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Leveraging the Canadian Space Sector to Improve Arctic Infrastructure and Communications: RADARSAT and Telesat

Emily Standfield
NAADSN Graduate Fellow

Jill Barclay
NAADSN Policy and Research Coordinator

Purpose

The purpose of this policy primer is to inform stakeholders and policymakers on the potential of public-private partnerships in outer space to solve Canadian defence, security, and public goods issues in the Arctic. By considering a successful public-private partnership in space—the RADARSAT Missions—it is possible to compare how the same approach might be used to rectify connectivity challenges in the Arctic.

Introduction

The history of commercial space activities can be traced back to 1962, when the United States launched Telestar 1 to deliver trans-Atlantic audio and video capabilities. Over the course of the following decade, more private broadcasting satellites, remote sensing satellites, and other systems were launched by private, commercially developed launch systems.[1] At that time, there were two primary actors involved in the space race: the U.S. and the Soviet Union (now Russia). Today, more countries are participating in space endeavours and commercial actors have become significant stakeholders in outer space.

Canada has had a long and robust history of space activity. With the launch of Alouette I in 1965, Canada became the first nation after the U.S. and Russia to design and build its own artificial Earth satellite.[2] With Canada's partnership in the International Space Station (ISS), the development of the first and second Canadarm, and the nation's long-standing collaboration with NASA, Canada has remained a significant actor in space. Likewise, the commercial actors within its borders—MDA Ltd., Telesat, GHGSat, and NorthStar, to name a few—have made significant gains in Earth observation, robotics, and remote sensing.

Canada has previously taken advantage of private space actors to solve national security and public good needs. There is no better example of this than in the Arctic. The launch of RADARSAT-1 in 1995 began a long and fruitful public-private partnership between the Canadian government and commercial actors that provides an invaluable tool for monitoring and protecting Canadian Arctic interests. This policy primer will summarize the challenges of Arctic remote sensing and communications infrastructure before outlining public-private partnerships that are working to solve these issues: the RADARSAT Missions and Telesat. The RADARSAT Missions serve as an example of a successful public-private partnership to improve remote sensing in the Arctic. Telesat, a Canadian satellite-based communications company, has announced that it will offer high-speed internet connectivity to the most remote communities in Canada by 2023. While Canada has made efforts to assist in Telesat's success, there are marked differences between the support given to RADARSAT and Telesat. The two public-private partnerships in the Canadian space sector—and their possible drawbacks and benefits—will be highlighted and discussed.

Space Satellite Solutions to Challenges in the Arctic

> *Satellite technology is playing an important role in facilitating transportation and other economic activities in the North, as well as maintaining safety and security. The October 6, 2011 loss of satellite services and the resulting disruption to communications and air travel demonstrated just how reliant Northerners have become on this technology. The Canadian Space Agency's submission to the Review outlined how space-based satellite technology currently supports transportation in the North through communications, weather reporting, navigation, surveillance, and search and rescue activities.*[3]

The Arctic remains of particular focus for the Canadian government. In Canada's 2017 defence policy, *Strong, Secure, Engaged* (SSE), the Arctic is highlighted as an "important international crossroads where issues of climate change, international trade, and global security meet."[4] Indeed, melting sea ice and advancements in technology are said to bring "increased safety and security demands related to search and rescue and natural or man-made disasters to which Canada must be ready to respond."[5] Further, SSE recognizes this and commits to investing in space capabilities, including space situational awareness, Earth observation, and satellite communications that achieve global coverage, including in the Arctic.[6] Space is going to be essential in solving security and safety issues in the Arctic. Two areas of high importance to combatting challenges in the Arctic are remote sensing and communications infrastructure.

Remote Sensing

Remote sensing is the process of acquiring information about an object or phenomenon without making physical contact with it. Space operators can observe and gather data on Earth and other planets using remote sensors attached to satellites and other aircrafts that detect emitted or reflected energy.[7] Improvements in remote sensing have made shipping routes in the Arctic safer and easier to navigate, search and rescue operations more successful, and infrastructure planning more informed.

Shipping

With longer shipping seasons and the increasingly accessible Northwest Passage (NWP), the demand on remote sensing services has and will continue to increase as marine transport in the Arctic becomes more frequent.[8] Coupled with existing technologies, the expansion of satellite coverage in the Arctic will improve the monitoring and protection of the Canadian North. RADARSAT's Automatic Identification System (AIS) has provided invaluable tracking capabilities for ships transiting in and through the Arctic. The more data that is available via satellite, the more comprehensive the picture of marine traffic in the Arctic will be, thus making transit routes even safer still. As stated by the Canadian Space Agency, satellites offer the ability to:

- ensure that activities conducted, even in isolated areas, comply with Canadian laws and respect the environment;
- manage marine traffic effectively to minimize impacts on the environment and the land; and
- prevent or intercept any illegal activities along Canadian coasts.[9]

Search and Rescue

The increased accessibility of the Arctic has simultaneously increased human activity in the region. As human activity surges, so too does the need and demand for search and rescue (SAR). Satellite data is vital in improving search and rescue (SAR) capabilities and response times in Canada's remote and isolated Arctic communities. Improvements in telecommunications capacity via satellite, combined with remote sensing capabilities, will support the collection and distribution of land and sea geographic information, including better information on sea ice and icebergs, which is used to inform SAR operators and support their operations.[10] Satellites are used to track ice changes, better understand climate change, ensure that sea routes and ice roads are safe to use, and support marine traffic navigation.[11]

Infrastructure Planning

Satellites can help overcome the overarching challenge of remoteness when building infrastructure in Northern communities. As permafrost melts, the ground upon which critical infrastructure, like airports and runways, highways, and other buildings, is built will shift and change. The future building of infrastructure in the Arctic will require valuable knowledge of ice thickness, permafrost, and climate change, which satellite radars can and do provide.[12]

In response to the infrastructure deficit in the Canadian North, the Government of Canada has shown a renewed interest in developing Northern transportation infrastructure, dedicating significant funding towards transportation improvements in recent years. The 2016 *Canada Transportation Act* Review Report included a chapter on Northern transportation and recommendations for the future of Northern infrastructure priorities and needs, highlighting how satellite capacities are vital to improving transportation and planning throughout Canada, but especially in the North. The surveillance of infrastructure—the detection of terrain disturbances, monitoring of permafrost melt, and tracking of deformations of bridges, roads, and rail—is crucial to Northern transportation and infrastructure.[13]

The benefits of remote sensing are vast for all of Canada, but especially in the Arctic. Improved communications infrastructure, the challenges of which will be discussed below, would offer similar advantages.

Air Traffic

The Cross Polar Working Group (CPWG), a forum of air navigation service providers and operators offering services in the cross-polar and Russian Trans-East traffic flows, estimates that air traffic over the Arctic will increase annually by 3.5%, or an additional 400-500 flights per year. Improved connectivity and satellite monitoring will "allow the airspace to accommodate increased traffic, enhance safety, and permit the introduction of new and more efficient routings."[14] Beyond the Arctic, the United Nations International Telecommunications Union has taken steps to enable satellites to begin tracking all aircrafts in the world in real time. These initiatives will help avoid aviation accidents caused by a lack of information and data.[15]

Communications Infrastructure

In 2016, the Canadian Radio-television and Telecommunications Commission (CRTC) declared broadband a basic telecommunication service. Jean-Pierre Blais, the CRTC's Chair at the time, stated, "The future of our economy, our prosperity, and our society — indeed, the future of every citizen — requires us to set ambitious goals, and to get on with connecting all Canadians for the 21st century."[16] The United Nations Human Rights Council released a similar resolution in 2016 affirming just that: internet access is a basic human right that is essential for economic, social, cultural, political, and civic participation in the digital era.[17] COVID-19 has amplified this notion, with lockdowns making the internet vital to people's livelihoods through online learning, virtual doctors' appointments, work, staying connected to family and friends, and more. Further, telecommunications infrastructure in the Arctic is vital to the maintenance and preservation of Indigenous peoples' cultures and livelihoods.[18]

Given the complex environmental conditions and large distances between population centres, delivering internet connectivity to the Canadian North has been a challenge. Even where internet is available, the connection reliability varies greatly, and the cost can be an inhibiting factor for many Northern residents.[19] While internet connectivity in the Arctic is essential to improving socio-economic opportunities and livelihoods in the Canadian North, more advanced and reliable telecommunication will be vital to address the complex set of defence and security needs in the Arctic. The Arctic has increasingly gathered international attention for its commercial opportunities, research, and military peace and stability concerns. Arctic sea ice has been melting rapidly due to global warming, creating opportunities for new maritime routes and outside intervention. As sea ice melts, the prospects for oil and gas extraction grow, as does the possibility of an alternative corridor for international shipping through the Northwest Passage (NWP).[20]

The 2017 report of the Arctic Council's Task Force on Telecommunications Infrastructure in the Arctic (TFTIA), *Telecommunications Infrastructure in the Arctic*, found that "no single technology alone will meet all telecommunications needs in the Arctic" and that the best way to serve the diverse geographies and users' needs will likely require a combination of technologies.[21] The Canadian space sector could offer expanded and potentially near-complete coverage for Arctic residents when working in conjunction with existing internet infrastructure.

Internet connectivity projects in the Arctic have been plagued with obstacles for years. Most recently, in 2019, the Government of Nunavut released a proposal to install a fibre-optic cable that would span from Iqaluit, Nunavut, to Nuuk, Greenland.[22] Shortly after the plans were released, the Government of Nunavut backed away from the Iqaluit-Nuuk fibre-optic cable route when the estimated cost of the project increased from C$107 million to C$209 million.[23] An alternate route from Iqaluit to Hudson Bay through Frobisher Bay and Hudson Strait emerged as a "higher value option."[24] In Hudson Bay, the cable would be connected to another cable that the Kativik Regional Government will be installing between Puvirnituq and Chisasibi in northern Quebec. At Chisasibi, the cable will link to the backbone of the North American internet, a land-based line running through Montreal.[25] The Government of Nunavut is also simultaneously working with CanArctic Inuit Networks, a private firm, to install a high-speed fibre-optic cable between Iqaluit, Nunavut, and Clarenville, Newfoundland.[26] While space-based internet is faced with its own set of complex challenges, having a multi-layered internet infrastructure offers more reliability for connectivity in the North.

Despite this, fibre-optic cables remain a cheaper option than satellite infrastructure, leaving the majority of investment in telecommunications networks to be driven by the private sector.[27] As stated by the TFTIA, the development of telecommunications infrastructure and connectivity in the Arctic "will require work by, and cooperation among, a constellation of different actors in the public and private sectors."[28] As such, partnerships between the private sector and the government will be of particular advantage in future connectivity projects.

Government Commitments to Improved Telecommunications Infrastructure

In the same year as the CRTC's declaration on the importance of telecommunications, the Canadian government began the Connect to Innovate program, which aimed to enhance access to high-speed internet for nearly 400,000 homes in 900 communities, including 190 Indigenous communities. Further broadband projects include the C$2-billion Rural and Northern Stream of the Investing in Canada Infrastructure Program, and the CRTC's C$750-million Broadband Fund.[29] In November 2020, amid the COVID-19 pandemic, the Canadian government made a promise to connect 98% of all Canadians to high-speed internet by 2026, reaching 100% by 2030. The C$1.75-billion fund to build infrastructure across the country (mostly in rural and remote communities) was announced in the 2019 federal budget. Beyond this, the government had also reached a $600-million agreement with Telesat to improve broadband in the North specifically.[30]

As outlined, space can play an important role in improving safety and security in the Canadian Arctic. However, the high costs and slow rollout of these efforts leave opportunities for the private sector to play a part in the Canadian space satellite sector by improving remote sensing and telecommunications capabilities.

Why Public-Private Partnerships?

Public-private partnerships offer unique opportunities to simultaneously drive Canadian innovation in space and solve public goods needs in the Arctic. These partnerships offer benefits that would be unavailable if pursued only through public or private avenues.

Governments looking to expand their capabilities in Earth monitoring, satellite communications, and navigation can make use of the reduced costs and risk offered through public-private partnerships.[31] There are many reasons why governments may engage in a public-private partnership to fill a public sector need. The expertise the commercial sector provides might offer citizens improved public sector services. Or maybe the public sector lacks the resources and capacity to develop infrastructure within a required timeframe.[32] Commercial space actors are not constrained by government bureaucracy, nor are they dependent on taxpayer funding, which makes them an attractive option for innovative undertakings.[33] For private companies in the space sector, government investment is always helpful. Space exploration is expensive and risky for investors; economic returns are far from guaranteed. If governments act as anchor investors, it will make it less risky for others to invest as well.

Public-private partnerships are sometimes challenging in the North. Projects such as the Stanton Hospital Project in Yellowknife are singular ventures, which are less attractive to investors that prefer long-term projects.[34] And, if private companies were to 'go it alone' in the Arctic, investment in Arctic services might not provide a sufficient consumer base to make a profit. The government subsidies often offered with public-private partnerships make projects in the Arctic more financially viable for private actors.

The RADARSAT Missions and Telesat are both examples of public-private partnerships in the Arctic, which attempt to fill public sector needs. While the RADARSAT Missions offer improved remote sensing capabilities, Telesat aims to provide broadband coverage to the entirety of Canada. Both offer lessons for future partnerships in the Arctic, which allow for benefits that the public or private sector could not individually realize.

The RADARSAT Missions: Solving Remote Sensing Challenges in the Arctic

RADARSAT-1 was a Canadian-led collaborative project between the federal government and the private sector. It was a remote sensing Earth observation satellite, which would prove to be the first of three in the RADARSAT program. Canada, with its vast territory and variety of landscapes, has long recognized the importance of Earth observation systems. RADARSAT-1 was developed to pursue this priority and was launched on November 4, 1995.[35] The private companies that designed and built RADARSAT-1 include Spar Aerospace, MDA, SED Systems, CAL Corporation, COM DEV, Fleet Industries, IMP, and FRE Composites.[36] RADARSAT International (RSI) was a private Canadian company established in 1989 to process and distribute the data gathered from RADARSAT-1. RSI was owned by several aerospace companies, before becoming a wholly owned subsidiary of MDA. RADARSAT-1 is, in part, why Canada remains a world leader in the processing of satellite remote sensing data.[37]

RASDARSAT-2 was launched on December 14, 2009, and remains active today. Technical advancements allowed for enhanced marine surveillance, ice monitoring, resource management, and mapping as compared to RADARSAT-1. The updated satellite gathers high-resolution images, regardless of weather or time of day. Unlike RADARSAT-1, MDA owns and operates RADARSAT-2 and its corresponding ground segments in Quebec and Saskatchewan.[38] MDA is also in charge of data distribution. While the Canadian government funded the construction and launch of the satellite, it recovered its investment through the supply of data gathered by RADARSAT-2.[39]

The RADARSAT Constellation Mission (RCM), launched on June 12, 2019, is the latest evolution of the RADARSAT program. The Constellation's use of three satellites allows for complete satellite coverage of Canada, flying over the Arctic up to four times a day, and provides access to 90% of the world's surface.[40] While RADARSAT-2 was able to capture an image of the exact same location every 24 days, the RCM is able to do so once every four days.[41] With its capabilities spread across three satellites, the RCM is a more robust, flexible system that is more cost effective to launch and operate. MDA was once again the primary contractor for the newest RADARSAT mission, although the Government of Canada owns the satellite and the data that it gathers. According to the Canadian government, "approximately 300 people worked on the construction of the RCM in some 50 companies across the country. In total, 125 suppliers across 7 Canadian provinces played a role in the project."[42]

The RADARSAT Missions are prime examples of successful public-private partnerships that helped solve security and public goods needs. Increased surveillance and observation are essential for Canada to protect its interests in the Arctic—a concern mediated by the RADARSAT Missions. RADARSAT-2 was especially influential in monitoring and protecting Arctic infrastructure, such as in the development of the Inuvik Tuktoyaktuk Highway (ITH) in the Northwest Territories.[43] The ITH, spanning 138 kilometres, is the first highway in Canada to connect to the Arctic Ocean. The Northwest Territories' government estimates that the ITH will reduce the cost of living in Tuktoyaktuk by approximately C$1.5 million annually. Images of the landscape between Tuktoyaktuk and the Arctic, provided by RADARSAT-2, were instrumental in planning the construction of the highway.[44] In the future, RADARSAT-2 imaging will better preserve existing Arctic infrastructure and identify risks for emerging projects. The RCM, on the other hand, has been influential in monitoring climate change. By offering imaging of the exact same location in the Arctic every four days, monitoring climate change and human impacts on the environment has been made easier and more immediate. The RCM is also equipped with an Automatic Identification System (AIS) for ships, which allows for the improved detection and tracking of vessels.[45] Overall, the RADARSAT Missions have enhanced Canadian capabilities in the Arctic, improved living conditions for those living in Arctic communities, and provided invaluable data for research in climate change and other areas.

Telesat: Solving Communications Challenges in the Arctic

Satellite communications is another area where the Government of Canada is already utilizing a public-private partnership to solve security issues in the Arctic. Despite the importance of the Arctic to the Canadian government, satellite communications capabilities remain limited to the Canadian Armed Forces (CAF) north of 65° North latitude.[46] Providing satellite communications would assist in defence capabilities, provide public safety and health services more efficiently to those living in the Arctic, and help with coordination between government activities.[47]

Telesat, a Canadian satellite-based communications company headquartered in Ottawa, Ontario, offers a solution to the connectivity issues present in the Arctic. Historically, Telesat and other satellite communications companies have utilized systems in geosynchronous orbit (GEO). These are large spacecraft that orbit 35,000 kilometres from Earth's surface—this covers a large area, allowing operators to monitor most of Earth with only three satellites.[48] Becoming increasingly popular, however, are constellations of satellites in Low Earth Orbit (LEO). These orbit only around 500 to 2,000 kilometres from Earth's surface and

thus allow for faster communications and higher bandwidth. By utilizing a constellation of LEO satellites, global coverage can be achieved.[49] Telesat plans to launch a LEO constellation composed of 298 satellites, called "Telesat Lightspeed."[50] It is expected to deliver high-speed internet connectivity to the most remote communities in Canada, and worldwide. According to the 2019 Memorandum of Understanding between Telesat and Industry Canada, Telesat will offer "broadband coverage to Canada's far north in 2022 and all of Canada from a constellation in mid-2023."[51]

Telesat has received strong support from the Canadian government to develop Lightspeed. In November 2020, the Government of Canada committed C$600 million in funding in order to provide subsidized broadband services to rural areas of Canada. This agreement enables "Internet and mobility service providers to acquire Telesat LEO capacity at substantially reduced rates to bring universal broadband connectivity to rural, Northern and Indigenous communities across Canada."[52] Additionally, on February 18, 2021, Quebec's provincial government announced it would invest C$400 million into Lightspeed.[53] Directly and indirectly, Telesat will invest C$1.6 billion back into Quebec, by having many of its operations run out of the province.[54]

Analysis and Conclusion

Public-private partnerships in space are an essential tool in solving security issues and public goods needs in the Arctic. This has been proven to be true in Arctic communications and Earth observation. The RADARSAT Missions were—and continue to be—highly successful in preserving Arctic infrastructure, improving operations, and monitoring climate change. Telesat, on the other hand, will allow for satellite communications north of 65° North latitude, something previously unavailable to Canada and its citizens.[55] This will not only serve to improve living conditions in rural Arctic communities, but assist in defence capabilities as well.

Canada should consider these public-private partnerships a success and draw lessons from them for future alliances with industry. The RADARSAT Missions were highly beneficial for the Government of Canada and MDA. RADARSAT-1 allowed MDA and its counterparts to market and distribute the data with RSI. RADARSAT-2 and the data it collected were owned by MDA totally, which (in part) is why MDA remains such a prominent leader in robotics satellite systems. While Telesat Lightspeed is not fully funded by the Government of Canada, unlike the RADARSAT Missions, Canada did make a public commitment to use its services when they become available to the public. This commitment has made it easier for others to invest in Telesat's Lightspeed. Often when there is an "anchor investor" (Canada), there is less risk for others to also invest. Canada can and should do this with other space companies in the future to help them finance their projects and encourage others to do the same.

The RCM is designed to last ten years, and there has not yet been a public announcement for a replacement system. Meanwhile, Telesat still has a minimum of two years before it reaches its full capacity. Canada should already be looking ahead for future opportunities and partnerships with the private space sector. In looking towards other opportunities to engage with the Canadian space sector, Canada should consider the following questions: What other security issues can space solve in the Arctic? How can Canada support and leverage the power of Canadian space industry to solve these issues? What can we learn from Canada's past successes and how can we apply them to ensure the future success of other partnerships?

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