sufficient fighter capability to ensure NORAD and NATO commitments can be fulfilled as currently defined; and
- e) Have well defined capital and sustainment costs as to not jeopardize the recapitalization of other much-needed military equipment.

Recommendation 2

That, for procurement contracts pertaining to aircraft utilized in the context of the far North region, pilot safety be a key consideration.

Recommendation 3

That the Government of Canada decide on the replacement of the current fleet of CF-18 fighter jets within the next 12 months.

Recommendation 4

That the Government of Canada recognize the importance of air-to-air refueling as it relates to the Royal Canadian Air Force's number one priority, which is sovereignty.

Recommendation 5

That the defence policy review evaluate the primary locations of Canada's Air Sovereignty Alert (ASA) assets to ensure they are optimally positioned to respond to asymmetric threats under the auspices of Operation NOBLE EAGLE (ONE).

Recommendation 6

³⁹⁹ Canada, "Canada and the Defence of North America: NORAD and Aerial Readiness," 61-62.

That the Government of Canada recognize the proliferation of cruise missiles, and related emerging technologies, as a threat to Canada and take the necessary action to protect Canada from this threat.

Recommendation 7

That the Government of Canada recognize emerging ballistic missile threats.

Recommendation 8

That the defence policy review reconsider Canada's position with regard to ballistic missile defence (BMD) in the context of Canada's defence priorities and limited financial resources.

Recommendation 9

That, in terms of Canada's potential role in ballistic missile defence, Canadian research and development be a consideration.

Recommendation 10

That the defence policy review take into account that witnesses have questioned the efficacy of the ballistic missile defence program.

Recommendation 11

That the Government of Canada recognize the detrimental effects of climate change in our North; and that the Government quickly adapt our northern surveillance and defences to a potential Russian threat.

Recommendation 12

That, with the end of the North Warning System's operational life approaching, the Government of Canada recognize the need to maintain and improve all aspects of Arctic domain awareness.

Recommendation 13

That the Government of Canada ensure that adequate safeguards are in place to protect Canada and Canadians from, and respond to, cyberattacks by foreign governments and non-state actors.

References

- Adams, Eric. "Why Only Israel Can Customize America's F-35 (At Least for Now)." *WIRED*. May 10, 2016. <https://www.wired.com/2016/05/israel-can-customize-americas-f-35-least-now/>.
- AIRCOM. "Icelandic NATO Mission accomplished by Czech Gripen." *NATO*. November 7, 2016. <https://ac.nato.int/archive/2016/icelandic-nato-mission-accomplished-by-czech-gripen->.
- Air Forces Monthly. "Weapons boost for Swordfish." May 10, 2017. <https://airforcesmonthly.keypublishing.com/2017/05/10/weapons-boost-for-swordfish/>.
- Atkinson, Michael M. and Kim Richard Nossal. "Bureaucratic Politics and the New Fighter Aircraft Decisions." *Canadian Public Administration* 24, no. 4 (Winter 1981). <http://dx.doi.org/10.1111/j.1754-7121.1981.tb00348.x>.
- Australia. "Facilities Requirements for the New Air Combat Capability." *Statement of Evidence to the Parliamentary Standing Committee on Public Works*. June 2014.
- Axe, David. "Austria Has No Business Flying These High-Performance Fighters." *War is Boring*. November 2, 2014. <https://warisboring.com/austria-has-no-business-flying-these-high-performance-fighters/>.
- Ballingall, Alex. "Boeing may have won a Battle, but not the war, says Quebec premier of Bombardier battle." *The Star*. September 27, 2017. <https://www.thestar.com/news/canada/2017/09/27/trudeau-disappointed-in-us-decision-to-slap-220-per-cent-duty-on-canadas-bombardier-jets.html>.
- Belanger, John. "Saab Press Briefing CANSEC 2018." *Saab*. May 30, 2018. <https://saabgroup.com/globalassets/corporate/media-news-press-stories/event-press-kits/zip-folders/cansec/cansec-2018-press-brief-finalx.pdf>.
- Berthiaume, Lee. "New fighter-jet competition to have national 'economic interest' requirement." *The National Post*. December 12, 2017. <http://nationalpost.com/pmn/news-pmn/canada-news-pmn/newsalert-new-fighter-jet-competition-to-have-economic-interest-requirement>.
- Berthiaume, Lee. "U.S. State Department OK with Sale of Super Hornets to Canada for Estimated at \$5.23B U.S." *The Toronto Star*. September 12, 2017. <https://www.thestar.com/news/canada/2017/09/12/us-state-department-oks-sale-of-super-hornets-estimated-at-523b-us-to-canada.html>.
- Bezglasnyy, Anton, and Douglas Alan Ross. "Strategically Superfluous, Unacceptably Overpriced: The Case against Canada's F-35A Lightning II Acquisition." *Canadian Foreign Policy Journal* 17, no. 3 (2011). <https://doi.org/10.1080/11926422.2011.638192>.

- Binnie, Jeremy. "IDEX 2017: UAE confirms order for third Saab GlobalEye." *IHS Jane's*. February 23, 2017. <https://archive.is/20170224024315/http://www.janes.com/article/68189/idx-2017-uae-confirms-order-for-third-saab-globaleye>.
- Birkler, John, John Graser, Mark V. Arena, Cynthia R. Cook, Gordon T. Lee, Mark A. Lorell, Giles K. Smith, Fred Timson, Obaid Younossi, and Jon Grossman. "Assessing Competitive Strategies for the Joint Strike Fighter: Opportunities and Options." *The RAND Corporation*, 2001.
- Bombardier. "Global 6000." Accessed September 4, 2018. <https://businessaircraft.bombardier.com/en/aircraft/global-6000#!#bba-pdp-section-1>.
- Bombardier. "Rollout of Elite GlobalEye Surveillance Solution Solidifies the Bombardier Global 6000 Aircraft as the Platform of Choice for Special Missions." February 26, 2018. https://www.bombardier.com/en/media/newsList/details.bba_20180226_rollout-of-elite-globaleye-surveillance-solution-so.bombardiercom.html.
- Brewster, Murray. "Ottawa facing decisions on the frigate replacements for navy." *Global News*. March 20, 2016. <https://globalnews.ca/news/2589029/ottawa-facing-decisions-on-frigate-replacements-for-navy/>.
- Brewster, Murray. "Stopgap Super Hornet Purchase Could have \$5B to \$7B Price Tag." *CBC News*. January 31, 2017. <http://www.cbc.ca/news/politics/fighter-jet-purchase-super-hornets-1.3956306>.
- Briganti, Giovanni. "First Technical and Operational Lessons from Kosovo Air Operations." *defense-aerospace.com*. Accessed September 4, 2018. <http://www.defense-aerospace.com/article-view/feature/19141/first-lessons-from-kosovo-ops.html>.
- Burns, E.L.M. *A Seat at the Table: The Struggle for Disarmament*. (Toronto: Clarke Irwin, 1972).
- Byers, R.B. "Canadian security and defence: The legacy and the challenge." *Adelphi Papers* 214 (1986). <https://doi.org/10.1080/05679328608448759>.
- Canada. "Apparent Conflict of Interest." July 23, 2015. <https://www.canada.ca/en/treasury-board-secretariat/services/values-ethics/conflict-interest-post-employment/apparent-conflict-interest.html#a3>.
- Canada. "ARCHIVED - 2007-2008 DPRs - Status Report on Major Crown Projects." Accessed September 4, 2018. <https://www.tbs-sct.gc.ca/dpr-rmr/2007-2008/info/mcp-gpe-eng.asp#t5-07>.
- Canada. "Budget 2018 Equality + Growth." February 27, 2018. <https://www.budget.gc.ca/2018/docs/plan/budget-2018-en.pdf>.

- Canada. "Canada and the Defence of North America: NORAD and Aerial Readiness." *Report of the Standing Committee on National Defence*. September 2016. <https://www.ourcommons.ca/Content/Committee/421/NDDN/Reports/RP8406082/nddnrp02/nddnrp02-e.pdf>.
- Canada. "Canada announces plan to replace fighter jet fleet." November 22, 2016. <https://www.canada.ca/en/departement-national-defence/news/2016/11/canada-announces-plan-replace-fighter-fleet.html>.
- Canada. "Canada First Defence Strategy." Accessed October 19, 2017. http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/CFDS-SDCD-eng.pdf.
- Canada. "Canadian Multi-Mission Aircraft." May 30, 2018. <http://dgpapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=975>.
- Canada. "CC-130 Hercules." June 28, 2017. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-130.page>.
- Canada. "CC-144 Challenger." June 29, 2017. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-144.page>.
- Canada. "CC-150 Polaris." June 28, 2017. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-150.page>.
- Canada. "CF-188 Hornet." Accessed September 3, 2018. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cf-188.page>.
- Canada. "CF-18 Hornet Estimated Life Expectancy." March 13, 2017. <http://www.forces.gc.ca/en/about-reports-pubs/next-gen-fighter-cf18-estimated-life-expectancy.page>.
- Canada. "CH-149 Cormorant." June 22, 2017. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-149.page>.
- Canada. "Challenge and Commitment - A Defence Policy for Canada." June 1987. http://publications.gc.ca/collections/collection_2012/dn-nd/D2-73-1987-eng.pdf.
- Canada. "CP-140 Aurora." November 28, 2017. <http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cp-140.page>.
- Canada. "CP-140 Aurora fleet modernization and life extension." June 6, 2018. <http://www.forces.gc.ca/en/business-equipment/procurement-projects/aurora-cp-140.page>.
- Canada. "Future Fighter Capability Project." August 16, 2018. <http://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/spdgp-ffcp-eng.html>.

- Canada. "Future Fighter Capability Project - Suppliers List Invitation (W847A-180210/A)." September 7, 2018. <https://buyandsell.gc.ca/procurement-data/tender-notice/PW-NGF-002-26574>.
- Canada. "Government launches open and transparent competition to replace Canada's fighter aircraft." December 12, 2017. <https://www.canada.ca/en/public-services-procurement/news/2017/12/government-launchesopenandtransparentcompetitio ntoreplacecanadas.html>.
- Canada. House of Commons, Standing Committee on National Defence. *Meeting 38 Evidence*. 40th Parliament, 3rd Session. December 7, 2010. <http://www.ourcommons.ca/DocumentViewer/en/40-3/NDDN/meeting-38/evidence>.
- Canada. "Integrating Australian Jets into the Current Royal Canadian Air Force Fighter Fleet." December 12, 2017. https://www.canada.ca/en/department-national-defence/news/2017/12/integrating_australianjetsintotheurrentroyalcanadianair forcefig.html.
- Canada. "RCAF MAP." July 19, 2013. <http://www.rcaf-arc.forces.gc.ca/en/rcaf-map.page>.
- Canada. "Replacing and Supplementing Canada's Fighters." December 12, 2017. <https://www.tpsgc-pwgsc.gc.ca/app-acq/amd-dp/air/snac-nfps/CF-18-eng.html>.
- Canada. "Royal Canadian Air Force Image Gallery." July 26, 2013. <http://rcaf-arc-images.forces.gc.ca/gallery/caf/search/>.
- Canada. "Strong Secure Engaged Canada's Defence Policy." 2017. <http://dgpaapp.forces.gc.ca/en/canada-defence-policy/docs/canada-defence-policy-report.pdf>.
- CBC. "Canada's military contribution in Libya." *CBC News*. October 20, 2011. <https://www.cbc.ca/news/world/canada-s-military-contribution-in-libya-1.996755>.
- CBC. "ISIS mission: Canadian CF-18s drop laser-guided bombs over Iraq." *CBC News*. November 2, 2014. <https://www.cbc.ca/news/politics/isis-mission-canadian-cf-18s-drop-laser-guided-bombs-over-iraq-1.2821425>.
- CBC. "Justin Trudeau Vows to Scrap F-35 Fighter Jet Program." *CBC News*. September 20, 2015. <http://www.cbc.ca/news/politics/canada-election-2015-trudeau-scrap-f35-halifax-1.3235791>.
- CBC. "Sky High: The search for a new Canadian fighter jet in the 1970s." *The Fifth Estate* (1978). https://www.youtube.com/watch?v=kTk-Z0Th_SA.
- Clancy, Clare. "Former fighter pilot turned MP criticizes federal decision to buy Super Hornets." *Edmonton Journal*. November 24, 2016.

<https://edmontonjournal.com/news/local-news/former-fighter-pilot-turned-mp-criticizes-federal-decision-to-buy-super-hornets>.

Clement, Tony. "Liberals must change course on sinking approach to shipbuilding." *Toronto Sun*. April 17, 2018. <https://torontosun.com/opinion/columnists/guest-column-liberals-must-change-course-on-sinking-approach-to-shipbuilding>.

CNBC. "Under Trump, Super Hornet gets a Boost: Production set to Double." May 8, 2017. <https://www.cnbc.com/2017/05/08/super-hornet-production-set-to-double-as-trump-gives-program-a-boost.html>.

Cohen, Zachary, Ryan Browne, Nicole Gaouette, and Taehoon Lee. "New missile test shows North Korea capable of hitting all of US mainland." *CNN*. November 30, 2017. <https://www.cnn.com/2017/11/28/politics/north-korea-missile-launch/index.html>.

Cunningham, Anna. "Keeping pirates at bay: On board with the Canadian navy off the coast of Nigeria." *CBC*. March 29, 2018. <https://www.cbc.ca/news/world/keeping-pirates-at-bay-on-board-with-the-canadian-navy-off-the-coast-of-nigeria-1.4590286>.

defenceWeb. "Swedish Gripens deliver 37% of Libyan reconnaissance reports." August 8, 2011. http://www.defenceweb.co.za/index.php?option=com_content&view=article&id=17886:swedish-gripens-deliver-37-of-libyan-reconnaissance-reports&catid=35:Aerospace&Itemid=107.

Defense Industry Daily. "F-X2: Brazil's Saab Contract for Gripen's a Done Deal." December 19, 2016. <https://www.defenseindustrydaily.com/brazil-embarking-upon-f-x2-fighter-program-04179/>.

Dombe, Ami. "China's Radars Tracked the US Stealthy F-22 Raptor." *Israel Defense*. February 22, 2016. www.israeldefense.co.il/en/content/chinas-radars-tracked-us-stealthy-f-22-raptor.

Donald, David. "Saab launches GlobalEye for Swing-role Surveillance." *AIN Online*. February 16, 2016. <https://www.ainonline.com/aviation-news/defense/2016-02-16/saab-launches-globaleye-swing-role-surveillance>.

Dowling, Stephen. "Russia's Bear: The old-fashioned plane still thriving." *BBC*. February 26, 2015. <http://www.bbc.com/future/story/20150225-the-worlds-noisiest-spyplane>.

Egnell, Robert. "The Swedish Experience in Operation Unified Protector." *USAF, RAND Corporation, Stockholm Center for Strategic Studies*. October 16, 2012. http://media.wix.com/ugd//012b60_f1ddfdb759804fe6809fb4f09f536405.pdf.

GE Aviation. "The F414 Engine." Accessed September 4, 2018. <https://www.geaviation.com/military/engines/f414-engine>.

- Granatstein, J.L. "Delays, deficit fighting and no direction." *Ottawa Citizen*. 6 December 2012.
- Hehs, Eric. "History of the F-16 Fighting Falcon." *Code One Online*. February 19, 2014. http://www.codeonemagazine.com/article.html?item_id=23.
- Hoeffler, Catherine and Frédéric Mérand. "Buying a fighter jet: European Lessons for Canada." *Canadian Foreign Policy Journal*, 22, No. 3 (2016). <https://doi.org/10.1080/11926422.2015.1083872>.
- Hoyle, Craig. "Saab has sky-high sales hopes for GlobalEye." *Flight Global*. February 28, 2018. <https://www.flightglobal.com/news/articles/saab-has-sky-high-sales-hopes-for-globaleye-446303/>.
- Hunt, Edward. "Fast Jet Operating Costs." *IHS Jane's*. March 13, 2012.
- Jennings, Gareth. "GlobalEye makes maiden flight." *IHS Jane's*. March 14, 2018. <https://www.janes.com/article/78582/globaleye-makes-maiden-flight>.
- Johnson, Reuben F. "Canada Ponders CF-18 Fighter Replacement." *AIN Online*. January 4, 2017. <https://www.ainonline.com/aviation-news/defense/2017-01-04/canada-ponders-cf-18-fighter-replacement>.
- Jones, Peter and Philippe Lagassé. "Rhetoric versus reality: Canadian defence planning in the time of austerity." *Defense & Security Analysis* 28, no. 2 (June 2012). <https://doi.org/10.1080/14751798.2012.678160>.
- Katz, Dan. "Specifications: JAS 39 Gripen." *Aviation Week Intelligence Network*. September 25, 2014. http://aviationweek.com/site-files/aviationweek.com/files/uploads/2014/09/asd_09_25_2014_jas7.pdf.
- Kerckhove, Ferry. "Foreword," *Charlie Foxtrot* (Toronto: Dundurn, 2016).
- Lagassé, Philippe. "Nils Ørvik's 'defence against help.'" *International Journal* 65, No. 2, Annual John W. Holmes issue on Canadian foreign policy (Spring 2010). <http://www.jstor.org/stable/25681122>.
- Leblanc, Daniel. "Canada Needs New Fighter Jets 'Now,' Defence Minister Says." *The Globe and Mail*. May 26, 2016. <https://beta.theglobeandmail.com/news/politics/canada-needs-new-fighter-jets-now-defence-minister-says/article30172969/?ref=http://www.theglobeandmail.com&>.
- Leblanc, Daniel. "Dogfight." *The Globe and Mail*. November 12, 2017. <https://www.theglobeandmail.com/news/politics/breaking-down-the-dogfight-over-canadas-next-fighter-jet/article30495055/>.
- Leblanc, Daniel. "Harper Bending to U.S. on Sole-Source Fighter Purchase, Documents Reveal." *The Globe and Mail*. June 10, 2010. <https://beta.theglobeandmail.com/news/politics/harper-bending-to-us-on-sole->

[source-fighter-purchase-documents-reveal/article4184697/?ref=http://www.theglobeandmail.com&](#)

Lendon, Brad. "Weapons the US, UK and France used to target Syria." *CNN*. April 15, 2018. <https://www.cnn.com/2018/04/14/politics/syria-airstrikes-weapons-used-intl/index.html>.

Leversedge, T.F.J. "McDonnell Douglas CF-188B Hornet." *Canada Aviation and Space Museum*. <https://documents.techno-science.ca/documents/CASM-AircraftHistories-CF-18Hornet.pdf>.

Lockheed Martin. "Charles Bouchard To Lead Lockheed Martin Canada." September 24, 2013. <https://www.lockheedmartin.com/us/news/press-releases/2013/september/0924hq-bouchard-lm-canada.html>.

Lockheed Martin. "F-22 Raptor." Accessed September 4, 2018. <https://www.lockheedmartin.com/en-us/products/f-22.html>.

Lockheed Martin. "The F-35 Cockpit." Accessed September 4, 2018. <https://www.f35.com/media/videos-detail/the-f-35-cockpit>.

Logan, Tim. "Brazil snubs Boeing Super Hornets in big fighter jet buy." *St. Louis Post-Dispatch*. December 18, 2013. https://www.stltoday.com/business/local/brazil-snubs-boeing-super-hornets-in-big-fighter-jet-buy/article_38bebef5-72f0-5cde-a3eb-c4294bf81850.html.

Macias, Amanda. "Behold the most expensive weapons system ever and all of its ammunition in one photo." *Business Insider*. July 26, 2016. <https://www.businessinsider.com/lockheed-martin-f35-and-all-its-weapons-2016>.

McKie, David. "Government gets poor grade for military spending." *CBC*. April 14, 2015. <https://www.cbc.ca/news/politics/government-gets-poor-grade-for-military-spending-1.3030862>;

McLaren, Kevin. "35 years of Canadian participation in NORAD AWACS program." *Royal Canadian Air Force*. November 24, 2014. <http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=35-years-of-canadian-participation-in-norad-awacs-program/i2kafyfb>.

Mizokami, Kyle. "The Navy's Super Hornets Are Getting an Upgrade." *Popular Mechanics*. March 22, 2018. <https://www.popularmechanics.com/military/aviation/a19563666/navys-super-hornets-block-iii/>.

Morin, Jean and Richard Gimblett. *Operation Friction 1990-1991 The Canadian Forces in the Persian Gulf*. Directorate of History of the Department of National Defence (Toronto: Dundurn, 1997).

- NORAD. "NORAD Operations." Brief to NDDN by Major-General Christopher J. Coates (Director of NORAD Operations). NORAD Headquarters, Colorado Springs (Colorado, U.S.). 2 May 2016.
- Nossal, Kim Richard. *Charlie Foxtrot* (Toronto: Dundurn, 2016).
- Nossal, Kim Richard. "Late Learners: Canada, the F-35, and Lessons from the New Fighter Aircraft Program." *International Journal* 68, no. 1 (2012).
<http://www.jstor.org/stable/42704966>.
- Ørvik, Nils. "Defence against help: A strategy for small states?" *Survival* 15, no. 5 (1973).
- Perry, David. "DND will be doing less with less." *iPolitics*. April 4, 2012.
<https://ipolitics.ca/2012/04/04/david-perry-dnd-will-be-doing-less-with-less/>.
- Planche, Stephan. "F-16 MLU." January 18, 2005. http://www.f-16.net/f-16_versions_article2.html.
- Quon, Alexander. "Ottawa reaffirms role of Halifax Shipyard in National Shipbuilding Strategy after company 'concerned' over remarks." *Global News*. August 14, 2018.
<https://globalnews.ca/news/4387096/irvings-halifax-shipyard/>.
- Rands, Chris. "RCAF wants Ottawa to buy two used jets for the VIP fleet." *CBC*, April 27, 2018. <https://www.cbc.ca/news/politics/challenger-vip-jet-fleet-1.4636818>.
- Ripsman, Norrin M. "Big Eyes and Empty Pockets: The Two Phrases of Conservative Defence Policy." *Diplomatic Departures: The Conservative Era in Canadian Foreign Policy, 1984-93 ed*, (Vancouver: UBC Press, 2001): 100-112.
- Robinson, Clarence A. Jr. "Gulf War 20th: Apache Raid." *Defense Media Network*. February 2, 2011. <https://www.defensemetwork.com/stories/gulf-war-20th-apache-raid/>.
- Roblin, Sebastien. "A 'Stealthy' F-15 'Silent Eagle': Smart Idea or a Waste of Money?" *The National Interest*. August 18, 2018. <https://nationalinterest.org/blog/buzz/stealthy-f-15-'silent-eagle'-smart-idea-or-waste-money-29127>.
- Rogoway, Tyler. "SAAB's Gripen NG Fighter Has An Awesome Way To Make Its Radar More Capable." *Foxtrot Alpha*. November 21, 2015.
<https://foxtrotalpha.jalopnik.com/saabs-gripen-ng-fighter-has-an-awesome-way-to-make-its-1743963539>.
- Russell, Shahan. "That Day The Serbs Did The Impossible And Shot Down An F-117 Nighthawk." *War History Online*. August 4, 2016.
<https://www.warhistoryonline.com/history/that-day-the-serbs-did-the-impossible-shot-down-an-f-117-nighthawk.html>.
- Saab. "A Successful First Flight with Gripen." June 15, 2017. <https://saab.com/gripen/our-fighters/evolution/first-flight/>.

- Saab. "Czech Air Force Gripen Policing the Baltic Airspace." *DefenceTalk*. May 26, 2009. <https://www.defencetalk.com/czech-air-force-gripen-policing-the-baltic-airspace-19207/>.
- Saab. "Deployable Aircraft Maintenance Facility." Accessed September 4, 2018. <https://saab.com/dam>.
- Saab. "Gripen E/F." Accessed September 4, 2018. <https://saab.com/air/gripen-fighter-system/gripen/gripen-ef/>.
- Saab. "Gripen E/F Forever Ahead." Accessed September 4, 2018. <https://saab.com/gripen/our-fighters/gripen-fighter-system/gripen-e-series/gripen-e/#seetheunseen>.
- Saab. "Gripen E in brief." <https://saab.com/globalassets/commercial/air/gripen-fighter-system/pdf-files-download-section/facts/gripen-e-fact-sheet--en.pdf>.
- Saab. "Gripen E: The Cost Edge." May 8, 2017. <https://saab.com/region/india/gripenfor/gripen-updates/gripen-stories-updates/gripen-e-the-cost-edge/>.
- Saab. "Gripen NG: 2009 Milestones / Supercruise." August 16, 2009. <http://www.gripenblogs.com/Lists/Posts/Post.aspx?ID=177>.
- Saab. "Gripen Technology Hub in Brazil." Accessed September 4, 2018. <https://saab.com/air/gripen-fighter-system/gripen/gripen/proud-to-be-brazilian/>.
- Saab. "Link 16 Added to Gripen's Datalink Systems." *defense-aerospace.com*. June 11, 2007. <http://www.defense-aerospace.com/article-view/release/83146/saab-adds-link-16-to-gripen-s-datalink-systems.html>.
- Saab. "More than a fighter, a national asset: Gripen – the smart fighter." March 2016. <https://saab.com/globalassets/gripen.com/downloads/gripen-brochure--en-.pdf>
- Saab. "Saab Brings Gripen Technology Transfer Programme to Brazil." November 23, 2016. <https://saab.com/air/gripen-fighter-system/gripen/gripen/proud-to-be-brazilian/gripen-updates/gripen-stories-updates/saab-brings-gripen-technology-transfer-programme-to-brazil/>.
- Saab. "Saab receives order from FMV for a new helmet mounted display system." November 7, 2016. <https://saabgroup.com/media/news-press/news/2016-11/saab-receives-order-from-fmv-for-a-new-helmet-mounted-display-system/>.
- Saab. "Swordfish Maritime Patrol Aircraft." Accessed August 3, 2018. <https://saab.com/air/airborne-solutions/airborne-surveillance/swordfish-maritime-patrol-aircraft/>.

- Saab. "Swordfish MPA A New Era in Maritime Air Power." Accessed September 4, 2018. <https://saab.com/globalassets/commercial/air/airborne-solutions/airborne-surveillance/swordfish-maritime-patrol-aircraft/swordfish-datasheet.pdf>.
- Saab. "Swordfish Redefines Tomorrow's Maritime Patrol Aircraft." February 5, 2018. <https://saabgroup.com/media/news-press/news/2018-02/swordfish-redefines-tomorrows-maritime-patrol-aircraft/>.
- Saab. "The RBS15 Family." Accessed September 4, 2018. <https://saab.com/air/weapon-systems/air-to-surface-missile-systems/rbs15-family/>.
- Schwartz, Norty. *Journey Memoirs of an Air Force Chief of Staff*. (New York: Skyhorse, 2018).
- Selex. "Seaspray 7500E." 2014. http://www.leonardocompany.com/documents/63265270/65501186/mm07777/Seaspray_7500E_LQ.pdf.
- Shah, Maryam. "Test pilot makes F-35 pitch." *Toronto Sun*. June 17, 2016. <http://torontosun.com/2016/06/17/test-pilot-makes-f-35-pitch/wcm/4e877334-adf3-484d-9d0a-174a0a8a87c4>.
- Simonsen, Erik. "Legacy of the Lightweight Fighter Competition." *Air Force Magazine*. February 2017. <http://www.airforcemag.com/MagazineArchive/Pages/2017/February%202017/Legacy-of-the-Lightweight-Fighter-Competition.aspx>.
- Smith, Rich. "Britain Goes All In for Boeing's P-8A Poseidon." *The Motley Fool*. April 21, 2016. <https://www.fool.com/investing/general/2016/04/21/britain-goes-all-in-for-boeings-p-8a-poseidon.aspx>.
- Sokolsky, Joel S. "Realism Canadian Style: National Security Policy and the Chrétien Legacy." *Policy Matters* 5, no. 2 (June 2004). <http://irpp.org/wp-content/uploads/assets/pmvol5no2.pdf>.
- Stijger, Eric. "Dutch Mig kill." *Code One Magazine*. July 31, 1999. <https://planken.org/balkans/allied-force/operations-day-day/dutch-mig-kill>.
- Thatcher, Chris. "Operation Innovation." *RCAF News Article*. February 28, 2017. <http://www.rcaf-arc.forces.gc.ca/en/news-template-standard.page?doc=operation-innovation/izkjrliv>.
- The Associated Press. "U.S. nuclear commander assumes North Korea tested H-bomb Sept. 3." *CBS News*. September 15, 2017. <https://www.cbsnews.com/news/u-s-nuclear-commander-assumes-north-korea-tested-h-bomb-sept-3/>.
- The Canadian Press. "Avro Arrow redesign pitched as alternative to F-35 stealth fighter jets." *The National Post*. September 9, 2012. <https://nationalpost.com/news/canada/avro-arrow-redesign-pitched-as-alternative-to-f-35-stealth-fighter-jets>.

- The Canadian Press. "Canadian jets intercept Russian bombers for first time in 2 years." *The Star*. April 21, 2017. <https://www.thestar.com/news/canada/2017/04/21/canadian-jets-intercept-russian-bombers-for-first-time-in-2-years.html>.
- The Canadian Press. "Navy must still 'catch and release' Somali pirates." *CBC*. January 24, 2012. <https://www.cbc.ca/news/politics/navy-must-still-catch-and-release-somali-pirates-1.1210954>.
- Tian, Nan, Aude Fleurant, Alexandra Kuimova, Pieter D. Wezeman, & Siemon T. Wezeman. "Trends in World Military Expenditure, 2017." *Stockholm International Peace Research Institute*. May 2018. [https://www.sipri.org/sites/default/files/2018-05/sipri fs 1805 milex 2017.pdf](https://www.sipri.org/sites/default/files/2018-05/sipri_fs_1805_milex_2017.pdf).
- United Kingdom. "Merlin Mk2." Accessed August 3, 2018. <https://www.royalnavy.mod.uk/the-equipment/aircraft/helicopters/merlin-mk2>.
- United States. "F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency." *United States Government Accountability Office*. Report to Congressional Committees. October 2017. <https://www.gao.gov/assets/690/687982.pdf>.
- United States. "The World Factbook: Austria." *Central Intelligence Agency*. Accessed September 4, 2018. <https://www.cia.gov/library/publications/the-world-factbook/geos/au.html>.
- United States. "The World Factbook: Czechia." *Central Intelligence Agency*. Accessed September 4, 2018. <https://www.cia.gov/library/publications/the-world-factbook/geos/ez.html>.
- Woods, Allan. "Russian bombers intercepted on eve of Obama visit." *The Star*. February 27, 2009. https://www.thestar.com/news/canada/2009/02/27/russian_bombers_intercepted_on_eve_of_obama_visit.html.
- Yalkin, Tolga R. and Peter Weltman. "An Estimate of the Fiscal Impact of Canada's Proposed Acquisition of the F-35 Lightning II Joint Strike Fighter." Canada. March 10, 2011. http://publications.gc.ca/collections/collection_2011/dpb-pbo/YN5-31-2011-eng.pdf.