National Defence Défense nationale

Canadian Forces College

Collège des Forces Canadiennes

# CANADIAN SPACE POLICY: THE HEAD IN THE SAND APPROACH

Maj Forrest L. Poole

## JCSP 44

## Exercise *Solo Flight*

**Disclaimer**

Opinions expressed remain those of the author and do not represent Department of National Defence or Canadian Forces policy. This paper may not be used without written permission.



## PCEMI 44

## Exercice *Solo Flight*

**Avertissement**

Les opinons exprimées n'engagent que leurs auteurs et ne reflètent aucunement des politiques du Ministère de la Défense nationale ou des Forces canadiennes. Ce papier ne peut être reproduit sans autorisation écrite.



Canada

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES
JCSP 44 – PCEMI 44
2017 – 2018

EXERCISE *SOLO FLIGHT* – EXERCICE *SOLO FLIGHT*

# CANADIAN SPACE POLICY: THE HEAD IN THE SAND APPROACH

Maj Forrest L. Poole



Word Count: 4631

Compte de mots: 4631

# CANADIAN SPACE POLICY: THE HEAD IN THE SAND APPROACH

## INTRODUCTION

Most academic papers pertaining to space environment inevitably begin with the clichéd reference to the Sputnik launch in October of 1957 as the genesis to humanity's endeavour in the space domain.[1] While past works by this author have admittedly fallen into the same trap, this paper will venture to use a different clichéd "attention grabber" to set the scene. In 2016 the global gross domestic product (GDP), or the summation of every GDP on the planet was just shy of $75.4 trillion in United States dollars (USD).[2] That number is forecasted to crack the $100 trillion threshold by 2022.[3] The amazing thing about that statistic is not sheer magnitude of the number, which is impressive, but rather the fact that it was largely made possible by 24 satellites circling the earth at an altitude of 26,600 kilometers.[4] Those 24 satellites make up the Global Positioning System (GPS) constellation on six orbital planes providing worldwide precision navigation and timing (PNT).

While the most people think of GPS as the "thing" in their car that gets them directions, far fewer are aware of the how much the modern world, and by proxy the modern economy, is wholly intertwined with GPS. In fact, the global banking system and financial trading markets are completely reliant on the precision timing aspect of GPS as a way of ensuring a common

---

[1] "Canadian Space Milestones," Canadian Space Agency Website, May 03, 2016, section goes here, accessed May 07, 2018, http://www.asc-csa.gc.ca/eng/about/milestones.asp.

[2] "Global GDP 2012-2022 | Statistic," Statista, section goes here, accessed May 07, 2018, https://www.statista.com/statistics/268750/global-gross-domestic-product-gdp/.

[3] Ibid.

[4] "GNSS Frequently Asked Questions - GPS," FAA Seal, December 20, 2016, section goes here, accessed May 07, 2018, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/faq/gps/#1.

global time standard.[5] The global financial sector uses the precision timing of GPS to "timestamp" transactions to negate the possibility of lost or duplicate transactions.[6] This kind of common timing architecture is only possible due to the global standardization provided by the GPS constellation. Beyond precision timing, GPS enables global trafficking of goods by providing a common navigation service. The global maritime trade routes are largely made possible through the use of GPS navigation.[7] The commercial aviation industry is completely reliant on GPS for navigation.[8] The list goes on and on with ways that GPS impacts the modern world. All of that money and power are hopeless linked to 24 satellites floating through space 26,000 kilometers over our heads.

Why is this important to Canada? This concept will be discussed in more depth later in the paper, but the short answer is that Canada, owner of the 10th largest economy, is wholly part of the modern world.[9] It is undeniable that the global economy, and with it Canada, are critically dependent on capabilities in space for their continued growth and prosperity. However, the conflict arises for Canada when these same space capabilities are also key enablers for the global projection of military power. In a country where the government and citizens prefer to draw a clear line between the military and domestic matters, it becomes politically charged when the two clash. The same technology enables Canada's $1.53 trillion USD economy, also enables Canada to destroy an entire airfield with a few well-placed GPS-aided bombs. The purpose of this paper is to how the military and domestic necessities of space can be reconciled to allow for informed space policy. This paper will prove that there is a current lack of understanding

[5] "Timing," GPS.gov: Agricultural Applications, accessed May 08, 2018, https://www.gps.gov/applications/timing/.
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] "Global GDP 2012-2022 | Statistic…

concerning the space domain and that this has resulted in an ambiguous way forward for Canadian involvement in the space domain. Finally, this paper will provide ways for Canada to increase its footprint in space while staying in line with traditional Canadian norms and national interests. Canada has a long history of collaboration and participation in the space domain. For the success of Canada, it is important to couple this successful history with education to shape the future for Canada in space.

## WILLFULLY UNINFORMED IN SPACE

### Ballistic Missile Defense

Over the last five plus decades Canada has been an active participant in the space arena. In fact, Canada was the third space faring nation, behind the Union of Soviet Socialist Republics (USSR) and the United States (U.S.).[10] On September 29th, 1962 an organically designed and built scientific satellite was launched out of Vandenberg Air Force Base, California.[11] In November 2018 a Canadian astronaut is scheduled to begin a 6 month mission above the International Space Station.[12] However, despite the long history of work in the space domain, an informational disconnects remains about what space really means to Canada. Nowhere is this lack of education more apparent that than the fiasco with ballistic missile defense (BMD) in the mid-2000's.

In 2004 Canada showed interest in North American BMD and agreed to "to be a de facto participant through its agreement that warning information collected under the auspices of the

[10] "Canadian Space Milestones," Canadian Space Agency.
[11] Ibid.
[12] "Coming up in 2018 for the Canadian Space Agency," Canadian Space Agency Website, January 16, 2018, section goes here, accessed May 07, 2018, http://www.asc-csa.gc.ca/eng/blog/2018/01/01/2018-canadian-space-projects.asp.

North American Aerospace Defence Command could be used in BMD".[13] Less than a year later, Canada backed out of the agreement with the United States over concerns that BMD was the equivalent to "weaponizing" space. Since this decision, two former Ministers of National Defence stated that this decision was largely motivated by political considerations and perceived negative public opinion.[14] There was the perception that BMD was just a continuation of President Regan's "Star Wars" efforts, which many Canadians thought would just lead to an arms race in space.[15] This false assessment shows the general lack of knowledge concerning the space domain. The only part of the entire BMD program that ever enters the space domain is the interceptor that is trying to interdict the incoming missile. Every other segment of the BMD program is takes place purely in the land and air domains.

While, there were certainly those within the Canadian government that understood the difference between a land-based missile interceptor and a space-based weapon, it was not enough to sway public perception of the program. Mr. Bill Graham, the Minster of National Defence at the time went on record during a senate committee stating that "there are many who argued that BMD was akin to…the weaponization of space, which by the way it is not my view any more than ballistic missiles themselves are weaponization of space. It is a land based system, not a space-based system".[16] Even more astonishing, Canada was never going to contribute anything that would provide a kinetic effect to the BMD program; Canada was only going to provide additional sensors that would be located in within the country. By removing themselves from the BMD program they were weakening their role in North American Aerospace Defense Command (NORAD) because by their own admission "Canada would be asked to leave the room when

[13] Canada, Standing Senate Committee on National Defence, *Responding to the Evolving Threat* (2014), pg. v.
[14] Ibid.
[15] Ibid.
[16] Ibid.

decisions were being made concerning BMD".[17] All of this turmoil was the result of a largely uninformed government and public not understanding what the weaponization of space actually meant.

Of course there are arguments to be made for not pursuing BMD that make sense in terms of furthering Canada's other national interests. Canada could use that same money to further diplomatic missions abroad or increase social programs at home. Those reasons are perfectly acceptable and would imply a well-though out approach to BMD and understanding of space. However, choosing not to proceed with the BMD program due to a perceived fear of putting weapons in space, is the result of willful ignorance, and is a sign of further troubles in the future if left unchecked. In the end, Canada's decision not to pursue BMD with the U.S. resulted in Canada being left out of a global military effort with 27 members of NATO, to include some of the countries closest allies.[18] It also weakened the relationship with NORAD, because BMD is very much a part of the defense of North America. As a self-described military "middle power", Canada prides itself on working with allies and organizations to further national interests. Due to a basic lack of understanding concerning the space domain, Canada excluded itself from something that the Standing Senate Committee on National Security and Defence recommended they should have been involved in all along.[19]

**The Space Threat Environment**

While the misstep with Ballistic Missile Defense is one example of a misinformed government making bad policy decisions in the space domain, it is certainly not the only way.

[17] Ibid.
[18] Ibid.
[19] Ibid.

Perhaps the larger and more troubling problem is the unwillingness to see the space domain for what it is. The new Canadian defense policy, *Strong Secure Engaged* (SSE), stance on the use of space is that Canada will "[continue] to promote the peaceful use of space". [20] Unfortunately, this statement leads one that space is currently a peaceful domain, which is a naïve point of view on the topic. A more realistic view is that due to the asymmetric economic and military advantages that the space domain provides to Canada and its allies, capabilities within the domain have become military targets.[21] Space is no longer the sanctuary that it was once considered, as countries look to negate potential advantages. SSE leads one to believe that as long as Canada promotes the peaceful use of space, other countries will do the same thing. Unfortunately, this just isn't true. China and Russia have shown the ability to "shoot down" satellites with ground-based interceptors. In recent anti-satellite tests, China has shown that it can strike satellites in any orbital regime using a ground-based interceptor.[22] While publicly China has been a proponent of the peaceful use of space in the UN and other forums, they are also the most aggressive nation in the world in building weapons to hold key space capabilities at risk.[23] Space is not peaceful, it is congested and contested.[24] Understanding and coming to terms with the current situation in space is the only way that Canada can develop a holistic and coherent national policy.

---

[20] Canada, Department of National Defence, *Strong, Secure, Engaged: Canada's Defence Policy* (Copyright Her Majesty the Queen in Right of Canada, as Represented by the Minister of National Defence, 2017), pg. 43.

[21] Bryan M. Bell and Evan T. Rogers, "Space Resilience and the Contested, Degraded, and Operationally Limited Environment," *Air & Space Power Journal* 28, no. 3 (November/December 2014): pg. 34, doi:10.21236/ada618128.

[22] Ibid.

[23] "Hyten: Deterrence in Space Means No War Will Be Fought There," U.S. DEPARTMENT OF DEFENSE, section goes here, accessed May 07, 2018, https://www.defense.gov/News/Article/Article/1061833/hyten-deterrence-in-spac/.

[24] Brian M. Bell..."Space Resilience and the…pg. 34.

Another aspect that shows a lack of understanding is how Canada views itself in space and how potential adversaries view it. For instance, in the past two decades Canada has taken an increased role in space situational awareness (SSA) by launching the SAPPHIRE satellites which monitor space debris.[25] Canada views this as a peaceful venture that helps to mitigate on-orbit collisions with satellites or the International Space Station. While Canada touts its ability to track space debris as an overall contribution to the peaceful use of space, Russia and China see a capability that can track their satellites on orbit to inform an overall machine that would hold their satellites at risk.[26] It is important for Canada to understand that their actions in space need to be informed by fact and an understanding of the world as it is and not the world as they believe it should be. Russia and China view anything that is done by the five eyes community as offensive regardless of what the Canadian government or public thinks.

The key to forcing the Canadian government to understand the current situation in space is to explicitly tie the threat environment to Canada's national interests. In fact, so much of what Canadians see as their national identify (e.g. growing economy, a working power grid for hospitals see patients under universal health care) are made possible by the GPS constellation of satellites that are inherently useful to both the military and civilian world. The dual-use technology of space capabilities make them invaluable to the citizens of Canada, as well as the military. However, this reliance on space and the duality of its use has not gone unnoticed by potential adversaries. An academic paper from 2017 at the Canadian Forces College states the problem exceptionally well, "if Canada's space trajectory continues, [we] will likely witness two contradictory trends in Canada. Space use and reliance will progressively increase, while

[25] Canada, Department of National Defence, Royal Canadian Air Force, *Royal Canadian Air Force Doctrine Note 17/01: SPACE POWER* (Department of National Defense, 2017), pg. 17.

[26] Brian M. Bell..."Space Resilience and the…pg. 34.

Canada's public and private domestic capacity to ensure its space presence will decline". [27] The author goes on to state that the space domain has a particularly large impact on the Canadian economy, as it does with most modern economies and as that impact grows it makes Canada more vulnerable instability in the space domain.[28] The fact that the space domain is a force multiplier for Canada and its allies means that countries like China and Russia would like to hold it at risk in the event of a future conflict.[29] As a result, the same capabilities that enable the prosperity that Canada enjoys so much are held at risk due to their military utility.

## POTENTIAL WAYS FORWARD IN SPACE

This paper has shown that there is a lack of understanding about the space domain in Canada, and that the government and citizens are critically reliant on space for their continued prosperity. As the protectors of Canada, the Canadian Armed Forces (CAF) needs to play a role in ensuring access to the space domain. So how does Canada move forward in the space domain? SSE states that "Canada will take steps to protect these critical [space] assets against sophisticated threats", but there is no further guidance on what that actually means.[30] Once the Government of Canada (GoC) acknowledges space domain as it is and not as they want it to be, they can begin to make educated policy decisions. These decisions can and should remain in line with a long history of non-aggressive behavior in space. Canada can still protect its interests and those of its close allies without departing from its own national interests and objective. This will mean an increased defensive and situational awareness posture to ensure access to and the safety

[27] K.R. Connerty, *SPACE TRAFFIC MANAGEMENT: IMPLICATIONS FOR CANADIAN ARMED FORCES SPACE POWER*, PhD diss., Canadian Forces College, 2017, pg. 9.

[28] Ibid.

[29] Brian M. Bell..."Space Resilience and the…pg. 36.

[30] Canada, Department of National Defence, *Strong, Secure*…pg. 15.

of critical capabilities in space. In fact, because protecting the Canadian economy is an issue of national security, moving defensively into space is exactly what the Canadians should do. This paper will propose a few potential paths that Canada can pursue which would strengthen their position in space, as well as that of key allies.

**Space Situational Awareness**

The first thing that the CAF can do to meaningfully increase its presence in the space domain is to expand upon its current SSA mission. In U.S. doctrine Joint Publication 3-14 (JP 3-14) SSA is defined as the foundational knowledge upon which space operations depend…SSA is integrating surveillance, collection, and processing of data to understand the U.S. and multinational (e.g. Canada) space readiness.[31] Similar to other physical domains, it is critical to have situational awareness of the battlespace so that commanders and governments can make the most informed decisions possible. Also like other domains, size and distance play an important role in maintaining good situational awareness. For instance, it is easier to find a battalion of enemy troops compared to a platoon. It is also easier to find a battalion at 5 kilometers (km) out than at 500 km out. Again the space domain suffers from these same principles of situational awareness. However, the tyranny of distance in the space domains is orders of magnitude larger. Instead of trying to find a battalion at 500 km, try to find them at roughly 36,000 km where satellites in geostationary orbit reside.[32] To make matters more complex, instead of finding a battalion sized adversary, imagine trying to find a satellite the size of a small car among the

[31] United States, Joint Chiefs of Staff, *Space Operations*, Annex: Defensive Space Control (Washington, D.C.: Joint Chiefs of Staff, 2012), pg. II-1.

[32] Ibid.

approximately 400 other satellites in geostationary orbit.[33] The technological challenges to maintaining SSA are immense and the currently there are not enough resources to accomplish the mission.

For this reason Canada launched SAPHIRE, its first military satellite, back in 2013 to show the United States that the CAF was serious about SSA and wanted a meaningful partnership in the mission area. At the time the U.S. only had one on-orbit SSA sensor (satellite) and the addition of SAPPHIRE provided critical support to the mission area.[34] While it is still not enough, currently Canada and the United States are the only two countries working together to formulate a SSA picture.

The SSA mission is one that aligns well with Canadian national objectives and provides a key capability to its closes allies. By providing this capability, Canada is the only other nation that is currently working with the U.S. to address challenges in the SSA mission area. By doing so, they are fostering a partnership with the U.S. for mutual defense of shared space-based capabilities. Canada simply does not have the budget to be able to maintain a substantial SSA network on their own, but by contributing to a larger effort they can receive the benefits of what the collective is doing.

**Monitoring SATCOM Links**

Another area where Canada can contribute to the larger effort is in the Defensive Space Control (DSC) mission area, and more specifically satellite communications (SATCOM) link monitoring. The purpose of monitoring SATCOM links is to ensure that all of the data traffic

[33] Elizabeth Howell, "What Is a Geosynchronous Orbit?" Space.com, section goes here, accessed May 08, 2018, https://www.space.com/29222-geosynchronous-orbit.html.

[34] Canada, Department of National Defence, SPACE POWER…pg. 18.

that should be flowing over those links is unobstructed (read: no one is jamming it). This means that SATCOM users are getting the information they need, when they need it. United States JP 3-14 defines defensive space control as "Operations conducted to preserve the ability to exploit space capabilities…protecting friendly space capabilities from attack, interference, or unintentional hazards…such as direct or indirect attack, space debris, [and] radio frequency interference".[35] There are numerous ways to execute the DSC mission area, but for the purposes of Canada monitoring SATCOM links from a ground-based antenna array is an ideal fit. For one, SATCOM monitoring aligns with the non-aggressive Canadian space posture. Additionally, monitoring SATCOM is an inexpensive when compared to other space domain capabilities and it is currently a critical capability shortfall among NATO allies.[36]

In addition to contributing to NATO and other key allies, monitoring SATCOM links for interference will be a key mission as the CAF moves forward implementing the policy outlined in SSE. SSE emphasizes sever new mission areas that need SATCOM for mission success.[37] In order to ensure that the SATCOM links are working, especially in a operationally degraded environment, the CAF will need to monitor the links to ensure there is no interference. Perhaps the best example of a mission new mission area that is wholly dependent on SATCOM is the increased role of Remotely Piloted Systems (RPS) for Intelligence, Surveillance, and Reconnaissance (ISR) missions within the RCAF.[38] While there are numerous benefits to RPS due to low cost, real-time ISR, and long loiter time, they are completely dependent on SATCOM for mission execution. Once an RPS is launched, it controlled exclusively by an operator via SATCCOM. If an RPS loses contact with the satellite for any reason, such as jamming, it goes

[35] United States, Joint Chiefs of Staff, *Space Operations*…pg. xi.
[36] Ibid.
[37] Canada, Department of National Defence, *Strong, Secure*...pg. 16.
[38] Ibid.

into a “lost link” flight profile. This means that the aircraft flies in a circle trying to reacquire the SATCOM link. If the aircraft cannot find the signal after a set period of time it will follow a return to base flight profile. Therefore, a simple adversary tactic to keep RPS out of their area of responsibility would be jam the SATCOM link. In order to counter that tactic, Canada would need to have SA of their links to notice the jamming so the RPS pilot could switch to another frequency; this is not possible without a DSC capability.

**Space-Based ISR**

Another potential way forward for Canada is to invest in new space-based ISR platforms for the purposes of collecting imagery of the Canadian arctic. While this capability is not one that would be useful to allies, it is something that would be extremely beneficial to the GoC as climate change creates new challenges in the arctic. National sovereignty over the Canadian Arctic has always been an issue due to the sheer scale of the country. Combine the size of the country with the remoteness and inaccessibility due to the weather and arctic sovereignty is a struggle for the government of Canada. Add to it that the U.S. Geological Association estimates that 30% of the world’s undiscovered gas and 13% of the oil is waiting to be extracted in the arctic, Canadian sovereignty becomes an issue of national security.[39] However, Canada will have a hard time defending claims to arctic sovereignty without being able to establish control of

[39] Josh Holder et al., "The New Cold War: Drilling for Oil and Gas in the Arctic," The Guardian, section goes here, accessed May 07, 2018, https://www.theguardian.com/environment/ng-interactive/2015/jun/16/drilling-oil-gas-arctic-alaska.

the area. Senator Dennis Patterson said it best when he said that "as is the case throughout history, sovereignty often relies on the realpolitik principle of 'use or lose it'".[40]

One way to do that is for Canada to increase their space-based ISR capabilities in the arctic to increase their situational awareness of areas that are hard to physically access. The least expensive and manpower-intensive method of doing this is space-based ISR. There are several options for how the GoC could move forward with respect to securing this capability. It is possible to run the entire program to "cradle to grave". However, that seems like an unlikely option due to the high research and development costs, but more importantly the manpower numbers to acquire, operate, and dispose of a satellite constellation is a non-starter. The more likely route is to invest in small satellites, with a short lifespan, and to buy them from a commercial vendor whenever needed. While this is a departure from the traditional military "cradle to grave" framework that other countries like the U.S. have employed, it is far better suited for Canada's needs. In fact other countries, like the U.S. are moving towards this type of cheap and easily replaceable, architecture for satellites that don't require a robust survivability architecture.

Traditionally, space-based ISR was something that only countries with large military budgets could afford. However, that trend has been changing in recent years. This is largely the result of extensive commercial involvement in the space industry. Traditionally access to outer space was provided purely by governments because of the cost to launch multi-billion dollar satellites.[41] However, over the past 20 years, that monetary threshold has come down

---

[40] National Post, "Canada Must Assert Sovereignty over the Arctic While There's Still Time," National Post, November 02, 2017, section goes here, accessed May 07, 2018, http://nationalpost.com/opinion/canadas-must-assert-sovereignty-over-the-arctic-while-theres-still-time.

[41] Andrew Chaikin, "Is SpaceX Changing the Rocket Equation?" Air & Space Magazine, January 01, 2012, section goes here, accessed May 07, 2018, https://www.airspacemag.com/space/is-spacex-changing-the-rocket-equation-132285884/.

significantly due to the proliferation of cubesats and microsats, some no bigger than 1 kilogram.[42] In fact, it is possible now to purchase a constellation of 10 imagery satellites with "good enough" picture quality for $1 million USD which includes the lift into orbit.[43] Even that price could come down as commercial space launch becomes cheaper due to technological leaps in rocket body reuse made famous by Elon Musk and SpaceX.[44] For instance the cost to launch one pound of material into space has dropped from approximately $100,000 to $10,000 USD in the last twenty years.[45] In fact, one of Elon Musk's goals is to bring that price all the way down to $150 USD per pound.[46] Considering that the GoC spend an estimated $800B USD on the RADARSAT constellation, and now they could have a similar, albeit less sophisticated, capability for $1M a year it shows how to barriers to entry have come down.[47]

## CONCLUSION

The lines between the advancement of humanity and the advancement of military objectives have always been blurred with respect to the space domain. Entering the space domain has always been seen as a prestigious accomplishment for any nation; a show of economic, technological, and military might.[48] While ability to put a man on the moon was seen as a huge scientific leap for mankind, it was also unquestionably seen by the USSR as a display of military might. Space always has been and will continue to be a domain of dualities; part is dedicated to

---

[42] "Nanosats Are Go!" *The Economist* 411, no. 8890 (June 7, 2014): pg. #, accessed May 07, 2018, https://search.proquest.com/docview/1534131243.

[43] Ibid.

[44] Andrew Chaikin, "Is SpaceX Changing the Rocket Equation?".

[45] Ibid.

[46] "Nanosats Are Go!".

[47] "Canadian Radarsat Constellation Mission Delayed, Cost Rises by $400M," SpaceNews.com, November 05, 2012, section goes here, accessed May 07, 2018, http://spacenews.com/canadian-radarsat-constellation-mission-delayed-cost-rises-400m/.

[48] Chester A. Crocker, *Leashing the Dogs of War Conflict Management in a Divided World* (Washington, DC: United States Inst. of Peace Press, 2013).

the betterment of mankind and part is dedicated to its destruction. Unfortunately, the two different paths are usually inseparable.

For the reasons highlighted in this paper and dozens more, now is the time that Canada must get involved in the space domain. Space has been called an innovation ecosystem, where technological innovation is commonplace.[49] However, if Canada does not stay current or involved it is difficult and costly to catch back up to the pack. Canada must move with a sense of urgency concerning space. Canada can no longer afford to pretend that the space domain is some nebulous idea that only gets considered when deciding what astronaut to put on the International Space Station. It is no longer acceptable to be uneducated or naive when it comes to the space domain. The mistakes and ill-informed politicians that allowed BMD of North America to be likened to the weaponization of space have to be a thing of the past. These cannot continue to happen because there are threats in space that pose a much greater risk to the Canadian way of life than ballistic missile defense cooperation with the United States.

The national security of Canada is tied in too many ways to space. The citizens of Canada have become accustomed to a way of life that capabilities in the space domain have afforded them. The problem is these same capabilities can be held at risk by Russia and China. These two countries recognize the close alliance shared between the United States and Canada and would seek to negate the asymmetric advantages that the countries currently have in space. However, in doing so these military attacks would spill over into the civilian world. Power would stop flowing to the hospitals which provide universal health care to the citizens of Canada, because the power grid that relies on precise timing to control the flow of power would overload local

[49] *The Future of Canada's Space Sector: An Engine of Innovation for Over 50 Years*, working paper (Toronto: Aerospace Industries Association of Canada, 2016).

power substations.[50] Universal health care is a source of national pride for Canada and yet most people don't know that there is a dependency on space capabilities. Even worse, the Canadian government doesn't fully understand the ramifications of their reliance on space and move to both increase their presence and ensure their access to this global commons. As this paper has proven, it is imperative that the GoC take seriously what is happening in the space domain and educated themselves accordingly.

Looking forward, it is critical that the Canadian government or CAF identify a few mission areas that would produce the greatest benefits for the country and its allies, all while keeping in line with national objectives. This paper provided a few possible items that could be explored further. The first recommendation was to build on the SSA mission that the CAF has already undertaken through the SAPPHIRE satellite. The CAF has already shown that they have a suitable infrastructure to accomplish this mission and there is definitely a need among key allies to secure more sensors. The second recommendation of monitoring SATCOM links would require the stand up of an entirely new mission area in the CAF. However, the necessity for such a expertise is crucial as the CAF looks to implement the different mission areas outlined in SSE. The ability to monitor Canadian SATCOM links for interference will only become more important as the CAF looks to exercise these new SSE focus areas in operationally contested areas. Additionally, monitoring SATCOM is a key capability gap for the United States as they need more resources to monitor their ever growing use of SATCOM. Finally, this paper made the recommendation that Canada needs to pursue some of the new imagery technologies being realized because of small satellite technology. While this capability does not work to protect capabilities in the space domain like the first two suggestions, it can be a key component in

[50] "Timing," GPS.gov: Agricultural Applications.

protecting Canadian national security in the arctic in the coming years. Canada must look to non-standard solutions with respect to how it deals with the challenges that climate change will bring to the Canadian arctic; the new developments resulting from the increased commercialization of space is just one of those potential solutions.

As this paper has asserted numerous times, Canada can ill-afford to continue ignoring the space domain. The country needs to act in a unified approach to space to defend critical capabilities with and through allies to ensure access to the capabilities that shape the Canadian way of life. As the top space professional in the United States military recently stated "[we have] to defend and protect the space environment so space is available for exploration for every generation in every nation…we have to deter bad behavior in space and we have to deter conflict in space".[51] General Hyten goes on to state that no rational person wants a war in space, because no one wins if that happens. However, the United States has to be prepared to fight and win a war in space if it comes to that.[52] As one of the United States' closest allies, Canada has a big role to play in that.

[51] "Hyten: Deterrence in Space Means No War Will Be Fought There,".
[52] Ibid.

## Bibliography

Bell, Bryan M., and Evan T. Rogers. "Space Resilience and the Contested, Degraded, and Operationally Limited Environment." *Air & Space Power Journal* 28, no. 3 (November/December 2014): 130-48. doi:10.21236/ada618128.

Canada. Department of National Defence. Royal Canadian Air Force. *Royal Canadian Air Force Doctrine Note 17/01: SPACE POWER*. Department of National Defense, 2017. 1-43.

Canada. Department of National Defence. *Strong, Secure, Engaged: Canada's Defence Policy*. Copyright Her Majesty the Queen in Right of Canada, as Represented by the Minister of National Defence, 2017.

Canada. Standing Senate Committee on National Defence. *Responding to the Evolving Threat*. 2014.

"Canadian Radarsat Constellation Mission Delayed, Cost Rises by $400M." SpaceNews.com. November 05, 2012. Accessed May 07, 2018. http://spacenews.com/canadian-radarsat-constellation-mission-delayed-cost-rises-400m/.

"Canadian Space Milestones." Canadian Space Agency Website. May 03, 2016. Accessed May 07, 2018. http://www.asc-csa.gc.ca/eng/about/milestones.asp.

Chaikin, Andrew. "Is SpaceX Changing the Rocket Equation?" Air & Space Magazine. January 01, 2012. Accessed May 07, 2018. https://www.airspacemag.com/space/is-spacex-changing-the-rocket-equation-132285884/.

"Coming up in 2018 for the Canadian Space Agency." Canadian Space Agency Website. January 16, 2018. Accessed May 07, 2018. http://www.asc-csa.gc.ca/eng/blog/2018/01/01/2018-canadian-space-projects.asp.

Connerty, K.R. *SPACE TRAFFIC MANAGEMENT: IMPLICATIONS FOR CANADIAN ARMED FORCES SPACE POWER*. PhD diss., Canadian Forces College, 2017.

Crocker, Chester A. *Leashing the Dogs of War Conflict Management in a Divided World*. Washington, DC: United States Inst. of Peace Press, 2013.

*The Future of Canada's Space Sector: An Engine of Innovation for Over 50 Years*. Working paper. Toronto: Aerospace Industries Association of Canada, 2016.

"Global GDP 2012-2022 | Statistic." Statista. Accessed May 07, 2018. https://www.statista.com/statistics/268750/global-gross-domestic-product-gdp/.

"GNSS Frequently Asked Questions - GPS." FAA Seal. December 20, 2016. Accessed May 07, 2018. https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/faq/gps/#1.

Hitchens, Theresa. "Debris, Traffic Management, and Weaponization: Opportunities for and Challenges to Collaboration in Space." *Brown Journal of World Affairs* 14, no. 1 (Fall 2007).

Holder, Josh, Ekaterina Ochagavia, Lindsay Poulton, Monica Ulmanu, Emma Graham-Harrison, John Mullin, David Levene, and Terry Macalister. "The New Cold War: Drilling for Oil and Gas in the Arctic." The Guardian. Accessed May 07, 2018. https://www.theguardian.com/environment/ng-interactive/2015/jun/16/drilling-oil-gas-arctic-alaska.

Howell, Elizabeth. "What Is a Geosynchronous Orbit?" Space.com. Accessed May 08, 2018. https://www.space.com/29222-geosynchronous-orbit.html.

"Hyten: Deterrence in Space Means No War Will Be Fought There." U.S. DEPARTMENT OF DEFENSE. Accessed May 07, 2018. https://www.defense.gov/News/Article/Article/1061833/hyten-deterrence-in-spac/.

"Nanosats Are Go!" *The Economist* 411, no. 8890 (June 7, 2014): 18. Accessed May 07, 2018. https://search.proquest.com/docview/1534131243.

National Post. "Canada Must Assert Sovereignty over the Arctic While There's Still Time." National Post. November 02, 2017. Accessed May 07, 2018. http://nationalpost.com/opinion/canadas-must-assert-sovereignty-over-the-arctic-while-theres-still-time.

"RF Interference Mitigation." RF Interference Mitigation | Kratos Technology & Training Solutions. Accessed February 04, 2018. http://www.kratostts.com/solutions/satellite-and-space/rf-interference-mitigation.

"Timing." GPS.gov: Agricultural Applications. Accessed May 08, 2018. https://www.gps.gov/applications/timing/.

United States. Joint Chiefs of Staff. *Space Operations*. Annex: Defensive Space Control. Washington, D.C.: Joint Chiefs of Staff, 2012.

Wills, Colin. "The Role of Air and Space Power and Control of the Air." In *Unmanned Combat Air Systems in Future Warfare: Gaining Control of the Air*, 57-92. Basingstoke: Palgrave Macmillan, 2015.

"Xi Jinping's 19th Party Congress Speech Heralds Greater Assertiveness in Chinese Foreign Policy." The New Southbound Policy | Center for Strategic and International Studies. May 11, 2018. Accessed May 07, 2018. https://www.csis.org/analysis/xi-jinpings-19th-party-congress-speech-heralds-greater-assertiveness-chinese-foreign-policy.