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From SOSUS to Satellites: Sovereignty, Security and Surveillance in the Canadian Arctic

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From SOSUS to Satellites: Sovereignty, Security and Surveillance in the Canadian Arctic

by

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Abstract

This thesis will present a detailed discussion of the relationship between sovereignty and security in the Canadian Arctic. More specifically, it will analyze the historical trends and current aims of surveillance projects in the region. This thesis will argue that the government of Stephen Harper prefers to answer sovereignty challenges with military security. It concludes that despite other branches of government such as the Royal Canadian Mounted Police and Coast Guard being the traditional enforcers of sovereignty, they have had little input in establishing the surveillance capabilities in the Arctic. Further, with the military having control over all aspects of the surveillance infrastructure, this government is positioning the military above other departments with respect to Arctic capabilities. Ultimately, the Harper Government has used sovereignty to sell a military build-up in the Arctic to Canadians. Without the guise of sovereignty, such expenditures would be difficult for the public to accept.

Acknowledgements

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Dedication

I would like to dedicate this thesis to my girlfriend and life partner Megan Visentin, who has been nothing but supportive through this long and laborious process.

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List of Symbols, Abbreviations and Nomenclature

Symbol	Definition
AIS	Automatic Identification System
AOPS	Arctic Offshore Patrol Ship
AWPPA	Arctic Waters Pollution Prevention Act
BMD	Ballistic Missile Defence
CAF	Canadian Armed Forces
CANDISS	Canadian Arctic Night and Day Surveillance System
CBSA	Customs and Border Service Agency
CCG	Canadian Coast Guard
CF	Canadian Forces
CIS	Canadian Ice Service
CSA	Canadian Space Agency
DEW Line	Distant Early Warning Line
DND	Department of National Defence
DRB	Defence Research Board
DRDC	Defence Research and Development Canada
DREA	Defence Research Establishment Atlantic
DREP	Defence Research Establishment Pacific
DREV	Defence Research Establishment Valcartier
D Space D	Directorate of Space Development
EEZ	Exclusive Economic Zone
ELINT	Electronic Intelligence
EO	Electro-Optical
GIUK Gap	Greenland-Iceland-United Kingdom Gap
IMO	International Maritime Organization
IMSWG	Interdepartmental Maritime Security Working Group
ISR	Intelligence, Surveillance, Reconnaissance
JSS	Joint Support Ships
M3MSat	Maritime Monitoring and Messaging Micro-satellite
MDA	MacDonald Dettwiler and Associates Ltd.
MSA	Maritime Situational Awareness
MSOC	Maritime Security Operations Centre
NGS	Northern Ground Station
NOL-WO	Naval Ordinance Laboratory – White Oak
NWMP	North-West Mounted Police
NWTDP	Northern Watch Technology Demonstration Project
OGD	Other Government Department
PE	Polar Epsilon
PE 2	Polar Epsilon 2
RCM	RADARSAT Constellation Mission

RCMP	Royal Canadian Mounted Police
RIP	Recording Instrument Package
RJOC	Regional Joint Operations Centre
RMP	Recognized Maritime Picture
S-AIS	Satellite Automatic Identification System
SAR	Synthetic Aperture Radar
SOSUS	Sound Surveillance System
UNCLOS	United Nations Convention on the Law of the Sea
VCDS	Vice-Chief of Defence Staff

CHAPTER 1: ALL OF THIS HAS HAPPENED BEFORE

The New Reality?

The Arctic region has seen massive environmental change over the last several decades. Regardless of the scientific reasoning behind this change the Arctic is warming at an extremely rapid rate. The most recent agreed upon estimates predict an ice-free summer by mid-century.[1] However, there are many in the scientific community who place the date much sooner. Prof. Peter Wadhams, for example, recently stated that he believes September could be ice free as early as 2015.[2] He is not alone in making a prediction that is not in agreement with the status-quo.[3] The truth is, the massive ice loss is a relatively recent phenomenon and, as a result, so is the science that creates the prediction models. The models do not have the benefit of drawing on decades of data and have to continually compensate for newly discovered phenomena such as methane release or albedo effect.[4] The Arctic has not been ice-free since modern humans have been in existence and it would be an understatement to say that this change is unprecedented. Regardless of why or when, the Arctic will not be the same cold, isolated place that it was in the past.

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[1] John Walsh and Donald Wuebbles et al., "Ch. 2: Our Changing Climate. Climate Change Impacts in the United States," in *The Third National Climate Assessment*, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds. (Washington: U.S. Global Change Research Program, 2014), 46-48.

[2] Nafeez Ahmed, "Ice-free Arctic in two years heralds methane catastrophe – scientist," *The Guardian*, July 24, 2013, http://www.theguardian.com/environment/earth-insight/2013/jul/24/arctic-ice-free-methane-economy-catastrophe.

[3] Wieslaw Maslowski, Jacln Clement Kinney, Matthew Higgins and Andrew Roberts, "The Future of Arctic Sea Ice," *Annual Review of Earth and Planetary Sciences*, 2012 (Vol. 40), 639.

[4] This is not to say that there had previously been no understanding of the albedo effect of sea ice and snow, but that it was not properly incorporated into sea ice models. There are have been many articles published on this topic and a good summation of the nonlinear properties of the albedo effect can be found in Michael Winton, "Sea Ice–Albedo Feedback and Nonlinear Arctic Climate Change," *Arctic Sea Ice Decline: Observations, Projections, Mechanisms, and Implications*, Geophysical Monograph Series 180, 111-131.

Additionally, the region has vast mineral deposits that are highly sought after by various corporations and states. Mary River is a high-grade iron ore site located 1000 kilometers north of Iqaluit on Baffin Island. Every year it will produce and estimated 18-30 million tonnes of high grade iron ore, which will then be shipped to international customers.[5] Diavik Diamond Mine is located 300 kilometers northeast of Yellowknife and is now Canada's largest. Although it is still 200 kilometers south of the Arctic Circle, the richness of the deposit (2.9 karats/ton) set off a massive amount of exploration throughout the region.[6] Lastly, the Sverdrup Basin in Nunavut is estimated to contain seventeen trillion cubic feet of recoverable natural gas, equivalent to almost three years of current Canadian gas production.[7] It is clear that the region has a huge resource potential and large projects are being developed. These projects will lead to a large increase in traffic throughout the region, placing a strain on government resources.

The Northwest Passage may soon be open to commercially viable summer shipping, posing problems for both Canadian security and sovereignty. While the prospect of a much shorter route between Asia and North America/Europe is attracting the eye of commerce, it also creates a security and sovereignty dilemma for Canada. The increased vessel traffic raises the possibility of the region being used for smuggling, human trafficking and other crimes. Some scholars further argue that the status of the Northwest Passage, be it internal waters as viewed by Canada or a strait used for international navigation as viewed by the United States and many

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[5] Baffinland Iron Mines Corporation, "The Mary River Project," accessed July 7, 2014, http://www.baffinland.com/mary-river-project/?lang=en.
[6] Rio Tinto, "Diavik Diamond Mine Visitor Information Booklet," April 1, 2013, accessed June 29, 2014, http://www.diavik.ca/documents/Visitor_information_booklet.pdf.
[7] Frédéric Beauregard-Tellier, "The Arctic: Hydrocarbon Resources," *Parliament of Canada*, October 24, 2008, http://www.parl.gc.ca/Content/LOP/researchpublications/prb0807-e.htm#.

European countries, could lead to a serious crisis.[8] It is clear that the Canadian Arctic is no longer the "fireproof house" that signified its isolation for millennia.

Despite the recent optimism, the realities of operating in the region are harsh, even with a changing climate. The Canadian Arctic includes around 19,000 islands and comprises forty percent of Canada's land mass. It is also sparsely populated, with only an estimated 108,000 inhabitants.[9] This poses a massive problem for the branches of government that are tasked with handling the increased activity in the area. Beginning in the early 2000s, the Government of Canada began to realize that the region would require a renewed focus as the realities of climate change began to set in. Beginning with the Martin Government's *Framework for a Northern Strategy* in December 2004, the Government of Canada began to act on issues facing the north. However, with the election of the Conservatives in 2006, the focus on Northern issues became even more intense. During that campaign, the Arctic became an election issue, with Harper telling Canadians that "Paul Martin talks eloquently about defending national sovereignty, but the reality hasn't matched the rhetoric."[10] Realizing that they had struck a chord with the electorate, the Arctic became a favourite element of the parties' platform and lead to a renewed focus on the region by the general population.

For the entire history of Canada the government has been able to adopt a "relaxed" approach towards Arctic policy due to its isolation. However, it is clear that the Arctic will not

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[8] Michael Byers, *Who Owns the Arctic?* (Vancouver: Douglas & McIntyre, 2009), 59.; Roger Howard, *The Arctic Gold Rush: The New Race for Tomorrow's Natural Resources* (London: Continuum, 2013), 184-188; Ken Coates, Whitney Lackenbauer, William Morrison and Greg Poelzer, *Arctic Front: Defending Canada in the Far North* (Toronto: Thomas Allen Publishers, 2008), 147-151.
[9] Canadian Forces Canada Command, "Canada Command Backgrounder: The Canadian Forces in the North," last modified April 9, 2012, http://www.emeraldsiberians.com/nr-sp/bg-do/12.003-north-nord-eng.asp.
[10] Quoted in CBC News, "Tories plan to bolster Arctic defence," December 22, 2005, http://www.cbc.ca/news/story/2005/12/22/elxn-harper-dfens.html.

remain isolated for much longer, as corporations begin to exploit the region's mineral wealth. Everything will be determined by the market, since companies need a high market price to justify the increased operating costs associated with the north. However, some companies are not waiting for the ice to melt or the infrastructure to be built. They are instead looking to technology to solve the long-standing logistical problems that have kept companies away for so long. These new innovations include ice-capable commercial ships and hybrid airships.[11] The proposed craft have the potential to allow companies to operate in the Arctic region much sooner than expected and at a lower operating cost.

In order to deal with in increase in activity and people, the government will require new equipment in order to properly monitor the region. There are currently four Twin Otters stationed in Yellowknife and a contingent of 5,000 Rangers throughout the region.[12] In addition, there are three CH-146 Griffon helicopters in Goose Bay for search and rescue operations.[13] Those are the only assets that the Canadian Armed Forces (CAF) has permanently stationed within reach of the Arctic regions and the capabilities of both the Twin Otters and Griffons are highly limited by their range. Most of the Arctic Archipelago falls under the jurisdiction of the search and rescue centre in Trenton, which is 4,300 kilometers from Alert, the furthest settlement under its mandate.[14] There has been a drive under the current government to improve the capabilities of

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[11] Baffinland, "Mary River Project Addendum to Final Environmental Impact Statement: Appendix 10D-10 Shipping and Marine Wildlife Management Plan", June 2013, 10; The Canadian Press, "Test airships for remote communities, MPs say," February 17, 2013, http://www.cbc.ca/news/canada/north/test-airships-for-remote-communities-mps-say-1.1376853.

[12] Canadian Forces Canada Command, "Canada Command Backgrounder: The Canadian Forces in the North"; Royal Canadian Air Force, "CC-138 Twin Otter: Transport/Search and Rescue Aircraft," last modified August 1, 2013, http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-138.page?.

[13] Royal Canadian Air Force, "CH-146 Griffon: Search and Rescue/Tactical Aviation Aircraft," last modified August 1, 2013, http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-146.page?.

[14] Royal Canadian Air Force, "Search and Rescue," last modified August 23, 2013, http://www.rcaf-arc.forces.gc.ca/en/search-rescue.page.

the CAF in the north. In 2007 it was announced that the Rangers would be expanded from 4,100 to 5,000 by 2012. The government also announced that it would procure six to eight Arctic/Offshore Patrol Vessels, which were originally intended to enter service in 2014. The government has been reluctant to give a new firm delivery date for the ships, but the latest update confirms that steel will not begin to be cut until at least 2015.[15] In addition, the government decided to use an abandoned mine site located in Nanisivik, Nunavut as a berthing and refuelling facility for both the Canadian Navy and the Canadian Coast Guard (CCG). It was originally intended to be open by 2015 but that date has been subsequently revised several times and only a limited amount of construction work has been done to date.[16] The current plan is to begin large scale construction in 2014, with the capabilities of the facility greatly reduced from what had originally been promised. Construction is planned to be completed by the end of the 2017 season.[17] Prime Minister Stephen Harper also announced in 2008 that the government would be building a new Polar class icebreaker, the CCGS *John D. Diefenbaker*. The ship was scheduled to be completed by 2017, but plans now call for construction to begin only after the completion of the navy's joint support ships in 2019-20. No firm date for completion has been announced, but plans are being made to extend the service life of CCGS *Louis St. Laurent* to 2021-22.[18] Additionally, there are still some lingering questions as to how capable the ship will be in multi-

[15] Public Works and Government Services Canada. "Backgrounder on the National Shipbuilding Procurement Strategy (NSPS) - Year 2: A Status Update," last modified November 13, 2013, http://www.tpsgc-pwgsc.gc.ca/app-acq/sam-mps/ddi-bkgr-10-eng.html.
[16] Canadian Forces Canada Command, "Canada Command Backgrounder: The Canadian Forces in the North."
[17] Stantec, "Nanisivik Naval Facility Project Specific Information Requirements: Revision 3," July 2013, http://ftp.nirb.ca/01-SCREENINGS/COMPLETED%20SCREENINGS/2013/09DN018-DND-Nanisivik%20Naval%20Facility/01-APPLICATION/130819-09DN018-NIRB%20Pt%201-IA2E.pdf.
[18] The Canadian Press, "Arctic icebreaker delayed as Tories prioritize supply ships," October 11, 2013, http://www.cbc.ca/news/politics/arctic-icebreaker-delayed-as-tories-prioritize-supply-ships-1.1991522.

year ice.[19] These projects show that the government is aware that the CAF and Coast Guard will need new capabilities in the future in order to ensure Canadian sovereignty is respected and enforce Canadian law.

Sovereignty: Open to Interpretation

In order to comprehensively tackle the issue of sovereignty in the Canadian Arctic it is important to first define what is meant by the term. Sovereignty is an international construct, open to individual interpretation. As argued by Michael Byers, "Sovereignty means different things to different people. Sovereignty can be about power, authority, autonomy, identity or moral equivalence."[20] In the case of the Canadian Arctic, the issue has nothing to do with the sovereignty of the Canadian state, rather the limits placed upon that sovereignty. While the Arctic may seem like a new frontier in international relations, the truth is that there are already extensive series of legal frameworks to govern action in the region. According to Charles Emmerson, "Deciding who has legal rights to what in the Arctic is complicated not because there is an absence of law, but because there is a surfeit of it. Different legal regimes apply to the land, the sea, and the seabed. The result is a palimpsest, with each set of rules overlaying the previous set of rules, but not quite effacing them."[21] Add to that mix the interplay between domestic and international law and situation becomes even more complicated.

Canada's most pressing major sovereignty challenges in the Arctic are not inclusive of the various territorial disputes. The impact of said disputes on relations with the United States and Denmark have been minimal and, with the exception of the Beaufort Sea dispute, involve

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[19] Canadian Coast Guard, "The CCGS John G. Diefenbaker National Icebreaker Project," last modified July 15, 2013, http://www.ccg-gcc.gc.ca/e0010762.
[20] Byers, *Who Owns the Arctic*, 5.
[21] Charles Emmerson, *The Future History of the Arctic* (New York: Public Affairs, 2010), 83.

relatively small pieces of territory. There will also be a minimal impact of sovereignty from the outcome of the demarcation of continental shelf rights. Under Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS), states can claim the economic rights to the seabed beyond the two hundred nautical mile exclusive economic zone (EEZ) if they can scientifically prove that it is an extension of said state's continental shelf.[22] These claims must be backed up with sound data and analysis in order to be successful. As Alun Anderson writes, "the question of who owns the Arctic becomes one of how to settle geologically sound overlapping claims."[23] These claims will also be in international waters, beyond the reach of domestic laws. Therefore sovereignty can neither be strengthened nor eroded via the continental shelf claims.

The one way in which UNCLOS will have a direct impact on Canadian sovereignty in the Arctic is through the section that defines an international strait. Article 37 of the Convention states that the right of transit passage "applies to straits which are used for international navigation between one part of the high seas or an exclusive economic zone and another part of the high seas or an exclusive economic zone."[24] The sovereignty implications of the provision revolve around the rights of a state to control and deny access to the waters. As explained by Byers:

> Sovereignty, like property, can usefully be thought of as a bundle of rights. A homeowner is still a homeowner if her property is subject to an easement entitling a neighbour to share a driveway, or to a covenant that prohibits the removal of trees. In the same way, if the Northwest Passage were considered an 'international strait,' rather than 'internal waters,' Canada would retain ownership of the waterway. One strand of our sovereignty would be lost, however: the ability to exercise full control over foreign ships passing through.[25]

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[22] United Nations, "United Nations Convention on the Law of the Sea," accessed July 10, 2014, 53-56. http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.
[23] Alun Anderson, *After the Ice: Life, Death, and Geopolitics in the New Arctic* (New York: Harper-Collins, 2009), 112.
[24] United Nations, "United Nations Convention on the Law of the Sea."
[25] Byers

As stated previously, sovereignty is a term steeped in ambiguity. This thesis will approach sovereignty from a multifaceted perspective, inclusive of several aspects. The most important aspects of sovereignty for this paper include domestic law enforcement, international law and recognition, the presence of effective governance, and, most importantly, security. It will argue that while security is an aspect of sovereignty and can certainly serve to enhance it, security alone is not the answer to sovereignty challenges. It will take the position that the Government of Canada has responded to the current sovereignty challenges in the Canadian Arctic with an almost exclusive military paradigm. It will argue that this is in stark contrast to the historical responses to sovereignty challenges and is actually a way of selling expensive defence projects to the Canadian public. It will make it clear that while the military has lines of communication with other departments, including those who traditionally enforce sovereignty in the Arctic, the system is reliant on the military being an open and communicative partner. It will be argued that such a system is open to abuse, whereby the military controls all the surveillance systems in the region and it is incumbent upon them to decide what information should be shared with other departments and agencies.

It should be noted as well that this thesis will deal almost exclusively with surveillance, with only a passing discussion of the enforcement side. The projects discussed in the following chapters have provided or will provide Canada with improved intelligence, surveillance, and reconnaissance (ISR). In order to enforce sovereignty, it is imperative that Canada first have a reliable and timely way of surveilling the Arctic region due to the low population and large distances. It will be made clear as to who the traditional enforcers of sovereignty have been throughout history, but these projects are

changing those responsibilities. This thesis takes the position that the section of government that holds the most sway over the surveillance side of sovereignty will dictate enforcement, in this case the military. As will be shown, they will be the only department with all the information at their disposal and will be in a position to control how much information is available to other governmental departments and agencies.

Plethora of Precedents

As stated, there have been numerous instances throughout the history of the country where the government or society has felt that Canadian control over the Arctic regions was being challenged. The response to these challenges has been varied, but one thing that is evident: the military rarely, if ever, was seen as the solution to questions of Canadian sovereignty.

One of the earliest security crises that the Government of Canada had to deal with in the Arctic region was the Klondike Gold Rush. It had long been known that there was gold in the region and that attracted relatively modest numbers of miners there, a large number of which were American. On August 7, 1894, Inspector Charles Constantine and S/Sgt. Charles Brown of the North-West Mounted Police (NWMP) arrived in the town of Fortymile in order to regulate the 1,000 miners, traders and trappers that comprised the non-native population of the Yukon. The force expanded to nineteen men in 1895, far too few for what was about to occur. In mid-August 1896 three miners made a strike on Bonanza Creek that was valued at thirty times the average ten-cent-strike-per-pan. The Yukon was soon inundated with tens of thousands of miners, forcing the NWMP to expand rapidly. The force reached 285 members by November

1898 and was further bolstered from 1898-1900 by a 200-man force drawn from Canada's permanent militia, known as the Yukon Field Force.[26]

While the government feared a large influx of Americans would undermine Canadian sovereignty in the region, it did not act until the complaints of religious ministers and traders reached the south.[27] The ministers complained that the miners were importing large amounts of liquor and corrupting the native population, while the traders complained about the loss of income due to goods being imported from the United States without being charged duty. This led W.R. Morrison to conclude in his 1974 article on the subject that "Although the government at Ottawa viewed the situation in the Yukon with unease, it took no formal action until complaints began to trickle down from the north."[28] The government feared that the loss of income would hinder the traders of the Yukon and hurt development in the region. Two outposts were established at the summits of the White and Chilkoot passes in order to collect duty on the goods being imported into the Yukon.[29] Collecting customs duties and ensuring the protection of the Inuit would also be two of the primary reasons for establishing NWMP detachments on the Arctic coast at Fort McPherson and Fullerton Harbour in 1903. It was feared that American whalers were undermining Canadian sovereignty through their presence in a sparsely populated territory. If there was enough American activity and no semblance of Canadian control, an American claim of sovereignty could be made.[30] Policing and collecting duties were the primary

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[26] Royal Canadian Mounted Police, "Klondike Gold Rush," last modified September 1, 2002, http://www.rcmp-grc.gc.ca/hist/ori-deb/debuts10-eng.htm.
[27] Shelagh Grant, *Polar Imperative: A History of Arctic Sovereignty in North America* (Vancouver: Douglas & McIntyre, 2010), 180.
[28] W.R. Morrison, "The North-West Mounted Police and the Klondike Gold Rush," *Journal of Contemporary History*, Vol. 9, No. 2 (Apr. 1974) 94.
[29] Royal Canadian Mounted Police, "Klondike."
[30] Grant, *Polar Imperative*, 201.

responsibility of the NWMP, with the support of the Yukon Field Force. From this point onward, the NWMP/RCMP was the primary enforcers of sovereignty in the North, with only an occasional supporting role to be played by the military.

During the Second World War, the pressure from the Japanese occupation of the Aleutians led to the belief that they could potentially cut off the sea route to Alaskan air bases. This would have posed a major problem for American supply lines and spurred the Americans to construct the Alaska Highway. It stretched 2,400 kilometres from the interior of British Columbia to southern Alaska. The project brought thousands of American troops to the region, though the Canadian government did not give much thought to the problem until well into the war. In *Arctic Front*, Coates, Lackenbauer, Morrison, and Poelzer write that:

> The Americans ran northwest Canada from early 1942 until the end of the war as a kind of friendly army of occupation. They changed the face of Whitehorse and the other small communities along the highway, building water treatment plants, theatres, baseball diamonds, and all sorts of other facilities. American military police enforced American law, sometimes on Canadian civilians.[31]

It was not until 1943, with the appointment of Brigadier W.W. Foster, that Canada had someone actively upholding a Canadian presence in the area. The Canadian government was assured that the soldiers would leave the North after the war and the government would be able to buy back any facilities completed or under construction.[32] While Foster was active military, he was just one man and was based out of Edmonton. It made sense for the government to appoint a military liaison for a military project, as this would allow the two sides to communicate effectively. However, the only people on the ground in the North at that time who were enforcing Canadian law, and in effect Canadian sovereignty, were the members of the Royal Canadian Mounted

[31] Coates et al., *Arctic Front*, 59.
[32] Ibid, 60.

Police (RCMP). While the military did have a presence in Foster, he was entirely symbolic and did little to ensure that Canadian customs and laws were respected by the foreign force.

With the defeat of Germany and the rise of the Soviet Union as the new global threat, it was realized that Canada and the United States would have to cooperate in order to ensure continental security. Throughout the 1950s the Soviet nuclear threat came in the form of bombers only, with intercontinental ballistic missiles being introduced in the 1960s. If the Soviets wished to strike at America with bombers, the most logical route would take them over the Arctic and through Canadian airspace. Therefore, it was decided that a radar line should be constructed in Canada. The first line constructed was the Pinetree Line, which ran roughly along the 50th parallel to Quebec, then turned north and ran along the Labrador coast to Frobisher Bar. The construction lasted from 1951-1954 and cost an estimated $450 million, with the U.S. supplying two thirds of the manpower and costs.[33] It was then suggested in 1954 that another line be constructed, this time along the 55th parallel. Named the Mid-Canada Line (or McGill Fence), it comprised of ninety-eight autonomous stations by 1957 at a cost of $250 million. The project was entirely Canadian, as it "averted the troublesome issue of American presence on Canadian soil."[34] While these new lines were being constructed, the Soviets were improving the speed of their bombers. Even before the Mid-Canada Line was constructed, it was realized that a radar chain in the high Arctic would be required.

The prospect of thousands of U.S. troops operating in the Arctic was not appealing to those in the Canadian government. Canada would not allow work to proceed until certain guarantees could be made by the Americans. An agreement to build the Distant Early Warning

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[33] Grant, *Polar Imperative*, 305-306.
[34] Coates et al., *Arctic Front*, 70.

(DEW) Line was finally reached on May 5, 1955, with the Americans making some large concessions. The Canadian portion of the line was to roughly follow the 69th parallel from the Yukon to Baffin Island. It was to be built, paid for and initially manned by the Americans. Title over the stations was to be retained by Canada and the Americans further agreed to abide by Canadian customs and laws. Lastly, the Americans were to avoid contact with the Inuit unless they were employed in the construction of the stations.[35] In this instance, the government did not dedicate new resources to ensuring the American forces respected all aspects of Canadian sovereignty, but instead reached a mutual agreement. This situation would be seen as totally unacceptable in the current climate.

The discovery of oil in Alaska's Prudhoe Bay in 1968 brought a renewed focus on the resource potential of the Arctic. In 1969 Humble Oil sent the ice-strengthened *SS Manhattan* through the Northwest Passage in order to test the feasibility of shipping oil from Alaska's North Slope to the eastern seaboard refineries as a cost-saving measure. The event caused another crisis of sovereignty in Canada. The Americans did not ask for Canadian permission to undertake the voyage due to the fact that they did not plan on entering Canada's three mile territorial waters. The ship was accompanied by the U.S. Coastguard icebreaker *Northwind,* which was replaced along the voyage by the *Staten Island,* and did not seek Canadian permission. Prime Minister Trudeau responded by granting the vessel permission unilaterally and sent the icebreaker CCGS *John A. Macdonald,* which ended up providing important assistance during the voyage.[36]

The voyage is controversial not just for the fact that the U.S. did not seek Canadian permission, but due to Canada giving permission unilaterally. Canada argues that their

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[35] Grant, *Polar Imperative*, 322.
[36] Byers, *Who Owns the Arctic?*, 45.

recognition that a voyage was taking place in internal waters and the presence of the *Macdonald* constitutes an exercise of control. Further, the heavy reliance on the *Macdonald* and CCGS Louis St. Laurent, which had to free the entire three-ship convoy in Viscount Melville Sound, raises questions as to whether the voyage could be used as a precedent.[37] Regardless of whether the case was weak, the government was still concerned that the voyage had the potential to bring into question Canadian sovereign control over the Northwest Passage. However, instead of attempting to enforce sovereignty by increasing the physical presence of Canada in the region, as it had done in the past, the government sought a legal solution to the problem. Parliament passed the *Arctic Waters Pollution Prevention Act (*AWPPA) in 1970 as a direct response to the *Manhattan* voyage. The Act extended territorial waters from three to twelve miles and imposed anti-pollution and shipping standards in a 100 nautical mile zone around the Archipelago. The United States and European nations protested that the Act was contrary to international law, but the government countered that it had a duty to protect the way of life of the Inuit and safeguard the balance of the delicate ecosystem. The act would give them the legal means to exclude vessels and assert control.[38] The protests over AWPPA receded and by the time UNCLOS was passed in 1982, the legislation had widely been accepted. This is evidenced by the inclusion of Article 234 of UNCLOS, which created the "Arctic exception", where a coastal state with ice-covered waters has the right to unilaterally enact laws regulating maritime pollution up to 200

[37] Grant, *Polar Imperative*, 350.
[38]Parliament of Canada, "Bill C-3: An Act to amend the Arctic Waters Pollution Prevention Act," December 19, 2008, http://www.parl.gc.ca/About/Parliament/LegislativeSummaries/bills_ls.asp?lang=F&ls=c3&Parl=40&Ses=1&source=library_prb.

nautical miles from the coast, so long as they were non-discriminatory and applicable to all.[39] Article 234 was inspired by AWPPA and was heavily influenced by Canadian diplomats.

During the Cold War the Arctic was being used as a transit route for the nuclear submarines of both friend and foe and recent evidence has revealed that the Soviets did have a thorough understanding of Canadian waterways.[40] However, Canada did not have the capabilities to monitor the region on its own. The *Oberon* class submarines used by the Royal Canadian Navy were diesel-electrics, incapable of patrolling beneath the Arctic icepack. The 1987 White Paper released by the Mulroney Government called for the purchase of ten to twelve nuclear-powered attack submarines. It was thought that this capability would enhance Canada's standing within NATO, while providing the navy with the capability to provide surveillance in the Canadian Arctic.[41] The plan was an attempt by Canada to take charge of its own security in the region. However, the idea was resisted by some in the American military, who feared that the introduction of another submarine operator in the Arctic could potentially destabilize the situation. However, Canada countered that it could not blindly rely on the benevolence of the Americans to fully consider Canadian interests and security if a conflict with the Soviet submarines did arise. As summarized by Nicholas Tracy in 1988:

> "The commitment of the Canadian Armed Forces to measures of continental defence, and to wider measures of collective security, increases the freedom of Canadian foreign policy by reducing the risk of war and hence the American need to control Canada's policy and territory."[42]

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[39] Byers, *Who Owns the Arctic?*, 47.
[40] Bob Weber, "Russian Maps Suggest Soviets Subs Cruised Canadian Arctic," The Globe and Mail, December 6, 2011, http://www.theglobeandmail.com/news/national/russian-maps-suggest-soviet-subs-cruised-canadian-arctic/article2261379/.
[41] Adam Lajeunesse, "Sovereignty, Security and the Canadian Nuclear Submarine Program," *Canadian Military Journal*, Vol. 8, No. 4 (Winter 2007-2008), 74.
[42] Nicholas Tracy, "Why Does Canada Want Nuclear Submarines?" *International Journal*, Vol. 43, No. 3 (Summer 1988), 511.

The Canadian government believed that Canadian submarines would provide an increased capability in the region, and therefore, further deter the Soviets.[43]

The planned acquisition of SSNs initially had fifty percent public support when the project was announced in June 1987, with thirty-seven percent opposed. However, as the economic situation in Canada declined and costs mounted, that support quickly eroded. By 1988 sixty percent were opposed, with that number rising to seventy-one percent by 1989.[44] The government simply could not justify such a large expenditure in the face of a weakened economy and a crumbling Soviet Union. While the planned purchase never did become a reality, there are several important distinctions to be made in this case. Firstly, the government planned to purchase the SSN's in order to counter what was thought to be a large number of incursions by Soviet submarines into Canadian Arctic waters. They would also allow Canada to be prepared at a time when tensions were rising, as well as allow the country to fully participate in the control and monitoring of other strategic areas, such as the North Atlantic. While the presence of the Soviet submarines was largely a security issue, relying on allied nations to maintain the integrity of security in the Arctic could be seen as an erosion of sovereignty. However, in order for these deployments to undermine Canadian control over the Northwest Passage, the allied submarine voyages would have to fulfill two main criteria: a Canadian admission that the voyages were known about without Canada having the ability to stop them and an open declaration from the Americans and others that their submarines have operated in the area. Voyages conducted through claimed international straits cannot be used as a precedent for establishing the marine traffic threshold.

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[43] Lejeunesse, "Canadian Nuclear Submarine Program," 75.
[44] Ibid, 81.

On the first point, recent research by Adam Lajeunesse has revealed that few, if any, American submarines operated in the Canadian Arctic without Canadian participation or knowledge. Lajeunesse argues that "after the USS *Skate*'s passage in 1962 there were a total of six American SSN voyages through the waters of the Archipelago. Records seem to indicate that the majority of these were undertaken with the full knowledge, concurrence and often even the participation of the Canadian government."[45] Canada having given permission to the Americans, participated in the operations and even requesting the transits means that U.S. submarine operations would have little impact in claiming a precedent for rite of passage.

In order for the Americans and others to exploit the second issue to undermine Canadian claims over Arctic waters, they would have to display for the world where and when their submarine forces have operated. This is highly secretive information that would give friend and foe alike great insights into the operational abilities and tendencies of a nation's submarine program. Some scholars, such as Michael Byers, have argued that "the issue of submarine voyages remains off the table, legally speaking, as long as both Canada and the United States continue to treat these activities as officially secret. But keeping secrets is becoming ever more difficult in a rapidly melting, increasingly busy Arctic."[46] The potential that the submarine operations of various countries could one day become public knowledge is highly unlikely. In the event that a decision was made to use submarine transits as precedents for transits through the Northwest Passage, Lajeunesse has shown that Canada has been much more involved in the submarine operations of allies than had been previously thought.

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[45] Adam Lajeunesse, "A very practical requirement: underice operations in the Canadian Arctic, 1960–1986," *Cold War History* (2012), 12.
[46] Byers, *Who Owns the Arctic*, 77-78.

While the government did utilize both legislation and cooperation in order to protect the sovereignty of the Canadian North throughout history, the most historically relied upon have always been the RCMP and Coast Guard. There have been numerous incidents in recent memory where the RCMP and Coast Guard have been far more actively involved in enforcing Canadian sovereignty than the military, but one in particular stands out. On June 22, 2007 the private yacht *Berserk II* arrived in Halifax from New York City. The crew was comprised of Norwegians who had plans to navigate the Northwest Passage, but they were not the average tourists. After two of them were involved in a bar brawl in Halifax, it was realized that they were part of the Norwegian branch of the Hells Angels.[47] The men were subsequently deported, but after returning to Norway they flew to Greenland to reunite with their ship. The ship arrived at Gjoa Haven on August 22, but departed before the local RCMP detachment became aware of their criminal history. When the ship approached Cambridge Bay the captain of the yacht put the two men ashore before the town and gave them weapons in order to avoid problems with the RCMP. The three men who remained onboard were detained by the RCMP upon arriving the Cambridge Bay, while the other two men were detained on August 29.[48] The entire group was deported from Canada back to Norway after personnel from the Canadian Border Services Agency arrived on the scene. The entire chain of events was only made possible due to the Coast Guard relaying information between the RCMP detachments.[49] While there was some poor communication during this event, raising issues with the so-called "whole of government" approach, it does

[47] Ibid. 17-18.
[48] Parliament of Canada, "All foreign vessels entering Canadian Arctic waters should register with authorities says report by Senate Fisheries and Oceans Committee," accessed October 1, 2013, http://www.parl.gc.ca/Content/SEN/Committee/402/fish/subsitedec09/VoyageOfTheBeserkII-e.htm.
[49] Committee on Fisheries and Oceans, "Controlling Canada's Arctic Waters: Role of the Canadian Coast Guard", December 2009, 23. http://www.parl.gc.ca/content/sen/committee/402/fish/rep/rep07dec09-e.pdf.

serve as an example of the traditional model for sovereignty enforcement in the region. The military has always played a very minor role, with the bulk of the heavy lifting being done by the Coast Guard and RCMP.

This section has briefly covered some of the more influential events in the history of Canadian sovereignty in the Arctic in order to provide insight into how the government has traditionally dealt with external threats. Legislation, bi-lateral agreements, and international law have been used throughout history to keep outsiders at bay. When there was a need for active enforcement by a government agency or department it was left to the Coast Guard and RCMP. This is a model that will likely no longer be utilized if the plans of the current government are fulfilled. The military will take a much more direct role in surveilling and enforcing sovereignty in the region. The evidence for this can be seen in the large investments the government has made in order to enhance the surveillance and command and control capabilities of the military, while providing no improvements for the RCMP, Coast Guard, and other applicable agencies and departments.

Seeking a Solution

In order to enforce sovereignty over such a vast and sparsely populated region, it is important to have a comprehensive understanding of the situation. Canada is a country with a very small population when compared to geographic size, resulting in a finite amount of financial resources. Government spending needs to efficient and effective in order to allow Canada to punch above its weight with other Arctic players like the United States and Russia. As a result, the government funding of programs in Canada carries much more implied importance than in other countries.

This thesis will study the investment in surveillance capabilities in order to assess the true aims of the government's approach to sovereignty in the Arctic. Surveillance capabilities were selected for several reasons. Firstly, there is currently little in the way of existing surveillance infrastructure and it has only been in the last fifteen years that there has been a significant investment. Where the money is being spent and how are serious questions that can provide insight into motivations and aims. Secondly, the group that controls the surveillance infrastructure will also be the one charged with directly enforcing sovereignty. As said, Canada has to be efficient with spending by nature and it would make little sense to spend billions on supposed surveillance programs to aid sovereignty if the end user does not have access to those tools. A simple mistake or communication oversight could lead to a major issue for the government. This was evident in the arrival of the Chinese research vessel the MV *Xue Long* at Tuktoyaktuk, Northwest Territories in 2001. In that case, the Chinese had followed all the required procedures and alerted the Department of Foreign Affairs to the intended port call. The Customs and Border Service Agency (CBSA) had to fly an immigration officer from Yellowknife to meet them.[50]

While the incident was completely innocent, it underscored the fact that situational awareness is key enforcement response can be timely and effective. When commenting on the *Xue Long* incident in front of the Standing Senate Committee on National Security and Defence on March 8, 2005, Rob Huebert argued that "Once we got notification and it was bobbled, we had no independent capability…It gets down to the ability to actually have those assets so we have a proper intelligence picture of what is going on, so we can then respond to whatever

[50] Byers, *Who Owns the Arctic*, 61.

level."[51] Surveillance is the first step in active sovereignty enforcement and is something that is often overlooked or understudied in discussions on the topic. It is the intention of this thesis to rectify that.

New innovations and technologies pose the largest threat to Canadian sovereign control of the Arctic. Be it double-hulled commercial vessels that allow them to transit ice-covered waters or new navigation technologies that provide allow for the safe transit of poorly charted or dangerous waters, technology is lowering the cost for entry into the region. This is allowing companies to see the potential cost-benefit of accessing resources, while also providing a potential for conflict between states that stand to profit. While technological development is the problem, it may also provide the Government of Canada with solutions. New technologies have had the effect of shrinking the distances on the planet for the entire history of human kind. From the lateen sail to the internet, technology has shown that the effect of distance can be mitigated. The cost of new innovations, however, is not cheap and this is especially true when it comes to military innovations. Inventions created for military purposes do not have the benefit of monetary returns, which can make it difficult for a government to justify large expenditures for items not perceived to be a threat by the public. The Arctic has long been an operational gap within the CAF's capabilities, venturing into the region to carry out the odd cold-weather exercise. There has been little in the way of sustainable investment in the CAF in order to sustain operations in the Canadian Arctic. Exercises such as Narwhal, Nanook, and Nunialivut provide good training, but only occur a couple months out of the year. However, the perceived

[51] Parliament of Canada, "Proceedings of the Standing Senate Committee on National Security and Defence, Issue 17 - Evidence, March 8, 2005 - Morning meeting." Accessed October 13, 2013. http://www.parl.gc.ca/Content/SEN/Committee/381/defe/17eva-e.htm.

sovereignty crises of the past decade has paved the way for an extreme increase in the funding dedicated to Arctic operations and military infrastructure.

Beginning with the 2006 election, the Arctic became a major focus for the political parties in Canada. On December 25, 2005, Stephen Harper shared what Arctic security would look like under a Conservative government. His plans called for an Arctic sensor system to monitor the movement of submarines, three armed icebreakers, a new naval port near Iqaluit, plane and drone patrols, an Arctic training centre at Cambridge Bay, expanding the Canadian Rangers force, and reconstituting the airborne regiment. The Conservatives estimated that the cost of these plans would be around $3.5 billion.[52] The Conservatives, who emerged victorious from that election, viewed the subject as more than an election issue and followed through on several of the promises made during that election. Work has been done on an Arctic sensor system, the Northern Watch Project. The idea of the armed icebreakers has been replaced with the Arctic Offshore Patrol Ships (AOPS). The Rangers have successfully been expanded and work has progressed on a naval station at Nanisivik. These plans were broad in scope and represented a significant investment in capitol for the new government that came to power with a platform that touted fiscal responsibility. They were able to sell this large military expenditure to the public because they linked it to Canadian sovereign control over its Arctic region.

This thesis will argue that the Government of Canada has used the sovereignty argument to justify a massive increase in military spending. It will further contend that the increased ability of the CAF in the Arctic is not the most efficient allocation of resources in order to solidify Canadian claims and enforce Canadian sovereignty. It will approach the topic by analysing two

[52] CBC News, "Tories plan to bolster Arctic defence."

significant and costly technology projects: the Northern Watch Technology Demonstration Project (NWTDP) and the RADARSAT Constellation Mission (RCM) satellite system. This approach is being taken due the technology being employed on these projects having specific functions. By studying these it is possible to gain insight into the role a project will play, despite the claims that the government has made. For example, despite how many times the American government claims that the Ballistic Missile Defense (BMD) is aimed at rogue actors such as Iran and North Korea, the fact that the technology *could* also intercept missiles from Russia and China escapes no one. In this sense, it is possible to approach the Arctic technology projects in the same manner. Despite how many times the Government of Canada says they are upholding Canadian sovereignty, the fact that these technologies are aimed primarily or solely at military interests is evidence that security is the ultimate goal. The Conservatives have used the sovereignty argument in order to get the public on side with a potentially unpopular military expenditure. It is also evidence that the current government is perhaps not as positive about the direction of the political situation in the Arctic as they claim to be and are, in fact, preparing for confrontation.

This chapter has provided some important background on the changes that are immediately facing the Arctic and gives insight into the current capabilities of the CAF in the region. It has also given some historical context regarding sovereignty enforcement in the region and has shown that the RCMP and Coast Guard have been the traditional upholders of sovereignty in the Arctic. While arguing for increased military expenditure so that the CAF will have the ability to operate in the region if need be, Coates et al. admit that "the Canadian Forces plays a supporting role to civil authorities, namely, the Coast Guard and the RCMP, which have a limited presence and capabilities to deal with criminal activities or emergencies in the

region."[53] Their view of the relationship between the CAF, Coast Guard and RCMP has been informed by the traditional relationship that can be observed throughout the history of Canada. This view, however, does not seem to match that of the current government.

The following chapter, *A Little-Known Fact: Acoustic Research in the Arctic during the Cold War*, will consist of an analysis of the precursors to the NWTDP, the Arctic sonobuoy and acoustic array research that was carried out in the region during the Cold War. It will survey the history of underwater sensor networks in the North in order to understand how the technology has been employed in the past and whether those working on the project were prompted by sovereignty and security implications. The chapter titled *An Array of Blunders: The Northern Watch Technology Demonstration Project* will cover the current acoustic research, the NWTDP, and what they may mean for Arctic security and sovereignty. There will be an analysis of the technologies being developed, the platforms they will operate from and who the end users will be. The thesis will then switch focus from the sea to space, with the chapter titled *Setting a Foundation: RADARSAT and Polar Epsilon.* It will discuss the history of the RADARSAT program and the success of the previous iterations of satellites. It will also delve into the ground infrastructure component that DND has developed to enhance the utility of the satellites, Polar Epsilon. This chapter will examine the various relationships between DND and other government departments and discuss the impact on sovereignty. The empirical chapters will conclude with Preferential Treatment: The DND Relationship with the RADARSAT Constellation Mission. It will cover in detail the much-touted RCM, examining how the program has been developed and in what manner the government intends to integrate the information with

[53] Coates et al, *Arctic Front*, 170.

allies. There will be a lengthy discussion of the development of the Automatic Identification System (AIS) and how it became a crucial component for DND, to the point of delaying the entire project. The thesis will close with *Concluding Thoughts*, a discussion of what this analysis means for sovereignty and security in the North. It will discuss why people have accepted the government argument that these expenditures will enhance Canadian sovereignty. It will also postulate what impacts the projects studied will have if they are implemented as planned.

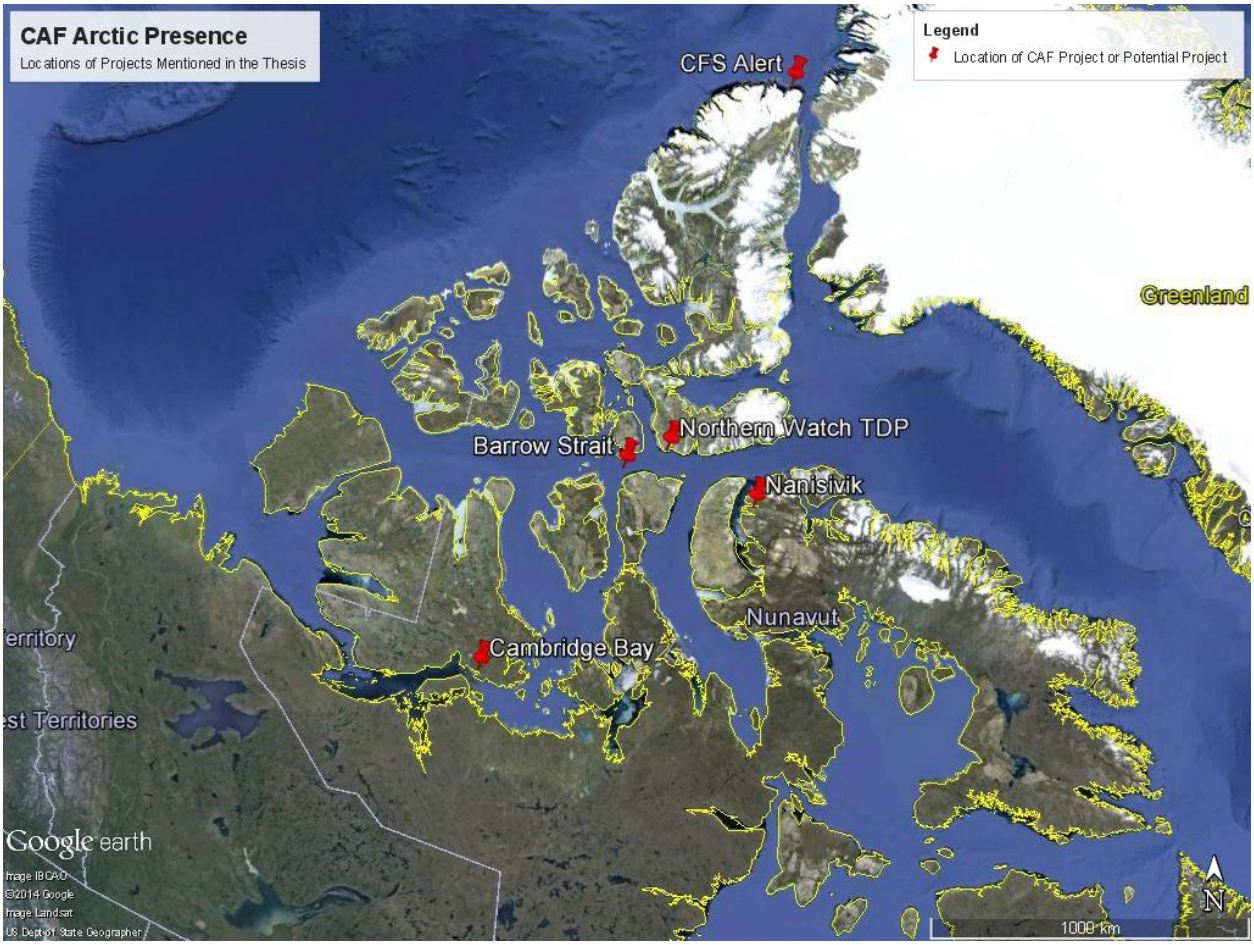

Figure 1: Map of Projects Mentioned in the Thesis

CHAPTER 2 – A LITTLE-KNOWN FACT: ACOUSTIC RESEARCH IN THE ARCTIC DURING THE COLD WAR

> I support very strongly the contention that the Arctic is or at least will be important to Canada and that the DND has a responsibility to support the broad national policy and objectives. My personal view is that the Arctic will grow rapidly in importance to the Canadian economy and that it is essential to maintain Canadian sovereignty and jurisdiction over the area. The economic exploitation will start soon and it is a matter of some urgency to establish a DND position on Arctic matters. – Derek Schofield, Scientific Advisor to the Vice-Chief of Defence Staff, January 9, 1969[54]

The words from the above quote may have been written in 1969, but they have never been more salient. The Arctic has continued to increase in importance to Canada and DND has been forced to move quickly to develop an Arctic policy. Taken at face value, it would seem that Schofield's words were not heeded, as very few of the actions undertaken by DND in the Arctic during the Cold War have become public knowledge. However, actions were undertaken by Canada during the period and were important in laying the foundation for modern projects. In place of hard evidence, there have long been rumors and conjecture surrounding Canadian action in the Arctic, but very little concrete evidence of programs that were undertaken. Much of this conjecture surrounds the deployment of a Sound Surveillance System (SOSUS) to the Canadian Arctic. It has long been known the NATO operated a robust surveillance network in the Greenland-Iceland-United Kingdom (GIUK) Gap, attempting to catch Soviet submarines in a natural choke-point. The fact that a SOSUS system formed a major component of this system became an open secret within military circles, but it was not officially confirmed until the system was declassified in 1991.[55]

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[54] Derek Schofield, "DND Policy in the Canadian Arctic," January 9, 1969.
[55] Edward C. Whitman, "SOSUS: The 'Secret Weapon' of Undersea Surveillance," *Undersea Warfare*, Vol. 7, No. 2 (Winter 2005), http://www.navy.mil/navydata/cno/n87/usw/issue_25/sosus.htm.

In the past, authors have made sweeping statements regarding the presence of a system, without citing any documented evidence. Some authors have made indications that they believe a surveillance system already exists in the Canadian Arctic. Michael Byers believes that NWTDP is merely meant to upgrade and improve sensors that were installed during the Cold War. He states that "It is also well known, though not publicly admitted, that Canada and the U.S. cooperated in the deployment of underwater surveillance devices at various choke points in the Canadian Arctic Archipelago."[56] If Canada did have surveillance equipment in the Arctic to detect submarines, Byers argues, no action was taken to counter their movements through Canadian waters. John Honderich wrote in 1987 that Canada operated one experimental sonar array across Lancaster Sound, again without citing any sources for his information. Honderich admits that SOSUS was only beginning to develop to the level where it could differentiate between the sounds made by the shifting ice pack and those made by submarines.[57] As recently as 2005 Sean Maloney casually listed SOSUS among a list of strategic sensor systems deployed by Canada during the Cold War. Again, there is no specific reference to documentary proof of this deployment, but it is accepted by Maloney as fact.[58] These authors have been forced to make these presumptions in published works because there has simply been no evidence available on the subject. Everything regarding SOSUS in the Canadian Arctic has remained classified to this

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[56] Byers, *Who Owns the Arctic?,* 60.
[57] John Honderich, *Arctic Imperative: Is Canada Losing the North?,* (Toronto: University of Toronto Press, 1987) 127-128.
[58] Sean M. Maloney, "Force Structure or Forced Structure? The 1994 White Paper on Defence and the Canadian Forces in the 1990s," in *Geopolitical Integrity*, Hugh Segal ed.(Montreal: The Institute for Research on Public Policy, 2005), 49.

day. This chapter will shed light on the use of SOSUS in the Canadian Arctic during the Cold War and provide evidence that it was less about sovereignty than security.[59]

Developing a Baseline

The Canadian experience with sound surveillance in the Arctic began on a very practical footing. By the mid-1960s there was a large body of evidence surrounding sound propagation in ice-free seas, but such data was useless in the Arctic. It is for this reason that the Defence Research Establishment Pacific (DREP), under the leadership of A.R. Milne, installed five Recording Instrument Packages (RIP) at strategic locations during August and September of 1967 with the assistance of the *CCGS Labrador*. The locations for the project included Baffin Bay, Lancaster Sound, Barrow Strait, Norwegian Bay and Viscount Melville Sound. These RIPs were "essentially a self-contained noise spectrum analyzer which makes a complete measurement once every hour for a year."[60] The information that was recorded on these instruments would provide a baseline for the natural ambient noise of the Arctic. This would be an important first step in developing an accurate acoustic surveillance system for the region.

The RIPs were some rather advanced pieces of technology for the period and underscore the effort DREP was placing into the project. Each RIP was composed "of a hydrophone, a spectrum analyzer, a recorder and a recovery system incorporated into a self-contained bottom-mounted unit."[61] The whole point of the exercise was to understand the natural noise of the

[59] The author is indebted to Adam Lajeunesse for the use of many of the documents in this chapter. He discovered a cache of items in a small American archive that have truly revolutionized what we know about Canadian action in the Arctic during the Cold War.
[60] A.R. Milne, "Noise Under Sea-Ice – A Year Round Vigil," 1967, 1.
[61] Ibid, 2.

Arctic ice and in order to do this the noise from the hydrophones was filtered into frequency bands in order to define a spectrum.[62]

The plan was to recover the RIPs the following summer with the assistance of another icebreaker. The icebreaker would transmit continuous wave tones at preprogrammed frequencies, which the unit would sense and release an underwater float. The float would allow the ship to utilize a guide wire and haul the unit aboard. The hoisting of the unit itself was no small task, as each RIP unit tipped the scale at one ton.[63] A letter from the Chairman of the Defence Research Board (DRB), Robert J. Uffen, dated 11 October, 1968 and addressed to the Chief of Defence Staff, reveals that all five bottom buoys were recovered during August of 1968.[64]

The recovery of the RIP units was not the only activity that was planned for the summer of 1968. The first major development was the extension of an invitation by A.R. Milne to M.M. Kleinerman of the U.S. Naval Ordinance Laboratory – White Oak (NOL-WO) to join in the venture. NOL-WO was "engaged in studies of under-ice acoustic reverberation" and was "particularly interested in the correlation of such reverberation data with the physical features of the ice-water interface."[65] The American involvement in the Canadian operation would not consist of personnel. Instead, NOL-WO stated that its participation "will consist of furnishing a suitable transducer or transducers and associated instrumentation, in addition to contributing the amount of $15,000 toward the stipulated overall cost ($42,000) of engaging the deep submersible *PISCES* for a five week period."[66] Thus, while the project remained largely Canadian, the fact

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[62] Ibid, 3.
[63] Ibid.
[64] Robert J. Uffen, "Memo to Chief of Defence Staff," October 11, 1968.
[65] No Author, "Memo from Commander of U.S. Naval Ordinance Laboratory, White Oak to A.R. Milne," February 21, 1968.
[66] Ibid.

that the Americans were brought in is evidence that security was the primary consideration. Giving the Americans, who just one year later would send the *Manhattan* through the Northwest Passage, access to Canadian surveillance technology would have given them the means to circumvent Canadian control in the long term. However, security, and in this case collective security, was the immediate goal, with little consideration of future implications.

The use of the deep submersible *PISCES* was the other major development during the 1968 season. $43,000 was not a small investment in 1968 and underscores DREP's commitment to the project. In typical Canadian fashion, however, enough partners were found for the project so that DREP only had to contribute $5,000 for the rental of *PISCES*.[67] There were five stated reasons for utilizing *PISCES* on the operation: assessment of small, deep submersibles in Arctic operations, simulation of high frequency acoustic backscatter, study bottom topography and geology, study biology, and assist in RIP recovery. Of these, the first two reasons are particularly interesting for their military application. By studying how a submersible operated in the conditions, DREP hoped "to determine the usefulness of such a vehicle for the installation and recovery of bottom-mounted apparatus."[68] It is clear that DREP was looking to the future with this statement and saw small submersibles as a possible solution to the precarious task of deploying sensitive equipment in the Arctic.

The high-frequency acoustic backscatter has a much more direct military application, as this referred directly to torpedoes. It is stated that "the aim is to obtain basic design information for weapons systems operating under the sea ice, e.g. surface capture probabilities for active

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[67] A.R. Milne to Chairman of the Defence Research Board, "DREP Summer Arctic Operation: Icepack 8/68," March 8, 1968, 2.
[68] Ibid, appendix, 1.

torpedoes. For these measurements, the *PISCES* is able to simulate the actual depth and track of operation of a torpedo. (USNOL and DREP interest)."[69] This focus on military application piqued the interest of many within the DND. A note from Commodore H.A. Porter, Director General Equipment Requirements, stated that "the Defence Research Board is co-sponsor of an Arctic Research project of considerable interest to CFHQ involving the Deep Submersible *PISCES* in the Canadian Arctic Archipelago."[70] As an expression of this interest, CFHQ agreed to transport the submarine and supporting equipment from Vancouver to Thule, Greenland.[71]

By all indications, the 1968 season was quite successful in accomplishing its stated goals. A letter from Chairman Robert J. Uffen of the DRB to the Chief of Defence Staff dated 11 October, 1968 conveyed his organization's thanks to the CAF for their professionalism in transporting the sensitive PISCES. The equipment left Vancouver on August 11th in a craft commanded by Captain W.R. Wilson and made the return flight from Thule on September 20th under the care of Captain R.D. MacArthur.[72] A short paper published by A.R. Milne in March 1969 provides a lot of insight into the events of the 1968 season. According to Milne, PISCES made a total of 15 dives during the expedition. The submarine made ice-covered dives in Norwegian Bay and at the west end of Viscount Melville Sound. Visibility was apparently quite favorable during the expedition, with visibility from the surface of 300 feet and at one point reaching 700 feet. Milne explained that "photographs of the bottom were taken at all dive locations, which included photographs of an RIP as it have been sitting on the bottom for a year

[69] Ibid.
[70] H.A. Porter, "Memo to Commander, Material Command," May 1, 1968.
[71] Ibid.
[72] Uffen, "Memo to Chief of Defence Staff."

just south of Cape Clarendon, Melville Island."[73] It is clear that Milne was satisfied with the operation of *PISCES*' ability to work in the Arctic region and that the goals of the 1968 season were accomplished.

Two Steps Forward, One Step Back

After the success of 1968, the scale of plans seemed to increase greatly for 1969. A minute sheet from 31 March, 1969 displays a very rapid shift from scientific analysis to the various options for equipment that can be deployed to the Arctic. It states that:

> the concept of air-dropped sonobuoys capable of penetrating ice is an attractive one but will pose some difficult technical problems. The environment may be well suited to Jezebel type detection system since there will be no surface-wave generated noise, and the sound channel may be close to the surface in Arctic waters. On the other hand, the most interesting targets will likely be Soviet Nuclear submarines operating at low speeds and thus generating relatively low acoustic levels. Depending on the cost and complexity of the buoys required, a case may evolve for fixed SOSUS type barriers at entry and exit points.[74]

These words would seem to indicate that the CAF was moving rather rapidly to developing an operational surveillance system in the Arctic. It is clear that the leadership was weighing the merits of various systems while for the first time recognizing that Soviet submarines are the primary target of this work. However, in the first several months of 1969, the research outpaced the planning. The military leadership involved in the project did not have a firm grasp on the complexity of the science, while the DRB lacked adequate guidance.

In the 9 January, 1969 letter that was quoted at the beginning of this chapter, Derek Schofield made several salient points. One in particular would become applicable over the next several months. He echoed a recommendation from a previous paper that called for the creation of an "Arctic Steering Committee" that would include elements from CFHQ, the DRB and the

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[73] A.R. Milne, "A Small Research Submarine in the Arctic," *Arctic*, v. 22, no. 1, Mar. 1969, 69-70. As of yet, the pictures to which Milne refers have not been located.
[74] A. Graham Bridgeman, "Minute Sheet," April 9, 1969.

office of the Defence Minister. The ultimate goal of this committee would be to assess and make recommendations on DND policy in the Arctic.[75] This committee was needed because "although DRB has continued over the years to carry out research in the Arctic, the justification for this has been on general grounds rather than support for a DND requirement. The conclusion of the paper studies and the recommendations of the Steering Committee would be important factors in the planning of future activity in the Arctic by DRB."[76] DRB would need stated requirements if they were going to work towards a functional array aimed specifically at detecting Soviet submarines. These requirements did not exist in early in 1969, despite the obvious interest of DND.

A detailed summation of the project dated 26 May and prepared by DREP for the Chairman of the Defence Research Board again laments at the lack of guiding policy. It stated that "we know of no stated requirement for a submarine detection system in the Canadian Arctic and therefore have no statement as to what its capabilities should be, we feel such a requirement may come in the future."[77] This again illustrates that the scientist charged with developing the surveillance system for the CAF were starved for direction and were continually raising the issue with the leadership within DND. As will be seen, this lack of foresight to adequately plan the research program would lead to almost a complete lack of inactivity during the 1969 season. The research program would require almost a total rethink before it was to move forward, something that would be echoed in the similar Northern Watch Technology Demonstration Project four decades later.

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[75] Schofield, "DND Policy in the Canadian Arctic."
[76] Ibid.
[77] J.E.D. McCord, "Arctic Research Project," May 26, 1969, 1-2.

In order to begin to develop an operational system, the scientists at DREP had to make it clear to the military planners that they were currently not required to actually build it. In a 26 May memo J.E.D. McCord stated that "our proposal is to investigate some of the factors which we believe are critical to such a system, NOT to build and test such a system, and any equipment such as sonobuoy components that are required will be used to produce research instruments for field investigation."[78] McCord went to great lengths to make it clear that DREP was not going to develop a working system any time soon and any work that was being done was strictly preliminary. In addition, he took issue with the reduction in the wake detection project and provides insight into what it involved. He argued that "we cannot recommend reducing the wake detection effort at this time. The requirement for long range detection of quiet submerged submarines has been stated and Dr. Grant's research has shown submerged subs can produce surface effects under certain conditions."[79] The concept of taking resources from a project with existing requirements seems to have not been an option for McCord. Additionally the reallocation of resources from developing a wake detection system for submerged submarines would have been an odd application of resources, especially if the project was returning promising results.

We Need to Talk

The revelation that had the largest effect on Canadian plans in the early months of 1969 was that the Americans were also working on developing a working system in the ice. A note from Milne to Dr. Albert Adey of the DRB, dated 29 May, suggests that the Canadians became aware of the American project by pure luck. Milne relates that while at the USN Symposium on

[78] Ibid., 2.
[79] Ibid.

Military Oceanography he began chatting with Meyer Kleinerman of USNOL. Through conversations, he managed to discover that the U.S. had been conducting their own research on the subject. Milne wrote to Adey that "The U.S. is in the pre-production phases of an Arctic sonobuoy system consisting of air-dropped A size device which is designed with a special impact head (non-explosive), which is able to embed the sonobuoy to a depth of 5 feet in sea ice or to allow it to penetrate through."[80] This revelation would have been surprising for the Canadians, not so much because the Americans were considering such a system, but due to how developed it was. Milne tells Adey that that Americans had already tested the sonobuoys in the Beaufort Sea, utilizing the transit of two nuclear submarines as test subjects.[81] DREP then began a process of reaching out to the Americans in order to become a partner in development.

Milne's note to Adey reads on the verge of desperate. He first asks Adey, who is good friends with Kleinerman, to reach out to the Americans, while also making official inquiries. Lastly, he confirms the lack of direction within the Canadian research, stating that "in view of the fact that we do not have an Arctic sonobuoy proposal in the works, there is some urgency in obtaining information of the nature mentioned on the U.S. Arctic system at the earliest possible date."[82] In these conversations there is no discussion of Canadian sovereign control and seemingly no issue with cooperating with a group that many perceived as a threat to the Canadian Arctic. DREP was under pressure to develop a working detection system and, given the lack of leadership in the Canadian project, the Americans closer to that goal.

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[80] A.R. Milne to Dr. A. Adey, "Arctic Research," May 29, 1969.
[81] Ibid.
[82] Ibid.

On 23 June a report was sent to Milne detailing the progress of the U.S. project. The summary was as follows:

> The device that they (USN, Standford, GM-AC/DRL) have developed combines a ruggedized, A-size sonobuoy combined with a special penetrating, lead-weighted front end. The sequence is as follows – the whole unit is dropped from the aircraft and, on impact, the nose section penetrates the ice but leaves the main sonobuoy section behind it in the whole and at such a level that the rear end is just about flush with the upper ice surface, with the whip antenna exposed. The hydrophone cable pays out in the usual way and suspends the hydrophone at the required depth below the ice. Six units were tested this spring in the vicinity of Ice Island T-3 (dropped from approximately 2,000 feet). One operated successfully through four feet of ice; a second unit was lost when the complete sonobuoy penetrated the ice; the other four failed to penetrate. The failure has been attributed to a small error in the impact angle (probably 5 – 10 degrees to normal). The ice was sufficiently thick that the front was not able to penetrate through the oblique path.[83]

From the report, it appears that the Americans were getting close to developing an operational sonobuoy for the Arctic, with Canadians awareness seriously lacking. The report also details two other important facts. Firstly, it is revealed that funding for the sonobuoy project was $100,000 per year, underscoring the American resolve to make the system work.[84] The second major revelation was that the U.S. was also working on developing a fixed array system. This system would not sit on the ocean floor like a traditional SOSUS system, but would be installed into stable polar ice. The work was begun by GM in the early 1960s and produced a fixed array and a mobile array system known as MOSES. The Fixed array utilized 30-40 hydrophones in a circular diameter of 1,200 feet. The hydrophones were suspended 30 feet into the water below T-3, as the channel was quite shallow.[85] The Moses array was to be a similar design to the T-3 device, but with the ability to be moved to various locations.[86] Thus by the summer of 1969, the Canadians were fully aware of the steps the Americans had taken towards and operational system and were eager to join, placing security ahead of sovereignty.

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[83] Note to A.R. Milne, "Arctic Acoustics and Sonobuoy Research," June 23, 1969. 1.
[84] Ibid, 2.
[85] Ibid, 2.
[86] Ibid, 3.

Cooperation picked up quite rapidly after the Americans became aware of the Canadian interest in collaboration. A Note to File by Schofield dated 24 June titled *US/Canada Cooperation – Underwater Acoustics* reveals that an informal cooperation agreement was quickly established. It stated that the efforts would be coordinated by the State Department and Department of External Affairs. Additionally, a USN official would be assigned to the DRB in Canada.[87] This was quickly followed by a memorandum by J.H. Greenblatt, Director of Physics Division in USN, dated 24 July. It states that there were extensive discussions with the Canadians and that "as a result of these discussions we feel that data of interest to Canada could be obtained, namely, propagation loses which could be used to make preliminary estimates of submarine detection ranges for various passive sonar systems in selected areas of the north."[88] Additionally, the memorandum identified Hudson Bay as the ideal testing area for the systems. Most importantly, it appears that the Americans were well versed with the pace at which projects moved in Canada. He stated that "if Canadian interest in this area continues to increase, it might be better to consider a more comprehensive program of acoustic measurements which could be done by Canada only. We do not foresee this being done before the summer of 1971."[89] Even this was a generous estimate given the state the DREP research program was in at the time

By the end of July the plans for the following two years were quickly falling into place. Phase I of the project called for acoustic measurements in Hudson Bay in September of 1970. The involvement required of Canada for this phase included the use of Churchill for logistics purposes, the use of CAF aircraft to drop explosive charges. The 1971 plan was for acoustic

[87] Derek Schofield, "Note To File: US/Canada Cooperation – Underwater Acoustics," June 24, 1969.
[88] J.H. Greenblatt, "Acoustics Measurements in Hudson Bay with U.S. Underwater Sound Lab (USN/USL)," July 24, 1969, 1.
[89] Ibid, 2.

measurements in the Hudson Strait and required Canada to operate a logistics base out of Frobisher Bay, CAF aircraft to drop charges, and the possible use of a ship.[90] Thus, despite a complete lack of communication between the Canadians and Americans prior to the spring of 1969, plans were able to come together rapidly. The planners were able to create a comprehensive vision for the project for the next several years.

Moving Forward

After the basic plan was established, the military planners took issue with the system not being the traditional SOSUS type. A memorandum from Commodore A.G. Bridgman on the Arctic Use of Sonobuoy Systems, dated 18 August, questions whether placing all hopes on sonobuoys is a wise decision. He argued that:

> having regard to the large variation of ice thickness to be expected, and the difficulty of providing infallible methods of piercing such ice, perhaps some consideration should be given to permanent under-ice installations. If these are feasible, the project could include an investigation of the potential of SOSUS techniques as well as those applicable to sonobuoys.[91]

While Bridgman is trying to get the most out of the research project, he seems to misunderstand what the project is about. DREP was involved in establishing a proof-of-concept, not a working system. C.R. Iverson, responding to the same document as Bridgman on 25 August, makes the DREP position very clear. He believed that "Certainly, the alternative of an under-ice mounted system of the SOSUS type warrants consideration at a later stage when and if we consider a submarine detection system for the north."[92]This is the last discussion in the documents of a traditional SOSUS system. After this point, DREP made it clear that their focus for the time being was solely on developing a working sonobuoy system for the north.

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[90] Derek Schofield, "Canada-U.S. Joint Acoustic Experiments in Hudson Bay and Hudson Strait," July 31, 1969.
[91] A.G. Bridegman, "Arctic Use of Sonobuoy Systems," August 18, 1969.
[92] C.R. Iverson, "DREP Project Review Group Submission 79 (Revised Version)," August 25, 1969.

By November of 1969 a detailed plan for the following season had been developed. The plan called for 20 buoys to be placed in the ice in April/May, with continual surveillance by CAF aircraft until they became unresponsive. The buoys themselves were fifteen feet in length and weighed approximately one hundred pounds.[93] DREP gave detailed estimates of buoy life within the ice and it is clear that they did not see them as a long term solution. They expected only 8 to be operational by 1 September and none by 15 November.[94] These buoys would record noise for several minutes each day. A CAF ARGUS would conduct flights at least every two weeks and activate the transmitters using radio signals. The transmitters would then send their data to the craft for 10 minutes, where it would be recorded on magnetic tapes.[95] The stated goals for the research project were as follows:

> (i) To measure the duration and extent of shore-fast ice. (ii) To measure the electrical and mechanical survival probabilities of sono-buoy-like devices. (iii) To record ambient background noise from buoys using different hydrophone suspension systems (each flight would plan to interrogate only 6 of the 21 units installed). (iv) To track the drift of ice once it begins to move in the summer and fall.[96]

It is clear that the focus for 1970 was still on understanding how the ice moves in the Arctic and finding equipment that can reliably operate in the harsh conditions. While little actual progress had been made since 1967, the plan for the program was on a much more solid foundation than in previous years and the attention it received would not diminish.

The results of the 1970 experiment correlated very closely with the expectations. By June the buoy failure rate was thirty-three percent. The failure rate reached sixty percent by the middle of August and eighty percent by the middle of September. The buoys that were installed in multi-

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[93] A.R. Milne, "Request for Arctic CF Air Support," November 5, 1969, 2.
[94] A.R. Milne, "Argus Flights for Sono-Drift-Buoy Interrogations in Western Perry Channel Spring and Summer 1970," November 27, 1969, 2
[95] Ibid, 3-4.
[96] A.R. Milne, "Argus Flights for Sono-Drift-Buoy Interrogations in Western Parry Channel Spring and Summer 1970," February 24, 1970, 2.

year polar ice lasted much longer than those installed in first-year ice. Surprisingly, the most losses occurred while there was full ice cover and limited movement as opposed to during the breakup of the ice with large movement.[97] While no explanation for this phenomena was given, it does make sense given the dynamics of the ice. There is a lot of pressure on the ice within the icepack, which increased the chance that the holes supporting the buoys or the buoys themselves could be crushed. The general failure of the project was confirmed in a February 1972 memo. No acoustic data and only minimal tracking data were recovered during the season. These issues were attributed to the short time between concept and deployment, as well as greater than anticipated ice drift.[98]

The spring of 1970 was spent solving the logistical issues involved in such a large endeavor to a remote region. The explosive charges for blowing holes in the ice were extensively tested and their configuration discussed in detail. This work was carried out in conjunction with Defence Research Establishment Valcartier (DREV).[99] There was also discussion regarding which types of buoys would be tested during the season. 60 SSQ 512 buoys were held at CFB Shearwater to be used by DREP. Two other types of buoys were mentioned as possible candidates for the tests. The best Canadian device said to be available was the 'minibuoy' while the Americans had their own 'Arctic Sonobuoy', both of which were not readily available as of March 1970.[100]

A secondary plan was developed during the summer of 1970, led by Defence Research Establishment Atlantic (DREA) in conjunction with the USN Underwater Sound Laboratory.

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[97] Stan Toole, "Letter to the Editor of the Project Ajax Bulletin," April 29, 1971.
[98] R.E. Banks, "USN Program Polar Bear," February 1, 1972.
[99] A.M. Patterson, "Attention: Mr. J. Jones, Weapons Research Group," February 27, 1970, 2.
[100] J.H. Ganton, "Sonobuoys for Artic Use," March 11, 1970.

This exercise became known as CANUS HUDSON, as it took place within Hudson's Bay.[101] The plan varied from the larger experiment due to the fact that

> the object of the experiment is to provide data on the sound attenuation, propagation and reverberation characteristics of ice free northern waters. Such data are necessary for the effective employment of acoustic submarine detection systems. Small charges dropped from the aircraft will explode underwater to provide a source of sound that will be detected by floating instrument packages and relayed by radio to the aircraft.[102]

A lot of work had gone into developing a system that could compensate for the ice, but no tests had been done in ice free conditions. The Arctic environment is unique and the shallow depth of the majority of the region provides different acoustic variables than the Atlantic or Pacific Oceans. This test was meant to fill a knowledge gap that had been overlooked with relatively minimal effort. The experiment lasted from the 8th to the 19th of August and by all accounts went fairly well. The organizations "obtained all the experimental data which we could reasonably have hoped to obtain."[103] The data was contained on seven reels of magnetic tape, along with miscellaneous items, that was analyzed by both the Canadians and Americans.[104] CANUS HUDSON was thus an example of not only the depth of analysis that went into the development of an Arctic sensor system, but also a testament to the ability of the United States and Canada to quickly plan and execute a cooperative venture.

March of the Polar Bear

In 1971 the Americans began a major research project without the cooperation of the Canadians. The POLAR BEAR I Operation involved installing four buoys in the polar ice off in the East Greenland Sea. Only two of the buoys responded to the first interrogation flight, one on

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[101] R.E. Banks, "Attention Mr. L.A.C.O. Hunt," July 24, 1970.
[102] R.E. Banks, "Letter to Mr. M. Shenstone," July 17, 1970.
[103] J.G. Retallack, "Maritime Proving & Evaluation Unit Cooperation in CANUS HUDSON," August 20, 1970.
[104] W.A. Von Winkle, "Letter to Chief of Naval Operations (U.S.)," September 22, 1970.

the second and none by the third. The blame for this was placed on the interrogation components, which were retrofitted from old NUTMEG buoys.[105] By 1972 the United States came forward with a project proposal known as POLAR BEAR II and wanted Canadian participation. The initial plan for the project called for up to three fields of sonobuoys, consisting of sixteen each, positioned throughout the Arctic. The locations included east of Greenland, Chukchi Sea and somewhere in the Canadian Arctic (either Baffin Bay, off Alert, or Barrow Strait). The objectives of the project were to "(1) Investigate survivability of surface floats and antenna systems, (2) Measure ice field dynamics, (3) Investigate effects of dynamic motion on deployed fields. Secondary objective, collect real time under ice acoustic data."[106] Thus, while more planning and thought has gone into the project since the early incarnations, the objectives have remained fairly constant.

The initial Canadian response to the American offer was fairly positive, but came with some major reservations and contingencies. They firstly questioned the operational policy of placing the buoys in open leads (areas of open water). DREP argued that this increasing the chance of a buoy being crushed, pushed out of the ice, or pushed under the ice. In addition, those that did not become trapped in ice would not serve the purpose of the project. The second major issue was with the design of the buoys themselves. DREP had developed a new receiver design that would activate the transmission from the buoys. They went so far as to argue that Canada should not participate unless the buoys could be modified.[107] This is rather strong language from Canada given that the Americans were the lead on the project, but it does underscore the

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[105] A.M. Patterson, "Summary Report of Meeting Between DREP, USNOL and USNOO Personnel – 28 June 1972," June 28, 1972. 1.
[106] No Author, "Confidential note form CANDEFRES Washington to DEFRES Ottawa," March 1972.
[107] G.D. Watson, "Polar Bear – Note to File," May 1, 1972.

confidence DREP had in its work and is evidence of the independence that was maintained between the two nations.

The Polar Bear II buoys were meant to test the survivability of buoys when placed in open leads as well as ambient noise and ice drift data. Sixteen were planned to be installed in the East Greenland Sea and six off of Point Barrow in September 1972. The plan involving Canada was to install between ten and twenty buoys in Baffin Bay in order to test survivability in different conditions from the East Greenland Sea. There was also discussion about Canada borrowing the POLAR BEAR III in the spring of 1973, but these discussions were very preliminary. [108]

One of the major developments to come out of this discussion was the proposal by DREP to place RF beacons near the POLAR BEAR II installation site. These beacons would assess the survivability of buoys placed in ice instead of leads, while also providing real time ice movement data. Allowing these to operate independently of the sound recording devices made it far less complicated, but much more likely to obtain.[109]

During the U.S. operations from August-September, many of the issues raised by the Canadian DRB were realized. Eight buoys were deployed fifty-five miles from Point Barrow on 2 August. They were placed six to seven miles from the edge of the icepack, so that four weeks later seven were still responding, but none had been absorbed into the icepack. In contrast, twenty-four buoys were deployed between Greenland and Spitsbergen on 13-15 September. Two major problems developed with the buoys. The first was that all of the buoys had a forty-five degree list, the reason for which was not determined. The second issue was that some of the

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[108] Patterson, "Summary Report of Meeting Between DREP, USNOL and USNOO," 2-4.
[109] Ibid, 4.

buoys were not synced to their broadcast times, creating issues for the over flights. The good news from the project was that after four weeks all of the buoys were alive and transmitting ice data.[110] This would be the first of numerous issues that the project would face in rapid succession. It is likely due to poor performance in the U.S. tests that American funding to the project was cut in the fall of 1972. As a result the DRB would not be receiving POLAR BEAR IIs from the Americans and the Canadian portion of the operation was called off.[111]

This failure led to a lot of attention being placed on the POLAR BEAR III Vertical Line Array System. The system was battery powered for operations on remote ice floes and could be deployed with relative autonomy. The main cable of this system was deployed through a hole drilled in the ice, while the electronics were housed in a warm shelter on the ice. It was comprised on eleven hydrophones, each of which were individually cabled to the surface. The main limitations of the system were that the power supply had to be changed every twenty-four hours and the tapes changed every twelve.[112] The NOL used the system twice before it was loaned to DRP. During these deployments NOL was able to iron out a number of issues with the equipment, as well as developing reliable deployment techniques for the system. DREP was to deploy this system in the Barrow Strait in 1974 and was to share the results with NOL in return.[113] The fact that there is a one year gap between the preliminary discussions and the actual agreement is evidence that the failure of the POLAR BEAR IIs was a major blow for the development of an Arctic acoustic sensor system. The documents used in this chapter do not reveal what occurred during that year, but it is likely that a major revaluation took place. The

[110] R.E. Banks, "Status Report on Polar Bear II," October 16, 1972.
[111] J. Mar, "MARCOM Support – Polar Bear II," October 12, 1972.
[112] No Author, "PB III – Vertical Line Array System."
[113] A.M. Patterson, "Letter to John Ganton," October 19, 1973.

emphasis after this point seems to have been placed on acoustic arrays and not sonobuoys and the cooperation between the Canadian and American research divisions continued.

Work that directly involved American participation continued in the Canadian Arctic throughout the 1970s and 80s. Lajeunesse has shown that U.S. SSNs made several voyages into the region between 1977 and 1983 at the request of the Canadian government in order to test installed array systems.[114] Based on documented evidence, it can be said with confidence that acoustic and magnetic sensors were in place in the Nares Strait, Barrow Strait and Lancaster Sound throughout this period.[115] While the systems seem to have been dismantled by the mid-1980s, the recent evidence that has been uncovered with regards to their development has been a revelation for Canadian-American relations during the period. As has been shown throughout this chapter, the DRB and NOL actively cooperated in the development of the technology. The Canadian government of the day was not focused on preserving Canadian sovereignty so much as ensuring the security of the North and contributing to continental defence. While there is arguably a net benefit for sovereignty because of this research, the position of the Americans on the status of Canadian Arctic waters cannot be ignored. Canada was willing to grant a nation that was openly challenging the Canadian position access to its surveillance technology.

The American Navy, for its part, was operating in the region at the invitation of the Canadians and under their supervision. The recognition of Canadian authority in the region may have been incidental, but it undermines the American argument on the status of Arctic waterways nonetheless. Perhaps the reason that this period of activity has remained classified until now is because it has the potential to undermine the position of both parties. The Canadian

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[114] Adam Lajeunesse, "A very practical requirement," 12-15.
[115] Ibid., 11.

government would certainly not want the public to know the extent of American involvement in the North, given the somewhat sensitive nature of the current state of affairs. Meanwhile, the Americans would not want the world to know that their navy operated in the region only at the request of the Canadian government. The argument could be made this cooperation and acquiescence to Canadian authority strengthens Canada's sovereignty claims, despite the intense level of cooperation with the United States. While this is true using the definition of sovereignty that this thesis has taken, individuals and governments may approach it from a different perspective. Security was the most important goal of the research and it is possible for those that do not fully understand the interplay between the two to overlook the implications for sovereignty.

CHAPTER 3 – AN ARRAY OF BLUNDERS: THE NORTHERN WATCH TECHNOLOGY DEMONSTRATION PROJECT

At the end of the Cold War, with the threat of the Soviets removed, the importance that was placed on the Arctic decreased significantly. When spending on defence dropped off in the 1990s, the Arctic was somewhat starved for resources. The situation had not significantly improved by the time the government imitated the NWTDP in 2008, when the impacts of climate change began to be understood. It was clear that the Arctic was undergoing a transformation that would have a major impact on operations in the region. While the majority of the Cold War documents remain classified in Canada, the previous chapter has shown that there was a large amount of research activity in the Canadian Arctic, but there is little mention of the work in the NWTDP documents. The background for the project merely states that "until recently, Canada's Arctic waterways have had too much ice in them to allow significant maritime traffic."[116] The only mention of previous research appears in a slideshow from June 10, 2010 that declares that the camp used in the project was established in the late 1960s and an Activity Plan that reads:

> The camp was originally established in the late early 1970s (sic) to support underwater sensor development. The scientists of the day tried several techniques to transit their sensor cables from the sea floor to the shore and finally settled on drilling the Foreshore pipe (sic). This pipe is drilled at an angle, through rock, to create a cable channel to a point below the ice line.[117]

While this provides evidence that the DRDC scientists were aware of the previous work that occurred at the camp, the limited number of times that the historical work was mentioned in the sources raises questions as to what knowledge the DRDC team is operating with. While DRDC

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[116] David Waller, Matthew R. MacLeod and Talia McCallum, *Measures of Effectiveness and Performance for the Northern Watch Station* (Ottawa: Defence R&D Canada – Cora, 2009), 3. Available at: http://pubs.drdc.gc.ca/PDFS/unc87/p531827.pdf.

[117] Bruce Grychowski, "Northern Watch Technology Demonstration Project," (Slideshow provided to Robert Bellizzie, June 10, 2010); Bruce Grychowski, "Gascoyne Inlet Camp Activity Plan 2007-2014," June 18, 2010.

is the modern successor of the DRB, the team's access to the historical work would depend entirely on their security clearance level.

With the government decision to turn to various technologies in order to solve the issue of operating in the vast Arctic region with limited resources, there will be a big need to invest in infrastructure and technologies in order for them to properly operate in the Arctic. The NWTD project was highly touted by the government when it was first announced in 2008. The project has since seen numerous delays and is no longer paraded by the government as a key example of what actions they are taking in the Arctic. This chapter will bring clarity to a number of questions that have surrounded the project over the last several years and will show that the link between the project and the enforcement of sovereignty is tenuous. Instead, the project has had major issues with scope, is linked directly to military applications and is also being developed with the cooperation of allies, some of whom oppose the Canadian position on the Northwest Passage.

The Project

The NWTDP is located at Gascoyne Inlet on Devon Island, positioned at a natural chokepoint for shipping in the area.[118] Its aim is to test various surface and underwater surveillance technologies in order to evaluate how they operate in the local conditions. When Northern Watch was first announced by the government in the spring of 2008, it received considerable attention from the media and other interested parties. On May 8, 2008 CBC News ran a story detailing how NWTDP was getting underway "as part of a major study to help affirm

[118] Jean Luc Forand et al., "Surveillance of Canada's High Arctic," (Presentation at ArcticNet 2007, Laval, Quebec, December 13, 2007). Available at: http://www.arcticnet.ulaval.ca/pdf/talks2007/Forand.pdf.

Arctic sovereignty and security."[119] The project as originally approved had a budget of $9.75 million, was scheduled to run from April 30, 2007 to March 31, 2011, and sought to demonstrate a 24/365 surveillance capability.[120] There has been a surveillance gap in the Arctic since the acoustic research was halted at the end of the Cold War. It has been believed that the nuclear submarines of friend and foe alike have used Canadian Arctic waters as a transit route, a worry that has been evidenced to reach as far back as the 1960s. On December 6, 2011 it was reported that Russian depth charts show indications that Soviet submarines operated in Canadian waters.[121] It would not be a stretch to believe that the Russians have continued to use the routes in recent years, fully knowing that Canada has no way of surveilling ice-covered waters. If it were occurring, the voyages would present a significant potential security threat in addition to an erosion of sovereignty.

There is credible evidence that some submarine activity has occurred in the Arctic in recent years. On July 31, 2008 a large explosion was heard in the vicinity of Pond Inlet, followed by a submarine sighting on August 9. In an After Action Report by Rear-Admiral Paul Maddison, Commander of Joint Task Force Atlantic at the time, wrote that "I agree with the Reporting Officer who concluded that an explosion did occur in Pond Inlet 31July 2008, and that the sighting incident of 9 August 2008 'can only be judged as a credible report of a possible submarine.'"[122] The following year, another sighting was reported in the vicinity of Grise Fjord by witnesses at different vantage points and at different times. The report on that incident concluded that "given the description identified given by all three witnesses to the (redacted), it

[119] CBC News, "Military Scientists Prepare for Arctic Surveillance Study," May 8, 2008, http://www.cbc.ca/news/technology/story/2008/05/08/arctic-test.html.
[120] Defence Research and Development Canada, "Northern Watch TD Objectives (Approved Apr 2007)."
[121] Bob Weber, "Russian Maps Suggest Soviets Subs Cruised Canadian Arctic."
[122] Paul Maddison, "After Action Report," September 9, 2008.

is assessed that the object observed was probably a submarine."[123] Quite clearly, submarine activity in the Canadian Arctic has continued and it has occurred without the knowledge of the Canadian military. If Canada were aware of friendly vessels, or even those of a foe, they would not have spent time and resources investigating the claims just to conclude that it was a submarine. Further, the reports would not have needed the approval of the commander of the Atlantic Fleet.

The NWTDP sought to rectify the surveillance issue, with a particular emphasis on the sub-surface. The project involved the testing of several sensor technologies, both under and above the surface of the water. According to a non-technical summary submitted by Defence Research and Development Canada (DRDC), the project originally consisted of acoustic, magnetic and electric field sensors positioned in the Barrow Strait, with a ten kilometer sea cable connecting them to the camp. The land based sensors included marine navigation radar, an Electro-Optical (EO) system, an Electronic Intelligence (ELINT) receiver and AIS. In addition, DRDC is testing ADS-B at the site. The reason for including ADS-B is that DND is considering the possibility that the CAF may need a separate warning system than that of Nav Canada and the Northern Watch Stations provided an opportunity to incorporate the technology.[124]

The acoustic technologies consisted of different variations of active and passive sonar, which utilized sound waves for the detection of submarines. Technical support for the acoustic

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[123] No Author, "Interview Assessment Report – Probable Submarine Sighting in Vicinity of Grise Fjord, NU," October 28, 2009.
[124] David Waller, Matthew R. MacLeod and Talia McCallum, *Measuring Northern Watch: Goals Inputs, Metrics and Outputs* (Ottawa: Defence R&D Canada – Cora, 2009), 18. Available at: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc81/p531224.pdf.

sensors was provided by the CAF's Acoustic Data and Analysis Centre.[125] Magnetic sensors are meant to detect local magnetic anomalies in the water, while electric sensors are meant to measure variations in the local electric field. These three technologies are complimentary and are employed together in modern maritime mines.[126] The combination of these technologies suggests that the work being done is focused heavily on subsurface detection. However, several items were tested in order to build a robust surface suite.

The first land-based sensor mentioned was the marine navigation radar. Navigation radar is an inexpensive piece of equipment, but it does have limitations in its display and processing functions. Therefore, it is not an ideal sensor when dealing with a fast craft with a small radar cross section.[127] However, the ships that will be travelling in Arctic waters will be large tankers and cargo vessels. These are slow moving ships with a very large radar cross section, making navigation radar a useful tool for monitoring their movements.

EO systems are sensors which read visible light band wavelengths between 0.4-0.7μm.[128] EO sensors use the sun as a light source to gather imagery and can be optimized to see through visual restrictors such as weather and pollution. Since EO sensors operate on the visible light spectrum, they do not operate at night and, as a result, are often found in tandem with infrared sensors. The imagining suite that was tested as part of NWTDP is known as the Canadian Arctic Night & Day Imaging Surveillance System (CANDISS). It consists of a high-resolution colour

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[125] Acoustic Data Analysis Centre (Atlantic), "Statement of Operating Intent (SOI) for Generic Acoustic Analysis and Training System (GAATS)," March 3, 2009.
[126] Defence Research and Development Canada, "Diver Signature Integrated Measurement System (DSIMS)," last modified August 18, 2011.
[127] E.S. Riseborough, *Detection of low observables with a low cost navigation radar* (Ottawa: Defence R&D Canada, 2008), 33. Available at: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc81/p530811.pdf.
[128] Ronald G. Driggers, Paul Cox, and Timothy Edwards, *Introduction to Infrared and Electro-Optical Systems*, (Norwood: Artech House, Inc., 1999), 1.

visible imager (EO), a multiple field of view thermal (Far-Infrared) imager, a high-resolution gated active Near-Infrared imager, along with a wide angle camera and laser for situational awareness and range. All of this equipment is mounted on a tilt and pan platform with an integrated data recorder and geo-referencing system.[129] CANDISS is a multi-use platform that was hoped to be of use to the project. However, a re-evaluation of the contributions of CANDISS was conducted in March and April of 2010.[130] The review concluded that "while CANDISS is a capable multi-sensor imagery system, most of its capability will not be used in the Northern Watch Surveillance system. The Northern Watch imagery requirement can be satisfied by a single Narrow Field of View Camera, cued by the Radar for bearing and range and/or AIS."[131] The standard visible light camera was justified due to more than 22 hours of daylight from mid-April to mid-August, which comprises the majority of the shipping season. However, light is reduced to 16 hours by mid-September, which is still within the shipping season.[132] It is perhaps for that reason that CANDISS reappeared in the NWTDP field notes during the 2012 season. The system was deployed to a hillside sensor camp known as BIRDSEYE, along with Radar and Radio Detection systems.[133] There is no indication as to how successful the system was during the season.

Another land sensor was an ELINT receiver, which was used to receive and interpret communications signals into a workable product that could be understood by the end user. This piece of equipment was being used during the NWTDP to provide electronic signal information,

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[129] Canadian Coast Guard, "Marine Communications and Traffic Services," last modified July 10, 2013, http://www.ccg-gcc.gc.ca/eng/CCG/MCTS_Major_Projects.
[130] Defence Research and Development Canada, *Northern Watch TDP Information Bulletin*, Edition 2, June 2010, 2.
[131] Bruce Grychowski and Dan Brookes, "Northern Watch Sensor Qualification Outcome," April 30, 2010.
[132] Ibid.
[133] Garry Heard, "Informal Email updates on our progress," August 2, 2012.

such as radar and communications. It can also provide a bearing for the signals that are received.[134] It is difficult to believe that this would be part of the autonomous end system since the power requirements to run the processor are quite large.[135] It seems likely that DRDC was using the NWTDP as an opportunity to do some cold-weather testing on communication and radar technologies.

The final land-based technology mentioned is AIS, which is a system that tracks the position of ships at all times. It operates in the VHF maritime band and uses GPS to calculate a ships position every two seconds. Other information that is sent includes data such as course, heading and speed. A national AIS system was launched in 2008 making it mandatory for ships of 500 tons or more to install the transponders and laying out special circumstances for other ships.[136] The International Maritime Organization (IMO) has ordered that ships over 300 gross tonnes or more which are capable of international voyages must be outfitted with an AIS system. In addition, all passenger vessels must have the system installed. As of April 2010, over 70,000 ships had been equipped with AIS.[137] While AIS is an integral part of marine navigation on the east and west coasts, the lack of receiver stations in the Arctic means that there is currently no operating AIS in the region. It is likely that DRDC was conducting cold-weather testing to see if an autonomous receiver station could function properly in the Arctic.

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[134] Canadian Coast Guard, "Marine Communications and Traffic Services."
[135] Northrop Grumman Electronic Systems, "LR-100 Receiver: Small Size/Big Performance," accessed March 25, 2014, http://www.northropgrumman.com/Capabilities/LR100/Documents/pageDocuments/lr100.pdf.
[136] Canadian Coast Guard, "Marine Communications and Traffic Services."
[137] David Mugridge, "COM DEV and exactEarth Deliver a New Maritime Surveillance Capability," *Canadian Defence Review*, Vol.16 No.2 (April 2010), 80.

Lessons Learned

The technologies that have been tested during the NWTDP are by no means cheap systems and testing them in such a remote location as Devon Island increases the costs dramatically. The costs associated with the project and adverse weather conditions caused the government to hesitate over the future of the project in 2009. A CBC report from August 8, 2008 states that the team had been unable to install the main underwater cable due to high winds.[138] In fact, only nine kilometers of sub-sea cable was installed, with none of the underwater arrays being added. In addition, only one land based sensor was installed that year.[139] It was then announced on July 23, 2009 that the project would be going on hiatus. According to the Department of National Defence (DND), researchers wanted to evaluate the data that had already been collected.[140] However, annual reports from the project show that no equipment had been installed at the site by the time the announcement was made. Work was indeed carried out during the summer of 2009, with the underwater array system being installed and tested between August 30 and September 4.[141] It is curious that the government would announce that work was not being done during that season while still continuing with the work.

The official reasoning for the hiatus did not match up with the timeline of activities and, as is often the case, the real reasoning for the uncertainty of the project is much more complicated. An email dated November 20, 2008 was the first to indicate that the project was in

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[138] CBC News, "High Arctic surveillance study hampered by strong winds," August 8. 2008, http://www.cbc.ca/news/canada/north/story/2008/08/08/northern-watch.html.
[139] Nelson McCoy, "DRDC Atlantic 2008 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board March 26, 2009.
[140] CBC News, "Northwest Passage surveillance study halted," July 24, 2009, http://www.cbc.ca/news/canada/north/story/2009/07/23/nortern-watch-hiatus.html.
[141] Nelson McCoy, "DRDC Atlantic 2009 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board April 15, 2010.

jeopardy. It announced that "the Northern Watch project has been red carded. This is the equivalent to the project being suspended until further notice, until any approval is granted by the Associate DGSTO, you are requested as of 20 Nov 08 to suspend all project spending, travel, and related activities including the NESTRA trials and the February conference."[142] A more definitive answer to the status of the project was provided the following day by Paul Poirier, the TDP Manager. He revealed that $50,000 was to be spent on a contract for options analysis, with additional funding becoming available if the Project Manager could justify it.[143]

The decision to red card the project and place it under review was made a week prior to the email announcement, on November 13, 2008. At the meeting that day it was revealed that there had been inadequate planning for adverse weather, damage to the cable array from ice and severe budget issues.[144] The project faced three possibilities: "cancel the project, maintain project objectives and schedule while increasing the costs up to 25%, or reduce project objectives to stay within the current schedule and budget."[145] It was with those options in mind that the review was conducted over the next several months.

As a result of the review, it was announced on June 9, 2009 that there were going to be some leadership changes, the most notable being Bruce Grychowski taking over as Project Manager from Nelson McCoy.[146] Grychowski developed a plan by August that maintained much of the original objectives, but revised the completion date to July 2013.[147] While Grychowski

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[142] Roger Dao, "RE: NW TD – CORE SRB RESULT," November 20, 2008.
[143] Paul Poirier, "RE: NW TD – CORE SRB RESULT," November 21, 2008.
[144] Klaus Kollenberg and Rick Williams, "Record of Discussion for the Northern Watch Technology Demonstration Project Status Report Meeting Held at 1430, 13 Nov 2008 in the ADM(S&T) VTC Conference Room, Constitution Building 8th Floor," November 28, 2008, 2.
[145] Ibid, 3.
[146] Jim Kennedy, "Northern Watch Project Management," June 9, 2009.
[147] Bruce Grychowski, "Northern Watch Plan Proposal August 2009," August 4, 2009, 5.

was busy developing a way forward for the project, work did continue at the site. According to the annual report from 2009, between June 25 and July 16 several buildings were repaired, a new bunkhouse was built, a propane toilet system was removed, and a water purification and heating system, washrooms and showers were installed.[148]

On November 2, 2009 it was publicly announced that the project would continue and the official reasoning for the hesitation was given. It was stated that the facilities at the site had been badly damaged during the winter and were in need of serious repair. It was also made public that the team was able to gather four weeks of data from the underwater sensor array, breathing new life into the project.[149] While the issue with the facilities was true, holding off on the public announcement that the project was going ahead gave the government an out. As far as the public was aware, the project was still suspended. The crucial aspect that allowed the project to proceed was the successful deployment and gathering of data from the underwater array. If no data had been gathered during the 2009 season, it is likely that the project would have been shuttered.

The confusion over the status of the project still persisted into 2010, however. On June 22, 2010 the land use permit issued by the Land Administration body for the Government of Nunavut expired.[150] It was not until July 14, 2010 that a request for an extension was received.[151] This confusion even led to a misstatement by Shelagh Grant in her book *Polar Imperative*. When discussing the announcement of Canada's Northern Strategy, she sates that Northern Watch had

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[148] McCoy, "DRDC Atlantic 2009 Annual Report."
[149] CBC News, "Arctic surveillance research moves ahead," November 3, 2009, http://www.cbc.ca/news/canada/north/story/2009/11/02/northern-watch.html.
[150] Joseph Monteith, "Re: Land Use Permit #N2008N0027,"email to Defence R & D June 22, 2010.
[151]John Craig, "Re: Land Use Permit #N2008N0027," email to Defence R & D July 15, 2010.

been cancelled.[152]While this may be a small error, it displays the confusion that was common to those who were observing the progress of the project during the first few years.

With some of the major issues seemingly behind it, the NWTDP seems to be moving forward with a cohesive plan for the future. As already stated, the project began in 2008 with the installation of a cable and one land-based sensor. Very little sensor data was collected during that season.[153] In 2009 the main sensor array was installed with the assistance of the *CCGS Terry Fox* and her ships' boats.[154] During the 2010 season military divers accompanied DRDC staff in order to remove loose gravel from the foreshore pipe. The pipe was drilled in 1985 by DND and the underwater end had subsequently been buried. The purpose of the pipe is to allow cables to be run from the seafloor to equipment on shore without being exposed to ice.[155] This pipe is likely associated with the previous sensor work done at the site during the Cold War. There was limited activity in 2011, with a small team of military engineers doing maintenance and construction work at the camp. In addition, "The underwater sensors from Gascoyne Inlet and Barrow Strait were recovered; these sensors were taken to Halifax for inspection and refurbishment."[156] This indicates that they were left over the winter from the previous season, likely to test the impact of ice on the integrity of the system. In 2012 the scientists successfully launched, tested, and recovered two acoustic systems with the assistance of *CFAV Quest*. They also placed an underwater data recorder at the mouth of Gascoyne Inlet, with the intent to

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[152] Grant, *Polar Imperative*, 442.
[153] McCoy, "DRDC Atlantic 2008 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut."
[154] McCoy, "DRDC Atlantic 2009 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut."
[155] Bruce Grychowski, "DRDC Atlantic 2010 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board April 2011.
[156] Tamara Van Dyck, "DRDC Atlantic 2011 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board March 21, 2012.

recover it in summer 2013.[157] That did not occur however, as activity at the site was limited to a single half-day visit during the season. There is expected to be more activity during the 2014 season, with the intent to conduct maintenance and building activities and replace some foreshore cables. [158]

With the failure of several seasons, technical setbacks and numerous other issues, the NWTP has seen several revisions to timeline and costs. As stated at the beginning of this chapter, the project was originally envisioned to run until 2011 and cost $9.75 million. By 2010 the completion date had been pushed to 2014 and costs were estimated at $15.7 million.[159] Before the end of the year, however, the cost estimate had already increased to $18.725 million for the project with funding extending through the fiscal year 2015/16.[160] The most recent figure for the total cost of the project is estimated at $16.1 million as of September 2013.[161] An updated timeline is also not included in the documents, but the 2012 Annual Report submitted to the NIRB states that a 6-month trial was scheduled for 2015.[162] Despite the failure of the 2013 season, DRDC is states in recent documents that it can maintain that schedule.[163]

Sharing their Toys

The government has said numerous times that the NWTDP will enhance Canadian sovereignty in the North, but the documents show just how limited that impact may be. Five

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[157] Tamara Van Dyck, "DRDC Atlantic 2012 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board March 8, 2013.
[158] Tamara Van Dyck, "DRDC Atlantic 2013 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut," sent to the Nunavut Impact Review Board March 28, 2014.
[159] Defence Research and Development Canada, "Northern Watch Technology Demonstration Project: Objectives Approved at Annual SRB," March 9, 2010.
[160] Benny Wong, "Technology Demonstration Program (TDP) Synopsis Sheet (TDP Project Approval) Northern Watch Technology Demonstration Project," November 15, 2010, 2.
[161] Mark Riley, "Northern Watch Brief," September 25, 2013.
[162] Van Dyck, "DRDC Atlantic 2012 Annual Report."
[163] Riley, "Northern Watch Brief."

different scenarios were developed in order to determine the effectiveness of the equipment during the NWTDP: declared shipping and cruise traffic through the Northwest Passage; undeclared maritime traffic; undeclared pleasure craft; pollution from a ship; and, willful, unannounced incursion by a foreign military vessel, with the last one being "chosen as it represents a severe test of Canada's ability to assert sovereignty in its northern territory".[164] In other words, the last scenario is the only one that would involve the military in the lead role. The remainder of the scenarios would be responded to by a mixture of RCMP, Coast Guard, Transport Canada, and the CBSA, with the Coast Guard being the only one to have any role in the NWTDP. In all but the last scenario, the military would have an extremely limited role. It is not that the DRDC team does not understand sovereignty, as Grychowski elegantly states that:

> Strategically, it is incumbent upon the Government of Canada to establish command and control over the Canadian Arctic to ensure that other nations and business with interests (sic) in the arctic agree to and respect Canadian ownership. Operationally, command and control encompasses the ability to exercise presence, detect and monitor the movement of traffic throughout the area, deny unauthorized presence, detect and respond to emergencies and enforce Canadian law.[165]

While that is a very accurate description of what is required, the military would have very little involvement in any of those activates. They seem cognisant of their constabulary role, arguing that:

> Changes in the Arctic could also spark an increase in criminal activity with important implications for Canadian sovereignty and security. This situation could very likely cause a potential requirement for additional military support in events where law enforcement (RCMP) or Customs and Border Service Agency (CBSA) officials will require support to enforce the laws of the land.[166]

Ignoring the implications of the military assisting with policing duties in a domestic context, the documents read as if the NWTDP is a model of cooperation and will be of great use for all

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[164]Waller, MacLeod , and McCallum, *Measures of Effectiveness* , 21.
[165] Bruce Grychowski, "Northern Watch Technology Demonstration Project," presented to DGSTO, October 27, 2009.
[166] David Mugridge and Peter Race, "Arctic Planning Scenarios: Scenario #2 – Safety and Security Scenario, Centre for Operational Research & Analysis," July 2011, 3.

government department and agencies.[167] However, there are some serious issues that present as problems for that view.

The project is conceived and run by the military, so naturally much of the documentation is focused on military applications. However, despite the claims that the NWTDP will benefit a multitude of departments and agencies, there is very little evidence that they have been consulted and involved in the project. The NWTDP Exploitation Strategy from September 2010 lists only Canada Command, Chief of Force Deployment, DRDC, and CMS as the currently covering beneficiaries. Departments such as Public Safety (RCMP) and the CBSA are listed as *potential* beneficiaries, which gives a clear indication of their involvement in the project.[168] Additionally, a possible display concept for the project describes how the NWTDP team and the military will access the information and display, but makes no mention of how other clients may access the data.[169] While the documents state that "the demonstration will not be limited to DND requirements but will consider the needs of whole of government for arctic sovereignty, and management (sic)", potential partners were rarely, if ever, consulted.[170]

The reason for the limited engagement with other departments is because DRDC ultimately views it as a military project. With the foundations the *Canada First Defence Strategy* and *Canada's Northern Strategy*, the NWTDP will "improve northern and maritime situational

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[167] The military has a very limited domestic mandate, especially when it comes to surveillance and policing actions. During the 2013 Idle No More protests J2/CJOC had to adopt a liberal interpretation of their mandate in order to justify its surveillance of the protests. See Justin Ling, "Canadian Forces spent virtually all of 2013 watching Idle No More protesters," *National Post*, June 1, 2014, http://news.nationalpost.com/2014/06/01/canadian-forces-spent-virtually-all-of-2013-watching-idle-no-more-protesters/.

[168] Defence Research and Development Canada, "Northern Watch TDP Exploitation Strategy," September 30, 2010, 1.

[169] No Author, "SDCC Display Concept."

[170] Bruce Grychowski, "Northern Watch Technology Demonstration Project: Expectations, Concepts and Objectives," October 26, 2009, 3.

awareness and response," which is a true defence and security issue.[171] Strengthening Canadian security should be the focus of the military, but ultimately the impact of the NWTDP on Canadian sovereignty will be limited by the access that other departments have to the data. If the military sees the project as belonging to them, then the decision to share the data will lie with the military. It will be the military that decides what is relevant and pertinent to share and what should remain classified. Further, potential partners like Public Safety, CBSA, and CCC are not seen as stakeholders in the plan for Surveillance System Integration. Although they are undoubtedly a major component of sovereignty enforcement in the region, the plan is dominated by Canada Command, Joint Task Force North and Joint Task Force Atlantic.[172] While the military will not say it directly, the lack of involvement by other potential stakeholders is evidence that the project will be a much more direct benefit for the military and hard security than it will other departments and agencies.

The Secret that Everyone Knows

With the government touting the NWTDP as a project that will enhance Canadian sovereignty in the North, it would be assumed that those who disagree with Canada as to the status of the northern waterways would not be involved in the project. However, the documents show a surprising and alarming amount of international collaboration. A lot of the cooperation involves other Arctic partners, who presumably face similar issues developing a system to handle the complex conditions of the region. In 2010 there were plans to conduct a cooperative sensor trial with Sweden in Halifax.[173] Tests were carried out from September 29 – October 5, 2010, as

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[171] Defence Research and Development Canada, "Northern Watch TD Military Fit."
[172] No Author, "Northern Watch TDP Assumptions."
[173] Bruce Grychowski, "Record of Discussion Northern Watch TDP Planning Metting Held 23-25 November 2009 at DRDC Ottawa," January 12, 2010, 5.

planned. The Swedish component comprised of electro-magnetic and acoustic sensors while the Canadian participation involved the Starfish Array being developed by DRDC. The tests involved placing the arrays in the water of Ferguson Cove at the NATO Sound Range and measuring the equipment readings against the observed ship traffic. Most importantly, "Participants will share the data to the extent it remains unclassified."[174] The Halifax test built upon a cooperative test with Norway around 2008, for which the Starfish Array was also employed.[175] The results of the Norwegian trial were directly considered in the NWTDP planning sessions.[176]

Officially, the Starfish Array has not been directly involved in the NWTDP trails, as it has not appeared in any annual reports or government-produced documents. However, it was considered as early as 2009 after the failure of the original array.[177] The Starfish is a prototype autonomous sensor that has magnetic, electric, pressure, acoustic and acoustic gradient sensors. Data from all the sensors are combined in a process known as "fusing", which computes characteristics such as speed, size and depth.[178] Currently DRDC is working on limiting the amount of power the computer processing uses, making it more effective as an autonomous unit.[179]

The reason that the collaborative research seen in the Starfish Array is important to the NWTDP is that both systems are built by the same company, Omnitech Electronics Inc. The

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[174] Omnitech Electronics Inc., "Next Generation Autonomous Systems – Starfish Cube Array," prepared for DRDC – Atlantic, March 31, 2011, 161.
[175] Garry J. Heard, et al., "Project Completion Report: ARP 11cn – Underwater Data Networks and Sensors for Autonomous ISR Systems, DRDC Atlantic Technical Report," October 31, 2008, 13.
[176] Bruce Grychowski, "Northern Watch TDP Standard Progress Meeting," December 1, 2010.
[177] Bruce Grychowski, "Northern Watch TDP Objectives and Way Ahead Meeting," October 27, 2009, 1.
[178] Omnitech Electronics Inc., "Next Generation Autonomous Systems," 4-16.
[179] Defence Research and Development Canada, "Autonomous Underwater Surveillance Systems for Coastal Waters," last modified August 18, 2011.

NWTDP array was built by Omnitech for $1.2 million.[180] Further, a large number of the DRDC personnel involved in the Starfish research are also assigned to the NWTDP team.[181] Considering that the same company is tasked with building both arrays and a number of the same DRDC people are involved in both projects, it would not be a stretch to believe that a lot of the same technology is being utilized in both projects. The testing that has been done with the Scandinavian countries makes sense from a security perspective, but only serves to undermine the argument that the NWTDP is about sovereignty. Allowing European allies to the testing allows for them to understand the weaknesses of the instruments and possibly exploit them should a sovereignty challenge arise. In addition, the US NorthCom is listed as a possible beneficiary of the NTDP data.[182] The views presented in the documents suggest that the NWTDP is seen by DRDC as contributing more directly to NATO collective security than to Canadian sovereignty. If it were truly about sovereignty, then allied nations that disagree with Canadian claims that the waters of the Arctic Archipelago are internal would not be given access to the technology that comprises our northern surveillance system. The documents paint a picture that cooperation with partners on the project is more the rule than the exception.

There are several examples of cooperation with partners in the documents having both indirect and direct impacts on the NWTDP. Collaboration on the Starfish Array included an exchange of scientists with the US Naval Research Laboratory, work within the Maritime Systems Group Technical Panel 9 (MAR TP-9) Underwater Networking Initiative with the United States, and work within the NATO Next Generation Autonomous Sensor Joint Research

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[180] Garry Heard, "UWSS Status Report," June 14, 2010.
[181] Neil Sponagle, "11cc – Distributed Surveillance Pods with Digital Signal Processing (DSP^2)," June 5, 2007.
[182] Defence Research and Development Canada, "Northern Watch TDP Exploitation Strategy."

Project.[183] Any of these avenues could have been an source of information sharing and collaboration that would give other states insight into the NWTDP. Further, NATO working groups such as the Radar & Infrared Synergy for Military Situation Awareness and the Modelling of Active EO Imaging Systems were seen as sources of knowledge for the DRDC with regards to the EO sensors of the NWTDP.[184] All of this evidence leads to the conclusion that the NWTDP is a security-first program, with the impacts on a more sovereign North being a secondary consideration.

All of these elements seriously undermine the concept of a "made in Canada" system, but it does largely amount to indirect collaboration. Official documents from DRDC and other departments make no mention of Starfish being used in the trials, but they in fact were. In a series of informal email updates Garry Heard, it is apparent that the Starfish sensors were an integral component of the 2012 field season. The type used was actually a wireless version that utilized acoustic modems to communicate, thereby resolving the problems experienced by the line array. They were first deployed on August 2 and, after a series of issues getting the system running, were successful in gathering a large amount of data. By the time of their recovery on August 23, the Starfish had gathered almost 90GB of data, while the traditional array was not successful in gathering data.[185] Clearly the Starfish were a success during the field trial and are likely included in the plan for the future. This technology, developed in direct cooperation with partners, has not been officially admitted as being involved, as it would seriously question the sovereignty aspect of the project.

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[183] Heard et al., "Project Completion Report: ARP 11cn," 23.
[184] Jean Luc Forand and Vincent Larochelle, "EO Sensors," May 19, 2009.
[185] Ron Verrall, ed., "Arctic Field Work – Summer 2012," September 2012.

Lost in Translation

If the government were to be taken at face value regarding the various statements made about the NWTD, one may be led to believe that the NWTDP will result in a comprehensive surveillance system throughout the Arctic. This perception is somewhat reinforced by some of the long-term visions produced by DRDC. A presentation given in 2007 by Dr. Jean Luc Forand, the lead scientist of Northern Watch, discussed several possible choke points for the deployment of the surveillance system. These sites include the Kennedy Channel between Ellesmere Island and Greenland, the small gap between Ellesmere Island and Devon Island, the current site in the Barrow Strait between Devon Island and Somerset Island, the Bellot Strait between Somerset Island and the Beothia Penninsula, the Dolphin & Union Strait between Prince Albert Island and the mainland, the Fury and Hecla Strait Between Baffin Island and the Melville Peninsula, and the Hudson Strait between Baffin Island and Labrador.[186] Note that this was just before the beginning of the NWTDP, so seeing such a system as the ultimate goal is understandable.

The key word in the project is *demonstration* and that is something that the scientists working on it have reiterated many times. Just like their counterparts working on the sonobuoys in the 1960s and 70s, it seems that the government and other elements of the military did not fully understand what the project was going to produce. Among the exclusions from the work conducted during the NWTDP was the development of any new EO/IR or underwater technologies, legacy installations of permanent surveillance sensor systems, and terrestrial based wide area surveillance of the approaches to the Arctic region.[187] While the exclusions may seem

[186] Forand et al., "Surveillance of Canada's High Arctic."
[187] Defence Research and Development Canada, "Northern Watch Technology Demonstration Project, Project Scope Version 1.0: Annex A," October 25, 2010, 5.

self-limiting, the NWTDP was given neither the budget nor the personnel to go beyond their given scope.

Another aspect the NWTDP has with the previous work on the sonobuoys is the lack of a stated user requirement. Obviously, there would have been a lot of frustration among the DRDC scientist who were tasked with delivering a project with no obvious end goals. The minutes from a meeting of the Senior Review Board on March 9, 2010 provide some insight into the lack of direction due to this gap. The subject was broached about:

> how the project is tied back to the CF capability deficiencies. Maj. [Francis] Fillion [CFD/ D Mil CM4-6/ EM Northern Watch] stated that there is no specific identified capability deficiency, but there are some generic capability deficiencies to which the requirement can be tied. LCol [John] Blythe [ADM(IM)/ DCCI 2] added that there are seven to eight sense capability deficiencies that apply. Mr. [Rick] Williams [DGSTO] requested that the project team take on a task to provide that linkage.[188]

Clearly this is a rather peculiar way of doing defence research and is evidence that the political leadership was very disconnected from the level the scientists work on. It is evidence that the project was indeed ordered by the politicians rather than developed internally by the military. If it were conceived by the military, it would have been in response to a capability deficiency instead of looking for one only after several years of research activities.

The March 9, 2010 meeting was critical, as it occurred at the same time as the selected sensors were being reviewed for their applicability to the project. During the discussion the question was raised as to:

> how the original suite of sensors were [sic] obtained and whether user requirements were considered. Mr. Williams explained that this TDP was unusual in that the original TDP was initiated without a specific user requirement but in response to a general government interest in the Arctic. As such, when the project was initiated, DRDC proposed a suite of sensors as a result of a series of conferences, with many of the initial sensors being quite specialized and not necessarily suited to the new objectives.[189]

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[188] Defence Research and Development Canada, "SRB #3: Minutes of 15EJ Northern Watch TDP SRB Meeting, 9 March 2010," issued July 23, 2010.
[189] Ibid.

This revelation, buried deep within meeting minutes, is an important one. It shows that many of the issues experienced by the NWTDP in the early phases did not occur as a result of DRDC capability or knowledge, but due to a lack of direction. The project was being led by politics and for political gain, the results of the project were secondary.

As has been shown throughout this chapter, the NWTDP is not going to lead to a complete, working sensor system that the government described when the project was first begun. The Conservatives gained a lot of traction with the Arctic during the 2006 election and looked to capitalize on it. The NWTDP was used as an opportunity to show that something was being done on the sovereignty front without committing a large amount of money and resources. Without a clear direction, DND transformed the project into something the department could recognize and exploit. It is due to the lack of requirements and the government's satisfaction with the illusion that something was being done that the NWTDP became a defence-first initiative. Of course it will have a positive effect on sovereignty, but those impacts are going to be indirect and limited due to the fact that the project is being run by the military almost exclusively. There has so far been no "whole of government" approach to the project and the current iteration is aimed solely at the sub-surface. While unauthorized submarine voyages do not look good in terms of Canadian sovereignty, they cannot be used as a precedent for claims that the Northwest Passage is an international strait. Therefore, in its current form, the NWTDP is firstly about security, with sovereignty benefits being ancillary.

CHAPTER 4 – SETTING A FOUNDATION: RADARSAT AND POLAR EPSILON

The Arctic poses major challenges to developing comprehensive ISR. Not only are the distances extremely large and resources limited, but as was shown with the development of sound surveillance, the conditions in the region do not favor the fragile mechanisms of advanced technologies. As a result, the government has placed a large emphasis on satellite surveillance and communications. Air patrols are carried out on a regular basis, but they are limited by their range, availability and are at the mercy of the weather. Satellites have the potential to fulfill a variety of roles regardless on the conditions on the ground. The various technologies are an answer for Canada to the advances in ship design and technology that are making shipping more viable in ice-covered areas. This realization came about as a result of the government's successful experience with the previous manifestations of RADARSAT. They demonstrated that synthetic aperture radar (SAR) equipped satellites had a variety of applications in the area of environmental observation, but also excelled at maritime surveillance. What they failed to realize, however, was that the data procurement process could actually serve to undermine Canadian sovereignty.

Creating the Capability

RADARSAT-1 was launched in November 1995 and gave Canada a satellite that was capable of delivering large amounts of data in a timely manner. The satellite was equipped with a SAR instrument, which allows it to collect images of the Earth day or night through all kinds of interference such as cloud cover, smoke, or haze.[190] The project cost an estimated $620 million, excluding the launch costs. $500 million was contributed by the federal government, Quebec,

[190] Canadian Space Agency, "RADARSAT-1," last modified April 26, 2013, http://www.asc-csa.gc.ca/eng/satellites/radarsat1/default.asp.

Ontario, Saskatchewan and British Columbia combined for a $57 million contribution and the private sector contributed $63 million. The project was managed by the Canadian Space Agency (CSA) and the work was sub-contracted to the private sector, with MacDonald Dettwiler and Associates Ltd. (MDA) and COM DEV among the main participants.[191] RADARSAT-1 was capable of using "a wide variety of beam widths…to capture swaths of 45 to 500 kilometers, with a range of 8 to 100 metres in resolution and incidence angles of 10 to 60 degrees."[192] The satellite could cover areas north of 70° daily, north of 48° every four days, and complete coverage of the majority of the Earth every six days. The satellite repeated its orbital path every twenty-four days at an altitude of 798 kilometres and can collect twenty-eight minutes of data in each 100.7 minute orbit.[193] The satellite could downlink its data to thirty-three data reception facilities throughout the globe, with two operated by the Canada Centre for Remote Sensing, which provides near-real-time monitoring of floods, maritime pollution, oil spills and other disasters, as well as monitoring ice, oceans, forests and much more.[194]

RADARSAT-1 was a large step forward for the CSA and the Government of Canada. It could provide them with data that would otherwise have to be acquired from other countries. The satellite also turned Canada into a major supplier for data to other nations. The satellite was originally intended to operate for five years, continued to function well past its expected expiry date. As of September 15, 2010 RADARSAT-1 had completed 77,764 orbits, planned 336,609 user requests and had acquired 630,520 minutes of SAR data. Funding at that point was provided

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[191] Canadian Space Agency, "RADARSAT-1: Construction and Cost," last modified September 11, 2006, http://www.asc-csa.gc.ca/eng/satellites/radarsat1/construction.asp.
[192] Canadian Space Agency, "RADARSAT-1: Components and Specifications," last modified April 30, 2013, http://www.asc-csa.gc.ca/eng/satellites/radarsat1/components.asp.
[193] Ibid.
[194] Ibid.

until March 31, 2012, though it mainly served as a backup for RADARSAT-2 in case it was over-tasked.[195] The Canadian Space Agency finally announced in May 2013 that the satellite was no longer responding and was considered lost. While losing the satellite was a blow to capabilities, it vastly exceeded the original life expectancy of five years. In the seventeen years of operation the satellite completed 90,828 orbits and provided 625,848 images to more than 600 clients and partners in Canada and 60 countries worldwide. In addition, it provided assistance to 244 disaster events and aided various mapping projects.[196]

RADARSAT-2: Securing the North?

Based on the success of RADARSAT-1 the Canadian Government entered into negotiations with MDA to construct and manage a second satellite. A deal with MDA was finalized on December 18, 1998, with the Government of Canada contributing $225 million and MDA providing $80 million. The government then recouped its investment by receiving $225 million worth of imagery from MDA.[197] The investment by the Government of Canada was later increased to $445 million, with the same agreement to recover the investment.[198] The satellite was equipped with a SAR antenna that is capable of resolution between 3 and 100 metres. What really improves the capabilities of RADARSAT-2 over RADARSAT-1 is the advancement in the polarization. RADARSAT-2`s SAR has enhanced polarization modes, which allows for better discrimination between various surface types and improved terrain classification. It also has right

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[195] Dean Flett, "RADARSAT-1 Update & RADARSAT Constellation Mission Overview," presentation at IICWD-XI, Washington, D.C., October 18-22, 2010.
[196] Canadian Space Agency, "RADARSAT-1: Seventeen Years of Technological Success," May 9, 2013, http://www.asc-csa.gc.ca/eng/media/news_releases/2013/0509.asp.
[197] Rob Huebert, "Canada and Commercial Satellite Imagery: Technology in Search of a Foreign Policy," in *Commercial Satellite Imagery and United Nations Peacekeeping: A View From Above*, James F. Keeley and Rob Huebert eds., (Aldershot: Ashgate, 2004) 200-201.
[198] Paris W. Vachon, "New RADARSAT Capabilities Improve Maritime Surveillance," Presentation at NATO NURC Geo Data Fusion Centre, October 18, 2010.

and left-looking SAR, which allows for faster revisit times. It operates at an altitude of 798 kilometers and orbits fourteen times a day, orbiting every 100.7 minutes. Using the 500 kilometer swath width the satellite covers areas north of 70° daily, areas between 48° and 70° every one to two days, and areas at the equator every two to three days.[199]

Boeing was then supposed to launch the satellite on a Delta II rocket in 2003, but the project was delayed due to technical issues and further concerns over access to the data. The satellite was finally launched in December 2007 on a Russian Soyuz-Fregat rocket.[200] The project has been a major success for Canada, as the satellite has the ability to measure ice, monitor ship traffic in remote areas, detect ships of more than 500 tonnes, and monitor forests, floods and fields.[201] The satellite is a vital piece of technology and is of critical importance to the Government of Canada, but it has the potential to be just as vitally important to other nations as well.

The state-of-the-art capabilities of the craft did create some problems with the Americans. It was originally agreed that NASA would launch the satellite in 2002, but it was deferred due to protests by the American Government. RADARSAT-2 was to be run as a commercial venture by MDA, which means that it could sell imagery to any government so long as the sale fit its mandate. Therefore, governments could buy imagery at three metre resolution and reveal sensitive information about various foreign governments. Negotiations were opened in June 2000 between the Canadian and American governments. The agreement that was reached

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[199] Canadian Space Agency, "RADARSAT-2: Built for Performance and Versatility," last modified November 29, 2007, http://www.asc-csa.gc.ca/eng/satellites/radarsat2/inf_tech.asp.
[200] Peter De Selding, "Canadian Earth-Watching Satellite Finally Reaches Orbit," *Space.com*, December 14, 2007, http://www.space.com/4706-canadian-earth-watching-satellite-finally-reaches-orbit.html.
[201] Canadian Space Agency, "RADARSAT-2: Applications," last modified November 28, 2007, http://www.asc-csa.gc.ca/eng/satellites/radarsat2/applications.asp.

called for the Canadian Government to implement controls over who has access to RADARSAT-2 imagery.[202] The details of the agreement were never disclosed, but it can be assumed that it precluded the sale of sensitive imagery. However, the definition of sensitive is open to interpretation and detailed images of contested waterways may be just as sensitive as images of military installations.

The sale of data from RADARSAT-2 is handled by MDA Geospatial Services Inc. MDA has a hierarchy of priorities that determine the acquisition of orders. They state that:

> Once a data order has been placed, MDA will confirm the availability of the RADARSAT-2 satellite to acquire the data. In the event of a conflict, the following priority guidelines will determine the final programming of the satellite: Satellite health and safety; Defence; Emergencies (national, international, humanitarian, environmental and commercial); Guaranteed Time Critical; Time Critical; Non Time Critical.[203]

While Canadian defence and emergencies take precedence, it is possible for another government to place an order that would result in data within a few days. However, emergency programming is available that would allow end users to receive imagery within hours.[204]

To the credit of MDA, they have worked to develop protocols to ensure Canadian security is not compromised by the sale of data. While the data produced by the satellite is unclassified, they have developed a Customer Access Profile (CAP) for each country, which determines ordering privileges for requests. Additionally, "the Government of Canada reserves the right to exercise a shutter control when the availability of the data might be detrimental to Canada's defence."[205] The limitations placed on end users are further enhanced by the terms of

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[202] Huebert, "Canada and Commercial Satellite Imagery," 201.
[203] MDA Corporation, "RADARSAT-2: Ordering Data," accessed March 5, 2014, http://gs.mdacorporation.com/SatelliteData/Radarsat2/OrderingData.aspx.
[204] MDA Corporation, "RADARSAT-2: Programming Services," accessed March 5, 2014, http://gs.mdacorporation.com/SatelliteData/Radarsat2/ProgrammingServices.aspx.
[205] MDA Corporation, "RADARSAT-2 FAQ: Data Policy," accessed March 5, 2014, http://gs.mdacorporation.com/SatelliteData/Radarsat2/DataPolicy.aspx.

use, which must be agreed to prior to the sale of data. The General Terms of Use make it clear that the data is being licensed, not sold, and it remains the property of MDA. Further, the name of the buyer must be clearly identified, as well as the names of all groups or individuals with which the data will be shared.[206] There are also restrictions on the post-processing of data, whereby users would modify or enhance the data that they receive from MDA. Users are not to:

> further process, or permit any third party to further process SLC Data to generate any product with (a) an impulse response resolution in either range or azimuth finer than (i) 2.0 metres for single- or dual-polarization modes, (ii) 6.0 metres for quad-polarization beam modes, where resolution is measured horizontally in the ground plane; if applicable, further process, or permit any third party to further process Spotlight beam mode to generate any product with an impulse response resolution finer than 2.0 metres in range and 0.74 meters in azimuth, where resolution is measured horizontally in the ground plane.[207]

These measures constitute the main was MDA seeks to restrict and safeguard the data that is produced by RADARSAT-2, but it is system that is open to abuse.

Firstly, there are many ways that nefarious governments, who may have a CAP which greatly limits their ability to obtain data from MDA, to circumvent the measures. What is to stop said countries from utilizing shell companies in less restricted countries from purchasing data and sending it to the true end users? More importantly, what controls are in place to ensure that the data is not tampered with and enhanced by end users as laid out in the terms of service? After all, the product being delivered is a data file that is can easily be copied and manipulated by those with the proper knowledge. Clearly if MDA has to state in the terms of service that users are not to enhance the product beyond 2 and 6 metres, it is possible. Otherwise, it would not have to be stated as such. Lastly, MDA is a for-profit company and while they likely have never

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[206] MDA Corporation, "RADARSAT-2: General Terms of Use," last modified August 29, 2008, http://gs.mdacorporation.com/products/sensor/GTU.pdf.
[207] MDA Corporation, "RADARSAT-2: Government User RADARSAT-2 End User Licence Agreement," last modified June 15, 2011, http://gs.mdacorporation.com/products/sensor/radarsat2/RS2_Gov_User_License_agreement.pdf.

knowingly violated the terms laid out by the Government of Canada, it cannot be said for certain. The company needs to turn a profit on its projects and may be willing to bend the terms of service or knowingly sell data to a shell corporation for the right price. While there are no known cases linked to MDA, that kind of behaviour may seem impossible in a Canadian company. Evidence for such behaviour can be seen in the recent experience of SNC Lavalin. The company, which has a large presence in the defence sector, has had a continuous series of scandals that include paying $160 million in bribes to Saadi Gaddafi and most recently stand accused of a $1.5 million bribe of federal employee.[208] A system in which the Government of Canada relies on a private company to act in the country's best interest is open for abuse. This is especially concerning given the kind of data that MDA is tasked with selling.

Data Sales and Canada Sovereignty

While the data produced by RADARSAT-2 is unclassified, it could still be used to the detriment of Canada. For example, there are many nations that disagree with Canada as to the status of the Northwest Passage, an area that is chocked with ice for the majority of the year and barely navigable the remainder. Ice poses a threat to shipping year round and it is imperative that ships have a complete understanding of the current ice conditions before attempting a transit. Ice detection is one of the main roles of RADARSAT-2 and "capabilities that benefit sea- and river-ice applications are the multi-polarization options that improve ice-edge detection, ice-type discrimination, and ice topography and structure information."[209] One of the largest factors is

[208] Tristin Hopper, "Federal agency boss took $1.5M in kickbacks from SNC-Lavalin contract to restore Montreal bridge, report alleges," *National Post*, February 13, 2014, http://news.nationalpost.com/2014/02/13/federal-agency-boss-took-1-5m-in-kickbacks-from-snc-lavalin-contract-to-restore-montreal-bridge-report/.
[209] Canadian Space Agency, "RADARSAT-2: Applications."

navigation is the determination of ice-type throughout a navigation route. Multi-year ice is much denser than first-year ice and is therefore a much greater threat to ship hulls.

Work using SAR imagery has been carried out on the classification of ice types, thin ice and open water discrimination, sea ice thickness estimation and determination of the thermodynamic state of sea ice.[210] The Canadian Ice Service (CIS) makes use of SAR imagery to great effect and has developed a system whereby the SAR images aid in the automatic classification of ice data, the first such system of its kind.[211] While the charts that the CIS produce are available to the public, they are large in scale and may not provide sufficient detail. The charts required for navigation would require more manipulation of the data by the end user.

Using this scenario, it is possible that a nation who disagrees with Canada's claim over the Arctic navigation channels to utilize a Canadian satellite to plan a voyage. A request for SAR imagery of ice data in the Arctic would not raise any suspicions and once it had been obtained, it would be possible to enhance to data to plan a navigation route. In this manner, a system that is meant to enhance Canadian control over the Arctic and assert sovereignty could actually serve to undermine it. This is a product of the cost sharing agreement that was made with MDA, leaving the data in private hands and for sale. It is a mistake that will be corrected with the RCM, as it is being built solely with government funds and will owe nothing to private companies.

Despite the possibility that RADARSAT data could be used to undermine the Canadian position in the region, the satellite has become a critical piece of equipment for the government. Its importance was displayed when the government chose to block the sale of MDA's

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[210] Jagvijay P.S. Gill and John J. Yackel, "Evaluation of C-band SAR polarimetric parameters for discrimination of first-year sea ice types." *Canadian Journal of Remote Sensing*, Vol. 38, No. 3, 306.
[211] Shuhratchon Ochilov and David A. Clausi, "Operational SAR Sea-Ice Image Classification," *IEEE Transactions on Geoscience and Remote Sensing*, Vol. 50, No. 11, (November 2012), 4405.

Information Systems Business division in 2008. MDA wanted to sell the division for $1.3 billion to Alliant Techsystems Inc. of Minnesota, which included Canadarm and RADARSAT-2. Then Industry Minister Jim Prentice blocked the sale using the Investment Canada Act, saying that the sale would not bring a net benefit to Canada. It was the first time that the act was invoked to block the sale of a Canadian company.[212] Even if Prentice had decided to allow the sale to proceed, it is unlikely that RADARSAT-2 would have been included in the deal. Under the 2005 Remote Sensing Space Systems Act the Minister of Foreign Affairs would have also had to sign off on the deal. The act states that:

> The Minister may, by order, exempt any person or remote sensing space system — or any class of person, system or data — from the application of any provisions of this Act or the regulations. The exemption order may be limited in scope or made subject to conditions. It may be made only if the Minister is satisfied that: (a) the exemption is neither injurious to national security, to the defence of Canada, to the safety of Canadian Forces or to Canada's conduct of international relations nor inconsistent with Canada's international obligations; (b) adequate provision will be made for the protection of the environment, public health and the safety of persons and property; and (c) the interests of the provinces are protected.[213]

The reason that the Foreign Affairs Minister Maxime Bernier would have likely used the act to veto the sale is based on the military application of the satellite. RADARSAT-2 has been an integral tool for DND ever since it was launched. The ability of the satellite to detect vessels has been of great importance to DND and Ultra-Fine beam mode (three metre resolution) allows for classification.[214] The importance of the satellite to DND was further enhanced through a program known as Project Polar Epsilon.

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[212] CBC News, "Govt. confirms decision to block sale of MDA space division," May 9, 2008, http://www.cbc.ca/news/business/story/2008/05/09/alliant-sale.html.
[213] Government of Canada, *Remote Sensing Space Systems Act: S.C. 2005, c. 45*, (Ottawa: Minister of Justice, 2005) last amended April 5, 2007, 3, http://laws-lois.justice.gc.ca/PDF/R-5.4.pdf.
[214] Canadian Space Agency, "RADARSAT-2: Applications"

Hitting the Ground

While Canada had made great strides in developing its satellite surveillance capability with the RADARSAT program, it lacked a system to deliver the data to end users. There was no way for the data to be processed and delivered to relevant departments, resulting in a crucial bottleneck that had the potential to negatively impact Canadian security and sovereignty. The solution to this issue was found in a project known as Polar Epsilon (PE), a ground segment meant to make the delivery of data more efficient and enhance the impact of the RADARSAT program on ISR.

The PE project "originated its Synopsis Sheet (Identification) in February 2003 to improve Canada's Arctic and maritime surveillance capabilities using space-based sensors as well as meeting surveillance requirements for Canadian Forces deployed abroad."[215] In May 2005 with $64.5 million in funding was earmarked in order to begin implementation of the project.[216] The project had four main aims: near real-time ship detection, Arctic land surveillance, environmental sensing and maritime surveillance radar beam optimization. The goal of the ship detection was to incorporate the information in the recognized marine picture (RMP) within fifteen minutes. In order to do so, the satellite would need access to local receiver sites to downlink the information. Polar Epsilon aimed to enhance the quality of the information provided by RADARSAT-2 by optimizing the beam for ship detection. [217] The development was

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[215] Robert Quinn, "Gap Analysis Version 2.6: Polar Epsilon (Joint Space-Based Wide Area Surveillance and Support) Statement of Requirements," June 3, 2011, 6.
[216] Marketwire, "Government of Canada Announces Location of Reception Ground Stations for Polar Epsilon," March 30, 2009, http://www.marketwire.com/press-release/government-canada-announces-location-satellite-reception-ground-stations-polar-epsilon-967526.htm.
[217] P.J. Butler, "Project Polar Epsilon: Joint Space-Based Wide Area Surveillance and Support Capability," in *International Society for Photogrammetry and Remote Sensing*, accessed December 4, 2011, http://www.isprs.org/publications/related/ISRSE/html/papers/1000.pdf.

completed in two phases. Phase 1, which included Arctic surveillance and environmental sensing, completed the definitions phase on December 13, 2007. Phase 2 involved a dedicated RADARSAT-2 ground segment and the optimized maritime beams. The definitions segment for this phase was completed on March 5, 2009.[218]

The project went through a test exercise in 2008 and 2009 with Operation Drift Net. The operation was meant to monitor illegal fishing in the western Pacific. RADARSAT-2 was used in conjunction with reconnaissance from CP 140 aircraft. During the operations the CAF was able to build a recognized marine picture that gave them the level of awareness in their operational area that they required.[219] In order to improve the timeliness of the information, it was announced in March 2009 that two new ground stations would be built. One was located in Masstown, Nova Scotia and the other in Aldergrove, British Columbia.[220] A signal processor was also included in the Aldergrove installation.[221] The ground stations have since been developed and are now operational.[222] Polar Epsilon increased the capabilities of RADARSAT-2 and the infrastructure will be in place when the RCM is launched. The project was transferred to Canada Command on June 29, 2010, giving the central command organization access to satellite imagery within a very short amount of time.[223]

In order to fully capitalize on the RADARSAT program and leverage the ground segment, DND has initiated the development of Polar Epsilon 2 (PE2). According to documents, PE2 "will exploit the Radarsat Constellation Mission (RCM) to reduce deficiencies in the

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[218] Quinn, *Gap Analysis*, 6.
[219] Robert Quinn, "Canada – Global Leader in Maritime Domain Awareness from Space," Presentation at Canadian Embassy, Washington D.C., March 26, 2009.
[220] Steve Fortin, "A new step for the Polar Epsilon project," in *The Maple Leaf*, vol.13, no.24 (July 21, 2010) 16.
[221] Quinn, *Gap Analysis*, 6.
[222] James Fergusson, "Thinking Big: Canada's RADARSAT Constellation," *Space Quarterly*, September 1, 2011.
[223] Fortin, "A new step for the Polar Epsilon project."

maritime, deployed and arctic surveillance domains that were not addressed completely by Polar Epsilon using the Radarsat-2 satellite."[224] The enhancements are to be built upon existing PE infrastructure and be developed to suite the RCM capabilities. The exploitation strategy involves "a. SAR imagery for feature extraction and change detection; b. SAR imagery for transfer to CDI and other customers who will perform their own exploitation; and c. A capability for the exploitation of SAR and AIS (automatic identification system) data for ship detection and identification."[225] The total cost for this project is estimated at $182.5 million, of which almost $58 million is for AIS, $37.5 million for interim capability upon the RCM launch, and $24 million for full PE2 capability.[226]

The capabilities that are proposed in PE2 will rely on a number of other DND projects. *Juniper Green*, a description of which could not be found in unclassified documentation, may collaborate with PE2 on imagery storage capabilities. It is planned to upgrade the Global Command and Control System – Maritime (GCCS-M) to a web-based capability to receive tracks and imagery from PE2. Planned new infrastructure includes a possible Northern Ground Station (NGS) to facilitate downlink capability, as well as a new Operational Command Building, which would include the Canadian Space Operations Centre.[227] Of course, as with all government projects, both ideas that come to fruition and projects run are schedule are few and far between. The Government of Canada placed a tender notice for PE2 from October 25, 2013 to May 30, 2014, the purpose of which was extremely preliminary. The tender stated that:

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[224] Robert Quinn, "SOR Version 1.5: Polar Epsilon 2 – Space-Based Surveillance and Reconnaissance Capability Statement of Operational Requirements," October 4, 2011, 9.
[225] Ibid, 29.
[226] No Author, "Design of an Integrated AIS on a Radar Satellite (DIASRS) Technology Demonstration Project (TDP) Update," May 27, 2011.
[227] Quinn, "SOR Version 1.5," 14.

> Canada is in the planning process for the procurement of the Polar Epsilon 2 (PE2) capabilities, which plans to develop ground infrastructure to collect and process data from the RADARSAT Constellation Mission (RCM). Canada is seeking to engage Industry in a consultation process for the refinement of the procurement strategy, along with the proposed delivery solution. One of the purposes of this Request for Information (RFI) is to register interested Respondent(s) wishing to participate in an Industry Day and/or the one-on-one meetings.[228]

The work in the tender is extremely preliminary and raises some doubts as to whether PE2 will be ready for the RCM launch in 2018. It is clear that the government is questioning its procurement abilities given several botched high-profile failures such as the F-35 and Sea King replacement helicopters. This reads as if the government is currently suffering from a lack a vision and desires for industry to lead the way. While the government may have confidence issues with regards to procurement, these certainly cannot be extended to sovereignty. The government has constantly played the sovereignty card when justifying these projects, but DND documents paint a different picture. The PE2 documents do make reference to sovereignty, but only by directly quoting government policy. They state that "Polar Epsilon was directly mentioned by Prime Minister Stephen Harper in the 2008 media background related to the CFDS and strengthening Canada's Northern Sovereignty. From the CFDS, 'first and foremost the CF must ensure the security of our citizens and help exercise Canada's sovereignty.'" [229] This serious questions as to whether DND clearly sees its mandate as directly enforcing sovereignty and whether PE will primarily be utilized in this role. DND seems to recognize the natural order of things when they say that:

> the CF must also be available to assist other government departments (OGDs) in addressing such security concerns as over-fishing, organized crime, drug and people-smuggling and environmental degradation. The CF must have the capacity to exercise control over and defend Canada's sovereignty, which includes the Arctic. Polar Epsilon 2 capabilities through the RCM will provide

[228] Public Works and Government Services Canada, "Polar Epsilon 2 Project (W8474-14PE02/A)," accessed April 5, 2014, https://buyandsell.gc.ca/procurement-data/tender-notice/PW-13-00510011.
[229] Quinn, "SOR Version 1.5," 9-10.

> surveillance of Canadian territory and maritime approaches; support search and rescue activities; and assist civil authorities and OGDs in their mandates.[230]

For the vast majority of the quoted requirements, the CAF would be the lead department only in a small minority of situations. Instead, PE will be playing a support role for other departments and raising questions as to why DND would be in charge of a project that will be largely domestic focused. Answers to this issue can be found in the exploitation and sharing strategy.

All for One, One for All?

Canada has been working for a number of years to develop interdepartmental cooperation with regards to the maritime domain. The Interdepartmental Marine Security Working Group (IMSWG) was created in October 2001 under the lead of Transport Canada. The group includes seventeen federal departments and agencies, which includes Canada Border Services Agency, Canadian Food Inspection Agency, Canadian Security and Intelligence Service, Canadian Space Agency, Defence Research and Development Canada, Department of Fisheries and Oceans/Canadian Coast Guard, Department of Justice, Department of National Defence, Environment Canada, Finance Canada, Department of Foreign Affairs and International Trade, Public Safety Canada, Government Operations Centre, Privy Council Office, Royal Canadian Mounted Police, Transport Canada, and the Treasury Board Secretariat.[231] The stated goal of the group "is to co-ordinate the federal response to marine security, analyze our marine system for security gaps, and develop possible mitigation initiatives to address these gaps."[232]

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[230] Ibid, 15.
[231] Transport Canada, "Interdepartmental Marine Security Working Group Partners," last modified May 14, 2012, https://www.tc.gc.ca/eng/marinesecurity/partnerships-303.htm.
[232] Quinn, "Gap Analysis," 9.

The group eventually produced the *National Strategy for Maritime Domain Awareness*, a document that sought to enhance marine safety and security in the country. The document included seven objectives: 1. Persistenly, monitor the maritime domain; 2. Access and maintain data on vessels, cargoes, facilities, and infrastructure; 3. Assess and maintain data on people and organizations; 4. Collect, fuse, analyze, and disseminate information; 5. Share information; 6 Coordinate efforts; and 7. Monitor and evaluate MDA (Maritime Domain Awareness) horizontal performance.[233] These objectives drove interdepartmental cooperation and strove to destroy the fiefdoms that government departments can so often be. Eventually, work within the group led to the creation of the Marine Security Operations Centres (MSOCs).

As laid out in Canada's National Security Policy in 2004, MSOCs were established in Halifax and Victoria to monitor both coasts and Niagara to monitor the Great Lakes. The partners in the MSOCs include Department of National Defence, Royal Canadian Mounted Police, Department of Fisheries and Oceans/Canadian Coast Guard, Canada Border Services Agency, and Transport Canada, all of which have a maritime component to their mandate.[234] The purpose of the MSOCs is to enable "government departments and agencies to work together and share intelligence, surveillance and reconnaissance information (within the legal mandate of agencies / departments) through interagency staffing and collaboration, which in turn allow the MSOCs to support an organized response to potential marine threats and avoid duplication to both efforts and resources."[235]

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[233] Ibid, 10.
[234] Transport Canada, "Marine Security Operations Centres," last modified May 23, 2013, https://www.tc.gc.ca/eng/marinesecurity/operations-269.html.
[235] Ibid.

Taken at face value, the MSOCs appear to be a great example of interdepartmental cooperation and an element that greatly enhances Canadian security and sovereignty. One senior DND official commented that cooperation within the MSOCs is hand in glove. However, a closer inspection of the MSOC mandates reveals that some issues can arise with respect to information sharing. Firstly, there are lead organizations for the MSOCs, with DND taking lead for the Victoria and Halifax installations and the RCMP in charge of the Great Lakes – St. Lawrence Seaway.[236] These lead organizations will form their perspective based on their mandate and have the potential to distort the view of personnel belonging to partner departments and agencies. DND will disseminate the information based on a security perspective, which may force the personnel of other departments to present their information within that paradigm. The same can be said of the RCMP and the law enforcement paradigm.

Another major potential issue with the MSOCs is the potential for information sharing. As stated in government documents, "While retaining their own mandates and lines of authority, these agencies work closely together within the MSOCs, sharing their expertise and, wherever possible, the content of their information systems to help identify and assess security threats."[237] Key emphasis should be placed on *wherever possible*, which is a recognition that departments and agencies have limitations placed on them regarding information sharing. The previously stated quote regarding the purpose of the MSOCs states with more clarity that the sharing has to be done "within the legal mandate of agencies / departments)."[238] Therefore, based on the mandates of the various departments and agencies, information may be withheld from partners so

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[236] Department of Fisheries and Oceans, "Canadian Coast Guard, Canadian Coast Guard: Maritime Security Contributions," 2011, 8.
[237] Ibid, 8-9.
[238] Transport Canada, "Marine Security Operations Centres."

as to ensure the security of said information. Further, as a result of the need for the compartmentalization of information, there is no pool of information being generated that can be access by all involved. Peter Avis summarized this point well, saying that as with "the Integrated Threat Assessment Centre (ITAC), the participating departments in these facilities have access to their own databases only – they cannot interconnect database information in order to 'connect the dots.'"[239]

This assessment undermines the impact of the MSOCs on Canadian sovereignty, as information that one department deems superfluous and may not be shared, could be viewed as critical by another. Further, information that may be seen as important by all parties may not be seen due to legal limitations. There is the potential for information fiefdoms to develop within the MSOCs, which could have a major impact during critical events. Finally, those who work within the MSOCs may have their perspective challenged by the lead department within the individual MSOCs, leading to an erosion of contrasting views and opinions that was envisioned.

The importance of the MSOCs and Polar Epsilon to sovereignty can be seen in DND's exploitation strategy. The MSOCs are directly supported by the Regional Joint Operations Centres (RJOCs), which will have direct control over Polar Epsilon assets.

> For maritime surveillance, the RJOC Atlantic or Pacific surveillance planner in consultation with the RJOC Surveillance Officer will determine the satellite collection plan. The collection plan will be provided to the satellite service provider in accordance with established RCM ordering procedures. Polar Epsilon will carry out the data processing functions required for the formation of images from satellite sensor data and, using a suite of exploitation tools, the processing required in the performance of target detection. Polar Epsilon will deliver ship target detection reports to the Recognized Maritime Picture (RMP). For maritime surveillance of global AOI's (Areas of Interest) where the CF may be deployed commanders will submit RFIs (Request for Information) into the CCIRM (Collection Coordination and Intelligence Requirements Management) process. Upon approval by the National CCIRM Manager, the Polar Epsilon RJOC planner will submit a

[239] Peter Avis, "Canadian Maritime Domestic Security – An Assessment in Late 2007, Two Years Prior to the 2010 Vancouver Olympics," *Canadian Military Journal*, Vol. 8, No. 4 (Winter 2007-2008), last modified July 14, 2008, http://www.journal.forces.gc.ca/vo8/no4/notice-avis-eng.asp.

> collection plan for RCM data to the DND/CF RCM Order Desk. Deployed commanders will feed the resultant maritime surveillance information into the RMP at the RJOCs where it will be required.[240]

Based on this strategy, the exploitation of Polar Epsilon will be done entirely within DND, as they are in charge of the entirety of the infrastructure. The outputs may be shared with other departments and agencies, but there are a number of circumstances that may prevent this. Information that is classified or deemed irrelevant may not be shared or information may be misinterpreted by an organization that places the security aspect of sovereignty above all others. This is further evidence that the Government of Canada has been allowed to build up a military capacity, which is explicitly stated to have a large impact on operations abroad, while primarily highlighting the benefits for Canadian sovereignty. While that is not to say that there will be no positive effects on sovereignty, as it will introduce a surveillance capacity where none existed before and therefore allow Canada to react to threats and events in the Arctic. However, Canadians have been ill-informed of the extent to which it will enhance military capabilities. It is a further example of selling security under the guise of sovereignty.

[240] Quinn, "Gap Analysis," 16.

CHAPTER 5 – PREFERENTIAL TREATMENT: THE DND RELATIONSHIP WITH THE RADARSAT CONSTELLATION MISSION

Following the success of RADARSAT-1 and the anticipated launch of RADARSAT-2, the CSA began planning for a successor, the RCM. The previous satellites were planned with relatively short lifespans and the CSA wanted to ensure that there would be no capability gap without a satellite in place. The makeup of the constellation was debated between the Department of Fisheries and Oceans, Transport Canada, the Canadian Ice Service and the Department of National Defence, with DND submitting requirements for up to six satellites. As a result of cost limitations, a constellation of only three satellites was approved.[241] The project was meant to enhance the capabilities that were developed with the previous satellites, as well as further leverage Polar Epsilon. While the project was run and organized by the CSA and meant to be exploited by a number of government departments, as will be shown, DND had a disproportionate amount of input and involvement.

On Time and on Budget, a Foreign Concept

Although planning for the RCM began as early as 2003, the project began in earnest in 2005 with an investment of $86 million for the design phase of the project. The design is being done by MDA, the builders of the RADARSAT-2 satellite, and was completed in October 2012. The build phase began in January 2013 and is currently ongoing. The 2010 federal budget allocated $397 million in new funds, combined with a $100 million contribution from the CSA, for a total investment of $497 million for the build phase of the project. The RCM was originally

[241] Guy Seguin, Ralph Girard, and Francois Malo, "RADARSAT Constellation project CSA-DND Working Group," March 24, 2009.

scheduled to be launched in 2014 and 2015.[242] Since the inception of the mission there have been some revisions to the cost and the timeline. A Revised Preliminary Project Approval that was submitted in December 2010 stated that the costs had increased from $625 million to $873 million. In addition, the launch dates had changed to 2014-2015 for the first of the three satellites and 2015-2016 for the other two.[243] The launch date has shifted further still since 2010, with the current projection estimating a date of 2018 for the first of the satellites.[244] With the continual delays have come a number of cost increases. The most recent estimate for the cost of the project now sits at $1.085 billion.[245]

The RCM is being designed to improve on the capabilities of RADARSAT-2 and increase revisit time using the constellation. Phase A, the requirement definition and amendment period ran from June 2005 to March 2008. This phase involved establishing the user requirements for the craft and developing the systems that would fulfill the requirements.[246] During Phase B of the project, the system design was refined and the preliminary design of the satellites was carried out. The CSA drafted a Data Utilization Plan in order to identify the core areas in which the data could be used.[247] There are three core areas that have been identified as primary users of the RCM data: maritime surveillance, environmental, monitoring and disaster management. Maritime surveillance includes ice and iceberg monitoring, pollution monitoring,

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[242] Prime Minister of Canada, "RADARSAT Constellation Mission," August 25, 2010, http://pm.gc.ca/eng/media.asp?id=3603.
[243] Canadian Space Agency, "2011-2012 Report on Plans and Priorities – Annex 4: Status Report on Transformational and Major Crown Projects," last modified June 9, 2011, http://www.asc-csa.gc.ca/eng/publications/rpp-2011-annexes.asp.
[244] Canadian Space Agency, "RADARSAT: Project Status," last modified January 9, 2013, http://www.asc-csa.gc.ca/eng/satellites/radarsat/status.asp.
[245] Canadian Space Agency, "Canadian Space Agency 2014-15 Report on Plans and Priorities: Annexes," 13, http://www.asc-csa.gc.ca/pdf/eng/publications/rpp-2014-annexes-eng.pdf.
[246] Canadian Space Agency, "Canadian Space Agency 2012–13 Departmental Performance Report," 13, http://www.asc-csa.gc.ca/pdf/eng/publications/pr-2013-annexes.pdf.
[247] Canadian Space Agency, "RADARSAT: Project Status."

vessel detection and information on marine winds. Environmental monitoring is comprised of forestry observation, monitoring protected areas and wildlife habitat, agricultural data, wetlands information and monitoring coastal change. Disaster management involves flood monitoring, observing wind storms, gathering data on earthquakes, providing information on landslides, monitoring volcanic activity and watching for changes in the permafrost.[248] Phase C, the critical design phase, began on March 17, 2010 and was originally scheduled to be completed by June 11, 2010.[249] However, this phase involved the design of all the systems that were to be included on the satellites, which led to problems with DND and the CSA regarding the plan for a war forward. MDA received the final design amendments on May 19, 2011, worth a total of $6.8 million.[250] Phase C was mostly completed in November 2012 after being delayed due to the technical issues. However, several items still required closing out and work was not fully completed on long-lead items and design reviews until March 2014.[251] However, contractual work continued on the project and a contract was signed with MDA on January 9, 2013 for Phase D (manufacturing) and Phase E1 (early operations.)[252]

The three RCM satellites will operate C-band SAR from an altitude of 600 kilometres. The satellites will be capable of obtaining imagery that is similar to that of RADARSAT-2, which is between 3 metres and 100 metres resolution. The satellites will be capable of obtaining imagery for twelve minutes per ninety-six minute orbit. They have a peak efficiency of taking imagery twenty minutes every three orbits and can continuously take images for a maximum of

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[248] Flett, "RADARSAT-1 Update & RADARSAT Constellation Mission Overview."
[249] MDA Corporation, "RADARSAT Constellation Mission contract update," March 17, 2010, http://sm.mdacorporation.com/news/pr17032010_en.html.
[250] MDA Corporation, "RADARSAT Constellation Mission design extended," May 19, 2011, http://www.mdafederal.com/press/radarsat-constellation-mission-design-extended/.
[251] Canadian Space Agency, "Canadian Space Agency 2014-15 Report on Plans and Priorities: Annexes," 12.
[252] Canadian Space Agency, "Canadian Space Agency 2012–13 Departmental Performance Report," 13.

ten minutes. The quad-polarization that is capable with the new SAR will greatly enhance the images that are collected by the satellites, as different polarizations serve different functions. The satellites will be capable of imaging anywhere in the world, except within 1,500 kilometres of the South Pole. Their orbits will greatly enhance the coverage provided to Canada and it's regions of interest. On any given day they will be able to monitor up to 1200 nautical miles from shore above forty-two degrees latitude and will be able to cover the entire Canadian land area every week. Coverage of the Arctic will improve greatly, with the vast majority of Arctic waters being covered by the satellites at least twice a day.[253] This last point will be of crucial importance as activity in the Arctic increases. A large reason for building a constellation of satellites was to increase revisit time and coverage of the North, with one 2005 email stating that "the optimization of revisit is more important (to DND and OGDs), than the obtainment of more detail on a less frequent basis."[254] However, such a large endeavour makes developing the project in isolation, especially in a period of such intense resource cooperation among allies. Canada is a partner in military and intelligence alliance such as NORAD, NATO, and the Five Eyes. To think that the assets would not be used by partner nations would be naïve.

Partners and Politics

While the RCM has been developed within Canada with very little outside consultation, there are extensive plans to leverage the data through international partnerships. The CAF argues that "*there is no surveillance holy grail* – no single capability, sensor, platform, or tool that will solve the CAF's wide area surveillance challenge. We *must employ a mix of capabilities* in a layered and complementary approach. It is important to understand what each capability can

[253] Flett, "RADARSAT-1 Update & RADARSAT Constellation Mission Overview."
[254] Rick Pitre, "RE: SAR Constellation," April 18, 2005.

bring and how to best exploit them."[255] Like the NWTP, the CAF has sought to increase the impact of technology programs by reaching out to allied partners and offering to share data. This is a large reason for keeping the RCM as a government-owned project, rather than following the model established by RADARSAT-2.[256] This allows the government to control who has access to the data and when, as opposed to navigating MDA's acquisition program. DND has argued that "partnerships with allies are another critical means [sic] for DND to achieve required space-based capabilities."[257] DND's Sapphire satellite is one example of how Canada is contributing to allied partnerships. The $83.6 million satellite was successfully launched in early 2014 and will be incorporated into the U.S. Space Surveillance Network to monitor other objects in orbit.[258] Additionally, DND also initiated an endeavor known as Project Bluestone, which is aimed at identifying follow-on capabilities in order to contribute to allied partnerships.[259]

With regards to the RCM, an International Engagement Strategy has been "drafted providing the framework and guidelines to facilitate the development of international partnerships related to the RCM; and clarify fundamental questions concerning extra capacity management, constraints, governance, and priorities."[260] The United States, Norway, and the European Space Agency are examples of partners who were engaged in order to "achieve synergy and maximize system utilization."[261] The United States, in particular, is a natural partner for Canada with regards to defence and the two are intertwined in an extremely large number or

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[255] P.A. Thauberger, "CF Arctic Surveillance Capabilities," Presentation to SJS Western Hemisphere Ops, August 14, 2009.
[256] Ibid.
[257] Elle Agnew, Scott Jones, and Ashlyn Milligan, "Briefing Note: National Defence and Space," December 6, 2011.
[258] Canadian Armed Forces, "Sapphire satellite system is declared fully operational," last modified April 22, 2014, http://www.forces.gc.ca/en/news/article.page?doc=sapphire-satellite-system-is-declared-fully-operational/hr1thk2x.
[259] Agnew, Jones, and Milligan, "Briefing Note."
[260] Flett, "RADARSAT-1 Update & RADARSAT Constellation Mission Overview."
[261] Ibid.

reciprocating agreements. It is likely that the RCM will be included in the United-States Canada Defense Surveillance Gapfiller Strategy. Led by USNORTHCOM and NORAD, the strategy aims to "integrate currently disparate Command and Control surveillance systems including those under other agencies and will integrate an advanced surveillance capability for initial improvement of homeland defence and security initiatives."[262] The strategy takes the view that the North Warning System is no longer adequate for continental defence, resulting in the desire for a more robust, layered approach. A Data Policy was developed to govern the relationships of those accessing the RCM and control the sharing of information. However, from the limited information available, it appears that the policy is not very confining for DND, as they argued for the "unrestricted ability to share any data and products."[263]

During a meeting of the CSA-DND Management Board on June 12, 2008, the extent of cooperation that DND was pursuing was revealed. According to the minutes:

> Several international space agencies have expressed interest in collaborating on the RCM mission. The International User Team will re-start consultations with other space agencies in the fall of 2008. Col Malo said that it is important to have sufficient capability (duty cycle) to satisfy our national requirements, as well as those of potential international partners. Our international engagement strategy should focus on increasing the size of the constellation vs the acquisition of data. Increasing the number of satellites increases persistence (coverage) over our maritime approaches thus enhancing the military utility of the RCM. The implications of increasing the number of partners are very important to consider. Dr. Sachdev said that we have to bear in mind that there might be other benefits to partnering that need to be fully explored.[264]

Data sharing, while crucial to ensuring that Canada maintains an important and active role in alliances such as NATO and NORAD, entirely undermines the sovereignty argument. It is evidence that DND was looking to maximize the "military utility" of the RCM at the expense of undermining the benefits it would bring to sovereignty. Allowing access to data makes complete

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[262] Meagan McGrath and John Mackinnon, "AFEC-A4 Northern Surveillance Phase One: 6 October 2008 – April 20 2009 Wrap Up," Department of National Defence, May 2009, 10.
[263] Seguin, Girard, and Malo, "RADARSAT Constellation project CSA-DND Working Group."
[264] No Author, "Minutes of the Seventh Meeting of the CSA-DND Management Board," July 8, 2008.

sense from the perspective of military utility, but some of Canada's partner nations disagree on the status of the Northwest Passage. Should the incentive be large enough for them to send a non-compliant vessel through the waterway, they would have full knowledge of Canadian surveillance capabilities. If DND were seriously concerned with sovereignty, the access of allies to the data would be restricted to an as needed basis, rather than the unfettered sharing that DND sought. The position that DND looks at the RCM from a military utility perspective is reinforced by the interminable conversation as to what components should be included on the RCM.

The Forgotten Critical Component

While the components comprising the imaging system on RCM is a subject of little debate, DND has spent a lot of time discussing whether or not to include space-based AIS on the satellites. AIS is a transponder system that is mandatory on ships over 300 tonnes. The transponder uses GPS to give the ship's position, speed, course and other pertinent data. However, there are some serious limitations to using only land-based AIS receiver stations. The signal has a range of about fifty nautical miles from ship to shore and twenty nautical miles from ship to ship. Therefore, while ships are able to communicate with each other and avoid collisions, those monitoring the marine environment do not have a full Maritime Situational Awareness (MSA). A satellite based system may provide a solution to this problem, since AIS signals can be detected by a satellite in a low earth orbit between 600 to 800 kilometres. Satellite Automatic Identification System (S-AIS), however, is not without its own problems. In areas of high density shipping, a satellite may have between 4,000 and 6,000 ships in its field of vision. With each ship sending an AIS message every two seconds, the satellite will be receiving

multiple signals simultaneously, leading to message collisions that make it extremely difficult to attribute the messages to the individual ships.[265]

The notion of including an AIS receiver on the RCM was considered while the satellites were in an early stage of design and development. An October 26, 2004 email from Ralph Girard, Manager of the Radar and Antenna Group in the Space Technologies division of the CSA, stated clearly that:

> DND will work with the CSA and the RFS (RADARSAT) contractor to refine the CONOPS as the system concept evolves. MDA shall assume that the constellation would be part of a larger system including a Global Automated Identification System to fuse with the constellation information. The Global AIS would provide real-time information on targets that would be used to perform discrimination during the detection process and provide labels on detected targets.[266]

It is clear that the inclusion of AIS was on the top of the list for DND and the CSA in the early stages, but DND saw the technology as a potential benefit for a number of government departments. The inclusion of "AIS combined with radar on the constellation will provide wide area detection, classification, identification, tracking, and intent enabling [sic] non-compliant or non-cooperative vessels to be identified. This is a common reqmt [sic] from DND, DFO, Transport Canada, Coast Guard, and Environment Canada."[267] Based on this view, AIS would be a benefit to a variety of departments and have a large impact on the enforcement of Canadian sovereignty in the North. However, events over the next several years display just how much DND wanted control over the project and an almost complete absence of cooperation between the departments.

In order to move forward with placing S-AIS on the RCM, studies were sought in order to assess the impact of AIS on the design and how it could be implemented. However, issues

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[265] David Mugridge, "COM DEV and exactEarth Deliver," 80.
[266] Ralph Girard, "Update on DND's Requirements for RFS," October 26, 2004.
[267] Rick Pitre, "RE: SAR Constellation."

arose almost immediately over the funding issue. Andy Samoluk, Project Director of Polar Epsilon II, proposed "a joint DND-CSA effort to fund the studies (50% - 50%) that weren't covered under the CSA-MDA SCM contract. If CSA was willing to Match DND funding, then I think we should have MDA conduct additional work to focus on areas of concern."[268] However, the CSA was not willing to agree to such an arrangement. Since it was a DND initiative, the CSA argued that "AIS development is not part of the scope of our project. You (DND) could fund it without problem and we can try to find some fund [sic] but I am not sure we can match yours."[269] After further back and forth between the parties where DND agreed to fund the work while also expanding the number of studies to four, the correspondence concludes with a positive tone from the CSA stating that "There is no problem for us to provide support to you in these area. [sic] However we should discuss more before moving forward. I will see if we can arrange a meeting soon."[270]

While there appeared to be momentum in 2005, all activity seems appears to have ceased on the project over the next several years. Minutes from a 2008 meeting between DND and the CSA reveal that "An AIS implementation strategy for the RCM is needed as soon as possible," underlining the lack of progress.[271] In early 2009 a formal agreement was finally put in place whereby "CSA and DND agreed to pursue the inclusion of an AIS payload on RCM satellites if DND would take responsibility for procuring the payload."[272] It was not until almost a year later, however, that significant action was taken on the matter. On February 12, 2010 the decision was

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[268] Andy Samoluk, "Potential DND Funds Available for Joint DND/CSA Projects," September 16, 2005.
[269] Guy Seguin, "RE: Potential DND Funds Available for Joint DND/CSA Projects," September 16, 2005.
[270] Guy Seguin, "RE: Potential DND Funds Available for Joint DND/CSA Projects," September 19, 2005.
[271] No Author, "Minutes of the Seventh Meeting of the CSA-DND Management Board."
[272] S.A. Beare, "Project Management Approach – Automatic Identification System (AIS) on Radarsat Constellation Mission (RCM)," March 19, 2010.

made by the Defence Technology Sub-Council to utilize a Technology Demonstration Project as a risk-reduction vehicle.[273] The risks of including AIS on the satellites were significant and modifying the design at that stage was no simple task. According to an MDA presentation in September 2010, including AIS on the RCM created a problem with bandwidth issues. Running the AIS system at all times would take up about twenty percent of the downlink capacity, which is not sustainable due to the need for the SAR to downlink its data. This problem could be solved by using an onboard decoder, and it appears that MDA amended the design to integrate this part.[274]

When the project was first announced the timeline for completion was the end of March 2012.[275] The funding for the TDP was set at $6 million, $5 million of which came from DND's Direactorate of Space Development (D Space D), $0.5 million from DRDC and $0.5 million from the CSA.[276] The source of the DND funding is actually a little more complicated than at first glance. The minutes from the May 17, 2010 meeting of the CSA-DND management board reveals that the reserve under the control of the Vice-Chief of Defence Staff (VCDS) was used to fund the effort. This move underscores "the high priority DND assigns to the AIS capability on board RCM.[277]

To the public, things seemed to have been progressing. While the CSA sates on their website to this day that "There is also a secondary payload allocation for a potential Automatic

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[273] Ibid.
[274] Danielle Renton, "RADARSAT Constellation Mission and AIS," Presented at Canadian Embassy, Washington D.C., September 2010.
[275] Benny Wong, "Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) TDP Project Approval," March 29 2010 presentation to the Senior Review Board (SRB).
[276] No Author, "Technology Demonstration Program (TDP) Project Synopsis Sheet: Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS)," May 6, 2010, A-6.
[277] No Author, "Minutes of the Ninth Meeting of the CSA-DND Management Board," October 6, 2010.

Identification System for ships (AIS) which is not planned as part of the baseline mission and is being considered by DND," contracts were being signed.[278] On May 19, 2011 MDA announced that it had signed contract amendments with the CSA pertaining to the AIS system. The amendments are valued at $6.8 million and would be included on the RCM payload.[279] On July 4, 2010 COM DEV, a leader in the technology, received an authorization to proceed from MDA for the Phase C work. The design portion was valued at $720,000. The contract was for the design of key payload subsystems and deciding hardware qualifications.[280] While AIS is not directly referenced, it would make sense for COM DEV to develop the AIS payload given the company's experience with the technology. However, these public announcements and contract signings are entirely contrary to what was happening within the project.

Even if the project was being run on schedule, the contract announcements by MDA predate the original March 2012 completion date. Even more questions are raised when the documents reveal that there were major delays in the TDP. AS of the SRB meeting on March 24, 2011, the project was already estimated to be a year behind schedule.[281] Additionally, the DIASRS TDP was running out of funds and could only fund the research to the end of Phase B and had no funds for Phase C research.[282] A solution was created similar to that seen in Northern Watch, whereby the objectives were changed until they were obtainable with the budget and timeline. The scope of the work was modified to simply demonstrate the feasibility of AIS on the

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[278] Canadian Space Agency, "RADARSAT: Components and Specifications," last modified February 28, 2011, http://www.asc-csa.gc.ca/eng/satellites/radarsat/components.asp.
[279] MDA, "RADARSAT Constellation Mission design extended."
[280] Canada Newswire, "COM DEV Begins Work on RADARSAT Constellation Mission Design Phase," April 6, 2010, http://www.newswire.ca/en/story/661411/com-dev-begins-work-on-radarsat-constellation-mission-design-phase.
[281] Defence Research and Development Canada, "Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) – 15EU TDP – SRB #2," March 24, 2011 presentation.
[282] Ibid.

RCM, with a revised completion date of December 2012.[283] While the documents do not cover what happened past mid-2012, the fact that Phase C was not entirely closed out until December 2013 is evidence that there were some lingering issues.

The inclusion of AIS was an important need for DND from the planning stages of the RCM, though their lack of action until 2010 is evidence of the level of foresight the department operates with. Regardless, the DND placed such a high emphasis on the inclusion of AIS that it was willing to hold up the entire RCM project. In a slide from one of the SRB meetings, two sentences of fine print on the schedule read: "Delivery dates are the latest allowable in RCM schedule. Delays will directly drive the RCM program." Those delays did certainly contribute to the continuous revision to the launch schedule of the RCM and the ballooning cost.

With the importance of AIS established, the question is raised as to whether AIS is oriented to security or whether it will have a broader impact on sovereignty in general. The answer is unequivocally the former. According to the project description:

> The aim of the Design of an Integrated AIS Sensor on a Radar Satellite TDP is to demonstrate the capability to conduct wide-area maritime surveillance of surface objects (both cooperative and non-cooperative) in the maritime approaches to Canada including the Canadian Arctic and in maritime areas of interest to the DND/CF worldwide. This capability will enhance the Canada First Defence Strategy goals to conduct national and continental operations and to defend Canada. An AIS payload co-located with a space-based radar will enhance identification of vessels of interest in maritime approaches in a timely manner by significantly reducing the number of unidentified detected vessels in an Area of Operations.[284]

Additionally, AIS will be directly integrated into PE, a fact that is underscored by the $58 million in funding provided from the PE budget to include AIS on the RCM.[285] Everything about

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[283] Defence Research and Development Canada, "Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) – 15EU TDP – SRB #3," March 27, 2012 presentation.
[284] No Author, "Technology Demonstration Program (TDP) Project Synopsis Sheet: Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS)," 2.
[285] No Author, "Design of an Integrated AIS on a Radar Satellite (DIASRS) Technology Demonstration Project (TDP) Update."

this project has been done in-house by DND, with cooperation by the CSA when needed. There is no evidence that other potential end users of the information were included in consultations. As stated in the previous chapter, the CAF's role in enforcing sovereignty is extremely limited and the level of information sharing between the various departments and agencies highly questionable. If DND spent so much time, money, and resources on ensuring that AIS was included on the RCM, it is unlikely they would simply allow their domestic partners unfettered access to the technology.

Options Analysis

While the issues with developing AIS for the RCM were unfolding, DND and the CSA were quietly building a stand-alone AIS satellite. The Maritime Monitoring and Messaging Micro-satellite (M3MSat) is a project that was jointly developed by DRDC and the CSA. The goal of the project was to "further develop a multi-mission micro-satellite bus capability, establish micro-satellites as operationally cost effective, allow optimization of the AIS payload in maritime traffic identification and significantly support Canadian industry business development strategies in a global market context."[286] The project was originally announced in 2008, with a $8.6 million contract being signed with COM DEV for the development of the satellite.[287] The most recent estimate for the project, however, has it coming in under budget at $7.7 million.[288] This number stands in contrast to a 2009 CAF presentation that estimated the

[286] Canadian Space Agency, "2012-2013 Estimates on Plans and Priorities – Section 2: Analysis of Program Activities by Strategic Outcome," 19.
[287] The Canadian Press, "Com Dev wins micro-satellite contract," June 23, 2008, http://www.cbc.ca/news/technology/com-dev-wins-micro-satellite-contract-1.696098.
[288] Canadian Space Agency, "Canadian Space Agency 2012-2013 Departmental Performance Report Annexes," 19.

cost for the suitcase sized satellite at $13.7 million.[289] The project has seen numerous delays, with the launch date being pushed back several times. When the project began, the expectation was that the satellite would be put into orbit by 2010.[290] The most recent plan was to launch in June of 2014 using a Russian rocket, but that plan was derailed due to sanctions over the Ukraine crisis.[291] Despite several years of delays, costs on the project have not spiralled like those associated with the RCM. Despite the last published cost being from 2012, it is highly unlikely that the satellite will come anywhere near the amount that it cost to put AIS on the RCM.

M3MSat was considered briefly by DND as an alternative to holding up the RCM in order to modify the design. In the winter and spring of 2011 the DIASRS TSP underwent a Systems Requirements Review (SSR). On January 17, 2011 Melissa Reyes, a DND/CAF Security Officer and Project Manager for the RCM, sent out an email with proposing two possible options for a way forward. The M3MSat was dubbed the "Volkswagen Solution", while the RCM PA was termed the "Cadillac Solution".[292] There is no record of what occurred at the meeting with between COM DEV, MDA, DND, and the CSA on February 9, 2011, but the heavily redacted agenda does reveal that the entire day was dominated by speakers from the two companies.[293] It is also known that the decision was made at the meeting to move forward with AIS on the RCM while continuing work on M3MSat. There could have been numerous reasons for such a decision, but it does seem odd given the cost differences and the major delays to the RCM launch schedule. It is likely that DND saw this as an opportunity to gain an asset that they

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[289] Thauberger, "CF Arctic Surveillance Capabilities."
[290] The Canadian Press, "Com Dev wins micro-satellite contract."
[291] COM DEV International, "M3M Satellite Launch to be Rescheduled," April 24, 2014, http://www.comdev.ca/images/finance/CDV_-_M3M_-_April_24_2014_v2.pdf.
[292] Melissa Reyes, "AIS SRR – Clarification," January 17, 2011.
[293] No Author, "Revised SSR Meeting Agenda," February 9, 2011.

would not otherwise have been able to procure. The government had lauded the RADARSAT program and at that point had already spent hundreds of millions of dollars on the project, all in the name of sovereignty. DND was able to leverage this to include the costly revisions to include AIS and go with the "Cadillac Solution". Given that M3MSat is meant to be a "complement to CSA's RADARSAT Constellation and DND's Polar Epsilon missions," it will have very clear military/security applications.[294] While this is important, perhaps the biggest detail regarding the review was that it was led by the private firms that would benefit most from the increased work. In the case of COM DEV, they were heavily invested in seeing both projects move ahead.

An Auspicious Relationship

When COM DEV was awarded the contract to develop and build M3MSat in 2008, the project was rather limited and straightforward in its aim. Despite this, however, the build saw numerous delays in its schedule, with the government offering no explanation aside from the launch issues currently being experienced. It seems that a major reason for the scheduling issues and the only reason that costs have not spiraled was that COM DEV took advantage of the platform for its own purposes. In its press release regarding the launch delay, COM DEV makes the revelation that "Both COM DEV and exactEarth made significant investments in the development of the satellite, and in upgrading its capabilities."[295] exactEarth is a wholly owned subsidiary of COM DEV that operates a commercial S-AIS system. The Government of Canada was complicit in these upgrades and supportive of them. In the description of the program by the CSA, they freely admit that the project will "significantly support Canadian industry business

[294] Canadian Space Agency, "2012-13 Estimates: Reports on Plans and Priorities," 29.
[295] COM DEV International, "M3M Satellite Launch to be Rescheduled."

development strategies in a global market context."[296] This is an indirect reference to COM DEV, as the satellite will be integrated into its commercial system. The DIASRS TDP synopsis sheet is much more direct on the matter. While discussing M3MSat, it states that "it is envisaged to be one of three microsatellites to be used by COM DEV Ltd. in a commercial AIS constellation."[297] While the use of a publicly funded satellite for private enterprise is cause for alarm, it is just the tip of the iceberg when it comes to the relationship between the government and COM DEV.

The Cambridge, Ontario based company began its S-AIS venture with a $30 million investment to design software that solves the issue of message collision associated with S-AIS as referred to previously. The program essentially "detangles" the large amount of information received by an S-AIS system and attributes the messages to the correct ships.[298] COM DEV began development of the system with the launch of the satellite NTS on April 28, 2008. It provided the company for the baseline data to develop the system.[299] COM DEV has continued to build its S-AIS system, adding more satellites to enhance the timely delivery of data and increase global coverage. The program has now been given its own division known as exactEarth and the system is now known as exactAIS. On November 21. 2013 the satellite EV5 was launched, bringing the total exactEarth constellation to five.[300] The system uses a series of ground stations to downlink the data, quite similar to RADARSAT-2. exactEarth says that its

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[296] Canadian Space Agency, "2012-2013 Estimates on Plans and Priorities – Section 2: Analysis of Program Activities by Strategic Outcome," 19.
[297] No Author, "Technology Demonstration Program (TDP) Project Synopsis Sheet" A-7.
[298] Mugridge, "COM DEV and exactEarth Deliver," 81.
[299] Satnews, "COM DEV Successfully Delves into AIS with Nanosat," April 28, 2009, http://www.satnews.com/cgi-bin/story.cgi?number=766090690.
[300] exactEarth, "exactEarth further Expands its Fleet of AIS Satellites," November 26, 2013, http://www.exactearth.com/news/2013-11-26/.

system is capable of downlinking information from the satellites at least once an orbit. They are currently looking to expand ground stations to the southern hemisphere to increase the downlink rate to twice an orbit, with the time between collection and downlink averaging 10-15 minutes.[301]

Once the information is received by the ground stations, it is sent to the data processing centre located in Toronto. The processor receives the data and extracts the messages within minutes. It also creates a back-up of the data, which is held for ten years. The facility itself has extremely high security measures, including biometric controlled entry, security walls and full-time guards.[302] The information is sent to customers once the processing centre has made sense of the information. The data is encrypted throughout the entire process, reflecting the sensitivity of the data. In order to receive the information an organization has to meet the IMO's criteria of a "competent maritime authority." If those criteria have been met, they may then receive data on all Class-A vessels within 1,000 nautical miles of the country's coastline, all vessels carrying that country's flag and all vessels who have listed their destination as ports in that country.[303]

There is evidence of a very deep relationship between COM DEV/exactEarth and the Canadian government. exactEarth does not list who their customers are, only saying that they deliver services to twenty-seven countries.[304] However, during the third meeting between the DIASRS team and the SRB on March 27, 2012, it was revealed that Canada has a "standing offer

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[301] exactEarth, "Earth Stations," accessed March 6, 2014, http://www.exactearth.com/technology/exactview/earth-stations/.
[302] exactEarth, "Data Processing Centre," accessed March 6, 2014, http://www.exactearth.com/technology/exactview/data-processing-centre/.
[303] exactEarth, "COM DEV establishes subsidiary exactEarth to offer Space-based AIS services beginning in 2010," June 9, 2010, http://www.exactearth.com/news/com-dev-establishes-subsidiary-exactearth-to-offer-space-based-ais-services-beginning-in-2010/.
[304] exactEarth, "Global Sales," accessed April 17, 2014, http://exactearth.com/company-info/Sales/.

to exactEarth $5M annual global SB-AIS [sic].”[305] It was also revealed at the time that there was a request for proposals (RFP) put out to seek a “replacement vehicle to continue SB-AIS $5M [sic].”[306] However, the chances of another company being able to provide that contract are almost nil, especially given the advantages provided to COM DEV by the CSA and DND. Their AIS had already been used in combination with RADARSAT data during RIMPAC 2012, the counter-piracy operations in the Horn of Africa, and during Mediterranean operations by the RCN (presumably the Libya operation).[307] The high level of cooperation does not cease with M3MSat, as it appears that the AIS portion of the RCM will be integrated in exactEarth’s constellation as well.

Although it has not been officially announced, considering that COM DEV is building the AIS components on the RCM, it is highly expected that they will be integrated into the exactEarth constellation.[308] There are several precedents in addition to M3MSat that lend credibility to this belief. On April 20, 2011 the Indian Space Organization’s ResourceSat-2 was launched, which included an AIS payload designed by COM DEV. The AIS system was then integrated into the exactEarth system.[309] The likelihood of DND developing a ground segment similar to that of exactEarth is extremely unlikely given the costs and resources required for such a task. It seems that the government will continue to rely on exactEarth for AIS date for the

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[305] Defence Research and Development Canada, “Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) – 15EU TDP – SRB #3.”
[306] Ibid.
[307] Ibid.
[308] John Ivison, “Stephen Harper steps in to save Radarsat upgrade after budget cutbacks threatened satellite program’s future,” *National Post*, December 19, 2012; Peter B. de Selding, “Canada’s ExactEarth Doubles Annual Revenue, Touts Nearly 100 Million Daily Ship ID Messages,” *SpaceNews*, December 13, 2012.
[309] exactEarth, “exactEarth announces successful launch of satellite,” April 20, 2011, http://www.exactearth.com/news-folder-2/exactearth-announces-successful-launch-of-satellite/.

foreseeable future. While giving them access to publicly funded satellites, likely in exchange for data services, is not a negative thing in or itself, there are several issues with the relationship.

While the close relationship between DND and some of the major space contractors in the country is a positive thing, the relationship has become inappropriate. During the meeting discussing the options available to move forward with AIS it was MDA and COM DEV employees that dominated the agenda. These companies have a vested interest in increasing their profit, so when it came to selecting between the "Cadillac" and "Volkswagen" options, the obvious choice for the companies was both. Further, the close relationship with DND, CSA and the private companies is evidence that AIS, at least, is a primarily defence-oriented technology. Despite the claim that it will be a benefit to and used by OGDs, there is no evidence that any of them were consulted on any of the matters. Perhaps they could have aided DND with the funding shortfall with regards to the DIASRS TDP, but that would mean they would have a say in development and expect access when the RCM was launched.

Another major issue in regards to the choice to go with both the M3MSat and AIS on the RCM comes down to simply math. As quoted above, the total cost for integrating the AIS on the RCM was about $58 million. With that cost in mind, DND could have built seven M3MSats and had a much higher level of capability with regards to AIS. However, it is unlikely DND saw it that way. For them, the RCM is a vehicle through which they are getting funding from the government. They are taking advantage of every opportunity to increase their capability and if that means saying the technology will enhance sovereignty, so be it. While many have argued that S-AIS is a solution to uncooperative vessels, it is not a comprehensive answer. Any vessel that does not wish to be tracked on the system can simply turn it off, rendering them invisible to the receivers, a fact known but not widely acknowledged by DND. In this situation, the military

would be relying on RADARSAT visual imagery to identify non-compliant vessels. Ultimately, while AIS and the RCM could have very positive influences on sovereignty in the Canadian Arctic, the evidence indicates they are security-first projects. DND has been involved far more heavily than any department aside from the CSA and all access for OGDs to the information will be done through the DND-controlled Polar Epsilon. For example, Transport Canada is tasked with enforcing the shipping rules in the Arctic Canada Traffic Zone (NORDREG), which requires vessels entering Canadian Arctic waters to report to the department to ensure they meet all the standards and regulations required by Canada.[310] According to the documents, however, they have had no input into the AIS being placed on the RCM and there have been no plans made to integrate it into the reporting system. The military will control all information from the AIS system and will be expected to share it with relevant partners. The point here is that there is no need for the military to be the lead department on this project if it were as much about sovereignty as the government claims. There are more relevant departments that have existing infrastructure that could be greatly aided by the inclusion of AIS and the RCM. It is further evidence that the sovereignty argument has been used in order to sell expensive military projects to the Canadian public.

[310] Transport Canada, "User Assistance Package for the Implementation of Canada's Arctic Ice Regime Shipping System (AIRSS)," May 1998: 24-28. http://www.tc.gc.ca/media/documents/marinesafety/tp12819e.pdf.

CHAPTER 6 – CONCLUDING THOUGHTS

Looking Backwards

This thesis has presented how the interplay between sovereignty and security has played out in the Canadian Arctic with regards to surveillance technologies. It has made it apparent that the Government of Canada under Stephen Harper prefers to answer sovereignty challenges with hard security. They apparently see little utility in allowing the traditional enforcers of sovereignty, the Coast Guard and RCMP, to take the lead on these projects. Despite the rhetoric, the only sovereignty challenge that the Canadian Arctic will face moving forward will be the status of the Northwest Passage and all of the technologies covered in this paper are primarily aimed at the maritime domain. If these waters are internal, as the government claims, is using the military the best approach? It could be argued that this stance undermines the overall argument. Internal waters should be subject to normal domestic rules and regulations enforced by *domestic* agencies. Doing so would exhibit traits of normal domestic sovereignty, making it difficult for others to enforce their will given the rights of a state under legal sovereignty and the Westphalian system. If the government continues to treat the Arctic as an exceptional circumstance, requiring the military to play a domestic role that has historically been done by other departments, then so too will those who disagree with Canada as to the status of the Northwest Passage.

Arctic sovereignty is not a new issue and in fact extends all the way back to Canada's inheritance of the region from Britain in 1880. Pressure on the region began with the Yukon Gold Rush and has been rarely absent since. It has led to an obsession with the past in order to establish historic utilization and state presence, one of the factors considered in weighing a claim of sovereignty. This is the reason the government has undertaken a search for the doomed

Franklin Expedition for the last several years.[311] By providing evidence that the British government had a state presence in the region, in particular the Northwest Passage, they can claim a history of state representation dating back to 1845. While it does provide a small piece of legal evidence for the sovereignty debate, the claim is relatively minor when compared to other arguments that the government could make. Firstly, they are to date almost completely ignoring the role the Inuit could play in making the argument for historical title. The Inuit have lived in the region for millennia, utilizing the routes of the Northwest Passage and establishing a presence throughout the North. Their history will be a strong card to play for the government moving forward, but there is still a need to engage them in the process.[312] While the Inuit were never recognized as having sovereignty prior to European contact, they have been de-facto citizens since establishing agreements with the Canadian government. Their activities, therefore, represent control being exercised by the state through its citizens and their historical claim is inherited by Canada. It is an avenue that is not exploited because the current government does not see it in the same context. It is further evidence that they are fixated on their narrow view of sovereignty, preferring to see it through the lens of military challenges and military answers.

The research activities that occurred in the Arctic during the Cold War are evidence that Canada had a continuous military presence in the region beyond that of the DEW Line sites. However, the information on those activities remains classified in Canada, with all information on the subject in this thesis being sourced from American archives. Perhaps Canada fears that revealing this history would undermine the Canadian position on the Arctic, given that the

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[311] Janet Davison, "Search for lost Franklin ships launched in Canada's Arctic," CBC News, August 23, 2012, http://www.cbc.ca/news/canada/search-for-lost-franklin-ships-launched-in-canada-s-arctic-1.1282454.
[312] Franklyn Griffiths, "Canadian Arctic Sovereignty: Time to Take Yes for an Answer on the Northwest Passage," in *Northern Exposure: Peoples, Powers and Prospects in Canada's North*, Frances Abele, Thomas Courchene, Leslie Seidle and France St-Hilaire eds., (Montreal: The Institute for Research on Public Policy, 2009) 131-134.

Americans were so intimately involved. There is also the possibility that those forming the policy and government position on sovereignty are entirely unaware of the history, given its classification and need-to-know status. However, the government has little to fear from making the history of acoustic sensor research in the North known to the general public. This thesis has shown that all of the research that was conducted with the Americans was at the invitation of the DRB. Further, Lajeunesse has concluded that the vast majority of submarine voyages conducted by the Americans within Canadian territory were undertaken at the request of their Canadian counterparts.[313] This activity would not undermine the Canadian position given the available evidence and would only serve to strengthen it.

The Canadian research was aimed at ensuring the Soviets and other unfriendly nations were not accessing the Arctic Archipelago without Canadian knowledge. In this case, the solution to answer a sovereignty challenge with the military was the correct course of action, given that the Soviets were making no claims as to the status of the Northwest Passage and other waterways. The submarines provided a military threat to Canadian territory and it was met with military resources. The intentions of the Soviet submarines were well known and represented a direct threat to the integrity of Canadian sovereignty.

The Modern Era

The NWTDP is a direct continuation of the previous Cold War research. Just as in the 1960s and 70s, DRDC is leveraging relationships with allies to develop a surveillance system for the North. These allies, however, disagree with Canada as to the status of the internal waters in the Arctic Archipelago. Granting them direct access to the technologies that may one day form

[313] Lajeunesse, "A very practical requirement," 12-15.

an Arctic surveillance system is evidence that the project is not directly concerned with sovereignty. This is further underscored by the trimming of the surface components of the project in order to get the underwater system functioning. The NWTDP is now focused on the detection of submarines, which, as stated, do not count as a transit of an international strait when submerged. The only function such a system would serve would be a military one, with the implications for sovereignty being a secondary concern. As stated, submarine voyages cannot be used as precedents for voyages through an international strait and therefore would have no impact on the status of the Northwest Passage. By focusing the project on the subsurface, the impact on sovereignty is limited, while there remains a direct benefit to the military.

Further evidence for this position can be seen in the level of cooperation between the departments that would potentially benefit from the NWTDP. Despite the repetitive mantra of the "whole of government approach" over the last several years, there is little evidence of this being practically implemented. Potentially important stakeholders such as the RCMP and the CBSA were not involved in the project at all. They made no contributions to defining the requirements and were not consulted on the progress. The CCG did have a role to play in the field testing, but they were only brought in when DRDC required their resources. Ultimately, DRDC is demonstrating the capabilities and potential use of a system that is designed with requirements laid out by DND. Without consulting other partners there is a large possibility that the system will not meet the needs of the other departments that the NWTDP claims it will benefit. Once again, this project is security under the guise of sovereignty, with no direct benefits outside of the military sphere.

The RADARSAT-1 and 2 projects are not as cut and dry with regards to the benefits for sovereignty. It cannot be denied that the imaging capabilities have been a boon for Arctic ISR

and have been a positive contribution to Arctic sovereignty. There are some aspects, however, which limit this impact and may actually serve to harm Canada's sovereignty claims. As shown, there is the potential that data sales from RADARSAT-2 could be used to undermine Canadian sovereignty claims. While this scenario cannot be confirmed, the possibility is extremely worrisome. At the very least, countries could purchase data from the Canadian satellite in order to enhance their own claims of sovereignty and aid in surveillance. This problem has arisen as a direct result of allowing the private/public relationship to shape how RADARSAT-2 is used, putting the profit of MDA ahead of security and sovereignty concerns. It is highly likely that the desire to avoid such a scenario in the future is the reason that the RCM has always been planned to be exclusively operated by the Government of Canada, despite rising costs.

Project Polar Epsilon has and will allow the government to exploit the RADARSAT satellites to the fullest extent possible. It has been a major investment by DND and will give the department a suite of tools that will provide support to Canadian sovereignty claims. Despite this, however, the project remains solely under the supervision of DND with support from the CSA. Despite claims that the project will benefit all numerous government departments, there is no evidence in the documents accessed for this thesis that they have been consulted during the development. The claim that PE will benefit a host of domestic departments and agencies raises the question as to why it is run by DND. The answer seems to be that the pieces about domestic benefits and sovereignty are thrown in as lip service to make the project more appealing. PE is a military project with direct military applicability, with an emphasis on supporting the CAF on deployments around the globe. It is likely that there will be some benefits to other departments through the relationships in the MSOCs, but the information shared in that environment is subject to classification. There is nothing compelling DND to share information gathered

through PE and they will do so only if they feel it is relevant. Thus, PE is another example of a project that has used the domestic sovereignty angle in order to sell an expensive military procurement to the Canadian public.

Much like the previous iterations of RADARSAT, it is plainly clear that the RCM will strengthen Canadian sovereignty claims by greatly improving Arctic ISR. However, the numerous issues raised in this paper will limit its effectiveness. The plans to share the data with partners and tie the system into various American programs will once again grant a country that disagrees with Canada`s sovereignty claims access to the very surveillance system that is meant to aid in the enforcement those claims. The potential does then exist for the Americans to use their knowledge of the systems to circumvent them should they chose to contest the status of the Northwest Passage. Again, this makes it clear that security, and in this case it is collective security, is a greater priority than sovereignty claims. The relationship between DND and the CSA is further evidence of this position. There was constant consultation between the departments, something that the other named beneficiaries did not have. The satellites were designed with direct input from DND and meant to suit their requirements. When DND finally made the decision that AIS was a critical component for them, the entire RCM was redesigned and put behind schedule to incorporate the equipment. There were alternatives to the chosen path, particularly the option presented by M3MSat, but DND saw an opportunity to increase its ISR capabilities. Once again, the project was touted as being of major benefit to Canadian sovereignty, but a large number of departments and agencies tasked with enforcing that sovereignty were not major stakeholders in laying out the requirements for the design. Instead, the design was made to suit military requirements with indirect benefits for sovereignty.

A Means to an End

Over the last decade sovereignty has become a buzz word that has been used liberally by the Government of Canada, in particular the Harper Conservatives. The appeal of the North resonated with voters and gave the government traction to act on an issue that, as evidenced in the introductory chapter, has been punted by successive governments throughout Canadian history. The government was able to use the apparent crisis of sovereignty to fund procurement and research projects that otherwise we not be saleable to the Canadian public. In this manner, sovereignty is a means to an end and that end is military security. While the Harper Government may genuinely feel that the military is the correct avenue through which to ensure sovereignty claims, they are undoubtedly aware of the opportunity that the sovereignty issue presents. Evidence of this position can be seen in the various projects that have seen sustained funding in recent years. In addition to the RCM and NWTDP, the commitment to find new fighters for the RCAF has continued to move forward. The government has also shown its priorities in the National Shipbuilding Strategy, in which the AOPS and the Joint Support Ships (JSS) have been given priority in the build order, leaving the completion of a new Polar-class icebreaker for the Coast Guard in doubt.[314] While these projects will certainly serve to strengthen Canada's hold on sovereignty in the Arctic, the military is not and cannot be required to conduct operations where they detain foreign nationals and enforce Canadian laws. The CCG, RCMP, and CBSA should be the primary beneficiaries of the current situation. Instead, Canadians are unknowingly sanctioning a military buildup in the Canadian Arctic under the misguided belief that it will provide a solution to the perceived sovereignty crisis.

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[314] Public Works and Government Services Canada, "Backgrounder on the National Shipbuilding Procurement Strategy (NSPS)."

REFERENCES

Acoustic Data Analysis Centre (Atlantic). "Statement of Operating Intent (SOI) for Generic Acoustic Analysis and Training System (GAATS)." March 3, 2009.

Agnew, Elle, Scott Jones, and Ashlyn Milligan. "Briefing Note: National Defence and Space." December 6, 2011.

Ahmed, Nafeez. "Ice-free Arctic in two years heralds methane catastrophe – scientist." *The Guardian*, July 24, 2013. http://www.theguardian.com/environment/earth-insight/2013/jul/24/arctic-ice-free-methane-economy-catastrophe.

Anderson, Alun. *After the Ice: Life, Death, and Geopolitics in the New Arctic* (New York: Harper-Collins, 2009), 112.

Avis, Peter. "Canadian Maritime Domestic Security – An Assessment in Late 2007, Two Years Prior to the 2010 Vancouver Olympics." In *Canadian Military Journal*, Vol. 8, No. 4 (Winter 2007-2008). Last modified July 14, 2008. http://www.journal.forces.gc.ca/vo8/no4/notice-avis-eng.asp.

Baffinland. "Mary River Project Addendum to Final Environmental Impact Statement: Appendix 10D-10 Shipping and Marine Wildlife Management Plan", June 2013. http://ftp.nirb.ca/03-MONITORING/08MN053-MARY%20RIVER%20IRON%20MINE/01-PROJECT%20CERTIFICATE/04-AMENDMENTS/ERP/03-ADDENDUM/Volume%2010/130620-08MN053-App%2010D-10-Shipping%20Marine%20Wildlife%20Management-IT8E.pdf.

Baffinland Iron Mines Corporation. "The Mary River Project." Accessed July 7, 2014. http://www.baffinland.com/mary-river-project/?lang=en.

Banks, R.E. "Attention Mr. L.A.C.O. Hunt." July 24, 1970.

Banks, R.E. "Letter to Mr. M. Shenstone." July 17, 1970.

Banks, R.E. "Status Report on Polar Bear II." October 16, 1972.

Banks, R.E. "USN Program Polar Bear." February 1, 1972.

Beare, S.A. "Project Management Approach – Automatic Identification System (AIS) on Radarsat Constellation Mission (RCM)." March 19, 2010.

Beauregard-Tellier, Frédéric. "The Arctic: Hydrocarbon Resources." *Parliament of Canada*, October 24, 2008. http://www.parl.gc.ca/Content/LOP/researchpublications/prb0807-e.htm#.

Bridgeman, A. Graham. "Arctic Use of Sonobuoy Systems." August 18, 1969.

Bridgeman, A. Graham. “Minute Sheet.” April 9, 1969.

Butler, P.J. “Project Polar Epsilon: Joint Space-Based Wide Area Surveillance and Support Capability.” In *International Society for Photogrammetry and Remote Sensing.* Accessed December 4, 2011. http://www.isprs.org/publications/related/ISRSE/html/papers/1000.pdf.

Byers, Michael. *Who Owns the Arctic?* Vancouver: Douglas & McIntyre, 2009.

Canadian Armed Forces. “Sapphire satellite system is declared fully operational.” Last modified April 22, 2014. http://www.forces.gc.ca/en/news/article.page?doc=sapphire-satellite-system-is-declared-fully-operational/hr1thk2x.

Canadian Coast Guard. “The CCGS John G. Diefenbaker National Icebreaker Project.” Last modified July 15, 2013. http://www.ccg-gcc.gc.ca/e0010762.

Canadian Coast Guard. “Marine Communications and Traffic Services.” Last modified July 10, 2013. http://www.ccg-gcc.gc.ca/eng/CCG/MCTS_Major_Projects.

Canadian Forces Canada Command. “Canada Command Backgrounder: The Canadian Forces in the North.” Last modified April 9, 2012. http://www.emeraldsiberians.com/nr-sp/bg-do/12.003-north-nord-eng.asp.

Canada Newswire. “COM DEV Begins Work on RADARSAT Constellation Mission Design Phase.” April 6, 2010. http://www.newswire.ca/en/story/661411/com-dev-begins-work-on-radarsat-constellation-mission-design-phase.

The Canadian Press. “Arctic icebreaker delayed as Tories prioritize supply ships.” October 11, 2013. http://www.cbc.ca/news/politics/arctic-icebreaker-delayed-as-tories-prioritize-supply-ships-1.1991522.

The Canadian Press. “Com Dev wins micro-satellite contract.” June 23, 2008. http://www.cbc.ca/news/technology/com-dev-wins-micro-satellite-contract-1.696098.

The Canadian Press. “Test airships for remote communities, MPs say.” February 17, 2013. http://www.cbc.ca/news/canada/north/test-airships-for-remote-communities-mps-say-1.1376853.

Canadian Space Agency. “2011-2012 Report on Plans and Priorities – Annex 4: Status Report on Transformational and Major Crown Projects.” Last modified June 9, 2011. http://www.asc-csa.gc.ca/eng/publications/rpp-2011-annexes.asp.

Canadian Space Agency. “2012-2013 Estimates on Plans and Priorities – Section 2: Analysis of Program Activities by Strategic Outcome.”

Canadian Space Agency. “Canadian Space Agency 2012–13 Departmental Performance Report.” http://www.asc-csa.gc.ca/pdf/eng/publications/pr-2013-annexes.pdf.

Canadian Space Agency. “Canadian Space Agency 2014-15 Report on Plans and Priorities: Annexes.” http://www.asc-csa.gc.ca/pdf/eng/publications/rpp-2014-annexes-eng.pdf.

Canadian Space Agency. “RADARSAT-1: Components and Specifications.” Last modified April 30, 2013. http://www.asc-csa.gc.ca/eng/satellites/radarsat1/components.asp.

Canadian Space Agency. “RADARSAT-1: Seventeen Years of Technological Success.” May 9, 2013. http://www.asc-csa.gc.ca/eng/media/news_releases/2013/0509.asp.

Canadian Space Agency. “RADARSAT-2: Applications.” Last modified November 28, 2007. http://www.asc-csa.gc.ca/eng/satellites/radarsat2/applications.asp.

Canadian Space Agency. “RADARSAT-2: Built for Performance and Versatility.” Last modified November 29, 2007. http://www.asc-csa.gc.ca/eng/satellites/radarsat2/inf_tech.asp.

Canadian Space Agency. “RADARSAT: Components and Specifications.” Last modified February 28, 2011. http://www.asc-csa.gc.ca/eng/satellites/radarsat/components.asp.

Canadian Space Agency. “RADARSAT: Project Status.” Last modified January 9, 2013. http://www.asc-csa.gc.ca/eng/satellites/radarsat/status.asp.

CBC News. “Arctic surveillance research moves ahead.” November 3, 2009, http://www.cbc.ca/news/canada/north/story/2009/11/02/northern-watch.html.

CBC News. “Govt. confirms decision to block sale of MDA space division.” May 9, 2008. http://www.cbc.ca/news/business/story/2008/05/09/alliant-sale.html.

CBC News. “High Arctic surveillance study hampered by strong winds.” August 8. 2008. http://www.cbc.ca/news/canada/north/story/2008/08/08/northern-watch.html.

CBC News. “Military Scientists Prepare for Arctic Surveillance Study.” May 8, 2008, http://www.cbc.ca/news/technology/story/2008/05/08/arctic-test.html.

CBC News. “Northwest Passage surveillance study halted.” July 24, 2009. http://www.cbc.ca/news/canada/north/story/2009/07/23/nortern-watch-hiatus.html.

CBC News. “Tories plan to bolster Arctic defence.” December 22, 2005. http://www.cbc.ca/news/story/2005/12/22/elxn-harper-dfens.html.

Coates, Ken, Whitney Lackenbauer, William Morrison and Greg Poelzer. *Arctic Front: Defending Canada in the Far North*. Toronto: Thomas Allen Publishers, 2008.

COM DEV International. “M3M Satellite Launch to be Rescheduled.” April 24, 2014. http://www.comdev.ca/images/finance/CDV_-_M3M_-_April_24_2014_v2.pdf.

Committee on Fisheries and Oceans. “Controlling Canada’s Arctic Waters: Role of the Canadian Coast Guard,” December 2009. http://www.parl.gc.ca/content/sen/committee/402/fish/rep/rep07dec09-e.pdf.

Craig, John. “Re: Land Use Permit #N2008N0027.” Email to Defence R & D July 15, 2010.

Dao, Roger. “RE: NW TD – CORE SRB RESULT.” November 20, 2008.

Davison, Janet. “Search for lost Franklin ships launched in Canada's Arctic.” *CBC News*. August 23, 2012. http://www.cbc.ca/news/canada/search-for-lost-franklin-ships-launched-in-canada-s-arctic-1.1282454.

Defence Research and Development Canada. “Autonomous Underwater Surveillance Systems for Coastal Waters.” Last modified August 18, 2011.

Defence Research and Development Canada. “Diver Signature Integrated Measurement System (DSIMS).” Last modified August 18, 2011.

Defence Research and Development Canada. “Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) – 15EU TDP – SRB #2.” March 24, 2011 presentation.

Defence Research and Development Canada. “Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) – 15EU TDP – SRB #3.” March 27, 2012 presentation.

Defence Research and Development Canada. “Northern Watch Technology Demonstration Project: Objectives Approved at Annual SRB.” March 9, 2010.

Defence Research and Development Canada. “Northern Watch Technology Demonstration Project, Project Scope Version 1.0: Annex A.” October 25, 2010.

Defence Research and Development Canada. “Northern Watch TD Military Fit.”

Defence Research and Development Canada. “Northern Watch TD Objectives (Approved Apr 2007).”

Defence Research and Development Canada. “Northern Watch TDP Exploitation Strategy.” September 30, 2010

Defence Research and Development Canada. *Northern Watch TDP Information Bulletin*. Edition 2, June 2010.

Defence Research and Development Canada. “SRB #3: Minutes of 15EJ Northern Watch TDP SRB Meeting, 9 March 2010.” Issued July 23, 2010.

Department of Fisheries and Oceans. “Canadian Coast Guard, Canadian Coast Guard: Maritime Security Contributions.” 2011.

Department of National Defence. *Canada First Defence Strategy*, 2008.

De Selding, Peter B. “Canada’s ExactEarth Doubles Annual Revenue, Touts Nearly 100 Million Daily Ship ID Messages.” *SpaceNews*. December 13, 2012.

De Selding, Peter. “Canadian Earth-Watching Satellite Finally Reaches Orbit.” *Space.com*, December 14, 2007. http://www.space.com/4706-canadian-earth-watching-satellite-finally-reaches-orbit.html.

Driggers, Ronald G., Paul Cox, and Timothy Edwards. *Introduction to Infrared and Electro-Optical Systems*. Norwood: Artech House, Inc., 1999.

Emmerson, Charles. *The Future History of the Arctic.* New York: Public Affairs, 2010.

exactEarth. “COM DEV establishes subsidiary exactEarth to offer Space-based AIS services beginning in 2010.” June 9, 2010. http://www.exactearth.com/news/com-dev-establishes-subsidiary-exactearth-to-offer-space-based-ais-services-beginning-in-2010/.

exactEarth. “Data Processing Centre.” Accessed March 6, 2014. http://www.exactearth.com/technology/exactview/data-processing-centre/.

exactEarth. “Earth Stations.” Accessed March 6, 2014. http://www.exactearth.com/technology/exactview/earth-stations/.

exactEarth. “exactEarth announces successful launch of satellite.” April 20, 2011. http://www.exactearth.com/news-folder-2/exactearth-announces-successful-launch-of-satellite/.

exactEarth. “exactEarth further Expands its Fleet of AIS Satellites.” November 26, 2013. http://www.exactearth.com/news/2013-11-26/.

exactEarth. “Global Sales.” Accessed April 17, 2014. http://exactearth.com/company-info/Sales/.

Fergusson, James. “Thinking Big: Canada’s RADARSAT Constellation.” *Space Quarterly*, September 1, 2011.

Flett, Dean. “RADARSAT-1 Update & RADARSAT Constellation Mission Overview.” Presentation at IICWD-XI, Washington, D.C., October 18-22, 2010.

Forand, Jean Luc and Vincent Larochelle. “EO Sensors.” May 19, 2009.

Forand, Jean Luc et al.. “Surveillance of Canada’s High Arctic.” Presentation at ArcticNet 2007, Laval, Quebec, December 13, 2007. Available at: http://www.arcticnet.ulaval.ca/pdf/talks2007/Forand.pdf.

Fortin, Steve. “A new step for the Polar Epsilon project.” In *The Maple Leaf*, vol.13, no.24 (July 21, 2010): 16.

Girard, Ralph. “Update on DND’s Requirements for RFS.” October 26, 2004.

Government of Canada. *Remote Sensing Space Systems Act: S.C. 2005, c. 45*. Ottawa: Minister of Justice, 2005. Last amended April 5, 2007. http://laws-lois.justice.gc.ca/PDF/R-5.4.pdf.

Grant, Shelagh. *Polar Imperative: A History of Arctic Sovereignty in North America*. Vancouver: Douglas & McIntyre, 2010.

Griffiths, Franklyn. “Canadian Arctic Sovereignty: Time to Take Yes for an Answer on the Northwest Passage.” In *Northern Exposure: Peoples, Powers and Prospects in Canada’s North*. Edited by Frances Abele, Thomas Courchene, Leslie Seidle and France St-Hilaire. Montreal: The Institute for Research on Public Policy, 2009: 107-140.

Ganton, J.H. “Sonobuoys for Artic Use.” March 11, 1970.

Gill, Jagvijay P.S. and John J. Yackel. “Evaluation of C-band SAR polarimetric parameters for discrimination of first-year sea ice types.” *Canadian Journal of Remote Sensing*, Vol. 38, No. 3: 101-117.

Greenblatt, J.H. “Acoustics Measurements in Hudson Bay with U.S. Underwater Sound Lab (USN/USL).” July 24, 1969.

Grychowski, Bruce. “DRDC Atlantic 2010 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut.” Sent to the Nunavut Impact Review Board April 2011.

Grychowski, Bruce. “Gascoyne Inlet Camp Activity Plan 2007-2014.” June 18, 2010.

Grychowski, Bruce. “Northern Watch Plan Proposal August 2009.” August 4, 2009,

Grychowski, Bruce. “Northern Watch TDP Objectives and Way Ahead Meeting.” October 27, 2009.

Grychowski, Bruce. “Northern Watch TDP Standard Progress Meeting,” December 1, 2010.

Grychowski, Bruce. “Northern Watch Technology Demonstration Project.” Presented to DGSTO, October 27, 2009.

Grychowski, Bruce. “Northern Watch Technology Demonstration Project.” Slideshow provided to Robert Bellizzie, June 10, 2010.

Grychowski, Bruce. “Northern Watch Technology Demonstration Project: Expectations, Concepts and Objectives.” October 26, 2009.

Grychowski, Bruce. “Record of Discussion Northern Watch TDP Planning Metting Held 23-25 November 2009 at DRDC Ottawa.” January 12, 2010.

Grychowski, Bruce and Dan Brookes. “Northern Watch Sensor Qualification Outcome.” April 30, 2010.

Heard, Garry. “Informal Email updates on our progress.” August 2, 2012.

Heard, Garry. “UWSS Status Report.” June 14, 2010.

Heard, Garry J., et al. “Project Completion Report: ARP 11cn – Underwater Data Networks and Sensors for Autonomous ISR Systems, DRDC Atlantic Technical Report.” October 31, 2008.

Honderich, John. *Arctic Imperative: Is Canada Losing the North?* Toronto: University of Toronto Press, 1987.

Hopper, Tristin. “Federal agency boss took $1.5M in kickbacks from SNC-Lavalin contract to restore Montreal bridge, report alleges.” National Post, February 13, 2014. http://news.nationalpost.com/2014/02/13/federal-agency-boss-took-1-5m-in-kickbacks-from-snc-lavalin-contract-to-restore-montreal-bridge-report/.

Howard, Roger. *The Arctic Gold Rush: The New Race for Tomorrow’s Natural Resources*. London: Continuum, 2013.

Huebert, Rob. “Canada and Commercial Satellite Imagery: Technology in Search of a Foreign Policy.” In *Commercial Satellite Imagery and United Nations Peacekeeping: A View From Above*. Edited by James F. Keeley and Rob Huebert. Aldershot: Ashgate, 2004: 193-206.

Iverson, C.R. “DREP Project Review Group Submission 79 (Revised Version).” August 25, 1969.

Ivison, John. “Stephen Harper steps in to save Radarsat upgrade after budget cutbacks threatened satellite program’s future.” *National Post*. December 19, 2012.

Kennedy, Jim. “Northern Watch Project Management.” June 9, 2009.

Kollenberg, Klaus and Rick Williams. “Record of Discussion for the Northern Watch Technology Demonstration Project Status Report Meeting Held at 1430, 13 Nov 2008 in the ADM(S&T) VTC Conference Room, Constitution Building 8th Floor.” November 28, 2008.

Lajeunesse, Adam. "A very practical requirement: underice operations in the Canadian Arctic, 1960–1986." *Cold War History* (2012): 507-524.

Lajeunesse, Adam. "Sovereignty, Security and the Canadian Nuclear Submarine Program." *Canadian Military Journal,* Vol. 8, No. 4 (Winter 2007-2008): 74-82.

Ling, Justin. "Canadian Forces spent virtually all of 2013 watching Idle No More protesters." *National Post*, June 1, 2014. http://news.nationalpost.com/2014/06/01/canadian-forces-spent-virtually-all-of-2013-watching-idle-no-more-protesters/.

Maddison, Paul. "After Action Report." September 9, 2008.

Maloney, Sean M. "Force Structure or Forced Structure? The 1994 White Paper on Defence and the Canadian Forces in the 1990s." In *Geopolitical Integrity*. Edited by Hugh Segal. Montreal: The Institute for Research on Public Policy, 2005.

Mar, J. "MARCOM Support – Polar Bear II." October 12, 1972.

Marketwire. "Government of Canada Announces Location of Reception Ground Stations for Polar Epsilon." March 30, 2009. http://www.marketwire.com/press-release/government-canada-announces-location-satellite-reception-ground-stations-polar-epsilon-967526.htm.

Maslowski, Wieslaw, Jacln Clement Kinney, Matthew Higgins and Andrew Roberts. "The Future of Arctic Sea Ice." *Annual Review of Earth and Planetary Sciences*, 2012 (Vol. 40): 625-654.

McCord, J.E.D. "Arctic Research Project." May 26, 1969.

McCoy, Nelson. "DRDC Atlantic 2008 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut." Sent to the Nunavut Impact Review Board March 26, 2009.

McCoy, Nelson. "DRDC Atlantic 2009 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut." Sent to the Nunavut Impact Review Board April 15, 2010.

McGrath, Meagan and John Mackinnon. "AFEC-A4 Northern Surveillance Phase One: 6 October 2008 – April 20 2009 Wrap Up." Department of National Defence, May 2009.

MDA Corporation. "RADARSAT-2 FAQ: Data Policy." Accessed March 5, 2014. http://gs.mdacorporation.com/SatelliteData/Radarsat2/DataPolicy.aspx.

MDA Corporation. "RADARSAT-2: General Terms of Use." Last modified August 29, 2008. http://gs.mdacorporation.com/products/sensor/GTU.pdf.

MDA Corporation. “RADARSAT-2: Government User RADARSAT-2 End User Licence Agreement.” Last modified June 15, 2011. http://gs.mdacorporation.com/products/sensor/radarsat2/RS2_Gov_User_License_agreement.pdf .

MDA Corporation. “RADARSAT-2: Ordering Data.” Accessed March 5, 2014. http://gs.mdacorporation.com/SatelliteData/Radarsat2/OrderingData.aspx.

MDA Corporation. “RADARSAT-2: Programming Services.” Accessed March 5, 2014. http://gs.mdacorporation.com/SatelliteData/Radarsat2/ProgrammingServices.aspx.

MDA Corporation. “RADARSAT Constellation Mission contract update.” March 17, 2010. http://sm.mdacorporation.com/news/pr17032010_en.html.

MDA Corporation. “RADARSAT Constellation Mission design extended.” May 19, 2011. http://www.mdafederal.com/press/radarsat-constellation-mission-design-extended/.

Milne, A.R. “A Small Research Submarine in the Arctic.” *Arctic*, v. 22, no. 1, Mar. 1969: 69-70.

Milne, A.R. “Arctic Research.” May 29, 1969.

Milne, A.R. “Argus Flights for Sono-Drift-Buoy Interrogations in Western Perry Channel Spring and Summer 1970.” November 27, 1969.

Milne, A.R. “Argus Flights for Sono-Drift-Buoy Interrogations in Western Parry Channel Spring and Summer 1970.” February 24, 1970.

Milne, A.R. “DREP Summer Arctic Operation: Icepack 8/68.” March 8, 1968.

Milne, A.R. “Noise Under Sea-Ice – A Year Round Vigil.” 1967.

Milne, A.R. “Request for Arctic CF Air Support.” November 5, 1969.

Minister of Public Works and Government Services Canada. *Canada’s Northern Strategy Our North, Our Heritage, Our Future*, 2009.

Monteith, Joseph. “Re: Land Use Permit #N2008N0027.” Email to Defence R & D June 22, 2010.

Morrison, W.R. “The North-West Mounted Police and the Klondike Gold Rush.” *Journal of Contemporary History*, Vol. 9, No. 2 (Apr. 1974): 93-105.

Mugridge, David. “COM DEV and exactEarth Deliver a New Maritime Surveillance Capability.” *Canadian Defence Review*, Vol.16 No.2 (April 2010): 79-82.

Mugridge, David and Peter Race. “Arctic Planning Scenarios: Scenario #2 – Safety and Security Scenario, Centre for Operational Research & Analysis.” July 2011, 3.

No Author. “Arctic Acoustics and Sonobuoy Research.” June 23, 1969.

No Author. “Confidential note form CANDEFRES Washington to DEFRES Ottawa.” March 1972.

No Author. “Design of an Integrated AIS on a Radar Satellite (DIASRS) Technology Demonstration Project (TDP) Update.” May 27, 2011.

No Author. “Interview Assessment Report – Probable Submarine Sighting in Vicinity of Grise Fjord, NU.” October 28, 2009.

No Author. “Memo from Commander of U.S. Naval Ordinance Laboratory, White Oak to A.R. Milne.” February 21, 1968.

No Author. “Minutes of the Ninth Meeting of the CSA-DND Management Board.” October 6, 2010.

No Author. “Minutes of the Seventh Meeting of the CSA-DND Management Board.” July 8, 2008.

No Author. “Northern Watch TDP Assumptions.”

No Author. “PB III – Vertical Line Array System.”

No Author. “Revised SSR Meeting Agenda.” February 9, 2011.

No Author. “SDCC Display Concept.”

No Author. “Technology Demonstration Program (TDP) Project Synopsis Sheet: Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS).” May 6, 2010.

Northrop Grumman Electronic Systems. “LR-100 Receiver: Small Size/Big Performance.” accessed March 25, 2014. http://www.northropgrumman.com/Capabilities/LR100/Documents/pageDocuments/lr100.pdf.

Ochilov, Shuhratchon and David A. Clausi. “Operational SAR Sea-Ice Image Classification.” *IEEE Transactions on Geoscience and Remote Sensing,* Vol. 50, No. 11, (November 2012): 4937-4408.

Omnitech Electronics Inc. “Next Generation Autonomous Systems – Starfish Cube Array.” prepared for DRDC – Atlantic, March 31, 2011.

Parliament of Canada. “All foreign vessels entering Canadian Arctic waters should register with authorities says report by Senate Fisheries and Oceans Committee.” Accessed October 1, 2013, http://www.parl.gc.ca/Content/SEN/Committee/402/fish/subsitedec09/VoyageOfTheBeserkII-e.htm.

Parliament of Canada. “Bill C-3: An Act to amend the Arctic Waters Pollution Prevention Act,” December 19, 2008. http://www.parl.gc.ca/About/Parliament/LegislativeSummaries/bills_ls.asp?lang=F&ls=c3&Parl=40&Ses=1&source=library_prb.

Parliament of Canada. “Proceedings of the Standing Senate Committee on National Security and Defence, Issue 17 - Evidence, March 8, 2005 - Morning meeting.” Accessed October 13, 2013. http://www.parl.gc.ca/Content/SEN/Committee/381/defe/17eva-e.htm.

Patterson, A.M. “Attention: Mr. J. Jones, Weapons Research Group.” February 27, 1970.

Patterson, A.M. “Letter to John Ganton.” October 19, 1973.

Patterson, A.M. “Summary Report of Meeting Between DREP, USNOL and USNOO Personnel – 28 June 1972.” June 28, 1972.

Pitre, Rick. “RE: SAR Constellation.” April 18, 2005.

Poirier, Paul. “RE: NW TD – CORE SRB RESULT.” November 21, 2008.

Porter, H.A. “Memo to Commander, Material Command.” May 1, 1968.

Prime Minister of Canada. “RADARSAT Constellation Mission.” August 25, 2010. http://pm.gc.ca/eng/media.asp?id=3603.

Public Works and Government Services Canada. “Backgrounder on the National Shipbuilding Procurement Strategy (NSPS) - Year 2: A Status Update.” Last modified November 18, 2013. http://www.tpsgc-pwgsc.gc.ca/app-acq/sam-mps/ddi-bkgr-10-eng.html.

Public Works and Government Services Canada. “Polar Epsilon 2 Project (W8474-14PE02/A).” Accessed April 5, 2014. https://buyandsell.gc.ca/procurement-data/tender-notice/PW-13-00510011.

Quinn, Robert. “Canada – Global Leader in Maritime Domain Awareness from Space.” Presentation at Canadian Embassy, Washington D.C., March 26, 2009.

Quinn, Robert. “Gap Analysis Version 2.6: Polar Epsilon (Joint Space-Based Wide Area Surveillance and Support) Statement of Requirements.” June 3, 2011.

Quinn, Robert. “SOR Version 1.5: Polar Epsilon 2 – Space-Based Surveillance and Reconnaissance Capability Statement of Operational Requirements.” October 4, 2011.

Renton, Danielle. “RADARSAT Constellation Mission and AIS.” Presented at Canadian Embassy, Washington D.C., September 2010.

Retallack, J.G. “Maritime Proving & Evaluation Unit Cooperation in CANUS HUDSON.” August 20, 1970.

Reyes, Melissa. “AIS SRR – Clarification.” January 17, 2011.

Riley, Mark. “Northern Watch Brief.” September 25, 2013.

Rio Tinto. “Diavik Diamond Mine Visitor Information Booklet,” April 1, 2013. Accessed June 29, 2014. http://www.diavik.ca/documents/Visitor_information_booklet.pdf.

Riseborough, E.S. *Detection of low observables with a low cost navigation radar*. Ottawa: Defence R&D Canada, 2008. Available at: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc81/p530811.pdf.

Royal Canadian Air Force. “CC-138 Twin Otter: Transport/Search and Rescue Aircraft.” Last modified August 1, 2013. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/cc-138.page?.
Royal Canadian Air Force. “CH-146 Griffon: Search and Rescue/Tactical Aviation Aircraft.” Last modified August 1, 2013. http://www.rcaf-arc.forces.gc.ca/en/aircraft-current/ch-146.page?.

Royal Canadian Air Force. “Search and Rescue.” Last modified August 23, 2013. http://www.rcaf-arc.forces.gc.ca/en/search-rescue.page.

Royal Canadian Mounted Police. “Klondike Gold Rush.” Last modified September 1, 2002. http://www.rcmp-grc.gc.ca/hist/ori-deb/debuts10-eng.htm.

Samoluk, Andy. “Potential DND Funds Available for Joint DND/CSA Projects.” September 16, 2005.

Guy Seguin. “RE: Potential DND Funds Available for Joint DND/CSA Projects.” September 16, 2005.

Guy Seguin. “RE: Potential DND Funds Available for Joint DND/CSA Projects.” September 19, 2005.

Satnews. “COM DEV Successfully Delves into AIS with Nanosat.” April 28, 2009. http://www.satnews.com/cgi-bin/story.cgi?number=766090690.

Seguin, Guy, Ralph Girard, and Francois Malo. “RADARSAT Constellation project CSA-DND Working Group.” March 24, 2009.

Schofield, Derek. “Canada-U.S. Joint Acoustic Experiments in Hudson Bay and Hudson Strait.” July 31, 1969.

Schofield, Derek. “DND Policy in the Canadian Arctic.” January 9, 1969.

Schofield, Derek. “Note To File: US/Canada Cooperation – Underwater Acoustics.” June 24, 1969.

Sponagle, Neil. “11cc – Distributed Surveillance Pods with Digital Signal Processing (DSP2).” June 5, 2007.

Stantec. “Nanisivik Naval Facility Project Specific Information Requirements: Revision 3.” July 2013. http://ftp.nirb.ca/01-SCREENINGS/COMPLETED%20SCREENINGS/2013/09DN018-DND-Nanisivik%20Naval%20Facility/01-APPLICATION/130819-09DN018-NIRB%20Pt%201-IA2E.pdf.

Thauberger, P.A. “CF Arctic Surveillance Capabilities.” Presentation to SJS Western Hemisphere Ops, August 14, 2009.

Toole, Stan. “Letter to the Editor of the Project Ajax Bulletin.” April 29, 1971.

Tracy, Nicholas. “Why Does Canada Want Nuclear Submarines?” *International Journal*, Vol. 43, No. 3 (Summer 1988): 499-518.

Transport Canada. “Interdepartmental Marine Security Working Group Partners.” Last modified May 14, 2012. https://www.tc.gc.ca/eng/marinesecurity/partnerships-303.htm.

Transport Canada. “Marine Security Operations Centres.” Last modified May 23, 2013. https://www.tc.gc.ca/eng/marinesecurity/operations-269.html.

Transport Canada. “User Assistance Package for the Implementation of Canada’s Arctic Ice Regime Shipping System (AIRSS).” May 1998. http://www.tc.gc.ca/media/documents/marinesafety/tp12819e.pdf.

Uffen, Robert J. “Memo to Chief of Defence Staff.” October 11, 1968.

United Nations. “United Nations Convention on the Law of the Sea.” Accessed July 10, 2014. http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf.

Vachon, Paris W. “New RADARSAT Capabilities Improve Maritime Surveillance.” Presentation at NATO NURC Geo Data Fusion Centre, October 18, 2010.

Van Dyck, Tamara. “DRDC Atlantic 2011 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut.” Sent to the Nunavut Impact Review Board March 21, 2012.

Van Dyck, Tamara. “DRDC Atlantic 2012 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut.” Sent to the Nunavut Impact Review Board March 8, 2013.

Van Dyck, Tamara. “DRDC Atlantic 2013 Annual Report for Operations at Gascoyne Inlet Camp, Devon Island, Nunavut.” Sent to the Nunavut Impact Review Board March 28, 2014.

Verrall, Ron, editor. “Arctic Field Work – Summer 2012.” September 2012.

Von Winkle, W.A. “Letter to Chief of Naval Operations (U.S.).” September 22, 1970.

Waller, David, Matthew R. MacLeod and Talia McCallum. *Measures of Effectiveness and Performance for the Northern Watch Station.* Ottawa: Defence R&D Canada – Cora, 2009. Available at: http://pubs.drdc.gc.ca/PDFS/unc87/p531827.pdf.

Waller, David, Matthew R. MacLeod and Talia McCallum. *Measuring Northern Watch: Goals Inputs, Metrics and Outputs.* Ottawa: Defence R&D Canada – Cora, 2009. Available at: http://cradpdf.drdc-rddc.gc.ca/PDFS/unc81/p531224.pdf.

Walsh, John and Donald Wuebbles et al. “Ch. 2: Our Changing Climate. Climate Change Impacts in the United States.” In *The Third National Climate Assessment*, edited by J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, 19-67. Washington: U.S. Global Change Research Program, 2014.

Watson, G.D. “Polar Bear – Note to File.” May 1, 1972.

Weber, Bob. “Russian Maps Suggest Soviets Subs Cruised Canadian Arctic.” *The Globe and Mail*, December 6, 2011. http://www.theglobeandmail.com/news/national/russian-maps-suggest-soviet-subs-cruised-canadian-arctic/article2261379/.

Whitman, Edward C. “SOSUS: The ‘Secret Weapon’ of Undersea Surveillance.” *Undersea Warfare*, Vol. 7, No. 2 (Winter 2005). http://www.navy.mil/navydata/cno/n87/usw/issue_25/sosus.htm.

Winton, Michael. “Sea Ice–Albedo Feedback and Nonlinear Arctic Climate Change.” *Arctic Sea Ice Decline: Observations, Projections, Mechanisms, and Implications*, Geophysical Monograph Series 180: 111-131.

Wong, Benny. “Design of an Integrated AIS Sensor on a Radar Satellite (DIASRS) TDP Project Approval.” March 29 2010 presentation to the Senior Review Board (SRB).

Wong, B. “Technology Demonstration Program (TDP) Synopsis Sheet (TDP Project Approval) Northern Watch Technology Demonstration Project.” November 15, 2010.