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Global Impacts of Insecurity in Space the Canadian Armed Forces and the Emerging Domain of Space Defence

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GLOBAL IMPACTS OF INSECURITY IN SPACE
THE CANADIAN ARMED FORCES AND THE EMERGING DOMAIN OF SPACE DEFENCE

By Major R.A.A. Mackenzie

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ABSTRACT

Historically space has been an environment for peaceful, multinational cooperation. Space was remote and the technology required to access space was advanced and expensive. For that reason, only the wealthiest nations could conduct space operations. As technologies have become more cost effective, greater numbers of space actors have emerged. Smaller nations as well as non-state actors including private commercial industry are becoming significant actors in the space domain. The plethora of space actors has created a congested, contested and competitive nature to space operations. The actor who dominates in space will have an advantage on earth as well. A tone that is adversarial and untrusting is replacing the cooperative, trusting and peaceful one. Canada has determined that its national and strategic assets in space need protection from the myriad of threats that exist in the modern age.

Canada's current approach to space defence is similar to its national space strategy in that it maintains a focus on cooperation with partners and allies. This paper argues that in admitting that space is a threatened environment, Canada is acknowledging that it is also a warfighting domain. This reality demands that Canada develop a military space capability that is not only capable of contributing to collective defence and security of space, but also must be capable of independently conducting military operations to, in and from space.

CHAPTER 1: INTRODUCTION

> *I occasionally think how quickly our differences worldwide would vanish if we were facing an alien threat from outside this world. And yet, I ask you, is not an alien force already among us? What could be more alien to the universal aspirations of our peoples than war and the threat of war?*
>
> - US President, Ronald Reagan, Speech to UN General Assembly, 1987

Humanity launched the first artificial satellite, Sputnik 1, into earth's orbit in 1957.[1] Canada became a co-founder of the Committee of Space Research (COSPAR); and with the launch of the ALOUETTE 1 satellite, Canada became the third nation to have a satellite on earth orbit in 1958.[2] In the decades that followed, the world's dependence on satellites has exploded, and Canada has played a role in this growth.

The technology of satellites, including telecommunications and remote sensing, has evolved at an accelerating pace. There are now almost 3000 active satellites controlled by eleven different countries and in service to hundreds of other nations.[3] In 2020, the estimated number of artificial objects in space is a half of a million pieces of space debris ranging in size from school buses to tiny ball bearings.[4]

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[1] "Sputnik Moments." *The Economist,* 2019, 12. https://search-proquest-com.cfc.idm.oclc.org/docview/2226726391?accountid=9867.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020). CounterSpace Satellite Treats and Global Impacts of Insecurity in Space The Canadian armed Forces and the Emerging Domain of Space Defence were both authored by MacKenzie, R.A.A. during JCSP 47 and published by CFC. The introductions of both papers share historic references and phrasing that are the same.

[2] "Canadian Space Milestones," , accessed November, 2020, https://www.asc-csa.gc.ca/eng/about/milestones.asp.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

[3] "UCS Satellite Database," Union Of Concerned Scientists, last modified 5 December, accessed November, 2020, https://www.ucsusa.org/resources/satellite-database.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

[4] N. Johnson, *Orbital Debris Management & Risk Mitigation* (Washington, DC: National Aeronautics and Space Administration,[n.d]).13.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

The modern world is dependant on space-based platforms and technology in almost every conceivable aspect of life including communications, environment, agriculture, archeology, disaster management, weather tracking, navigation, commerce, medical, entertainment, security and defence just to name a few.[5] Canada shares this dependency and is a leader in space technology. Canada has invested billions of dollars into the development of space-based technology, and plans to continue in this manner into the future.[6]

Space is cluttered with artificial satellites and debris. Emissions interference and physical collisions are serious and credible concerns. New and advanced technologies emerge daily which increase the accessibility and use of space by, hither to now, non-space actors. The combination of these elements creates a perception of threat, and these threats are managed by individual nation states and coalitions. Invested nations often present an adversarial tone amid the congested, contested, and competitive domain of outer space.[7] The dependence on space-based platforms is global, and the loss of these capabilities would be catastrophic for all nations invested. This constitutes a national security threat and each state has a keen interest in protecting its assets from an economic, security, and defence perspective.[8]

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[5] "Satellites in our Everyday Lives," , accessed November, 2020, https://www.asc-csa.gc.ca/eng/satellites/everyday-lives/default.asp.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

[6] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* (Ottawa, Ontario , Canada: Her Majesty the Queen in Right of Canada,[2019]).; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

[7] R. G. Harrison, "Unpacking the Three C's: Congested, Competitive, and Contested Space," *Astropolitics* (2013)123.; R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interference on Orbit" Canadian Forces College, 2020),

[8] Wendell Codrington Wallace, *"National Security."* , ed. Bruce A. Arrigo, In The SAGE Encyclopedia of Surveillance, Security, and Privacy, ed.Thousand Oaks, CA: SAGE Publications, Inc., 2018), 647-54. 2

Many nations, including Canada, struggle with the tension created by wanting to contribute to a space environment that is weapons free and peaceful while protecting its own national strategic interests and security. Canada's strategy concedes that space is an operational domain but falls short of treating it as a warfighting domain.[9] However, many of Canada's allies and adversaries are actively pursuing space dominance through offensive counterpace capabilities. Canada's dependence on space constitutes a national security risk and as such, Canada needs to have an ability to preserve its freedom of operation there.[10] This will require a military space capability, yet no military capability can be effective if it focusses solely on the defensive and enabling attributes of the domain. Comprehensive military space defence needs to synergize the full spectrum of operational capabilities (offence, defence and enabling).

The most comprehensive strategies and defence policies view space as not only an operational domain but also a warfighting one. Warfighting in space will require an ability not only to dominate the current operational environment, but the one of the future. This future environment will likely see military capabilities operating on orbit and, while Canada is devoted to the peaceful use of outer space, defence in space will likely require an ability to operate in and indeed fight in that same environment.

This paper will argue that space is an operational warfighting domain and that the Canadian Armed Forces (CAF) should create a military space defence organization simultaneously capable of enabling offensive and defensive operations. This argument will be supported over five chapters. First, using current space threat assessments, this

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[9] Canadian Armed Forces, *Pan-Domain Force Employment Concept Prevailing in an Uncertain World* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2020b]).4

[10] Joan Johnson-Freese, *Space Warfare in the 21st Century: Arming the Heavens* (London: Routledge Taylor & Francis Group, 2016)68.

study will establish a comprehensive understanding of the threat environment. The second chapter will examine some of the theories associated with space defence. Third, this paper will conduct a policy review for the Canadian Space Agency (CSA) and the CAF. Chapter four will examine the space strategy and doctrine adopted by some modern space faring nations. The fifth chapter will be the examination of the Canadian Space Defence enterprise and substantiate a requirement for a Canadian Space Defence entity capable of full spectrum operations in the current and future security environment of space.

The international community accepts space as an operational domain. It is much less widely accepted to be a warfighting domain; however, the threat environment suggests that whomever dominates in space will also dominate on earth. As such, space dominance is critical to any nation's space defence capability. A nation must have freedom of operation to, in and from space in order to assert space dominance.

CHAPTER 2: SPACE THREATS

Introduction

The world today is a multipolar environment. It includes the dominant military, economic and technological power of the US interacting with a variety of emerging powers such as Brazil, Russia, India, China and South Africa (BRICS). There are additional poles created by coalitions, alliances and regimes such as the United Nations (UN) and the North Atlantic Treaty Organization (NATO). However, perhaps the greatest complicating participant in this multi-polar world are the non-state actors, private and commercial industry such as SpaceX, Blue Origin and OneWeb. These new poles positively contribute from a security, economic and trade perspective. However, without established rules-based and democratic policy for multi-national (MN) cooperation, international order can de-stabilize to the detriment and menace of all.

Consisting of two parts, this chapter will first examine space as an environment that has grown in importance and has changed over time. It will show that while the environment of space has evolved significantly, the policies that govern it have not and, as such, the tone of operations in space is changing from one of cooperation and transparency to one of mistrust and secrecy. It will define the elements that now exist which are changing the way the international community views space and how these views and perceptions are driving actions that are adversarial and combative in nature.

The second half of the chapter will define and discuss the space threats of the modern era. While the focus is military threats, one cannot fully appreciate military threat interventions without also understanding the complex and interconnected relationships between military space threats and environmental as well as non-state actor threats. The

conclusion this chapter draws is that, while space is a global common that should be a cooperative and peaceful domain for the benefit and prosperity of all, it has become both a threatened and threatening environment. Canada needs to take the necessary steps to protect its own space power while contributing to the preservation of a rules-based and cooperative space environment.

A Global Common

The earth is, in terms of measurement, the centre of the environment of outer space. There is no clear boundary for where the earth ends and space begins. However, there is something called the Karman line which is the point at which beyond it an object is capable of maintaining an unpowered orbit. This point occurs at 100km above sea level and is the jurisdictional line under international law.[11] The environment that starts at 100km above sea level and extends to infinity seems abundant, but the most contested, congested and competitive portion of space, as a global common, is this physical area around earth.[12] The categories of Satellite earth orbits are depicted below in Figure 1.1.

[11] Elirik Elvevold Billingso, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" NOVA FCSH Universidade Nova de Lisboa, 2019), 150.
[12] whitman, C and Wendy, N, *Privatizing Peace: How Commerce can Reduce Conflict in Space* (United Kingdom: Taylor and Francis Group, 2020), 56-75.57

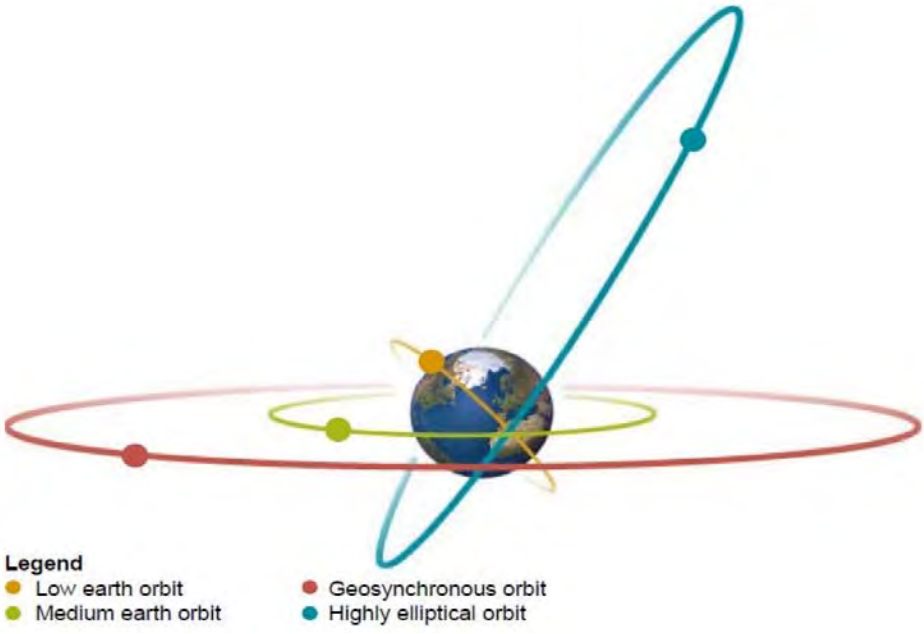

Figure 1.1 – Categories of Satellite Earth Orbit

(Department of National Defence, Royal Canadian Air Force Doctrine Note 17/01 2017)

Under current international law, a global common is a resource that is held in common by all of humankind over which sovereignty cannot be claimed by any state or entity. Examples of global commons are international waters and Antarctica. However, unlike terrestrial based commons, space is not as easy to access. Nevertheless, the benefits of and reliance on the global common of space are shared by both space faring and non-space faring nations. Furthermore, advances in technology are making accessing space easier and cheaper for everyone, including both state and non-state actors.[13] As the number of actors in space increases, the tone of space operations is migrating away from cooperative toward adversarial.[14] A set of international policies, regulations and

[13] Whitman, C and Wendy, N, Privatizing Peace: How Commerce can Reduce Conflict in Space (United Kingdom: Taylor and Francis Group, 2020), 57, 97.
[14] National Academies Press, *National Security Space Defense and Protection Public Report (Wa*shington, DC: National Academies Press,[2014]).7

mechanisms for governing space are essential to preserving the status of space as a peaceful global common.

International Guidelines and Regulations for Space Operations

A combination of treaties and agreements are the mechanisms through which the governance of operations in outer space is accomplished.[15] There are four essential international treaties and an additional four international agreements that govern the use of space.[16] To compliment this, four UN organizations provide oversight for the use of space. These are The Conference on Disarmament, the Committee on the Peaceful Uses of Outer Space, the International Telecommunications Union, and the UN General Assembly.[17] All of these mechanisms for governance and oversight reveal an international acknowledgement that the fair and peaceful use of space requires not only a regulatory oversight capability, but also an enforcement capability.

These mechanisms once ensured that space operations were subject to international law. However, as the use of space grew in scope, technology advanced and the number of space actors swelled, the policies proved inadequate. Conflict is no longer simply the combative attributes of traditional armed conflict; it has expanded to include

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[15] Buergenthal, T, Public International Law in a Nutshell or the Encyclopedia of Public International Law, vol. 7, 459-415. Treaties are international in nature, exist in written form and international law governs treaties. Agreements exist between two or more parties based on parameters agreed to by the invested parties. The parties involved govern agreements.

[16] The treaties are the Outer Space Treaty, which was created in 1967, The Rescue and Return Treaty, which was created in 1968, The Conventions on Liability which was signed in 1973 and finally, The Conventions on Registration which was signed in 1976. The agreements are The Limited Test Ban, established in 1963, The Anti-Ballistic Missile Treaty (ABMT) established in 1972, The International Telecommunications Convention, which was created in 1973, and The Convention on the Prohibition of Military and other Hostile Use of Environmental Modification Techniques, which was established in 1980. Elvevold, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" 150

[17] *Ibid*.

cyber, espionage, criminal and other non-violent acts of intimidation and coercion. The current space policies do not address grey zone aggression[18] and adversarial behaviour below the threshold of armed conflict. This has led to the degradation of transparency and confidence where international space governance is concerned.[19] The changing tone of space operations combined with antiquated mechanisms of governance and enforcement is driving dialogue concerning the potential for space war or conflict in space. Examining liberal and realist IR theory allows for an appreciation of conventional opinion on how to achieve equilibrium and preserve peace in a space environment.

International Relations Theories and Space

Space is subject to international treaties and space law.[20] Space is a significant focus for the UN and NATO and these bodies of governance maintain that the exploration and use of outer space shall be done for the benefit, and in the interests, of all of humankind and that space is to be free of weapons and arms.[21] Peaceful cooperation and mutual benefit have always been terms closely tied to the use of this global common. These guiding fundamentals have become strained in recent years with the creation of advanced technology, the proliferation of space-based platforms, the changing world dynamic, and the nature of conflict in the 21st century.

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[18] The U.S. Special Operations Command defines grey zone challenges as "competitive interactions among and within state and non-state actors that fall between the traditional war and peace duality." "Challenging the Grey Zone: The Changing Character of Warfare and the Application of International Law," , accessed April, 2021, https://www.law.upenn.edu/institutes/cerl/conferences/greyzone/.

[19] Elirik Elvevold Billingso, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" NOVA FCSH Universidade Nova de Lisboa, 2019), 150, 26.

[20] Cassandra Steer, "Global Commons, Cosmic Commons: Implications of Military and Security Uses of Outer Space," *Georgetown Journal of International Affairs* 1, no. 18 (2017)10.

[21] *International Space Law: United Nations Instruments,* (May, 2017): 10.; Committee on Peaceful Uses of Outer Space, *Towards a United Nations Space Policy* (New York: United Nations General Assembly.(2010),8,9.

No single universal body enforces space law. That enforcement is the responsibility of the nation of origin for each space-based platform.[22] Liberalist international relation (IR) theory posits that the characteristics of nations contribute to their international relations.[23] In the case of operating in space, nations will increase their soft power or span of influence by displaying characteristics of rules based international cooperation and sharing of resources for mutual benefit. Realist IR theory suggests that nations will act in their own interest and that different nations' interests can be in opposition to each other. From this perspective, deterring other nations from seeking advantage or hegemony in space happens through acts of hard power or coercion.[24] The liberalist IR perspectives and soft power equities gained through national characteristics conducive to cooperation and mutual benefit in space have begun to be overshadowed by the realist attitude of protection of self-interest and the hard power benefits of dominating and controlling the domain of space. Simply put, if a nation is vulnerable in space, then it is vulnerable on earth and the nation that dominates in space will dominate on earth.

Historically space power has been a great source of soft power. Liberalist theory suggests that space conflict has been avoided due to the requirement for cooperation and well-crafted regulatory institutions between space faring states. The Liberalist approach to space accounts for commercial competition through complex governance focused on negotiation and the use of advocacy coalitions and soft power.[25] During an era when the

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[22] *International Space Law: United Nations Instruments,* 46

[23] Slaughter, Anne-Marie, and Thomas Hale, *International Relations, Principal Theories* (Oxford: Oxford University Press, 2013)4.; A. Moravcsik, "Liberalism and International Relations Theory" harvard University, 1992), 10,11.

[24] W. J. korab-Karpowics, "Political Realism in International Relations," *The Stanford Encyclopedia of Philosophy*, no. summer (2018)1. https://plato.stanford.edu/archives/sum2018/entries/realism-intl-relations/.; Slaughter, Anne-Marie, and Thomas Hale, *International Relations, Principal Theories*4.

[25] Slaughter, Anne-Marie, and Thomas Hale, *International Relations, Principal Theories* (Oxford: Oxford University Press, 2013)4.8.33

number of space faring nations was relatively small and the technology challenging and expensive, space exploration did enjoy such a complexion. However, as space technology advances and the world's economies, militaries and communications become increasingly dependent on space-based platforms, the planet-wide desire to join the space-faring cohort has caused a level of international competition that falls short of soft-power liberalist theory.[26]

Realist theory posits that in this anarchic era of competition and insecurity in space, combined with the concepts of dual-use technology, nations have aligned their space activities into conflict groups and demonstrations of hard power.[27] This means that the most powerful and wealthy nations on earth have developed the greatest amount of influence in space. The weaker nations who cannot afford the developmental costs of an advanced military space program are dependent on and dominated by the great power nations.[28]

Realist theory maintains that truly powerful states engage in only self-benefitting behaviour and techno-nationalist realpolitik in space. International space politics is adversarial in nature and technological over-match and alliance building can serve as mechanisms to achieve balance between adversaries. Russia, China and the US, the three most dominant space powers of the 21st century, no longer fully cooperate in space. This undermines the strength of the policies, treaties and accords as they have lost the confidence of three of the most powerful space faring nations. It is evident that these

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[26] Trevor Brown, "Soft Power and Space Weaponization," *Air & Space Power Journal* 23, no. 1 (2009)70. https://search-proquest-com.cfc.idm.oclc.org/docview/217789348?accountid=9867.
[27] Elvevold, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" 9
[28] Elirik Elvevold Billingso, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" NOVA FCSH Universidade Nova de Lisboa, 2019), 9.

great power nations highly prize the commercial and industrial value of space and invest heavily in these areas. As more states learn the benefits of a space capability and that capability becomes increasingly accessible due to cheaper technology, the distribution of space power is migrating from a bi-polar to a multi-polar dynamic.[29] The multi-polar pursuit of space power has changed the character of space operations. What was once the peaceful cooperative domain of the few has become the competitive, contested and congested domain of the many.

Competitive, Congested and Contested

The Space environment is congested, competitive and contested. As identified by the CAF's DG Space BGen Adamson, the convergence of these three characteristics poses the greatest threat in space.[30] Space represents a precious resource that if harnessed and exploited, provides great benefit to the nation accessing it. Economically, technologically, militarily and politically space has become instrumental. All nations have grown dependent on, and eager to expand, their capabilities in space. The nation that dominates in space will have the competitive edge on earth.[31] This fevered competition has contributed to an issue of congestion.

Congestion in space is a major problem and presents a myriad of threats. The sheer number of artificial bodies in space is staggering and physically represents a significant threat. Firstly, these objects tend to remain in orbit indefinitely and can become erratic, unpredictable and cause collisions on orbit. These collisions not only

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[29] Elirik Elvevold Billingso, "War in Space: Why Not? A Neorealist Analysis of International Space Politics (1957-2018)" NOVA FCSH Universidade Nova de Lisboa, 2019),31.
[30] "Interview with BGen Adamson DG Space CAF." *Airforce Magazine* 44, no. 4 (25. https://www.rcafassociation.ca/the-magazine/current-issue/.
[31] Brown, "Soft Power and Space Weaponization," 67

cause damage to functioning satellites, but also create additional debris, which further exacerbates the problem. Secondly, the competitive advantage of having space-based assets and the requirement to send more space assets into orbit due to rapid advances in technology add to the issue of congestion on orbit. All of these myriad space platforms result in electronic emission pollution and interference. As such, the polluting effect of all of this congestion is in both the physical and the electromagnetic form.[32]

The combination of this competitive and congested environment has led to space migrating away from cooperative global benefit to a much-contested tone. Space faring nations are trending away from cooperation and due to acts of grey zone aggression and hybrid threats space powers are actively investing in and seeking military advantage. The fear is growing that space war is a possibility and the loss of space capabilities would be catastrophic. Accordingly, major world powers such as the US, Russia, China and India are undergoing major reorganization of their military space capabilities and activities, which has contributed to a globally adjusted focus to space now being a potential war-fighting domain.[33] When considering the competitive, congested and contested nature of space, there are a number of categories for threats that emerge which help in terms of understanding the scope and complexity of the space threat environment.

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[32] von de Dunk, F. G., "A European "Equivalent" to United States Export Controls: European Law on the Control of International Trade in Dual-use Space Technologies ," *Astropolitics* 7 (2009)147. https://www.tandfonline.com/loi/fast20.

[33] Secure World Foundation, *Global Counterspace Capabilities: An Open Source Assessment* (525 Zang Street, Broomfield, Colorado and 1779 Massachusetts Ave NW, Washington, DC: Weeden Brian, Samson Victoria,[2019]).xiv; Defense Intelligence Agency, *Challenges to Security in Space (US*A: DIA Military Power Publications,[2019]). 36

Military Threats

Counter space weapons vary significantly, ranging from the extremely expensive and technologically advanced to the inexpensive and comparatively technologically simple. Additional factors to consider when assessing their level of threat is how precise, destructive and permanent their effects are. All of these factors vary to certain degrees for each type of counter space weapon. According to the Center for Strategic International Studies (CSIS) Space Threat assessment 2020, modern military counter space weapons break down into four categories: Kinetic-Physical, Non- Kinetic Physical, Electronic, and Cyber.[34]

Kinetic Physical counter space weapons are warheads designed to directly engage or detonate in proximity to a satellite or ground terminal/station. These types of weapons can include direct-ascent Anti-Satellites (ASAT) that are designed to strike a space based platform using a trajectory that the target cannot counteract without placing the interceptor into orbit. It is possible to upgrade ballistic missiles or missile defence interceptors to accomplish this if they have the necessary thrust/energy to reach the target's orbit.[35]

Co-orbital ASAT weapons are different from direct ascent weapons in that these objects can remain on orbit for a period ranging from days to months. During this period, they are completely dormant until they receive the command to engage a target. At this

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[34] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020* (1616 Rhode Island Avenue NW Washington, DC 20036: Center for Strategic and International Studies,[2020]).2, 3.

[35] Defense Intelligence Agency, *Challenges to Security in Space 36*

point, they manoeuvre to and strike the object while they are both on orbit.[36] In addition to Co-orbital ASAT and Direct Ascent ASAT, ground based terminals and ground stations are vulnerable to conventional long-range missile and small arms attack.[37]

Both the Direct Ascent and Co-orbital technologies are sophisticated and expensive. These types of weapons are generally trackable; so attribution of responsibility is possible and has an effect that is destructive and irreversible. Additionally, the attacker will likely know if their strike was successful quickly if not immediately.[38]

Non-Kinetic Physical counter space weapons employ methods such as lasers, high-powered microwave (HPM) and electromagnetic pulse (EMP). These weapons are capable of having effects on space assets when making physical contact with their target. They employ technology that is extremely expensive, sophisticated and difficult to assess for effectiveness.[39] Lasers can damage sensitive satellite components and solar arrays. They can either temporarily dazzle or permanently blind sensors.[40] HPM weapons can disrupt a satellite's electronics, cause data to be corrupted or lost and in some cases, can cause permanent damage to electrical circuits. HPM weapons need to be in relative proximity to be effective and, as such, are most effective from space-based platforms.

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[36] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020*2, 3.
[37] Firth Niall, "How to Fight a War in Space (and Get Away with it)," *MIT Technology Review,* July, 2019, .
[38] Brian G. Chow, "Stalkers in Space: Defeating the Threat: SSQ," *Strategic Studies Quarterly* 11, no. 2 (2017), 82-116. https://search-proquest-com.cfc.idm.oclc.org/docview/1923045318?accountid=9867.; J. Hecht, "Dual Threat," *Bulletin of the Atomic Scientists* (Sep, 2015)15.
[39] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020*.3.
[40] Firth Niall, "How to Fight a War in Space (and Get Away with it)," Defense Intelligence Agency, *Challenges to*
Security in Space 9.

EMP weapons tend to have indiscriminate effects. Nuclear weapons detonated on orbit would have an effective, yet indiscriminate, impact on any space platform in range.[41]

Electronic counter space weapons target the transmitters and receivers of space infrastructure. This is through methods such as jamming and spoofing. The technology required for this type of radio frequency (RF) jamming is cheap, readily available and inexpensive. The effects of these types of attacks are generally limited duration and non-destructive.[42] Jamming can also be very difficult to detect and hard to distinguish from accidental interference due to the extreme congestion on orbit.[43] Spoofing is the electronic trickery wherein the targeted system is fooled by the targeting system. Through spoofing technology, it is possible for an adversary to take control of a targeted satellite. Again, this technology is relatively inexpensive and accessible, and attribution can be challenging.[44]

Cyber counter space weapons target the data and the systems rather than the hardware. Cyber-attacks can be in the form of monitoring and or manipulating a targeted system's data. While the technology is relatively inexpensive, it does require a certain level of understanding of the targeted system in order to be effective. Cyber-attacks can be devastating as loss of data, catastrophic disruption and even satellite platform loss can

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[41] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020*, 4

[42] Firth Niall, "How to Fight a War in Space (and Get Away with it),"

[43] Defense Intelligence Agency, *Challenges to Security in Space 9.;* Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020*, 4.

[44] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020* (1616 Rhode Island Avenue NW Washington, DC 20036: Center for Strategic and International Studies,[2020])., 4

be the result.[45] Cyber-attacks can be extremely difficult to attribute since they can conceal their identity or use commandeered/hijacked servers to perpetrate their attacks.[46]

China, India, USA, Russia, North Korea, Iran, France, Israel and the UK all possess some or all of these technologies. In 1959, the US tested its first ASAT weapon, which makes such weapons almost as old as the space program itself. Examples that are more recent include China's first ASAT test in 2007 followed up in 2013 by its second and more advanced test of ASAT.[47] In 2018, Russia tested an aircraft launched ASAT weapon and repeated it again in 2020.[48] In 2019, India conducted its first ever ASAT test.[49] The proliferation of these counter space weapons in a multi-polar space environment constitute a major threat to the cooperative and peaceful operation in space. Yet it is not just in the military sphere where threats in space exist.

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[45] B. Weeden, *Case Study of the Interagency Process for Making Presidential Policy Decisions on Dual-use Space Technology: The Global Positioning System and Space Traffic Management* (George Washington University: The Columbia College of Arts and science, 2017)9-1. "Paradoxes of the Grey Zone," last modified Feb, accessed November, 2020, https://www.fpri.org/article/2016/02/paradoxes-gray-zone/#:~:text=Gray%20zone%20conflict%20is%20best,conflict%20and%20open%20interstate%20war.&text=Gray%20zone%20challenges%2C%20in%20other,ambiguous%20and%20usually%20incremental%20aggression.;B. L. Triezenberg, "Deterring Space War an Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space War" Pardee RAND Graduate School, 2017), 1-93.,31;E. Bowen leddyn, "From the Sea to Outer Space: The Command of
Space as the Foundation of Spacepower Theory," *Journal of Strategic Studies* 42 (2017).541.

[46] Harrison Todd, Johnson Kaitlyn, Roberts Thomas G. , Way Tyler, Young Makena, *Space Threat Assessment 2020*,5

[47] "Chinese ASAT Test," , accessed Jan, 2021; George, J.P., History of Anti-satellite Weapons: US tested first ASAT missile 60 years ago, March 27 2019, https://www.theweek.in/news/sci-tech/2019/03/27/history-anti-satellite-weapon-us-asat-missile.html.

[48] "Russia Tests Direct-Ascent Anti-Satellite Missile," , accessed Jan, 2021, https://www.spacecom.mil/News/Article-Display/Article/2448334/russia-tests-direct-ascent-anti-satellite-missile/.; H. Weitering, "Russia has launched an anti-satellite missile test, US space command says," 16 December 2020, https://www.space.com/russia-launches-anti-satellite-missile-test-2020 .

[49] George, J.P., History of Anti-satellite Weapons: US tested first ASAT missile 60 years ago, March 27 2019, https://www.theweek.in/news/sci-tech/2019/03/27/history-anti-satellite-weapon-us-asat-missile.html.

Environmental Threats

Space is a medium in which nations chose to operate, and through which natural energies and resources must pass. The international laws that govern space and protect against its pollution hold the state of origin responsible for the effects caused by its space assets.[50] Not all states employ the same standards for governance where the preservation of space as an environment is concerned.[51] Operating in space is expensive and creates a dynamic of "have" verses "have not" space powers.[52] To operate responsibly, and assuring that space does not become degraded, is even more expensive and adherence to these standards can cause a widening of the power gap and further disadvantage smaller states.

Space exploration, as an industry, is a polluting one. Noise, fossil fuel exhaust, dust as well as debris are all by-products of the launch phase for every object put into orbit. Once on orbit, electromagnetic emissions, more debris and radiation are all results.[53]

Space debris is by far the greatest environmental and pollution related concern on orbit.[54] From paint-flecks to objects the size of school busses, there are over 500,000

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[50] L. Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future* (Leiden Boston: Martinus Nijhoff Publishers, 2008)21.
[51]UN General Assembly, *Role of United Nations Entities in Supporting Member States in the Implementation of Transparency and Confidence-Building Measures in Outer Space Activities United N*ations General Assembly,[2016b]). 6; Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future*21,23.
[52] Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future.* 21,23.
[53] L. Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future* (Leiden Boston: Martinus Nijhoff Publishers, 2008), 29..
[54] von de Dunk, F. G., "A European "Equivalent" to United States Export Controls: European Law on the Control of International Trade in Dual-use Space Technologies ," , 101-133131.

pieces of debris on earth's orbit and all of them are capable of causing physical damage to other space infrastructure and, by virtue of that, creating even more debris.[55] These objects can and do hinder our ability to perform observation from earth into deeper space.[56]

Some of these objects consist of nuclear reactors and, when these systems are de-commissioned, they remain on orbit. In some cases, these objects will re-enter earth's orbit and crash back to earth, causing significant and dangerous radioactive pollution.[57] For a population that lives beneath the orbit of a nuclear propelled satellite, this could be dangerous. An example of this type of dangerous situation took place on 24 January 1978 in the Northwestern territories of Canada. The Soviet satellite Cosmos 945 had an un-programmed re-entry into earth's atmosphere. It was equipped with a uranium-fueled nuclear power source. The satellite disintegrated on re-entry and scattered radioactive debris across a large swath of land in northern Canada. Analysts assessed that some of the recovered material was lethally radioactive and had it landed in a more populous area, massive damage to health and property would have resulted.[58]

The complex operating environment of space means that military interventions and mechanisms for defence need to be both capable of operating within a contaminated and polluted environment as well as compliant with all environmental policies and standards. Many of the leading edge technologies for the safe and efficient operation in

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[55] Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future*29
[56]Defense Intelligence Agency, *Challenges to Security in Space 35*; Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future*29, 33.
[57] Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future,* 48.
[58] L. Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future* (Leiden Boston: Martinus Nijhoff Publishers, 2008)29.;B. Aikman, "Chapter 10, Operation Morning Light," in *Canadian Arctic Operations, 1941-2015 Lessons Learned, Lost and Relearned.*, ed. Adam Lajeunesse Whitney Lackenbauer (Fredericton, NB: The Gregg Centre for War & Society, 2017)245,246.

space are not government controlled or funded innovations, but rather originate from private industry.[59] These commercial businesses therefore have military impact and defence significance as non-state actors.

Non-State Actor Threats

Commercial competition in space can be a very good thing and may even contribute to the stabilization of space. SpaceEx, Blue Origin and other commercial organizations are making advances in technology and rendering space accessible to both less wealthy states and civilian organizations and businesses. There are elements that cause non-state actors to fall under the category of potential space threat. Firstly, the current treaties, policies and mechanisms for governance are created for nation states.[60] Private business and commercial enterprise are only beholden to the laws and regulations that their parent nation enforces. In order for this to be rectified and ratified, the laws pertaining to space use need to expand to better protect and govern non-state actors. Secondly, is the issue of dual use technology. Much of the technology used for private business and commerce also supports military services.[61] In fact, much of the world's defence communications are provided through civilian satellite platforms. Distinction becomes an issue where dual use/purpose technology is concerned.

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[59] Hecht, "Dual Threat," , 14-16, 15; A. Ferreira-Snyman, *Legal Challenges Relating to the Commercial use of Outer Space, with Specific Reference to Space Tourism, Vol. 1*7 (AJOL: Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad, 2014)5.; Weeden, *Case Study of the Interagency Process for Making Presidential Policy Decisions on Dual-use Space Technology: The Global Positioning System and Space Traffic Management*2

[60] Whitman, C and Wendy, N, *Privatizing Peace: How Commerce can Reduce Conflict in Space*97, 114.

[61] R. S. Strapp, "Space Dominance can the Air Force Control Space?" Air Command and Staff College, 1997), 24.; Whitman, C and Wendy, N, *Privatizing Peace: How Commerce can Reduce Conflict in Space*97.

There is no aspect of Canadian daily life that is not dependent on space infrastructure. Some of this infrastructure is in the form of ground based control stations and terminals. Some are research and development labs and research facilities. Much exists as space-based platforms and spacecraft on earth's orbit as well. This entire infrastructure is vulnerable to the myriad of space threats defined in this chapter. In 2017, the Senate Committee on National Security and defence published a report that recommended, amongst other things, that Canada designate satellites and radar installations as critical infrastructure. It further recommends that Canada work closely with allies to determine ways to secure this critical infrastructure against cyber, electromagnetic and physical threats.[62]

Conclusion

Space is ubiquitous to the Canadian way of life and, because of this; it represents Canada's greatest vulnerability. Security is important in and of itself, but more so when considering the national dependence on space and the myriad of space threats to contend within that environment. Canada is vulnerable to military, environmental, commercial and criminal space threats. The comfort generated from a liberalist, soft power approach to collectively managing and sharing the global common of space has been replaced by an adversarial realist approach bent on domination through the hard power equities of technological and economic advantage and coalitions. While the political management of space defence might be delicate, the military approach will need to be comprehensive and robust.

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[62] Government of Canada, Senate Report of the Standing Senate Committee on National Security and defence, Military Underfunded: The walk must match the Talk, April 2017, 29-30.

Space has been a long-standing source of soft power and Canada has a stake in ensuring that it remains as such. Canada faces an era where its desire to preserve space as a peaceful and cooperative global common for the benefit and prosperity of all is being challenged by a requirement to protect its national strategy and space power in this operational and warfighting domain. To understand this dilemma, one must first comprehend where a nation derives its power and what theories exist that explain the nature of conflict that emerges from power competition.

CHAPTER 3: DEFENCE THEORIES & SPACE

Introduction

Currently, there is no universally agreed upon definition of space power. The 2020 US Defense Space Strategy (DSS) summary defines it as "The sum of a nation's capabilities to leverage space for diplomatic, information, military, and economic activities in peace or war in order to attain national objectives."[63] From this definition, one can extrapolate that the source of a nation's space power is space-based technologies that provide an economic, technological, military and political advantage.[64] These sources of advantage constitute strategically important, if not critical, national assets. The advantage provided by using space technology is extremely potent and many nations' dependence on these assets has grown significantly to the point of dependence without redundancy.[65] Strategic assets need protection from interference and hostile acts of subversion. These assets are vulnerable and, in order to solidify a nation's space power, they must enjoy secure freedom of operation in space. Thus, the combining of economic, commercial, technological, political, security and defence in space is critical to maximizing a nation's space power as a part of that nation's grand strategy.[66]

This chapter will first discuss the literature on the modern treatment of the subject of the operational domain of space. It will then discuss the different aspects of these theories and their relation to defence in more conventionally understood environments such as land, sea and air. It will support the overall argument that Canada is a leader in space and, in order to maintain that status, it will need to design a space defence strategy that accounts for leadership in space defence as well. Finally, this chapter will consider

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[63] US DoD, *Defense Space StrategySummary (WA*SHINGTON: United States DoD,[2020]).*2.*
[64] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020]).13
[65] B. Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma* (USA: Taylor & Francis Group, 2021)65.
[66] leddyn, "From the Sea to Outer Space: The Command of
Space as the Foundation of Spacepower Theory," 541

what this discussion means for Canada and the Canadian Space Defence Enterprise (CDSE).

Literature Review

Doctrine is an important aspect of military literature, and there is a growing body of doctrine dealing with the emerging space domain. NATO doctrine breaks the space domain down into three operational mission areas. First is Space Situational awareness. The second is Space Force Enhancement; and the last is Space Control. The first two fall under the Information-centric space defence theory. It posits that space is inherently cyber in that the reason and purpose of space assets, both space born and terrestrial based, are for the purposes of information collection, sharing and use. As such, detection, surveillance, communications, time and location tracking are all functions wholly dependent on data transfer through space infrastructure. This cyber aspect constitutes one of the predominant space defence theories.[67] The third operational mission area falls under the Space control first space defence theory.

U.S. Space Force produced a space doctrine in 2020 entitled Space capstone publication *Space Power Doctrine For Space Forces*. This doctrine identifies the typical basis for its existence because of the ubiquitous nature of space and the reliance that the modern way of life has developed on space technology and access. It further describes the changing nature of space from historically being a peaceful domain of the great power nations of the word to a contested, congested and competitive domain accessed and

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[67] B. Townsend, "Space Power and the Foundations of an Independent Space Force," *Air and Space Power Journal*, no. winter (2019)18.;NATO, *Nato Standard Ajp-3.3 Allied Joint Doctrine for Air and Space Operations, B ed.NATO* STANDARDIZATION OFFICE (NSO), 2016)5-6.

employed by myriad nations.[68] The US and its allies desire a space domain that is stable, secure and accessible to all. The US sees the space actions and operations of its adversaries as a fundamental threat to the stable, secure and peaceful employment of space. As such, the space domain is instrumental to US space power. The threat to this space power constitutes a national threat, and as such, space has become a warfighting domain. Military space warfighters are those military forces whose task, role and purpose is to protect, defend and project military power to, from and in the space domain.[69]

Space is an environment, a physical space that, from a warfighting and defence perspective, it shares much in common with the air domain; it is both separate and distinct in its make-up, physical attributes and potential for operational employment. The theory posits that all other functions of space happen through a nation's control of space. This theory of defence of space as a physical environment is the space control-first theory as represented in scholarly discussion of space.[70]

Academic work and professional discourse on the domain of space focuses largely on the changing dynamic of IR resulting from the emergence of the space domain as a military operational domain. Much of what constitutes the UN's dialogue on the subject is in the form of General Assembly reports focussed on preventing the weaponization of space.[71] This line of dialogue is acknowledged in the strategic space

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[68] United States Space Force, *Space Power Doctrine for Space Forces*, iv.
[69] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])..,, vi.
[70] R. Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space* (USA: Aerospace Corporation,[2019]).. 1
[71] UN General Assembly, *Committee on the Peaceful Uses of Outer Space Fifty-Ninth Session* (Vienna: United Nations,[2016a]).; United Nations Office for Outer Space Affairs, *International Space Law: United Nations Instruments (Vienna: U*nited Nations,[2017]).;UN General Assembly, *Towards a United Nations Space Policy Working Paper Submitted by the Chair* (Vi*enna: United Nations,[2010]).

policies published by Canada,[72] France,[73] The United Kingdom[74] and the United States (US).[75] Simultaneously, most national strategic policies clearly identify that space is an essential element to their national grand strategies and, as such, requires protection. Most of these national policies highlight the importance of space defence but fall somewhat short of stating that space has become a warfighting domain. This distinction seems mainly to be captured under the military strategic policies of the United States and China.[76]

Primary resources that define the threat environment are the Secure World Foundation (SWF) and the Center for Strategic and International Studies (CSIS). Though there are many secondary sources on the subject of space defence, there are only a few academics writing them. The works of these authors tend to fall into the categories of: theoretical discussion on the nature of space warfare and the future of space defence, international relations implications of a contested, congested and competitive space domain, the pacification of space operations for a mutually beneficial and cooperative outcome, and finally space dominance.

In his article entitled "Soft power and Space Weaponization," Trevor Brown highlights that the United States has injured its ability to leverage space for its soft power equities. He discusses parallels with the US's maritime history and recommends civilian

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[72] Department Of National Defence, *Strong Secure Engaged Canada's Defence Policy* (Ottawa, Ontario , Canada: Her Majesty the Queen in Right of Canada,[2017b]).
[73] The French Ministry for the Armed Forces, *Space Defence Strategy (France*: Government of France,[2019]). 31
[74] UK Ministry Of Defence, *Towards a Defence Space Strategy (UK: UK Min*istry Of Defence,[2020]).
[75] US DoD, *Defense Space StrategySummary*
[76] A. J. Tellis, "China's Military Space Strategy," *Survival* (2007)60. https://www.tandfonline.com/doi/full/10.1080/00396330701564752.; US DoD, *Defense Space Strategy Summary, 1*

commercial methods to achieve space supremacy rather than military ones. This would increase power and influence in space without driving military escalation and confrontation in that domain.[77]

J. Hecht's article "Dual Threat" in the *Bulletin of the Atomic Scientists* discusses the challenges presented through dual use technologies both in terms of security but also in terms of distinction. It discusses economic and defence benefits gleaned through dual use technology while opening the door to harming national interest when civilian infrastructure becomes military targets, and examines the ethical dilemmas concerning distinction that could emerge.[78]

Howard Kleinberg has written extensively on the subject of space power and space warfare theories. His analysis applies a first principle approach to the nature of warfare as defined by war theorists like Clausewitz, Douhet and Jomini and applies them to the relatively new warfighting domain of space. Kleinberg posits that while space is a new and unique operational domain, the theoretical nature of warfare has not changed and many fundamental elements of terrestrial warfare remain extant in the space domain as well[79]

Charity Weeden has contributed to a variety of different articles on the subject of space defence, but perhaps her most interesting contribution comes in the form of a dissection of the Canadian Armed Forces Policy *Strong, Secure, Engaged* (SSE). Weeden's article "Strong, Secure, Engaged in a Threatened Space Domain" addresses the problem space facing the CAF while showing where and potentially how SSE could

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[77] Brown, "Soft Power and Space Weaponization," , 66-72,127
[78] Hecht, "Dual Threat," , 14-16
[79] H. Kleinberg, "On War in Space," *Astropolitics* (2007), 1-28.;

define its solution space. Her argument is that while the CAF has made progress in identifying the requirement for defence of the environment of space, if falls short of identifying how.[80]

Russell Rumbaugh discusses the schools of thought governing the operational environment of space from a military perspective. He acknowledges the newness of the theoretical subject and that there is currently no shared consensus on it. However, he does focus the reader on the main theoretical schools of thought that govern not only the current operating environment, but also the ones of the future. His explanations (elaborated on below) help the reader to understand what is motivating the contemporary decision making process for national defence.[81] They also relate to the dominant space theories.

Theories

Space activities fall into the four categories of civil, commercial, intelligence and military.[82] Similar to the sea, land and air domains they can be utilized for peaceful, economic, diplomatic and informational purposes if supported by a capable and disciplined military entity.[83] Military space activities are those which strive to achieve political aims through either offensive or defensive operations in, through or from space.[84] This depicts military space activity as extending beyond enabling terrestrial

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[80] C. Weeden, "Strong, Secure, Engaged in a Threatened Space Domain," *Canadian Global Affairs Institute* (2018), 1-9.1-9
[81] Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space*
[82] R. Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space* (USA: Aerospace Corporation,[2019])., 7
[83] J. L. Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces* (USA: IS Army War College Press, 2018).xii
[84] J. L. Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces* (USA: IS Army War College Press, 2018), 8.

military operations from space to the prosecution of military action in the domain of space itself.

The belief that outer space is an entirely collaborative and cooperative environment is inaccurate.[85] As discussed in the previous chapter, space is congested, contested and competitive. To further complicate things, it is remote, expensive to reach and insufficient to support organic life. Due to the inherently inhospitable and hostile nature of the space environment, the successful manipulation, use and exploitation of the space environment is dependent on technology.[86] Many nations are developing technologies to both exploit the benefits of and for conducting warfare in space.[87] In his essay entitled "On War In Space," Howard Kleinberg posits, "The nature of warfare does not change fundamentally just because the nodes are orbiting in space and the lines are electromagnetic in nature."[88] Thus, it is logical to look at some conventional examples of warfighting theories as a means to understand those specific to the domain of space.

Conventional Warfighting Theories

It is possibly easier to discuss space defence theories by first considering the similarities that the space domain shares with the other more conventional domains. Warfighting principles and theories may be relevant across more than one domain.[89] Concepts such as pitting one's strength against the enemy's weakness in order to achieve advantage, severing lines of communication (LOC) and imposing one's will over that

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[85] *Ibid*, xii
[86] John J. Klein, *Understanding Space Strategy: The Art of War in Space*, 1st; 1 ed., Vol. 1 (Milton Park, Abingdon, Oxon; New York, N.Y: Routledge, 2019). 48
[87]Kleinberg, "On War in Space," , 1-28
[88]H. Kleinberg, "On War in Space," *Astropolitics* (2007), 1-28.
[89] H. Kleinberg, "On War in Space," *Astropolitics* (2007), 1-28. 5.

enemy to achieve victory transcend all operational domains.[90] The terms key terrain and vital ground define spatial, geographic positions of advantage. LOC are those routes, physical, and electromagnetic, through which a military force can project and sustain itself.[91] All of this terminology remains relevant in the considering of space as a warfighting domain.

There are ample similarities between naval warfare and space warfare, while the domains of air and space certainly have a great deal in common.[92] As a physical entity and global common, space and the sea are similar environments.[93] They are both mediums through which commerce thrives.[94] They are also environments that are sources of natural resources of great value as well as subjects of study and research.[95] Ultimately, from a security perspective, sea and space are environments that contain similar concepts for routes and sectors that are valuable for their navigability, such as shipping lanes in the sea verses orbital slots/lanes in outer space; ports verses launch sites, anchorages verses space stations.[96] The sea and outer space are both environments, inside of which human life is unsupportable without technology. Nations secure these domains by a persistent and technologically robust military and security presence.[97] The conduct of operations in

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[90] *Ibid;* Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma*57
[91] *Ibid.*
[92] Hays, P, Rumbaugh, R, Gleason,M., *Developing a Foundational Spacepower Doctrine: Fostering an Independent Space-Minded Culture and Identity (USA: CENTE*R FOR SPACE POLICY AND STRATEGY,[2021]).5
[93] *Ibid;* Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces*45
[94] Triezenberg, "Deterring Space War an Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space War" 1-9331.
[95] B. L. Triezenberg, "Deterring Space War an Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space War" Pardee RAND Graduate School, 2017), 1-93.31
[96] Kleinberg, "On War in Space," , 1-28,10
[97] *Ibid;* Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces*45

both the sea and space tend to employ platforms that remain on station in that environment for months and years rather than hours, days or weeks.[98]

Air operations and space operations have some similarity also, although in different ways. The air environment and space environment envelop the land and sea domains and as such are uniquely positioned to support and enable operations in those environments.[99] Both operate in the third dimension, and so there are no physical boundaries or borders in the air or outer space.[100] Additionally, there are no terrain features in either air or space, which tend to characterize these domains as more offensive than defensive in nature.[101]

In its infancy, air power executed reconnaissance and artillery spotting tasks.[102] This proved advantageous, and despite being a purely supportive or enabling function, it contributed to the warfighting effectiveness of both the land and naval forces of the period. This advantage created the contentious nature of the air environment and, in order to topple that advantage, enemies began to target those air assets both in the air and on the ground.[103] As such, the air environment became a battleground or warfighting domain in and of itself inside of which the combination of land, sea and air assets targeted enemy air assets. Furthermore, when combined with air power, both land and sea power were complemented and strengthened. Throughout time air power evolved from simply being an enabling, info gathering function to a major combat oriented entity capable of strategic

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[98] Kleinberg, "On War in Space," , 1-28, 10
[99] Townsend, "Space Power and the Foundations of an Independent Space Force," , 11-22,21
[100] Kleinberg, "On War in Space," , 1-28, 12.
[101] B. Townsend, "Strategic Choice and the Orbital Security Dilemma," *Dtrategic Studies Quarterly P Perspective* Spring (2020), 64-90.75.
[102] Space Power and the Foundations of an Independent Space Force. 21.
[103] Kleinberg, "On War in Space," 18, 12.

access, operational enablement and tactical combat.[104] Air power concepts evolved and became most effective when achieving the status of superiority or supremacy in that environment.[105] This status ensured that friendly forces enjoyed full freedom of action and benefit from that domain while denying the same to the enemy.[106]

The similarities between space and other warfighting domains are apparent and it is relevant to consider the nature of warfare in general as a means to better understanding emerging concepts of space warfare. Space is simultaneously a physical space and an operational medium and each of these components has similarities with the sea and air domains. Space too has critical infrastructure, lines of communication and key and vital physical spaces.[107] The space domain, as a warfighting environment, is comparatively new and, as such, there is a dearth of experiential evidence for how to employ it in a warfighting scenario. However, by examining the developmental trajectory of the air force and its evolution as a warfighting domain, we can get the clearest appreciation for the potential and even likely path that the space domain will follow.

Space Warfighting Theories

Russell Rumbaugh identifies six different schools of thought that govern military space operations. The initial one is the space control first theory, which draws on historical context from land, sea and air domains. This theory posits that a domain requires presence and dominance to establish control and maintain freedom of operation

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[104] H. Kleinberg, "On War in Space," *Astropolitics* (2007), 1-28.16. This is similar to Rumbaugh's *Keeping the Plumbing Running* theory. Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space*, 10

[105] Kleinberg, "On War in Space," , 1-28 14.

[106] *Ibid,* 14

[107] *Ibid*, 11.

within that domain. Second is enable global missile warfare, which accepts the central role that precision-guided munitions play in warfare across all domains, including space. Third is keeping the plumbing running theory, which posits that traditional domains will continue to dominate warfare and that space will remain an enabling domain.[108] Fourth is frictionless intelligence. In this theory, the intelligence gathering aspects of the space domain supersede all other military elements of the domain. The fifth, nuclear weapons matter most, theory declares nuclear weapons as the greatest military threat in existence and, as such, space needs to focus efforts to mitigate the threat of nuclear weapons. The sixth and final school is galactic battle fleet. This theory sees a requirement to focus, on not only the current threat environment in space, but also the future space domain. This theory emphasizes preparations for the conduct of military operations on earth's orbit as a physical force dominating in that domain as a space based fighting force.[109]

In its current state, space power is focused on information. Space is inherently cyber and the true power function of space power lies in the ability to use and maximize the benefits of information.[110] This was a similar situation to the role of all military power, in that, deception, surprise, manoeuvre, dislocation and concentration are all critical aspects to achieving victory and avoiding defeat in war.[111] Commercially, banking, trading, entertainment and communications are all sources of information that are passed through, or managed by, space-based infrastructure.[112] Similarly, security

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[108] Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space*,1, 1, 4, 7, 10.
[109]Ibid, 13, 15, 17.
[110] Rajeswari Pillai Rajagopalan, *Electronic and Cyber Warfare in Outer Space (Ge*neva, Switzerland: United Nations Institute for Disarmament Research,[2019]).5.
[111] Kleinberg, "On War in Space," , 1-28, 5.
[112] Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces*,Xii.

information such as military intelligence, criminal data and surveillance, marine fleet tracking, environmental and natural disaster prediction are but a few examples of the security-centric information that is dependent on space based platforms.[113] Space defence is not only about the use of this security information for military purposes here on earth, but also the protection of all of that information in order to protect and secure the Canadian economy and way of life. The best way to protect the information is to protect the assets that manage it and the best way to protect those assets is through the achievement of superiority or supremacy in that domain.[114]

The nation with the greatest space presence will have the greatest influence (commercial, military, and policy).[115] Dominance in space means dominance on earth.[116] If a nation will behave in accordance with game theory, then it will act in accordance with its own best interests, which might mean the pursuit of space dominance.[117] The lowering of costs in space, the expansion of space actors and the threat of rogue nations complicates this.[118] The greatest threat actually does not come from peer or near peer nations with national grand strategies. They have accountability metrics in place to keep them operating (for the most part honestly and above board).[119] The rogue nations are

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[113] Townsend, "Space Power and the Foundations of an Independent Space Force," , 11-22, 20.
[114] Rumbaugh., *What Place for Space: Competing Schools of Operational Though in Space* 4.
[115] Townsend, "Space Power and the Foundations of an Independent Space Force," , 11-22, 17.
[116] *Ibid.*
[117] Triezenberg, "Deterring Space War an Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space War" 1-93,21.; "Space Superiority," , accessed 26 April, 2021, https://www.thefreedictionary.com/space+superiority. The degree of dominance in space of one force over another that permits the conduct of operations by the former and its related land, sea, air, space, and special operations forces at a given time and place without prohibitive interference by the opposing force.;
[118] B. Townsend., "Strategic Choice and the Orbital Security Dilemma," *Strategic Studies Quarterly - Perspective* spring (2020), 64-90. 65
[119] leddyn, "From the Sea to Outer Space: The Command of Space as the Foundation of Spacepower Theory," 541

harder to predict and control and as such, pose the greatest threat and require the most robust defence strategy.

Conventional warfighting theory often refers to Clausewitz' concept of centres of gravity (COG). Traditionally, COGs are those things that constitute an enemy's source of power and ability to fight the likes of which, if denied or attacked, the enemy's chances of success are rendered impossible.[120] Space assets have become so critical to a nation's ability to wage and achieve victory in war that the loss of space enabled communications, targeting, navigation, surveillance and intelligence would leave that nation negatively impacted.[121] As such, space has become a COG for not only space faring nations, but also nations whose military capability relies on satellite-enabled support.[122]

Conclusion

Canada's national strategy is also dependent on the exploitation of space infrastructure. Under a rules based system, Canada would likely be the benefactor of multiple actors in space. However, rogue nations do not necessarily observe international laws and as such pose a risk to Canada's ability to operate, free of interference, in space. While it is logical to preserve the peaceful nature of space for as long as possible, space is becoming adversarial in nature and Canada must protect its interests in space. In comparison to all other operational domains, space shares many defining characteristics of a warfighting domain. There is a natural overlap and operational relationship between

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[120] D. Eikmeier, "Let's Fix Or Kill the Center of Gravity Concept," *Joint Force Quarterly* 83, no. 3rd Quarter (2016)109-110.
[121] Igl, C.D. Smith, C.S., Fowler, D.R., Angerman, W.L., "568 Balls in the Air Planning for the Loss of Space Capabilities," *Joint Force Quarterly* 90, no. 3rd Quarter (2018)25.
[122] Kleinberg, "On War in Space," 18

Canada's space strategy and Canada's space defence strategy. Examining these policies provides a clearer picture of what risks, as a warfighting domain, are inherent to space and what measures Canada is taking to protect against them.

CHAPTER 4: CANADIAN SPACE POLICY REVIEW

Introduction

In order to appreciate how Canada is managing and protecting it space related resources and relationships, it is important to have an understanding of the detailed tasks, roles and priorities that these departments perform as well as the points of integration and cooperation between them. It is also critical to appreciate the cooperative multi-national relationships that Canada fosters for these purposes as well. Investment in space without responsible and cooperative interoperability is wasteful and to tether Canada's national strategy to these assets without properly accounting for their protection is imbalanced.

For the purposes of managing and protecting Canada's strategic equities in space, two principal departments are deeply involved. The first is the Department of Innovation, Science and Industry; and specifically the Canadian Space Agency (CSA), which is the lead government agency for the development and implementation of programs and policies, related to the civil use of space. The Second is the Department of National Defence; and specifically the RCAF-led space defence program, which is responsible for four lines of effort: surveillance of space, surveillance from space; intelligence, surveillance & reconnaissance (ISR); positioning, navigation & timing, and satellite communications.[123]

[123] "Canadian Armed Forces Joint Capabilities," , accessed Jan, 2021, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/proactive-disclosure/supp-estimates-a-2020-21/other-issues/joint-capabilities.html.

Canadian Space Agency (CSA)

The CSA leverages strong relationships with government, industry, academia, international organizations and now defence.[124] In 2019, CSA released an updated national space strategy entitled "Exploration, Imagination, Innovation: A new Space Strategy for Canada" as well as a new Departmental plan in 2020. Examining these two new policy documents permits a stronger appreciation for the strategic importance that the Government of Canada (GOC) assigns to being a leader in space.

The 2020/2021 departmental plan states that growth in the space sector is the CSA's main purpose. This growth is achieved through ensuring that Canadian scientists retain access, involvement and status in space science development. This investment in Canadian based space science will maximize the benefits of space for Canadians and strengthen Canada's status as a leader in space. For 2020/2021, the CSA lists four focused priorities: 1. Lunar program, 2. Provide data and new capabilities to Other Government Departments through the operation of the RADARSAT Constellation Mission (RCM), 3. Engage young Canadians (Junior Astronauts and CubeSat) and 4. WildFireSat Mission.[125]

The Lunar Program (Priority 1) is the cornerstone of the new Canadian Space strategy and is the combination of both the Lunar Gateway and Lunar Exploration Accelerator Program (LEAP). The initiatives represent a 24-year $2.05 billion commitment to ensuring that Canada remains a leading space faring nation. Priority 2 is

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[124] "Canadian Space Agency," last modified -09-16, accessed Jan, 2021, https://www.asc-csa.gc.ca/eng/about/csa-organization.asp.

[125] Bains Navdeep, *Canadian Space Agency 2020-21, Departmental Plan* (Saint-Hubert, QC: Her Majesty the Queen Right of Canada, 2020)3..

the sharing of data and capabilities across government departments through the RADARSAT Constellation Mission (RCM).[126] RCM is the newest Canadian earth observation technology launched in 2019. It consists of three identical satellites working together to solve potential challenges to Canadians.[127] Thirteen partner departments and agencies will have access to near real time observation of the earth from space enabling new capabilities and daily space supported problem solving for the purposes of improving the Canadian way of life.[128]

Priority 3 enjoys the focus of engagement with youth.[129] Knowing that both Canada's youth and space prospects represent Canada's future, the CSA is investing in efforts to combine the two. The junior astronaut program and Cubesat project represent efforts to increase students' interest in science, technology, engineering and math (STEM), develop students' expertise in space domains, provide hands on experience, and prepare them to join the job market and to advance space science and technology.[130] These programs target 450 post-secondary students and receive funding under 15 different grants, ranging from $200,000 to $250,000 annually, representing almost a $4 million commitment to inspiring Canadians to engage with space.[131] Priority 4 is the WildFireSat Mission.[132] In 2020 and 2021, CSA invested in this earth observation

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[126] Bains Navdeep, *Canadian Space Agency 2020-21, Departmental Plan* (Saint-Hubert, QC: Her Majesty the Queen Right of Canada, 2020),3.
[127] "RADARSAT Constellation Mission," , accessed Jan, 2021, https://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp.
[128] Bains Navdeep, Canadian Space Agency 2020-21, Departmental Plan (Saint-Hubert, QC: Her Majesty the Queen Right of Canada, 2020)3.
[129] *Ibid.*
[130]"Junior Astronauts," , accessed Jan 21, , https://www.asc-csa.gc.ca/eng/resources-young/junior-astronauts/default.asp.
[131] *Ibid,.*
[132] *Ibid,* 5.

mission to detect and observe wildfires daily from space. This technology will be able to monitor and measure emissions, air quality and smoke with precision. This will be a major contribution to Canadian wildfire management.[133]

The main CSA policy directive is entitled Exploring, Imagining, Innovation: a New Strategy for Canada. As a vision statement, it lists:

> Canada recognizes the space sector is a strategic national asset and seeks to ensure Canada remains a spacefaring nation. Looking forward, Canada seeks to create a vibrant and sustainable space sector anchored by a whole-of-government effort that sets a new vision for Canadian space exploration, sees increased partnership with industry to create the jobs of the future, leverages the power of space to inspire youth, and harnesses the potential of space to solve everyday challenges for Canadians while unlocking the secrets of our universe.[134]

The strategy lists two priorities. First, is participation in the US-led Lunar Gateway mission; and second is retention of status as a world leader in AI-enabled space robotics and dedicates $1.09 billion to it. Building on Canada's $4 billion investment in research and the next generation of homegrown scientists, Canada's involvement in Lunar Gateway will increase Canada's opportunities, relationships, role as a leader in space and international status.[135]

Canada has a desire and a plan to leverage space for the improved quality of life for all Canadians. The Canadian space strategy lists five specific ways that it proposes doing this. The first is connecting with Canadians everywhere, a five-year initiative $100 million plan to invest in projects for low earth orbit (LEO) satellite technology. This will enable broadband and high-speed networks for Canadians regardless of how remotely

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[133] Bains Navdeep, *Canadian Space Agency 2020-21, Departmental Plan*. 3.
[134] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada*. 9
[135] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* (Ottawa, Ontario , Canada: Her Majesty the Queen in Right of Canada,[2019]).10, 11.

they live. The second is Enhanced Security and sovereignty. This will be the use of space technology to secure Canada's borders and monitor its territories and territorial waters. Canada's Defence policy identifies the domain of space as being critical to Canada's defence against new and emerging threats and technologies and, as such, it identifies the requirement for robust investment and funding for space observation and strategic satellite communications.[136]

The third is improved remote medicine and health care. The use of space technology and research for the purposes of astronaut health and health care will not only increase Canadian remote health capabilities for the use in space, but also at home on earth.[137] In particular, due to the great geographic size of Canada and the remoteness of the northern communities, this technology for health monitoring, diagnosis and delivery will be a major example of how investment in space will have a direct benefit to Canadians at home. The fourth is enhancing access to nutritious food. Developing the knowledge and technology for growing food remotely, in harsh environments will allow Canadian explorers to grow food in deep space or on the moon. The federal government will collaborate with provinces and territories to achieve this shared goal with the additional benefit of leveraging this capability to support future space exploration. The fifth one is supporting future secure communications. Beginning in 2017, the Canadian government committed up to $80.9 million to the CSA for the purposes of creating new

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[136] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* (Ottawa, Ontario , Canada: Her Majesty the Queen in Right of Canada,[2019])., 14.
[137] *Ibid,* 15.

projects that develop technologies for secure and encrypted communications. An example of this would be the Quantum Encryption and Science Satellite (QEYSSat).[138]

This strategy solidifies not only Canada's commitment to the CSA, but acknowledges space's status as a critical national strategic entity. Commercial investment and partnership with industry creates jobs, stimulates and diversifies the Canadian economy while advancing technologies that will continue to unlock the great potential and wealth of space for the benefit of all Canadians and Canada's international partners. Canada's reliance on space has become so pervasive that the creation of a comprehensive defence mechanism must take place. The Canadian Armed Forces is tasked with this defence priority.

Canadian Armed Forces

In 2017, the Canadian government released its defence strategy entitled *Strong, Secure, Engaged* (SSE). This policy lists two new or emerging domains of cyber and space among its priorities and targeted areas for growth and investment. The document highlights interoperability with allies and the attainment of an operational advantage over potential adversaries as critical elements of this defence strategy. The policy targets space, as essential and identifies a popular growth of 3,500 personnel for those purposes.[139] It further identifies technological advances and acquisitions of space based surveillance assets as part of its space modernization agenda. Significantly, SSE also discusses the importance of protecting these assets against increasingly sophisticated

[138] "Quantum Encryption and Science Satellite (QEYSSat)," , accessed April, 2021, https://uwaterloo.ca/institute-for-quantum-computing/qeyssat.
[139] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* 15.

threats while promoting the peaceful use of space.[140] The policy clearly identifies the importance of space, Canada's ability to operate in and from it, as well as the vulnerability that space operations present. SSE identifies the RCAF as the departmental lead for the space defence program:

> The RCAF is now responsible for the development of Canada's defensive space program. Given the role of RCAF, CA and RCN personnel in DG Space staffing, training and development activities, the transition to a more robust space environment will require careful management on the part of the RCAF.[141]

One can best understand the CAF policy and guidance concerning space through the examination of *RCAF Vectors* and the RCAF CONOP for the Canadian Joint Space Program. *Vectors* lists four core space capabilities, each of which has a number of essential roles, missions and activities (RMA). The first capability is space force enhancement: RMA listed as intelligence, surveillance and reconnaissance (ISR), as well as satellite communications (SATCOM), signals intelligence (SigInt), positioning, navigation and timing (PNT) which includes navigation warfare and finally ballistic missile warning and launch detection. The second is space support: RMA listed as space launch and satellite operations. The third is space control: RMA listed as Defensive counter-space (DCS) and Offensive counter-space (OCS). The fourth is space influence: RMA listed as military, commercial, national/international political, diplomatic, trade and economic.[142]

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[140] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* (Ottawa, Ontario , Canada: Her Majesty the Queen in Right of Canada,[2019]). 15.
[141] Director General Air Readiness, *Rcaf Vectors* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2019]).31
[142] *Ibid, 38*

Each of these core capabilities are new, in development, and the CAF will need to evolve to support them. In order to accomplish this development, the RCAF has identified four space concepts. First, the evolution of space into a discrete environmental domain will necessitate realigning and bolstering RCAF high readiness in relation to postings, career streams and post graduate training. Second, space-based satellites support all operations and are essential for navigation, communications and command, control, communicate, computers, intelligence, surveillance and reconnaissance (C4ISR). As such, the RCAF must protect them from orbital debris, increased activity, congestion and deliberate interference or denial of access by adversaries using their ASAT capabilities.[143] Third, the RCAF will collaborate with allies and likeminded partners, where appropriate, in the development and deployment of space capabilities. Lastly, the RCAF will explore avenues and opportunities for the collaboration with the private sector, particularly as the space industry continues to grow.[144]

From a budgetary perspective, the CAF has secured a defence budget based on a Department of National Defence (DND) estimate of $21.9 billion.[145] From this, approximately $1.06 billion belongs to the RCAF to fund all of its initiatives, of which the Canadian Defence Space Enterprise (CDSE) is only one.[146] In previous years, Director General (DG) Space has published business plans (BP) that identify operational budgets that range from approximately $10 million funded and approximately $15 million unfunded for fiscal year (FY) 2020-2021 to approximately $7 million funded and

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[143] Director General Air Readiness, *RCAF Vectors* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2019]), A 66.
[144] Government of Canada, *Exploration Imagination Innovation A New Space Strategy for Canada* A-66.
[145] https://www.canada.ca/en/department-national-defence/corporate/reports-publications/transition-materials/defence-101/2020/03/defence-101/rcaf.html
[146] *Ibid.*

approximately $3 million unfunded in FY 2021-2022.[147] These budgets cite departmental interdependencies and level four (L4) reallocation as mitigations to the funding deficiencies.[148] It is clear in both BPs that the next number of years are critical for setting the conditions for growing the capability and accomplishing the CAF's space defence ambitions.[149]

Additionally of the 12,074 regular force, 1,969 reserve and 1,518 civilian personnel in the RCAF the CDSE owns 152 regular force, 3 reserve and 120 civilian personnel.[150] The scope of the CDSE is depicted below in Figure 3.1.

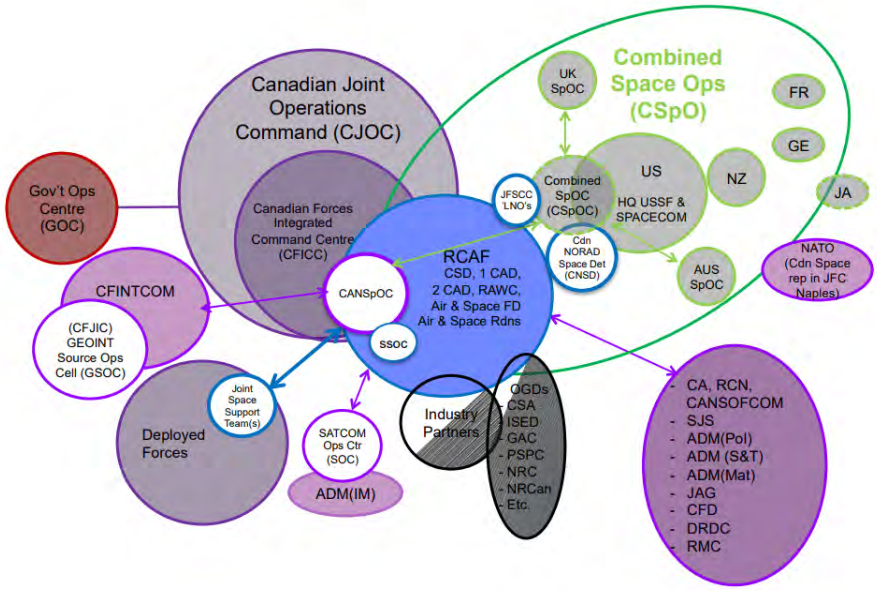

Figure 3.1 – CDSE

(Royal Canadian Air Force,Concept of Operations for the CAF Joint Space Program 2020)

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[147] RCAF, *DG Space Level Three Business Plan FY 20/21 (O*ttawa, Ontario , Canada: RCAF,[2021]).4
[148] RCAF, *DG Space Level Three Business Plan FY 20/21 (O*ttawa, Ontario , Canada: RCAF,[2021])., 7.
[149] *Ibid*.
[150] Royal Canadian Air Force, *RCAF Space CONOP* (Ottawa, Ontario , Canada: Department of National Defence, 2020b)., 8.

While a dedicated space occupation was seriously considered, it was discounted due to the small regular force personnel totals approved to support the CDSE.[151] There is a recognition that despite not having a dedicated space occupation, core members of the CAF Joint Space organization do require some specialized training and as such will be recognized by those individuals wearing the CAF Space Specialist Skill Badge.[152] This is an interim step in the plan and appears to be rooted in economizing the development and growth of a space defence capability by grouping strategic space force development and readiness under existing RCAF leadership with a dedicated joint space staff. The establishment of a level two Space division would further reinforce the space capability.[153]

This division will adopt the growing force generation and force employment roles for the CDSE.[154] The CDSE development timeline referenced in all CAF policy is unspecific. The only clearly identified milestone is for personnel levels to reach the designated 275 people no later than 2028. SSE goes on to state that over the next 20 years, significant CAF investment in joint training and space capability development must be undertaken.[155] It is likely that, as part of a future implementation directive, a clearer incremental breakdown of milestones will be included. At the time of writing, while the previously mentioned concepts are the contents of an implementation plan, there has not yet been a signed implementation directive published sanctioning these

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[151] Royal Canadian Air Force, *RCAF Space CONOP* (Ottawa, Ontario , Canada: Department of National Defence, 2020b)., 8.
[152] "New CAF Space Specialist Skill Badge," , accessed 26 April, 2021, http://www.rcaf-arc.forces.gc.ca/en/article-template-standard.page?doc=new-caf-space-specialist-skill-badge/k9r9gv74.
[153] Royal Canadian Air Force, *RCAF Space CONOP*, 9
[154] *Ibid,* 8
[155] *Ibid*, 24.

activities. The proposed mandate, structure and detailed resourcing of the Canadian Space Division (CNSD) will be the subject of chapter 6 of this study.

Operationally the space domain is Force Employed by the Canadian Space Operations Centre (CANSpOC).[156] The CAF created CANSpOC in 2012 in order to provide domain awareness and integration of space assets for the support of military operations.[157] It is a persistent operational watch for space contained within the Canadian Forces Integrated Command Centre (CFICC) and works in close cooperation with all CAF allies and partners. Some of the tasks managed by CANSpOC are threats related to debris and potential collisions, missile warning, weather in space and the status of space mission systems.[158] The CANSpOC coordinates with and contributes data to the Combined Space Operations Centre (CSpOC).[159]

Cooperation in Space

The sheer scope, complexity, vulnerability and expense of space based technology means that no nation could accomplish its military space goals independently. Bi-lateral and multinational engagement and cooperation with key allies and partners are essential to protect Canada's space capabilities. In conjunction with the protective benefits of these arrangements is the opportunity to share allied space capabilities where shared interests exist. Thus, domestic cooperative arrangements and international alliances are equally

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[156] "Royal Canadian Air Force Space Operations," last modified -10-13, accessed Jan, 2021, http://www.rcaf-arc.forces.gc.ca/en/space/operations.page. Force Generation (FG) constitutes those activities directed toward the training, equipping and preparing of military forces. Force Employment (FE) are those activities undertaken by military forces as part of operational employment both domestic and expeditionary employment of military forces.
[157] Royal Canadian Air Force, *RCAF Space CONOP*, 24
[158] "Royal Canadian Air Force Space Operations,"
[159] *Ibid.*

essential to achieving Canada's space goals.[160] Domestically the CAF leverages a wide range of governmental department cooperation and interdependency. Some of the key stakeholders are Global Affairs Canada (GAC), Canadian Space Agency, Natural Resources Canada (NRCan), Innovation Science and Economic Development (ISED), as well as Environment and Climate Change Canada (ECCC). The level of collaboration between the CAF and these OGDs is continuous, ongoing and likely to grow. As these instances of cooperation increase, so too will the level of protection and defence as well as requirements for pan departmental policy and governance to appropriately integrate and manage these assets and relationships.[161] Internationally, Canada secures its military space relationships through NATO, the UN as well as the CSpOC.

NATO declared space an Operational Domain and approved a new space policy in 2019.[162] NATO Secretary General, Jenns Stoltenberg, acknowledged that NATO has a military reliance on satellites in a variety of areas including surveillance, communications, navigation, early warning and tracking.[163] Over half of NATO nations employ space capabilities. The US owns the bulk of these and along with the other NATO space faring nations, sharing of these capabilities, data and awareness is currently accomplished.[164] Though NATO is yet to release a strategy, the US Department of Defense (DoD) has updated theirs and identifies three key aspects that NATO must adopt

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[160] Royal Canadian Air Force, *RCAF Space CONOP*, 22.
[161] Canadian Armed Forces, *Pan-Domain Force Employment Concept Prevailing in an Uncertain World* 4,5; Royal Canadian Air Force, *RCAF Space CONOP*, 23.
[162] B. Bowman, "NATO 2020 Defined, NATO Declares Space "Operational Domain" but More Work Remains," *Defense News. Com* (2019).2.
[163] *Ibid*; R. S. Cohen, "Building the New Space Coalition," *Air Force Magazine* (2021). https://www.airforcemag.com/article/building-the-new-space-coalition-2/.
[164] G. L. Schulte, "Protecting NATO's Advantage in Space," *Transatlantic Current National Defense University*, no. iNSS (2012), 1-7.4

in order to ensure the responsible use of space amongst its contributing nations.[165] These are promoting responsible use of space, deterring and protecting against attacks on space capabilities and operating with allies and partners.[166]

The US DoD further acknowledges a number of strategic approaches that it sees as essential to future military space cooperation. These are the promotion of responsible use of space, provision of improved space capabilities, international and commercial partnerships, prevention and deterrence of aggression against space assets, and preparation for the defeat of attacks and an operational capability in a degraded space environment.[167] NATO's role in the military space environment is essential, and despite lacking a strategy, it is in a unique position to legitimize deterrence in space and synchronize multinational efforts toward the peaceful uses of space. In order to realize these goals, NATO will need to develop not only a strategy, but also doctrine and plans to strengthen and protect allied dependence on space.[168]

The UN has been a major stakeholder in space since the early days of space exploration. The Committee on the Peaceful Uses of Outer space 59th session states that the: "Role of United Nations entities in supporting member states in the implementation of transparency and confidence building measures in outer space activities."[169] As previously detailed, there are a number of UN policies, treaties and directives that govern the use and pacification of the space environment. These remain important and the UN will remain a key player in the management and use of the global common of space.

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[165] G. L. Schulte, "Protecting NATO's Advantage in Space," *Transatlantic Current National Defense University*, no. iNSS (2012), 1-7., 1.
[166] *Ibid,* 2.
[167] Ibid, 3
[168] *Ibid,* 5; Cohen, "Building the New Space Coalition,"
[169] UN, General assembly, Committee on the Peaceful Uses of Outer Space Fifty-ninth session Vienna, 8-17 June 2016, 1.

However, reinvigoration, modernization and empowerment of its policy and doctrine is essential to not only re-establish its worth and trust as an allying body for military purposes, but also for commercial and environmental reasons. The synchronization of UN policy with other coalitions and cooperatives will be essential to achieving fairness, accountability and peace in space.[170]

In 2017, Canada contributed a submission to the Office of Outer Space Affairs and the Office of Disarmament Affairs on its implementation of the report of the Group of Governmental Experts on Transparency and Confidence Building in Outer Space Activities.[171] As part of this submission, Canada strongly supported all of the recommendations contained in the report published after the 65th session of the UN General Assembly and further co-sponsored its resolution on transparency and confidence building measures in outer space activities. Canada went on to state in the same document that the international community needs to adopt new rules for operating in space. Rules would include those measures identified in the resolution that would help to strengthen international norms and create the climate of trust and confidence necessary for the development of legally binding and enforced measures for the governing of space.[172]

As the greatest military power on earth, it comes as no surprise that the US is a military leader in space as well. Through the creation of CSpOC and Delta 5, it has

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[170] *International Space Law: United Nations Instruments,* 14
[171] Government of Canada, *Canada's Submission to the Office of Outer Space Affairs and the Office of Disarmament Affairs on its Implementation of the Report of the Group of Governmental Experts on Transparency and Confidence Building in Outer Space Activities* (Canada: Government of Canada,[2017]).1
[172] *Ibid,* 5.

created a combined, multinational command and control (C2) capability for space operations.[173] The CspOC and Delta 5 insignias are as depicted in Figure 3.2.

Figure 3.2 – CSpOC and Delta 5 Insignia

(US Department of Defense,Combined Space Operations Center/ Space Delta 5 fact Sheet 2020)

CspOC has the stated mission to execute operational command and control of space forces to achieve theatre and global objectives.[174] CspOC's vision is "Department of Defense's premier space operations center, and ensuring effects for the nation, joint

[173] CSpOC, *Combined Space Operations Center / Space Delta 5 Fact Sheet (Va*ndenberg Air Force Base, Calif.: US DoD, 2020).; Cohen, "Building the New Space Coalition,"
[174] CSpOC, *Combined Space Operations Center / Space Delta 5 Fact Sheet;* Cohen, "Building the New Space Coalition,"

forces and allies…right effect, right place, right time."[175] In 2017, US Air Force (USAF) General John Hyten directed the transition from the Joint Space Operations Center (JSpOC) to the Combined Space Operations Center (CSpOC). The intent of this change was to foster enhanced cooperation and coordination between the U.S. and its allies and, in so doing, safeguard their shared space domain. This combined enterprise ensures that the allies are capable of outpacing and overmatching any emerging space threat.

The CSpOC will be able to provide the collective input to develop the ability to detect, warn, attribute, define and defend against disturbances to and attacks against space assets.[176] It operates 24 hours a day and seven days a week for the purposes of coordinating, integrating, planning, synchronizing and executing space operations.[177] CSpOC reports to the Combined Force Space Component Commander (CFSCC) and works closely with a number of internal US departments as well as the space defence entities from Canada, Australia, France, United Kingdom, Germany and New Zealand.[178] Each contributing nation ensures a representative attends the CFCC weekly Combined products brief (CPB). This is the operational forum inside of which, the synchronization of coalition space strategy and the CFSCC Space task orders are communicated and approved.[179]

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[175] CSpOC, *Combined Space Operations Center / Space Delta 5 Fact Sheet;* Cohen, "Building the New Space Coalition,"
[176] "Joint Space Component Command, Combined Space Operations Center Established at Vandenberg AFB," last modified Oct. 2, accessed Jan, 2021, https://www.spacecom.mil/News/Article-Display/Article/1977714/combined-force-space-component-command-established-at-vandenberg/.
[177] CSpOC, *Combined Space Operations Center / Space Delta 5 Fact Sheet*
[178] *Ibid.*
[179] US Space Command Public Affairs, "USSPACECOM, Public Affairs, USSPACECOM Expands Key Allied Space Partnerships through Multi-National Operations, Vandenberg Air Force Base California, ," (2019). https://www.spacecom.mil/News/Article-Display/Article/2047780/usspacecom-expands-key-allied-space-partnerships-through-multi-nation-operations/.2.

Space Delta 5 is the U.S. Space Force Command and Control organization within the Space Operations Command. It works in coordination with the United States Space Command (USSPACECOM) and the CFSCC to accomplish the CSpOC mission. Space Delta 5's mission is to prepare, present, and fight assigned and attached forces for conducting operational-level command and control (C2) of space forces to achieve theater and global objectives. The fact sheet goes on to say that:

> DEL 5 manages assigned weapon system architectures and ensure operations are intelligence-led, cyber-resilient, and driven by innovation, while postured to succeed in a Contested, Degraded, and Operationally Limited environment. USSPACECOM augments DEL 5 with U.S. Air Force, Army, Navy, and Marine space personnel and along with exchange officers from Australia, Canada, and the United Kingdom, they form the CSpOC.[180]

Dual Use Technology

Dual-use technologies are technologies that are employed for both military and non-military purposes. In the case of space, it is not only possible to make use of types of technologies for dual-use, but specific platforms and space infrastructure can be employed for both military and non-military purposes simultaneously. This is a significantly complicating factor as it brings up the concept of distinction and classification of defence infrastructure. A single private commercial satellite can be used for both military and civilian communications and the targeting of that satellite for military purposes can have drastic consequences for the civilian population that depends on that platform. There is no question that a piece of infrastructure would qualify as a legitimate military target, but the question of proportionality becomes complicated when measured against the impacts its destruction might have to a civilian population and the

[180] CSpOC, *Combined Space Operations Center /Space Delta 5 Fact Sheet*

services it depends on for daily necessities.[181] In the last 30 years, space operations have grown increasingly focused on non-military and private sector use.[182]

Moreover, the current global space economy has grown to be approximately $320 billion per year with trillions more attributed to indirect benefits such as agricultural, meteorological, environment and security.[183] Regulations for the management of commercial and dual-use space technology remains the purview of each independent nation state. This presents great opportunity but also threat and confusion. Matthew Hoey, a research associate at the Institute for Defense Disarmament studies warned, "You can't take all programs at face value." He suggests that there is significant reason to believe that technologies developed and used for non-military reasons could be employed for militaristic purposes.[184]

Recent examples of potential dual use technologies are seen through the activities of the Chinese SJ-17 and Russian Luch Olymp K satellites. Both of these satellites deployed onto orbit with the expressed purpose of testing close proximity operations and rendezvous capabilities. In and of themselves these technologies could be of enormous benefit for the avoidance of on orbit collisions and the creation of additional space debris. As well, this technology could enable reparation activities and maintenance on orbit. However, their actions suggest that they are capable of and in the process of conducting space interference and espionage activities. In some cases, these satellites have operated in close proximity to both commercial and dual use satellites. One can interpret these

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[181] Canadian Judge Advocate general, *Law of Armed Conflict at the Operational and Tactical Levels,B-GJ-005-104/FP-021* (Ottawa, Ontario , Canada: Canadian Armed Forces, 2001)4-1.
[182] Weeden, *Case Study of the Interagency Process for Making Presidential Policy Decisions on Dual-use Space Technology: The Global Positioning System and Space Traffic Management*,3.
[183] *Ibid,* 4.
[184] Hecht, "Dual Threat," , 14-16, 15.

actions as threats below the threshold of combat. In either case, they are difficult to classify and as such contribute to the degradation of trust and transparency amongst space faring nations.[185]

This aspect of space operations highlights the challenges Canada will face in trying to secure its own freedom of operation and space defence priorities while preserving space as a peaceful and weapons free domain. Dual Use technology raises questions about distinction and the delineation between military and civilian is not as clear as it needs to be for classifying space infrastructure and as such the weaponization of space assets is not only possible, it is likely. Canada's employment of dual use technology is a reality, most recently through RADARSAT constellation.[186] Canada's adversaries could perceive this technology as a national security threat and they may choose to target these assets. Conversely, such dual use technologies pose a threat to Canada's assets.

Conclusion

Canada has made investments to ensure that it is not only a contributor to operations in space but also an international leader. The reliance on space, space based platforms and earth based space infrastructure is undeniable and without the use of these assets Canada's entire way of life is threatened. This reliance presents a significant vulnerability and while the peaceful use of space remains important to Canada, the requirement to protect the Canadian space interest is critical.

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[185] R. A. A. MacKenzie, "Counterspace Satellite Threats; Close Quarters Interferance on Orbit" Canadian Forces Colledge, 2020), .; Defense Intelligence Agency, *Challenges to Security in Space, 21*.

[186] "RADARSAT Constellation Mission," last modified -12-19, accessed Jan, 2021, https://www.asc-csa.gc.ca/eng/satellites/radarsat/what-is-rcm.asp.

The CAF has evolved its defence concepts, theories and policy to account for this vulnerability and has identified space defence as an area for growth and development. Canada did this in lock step with Canada's space partners. What needs examination is whether Canada can retain that status without developing a stronger and more interoperable capability for space defence. In order to assess that, there needs to be a better understanding of what Canada's space partners, allies and coalitions are doing and investing in for the secure and peaceful operation in the space domain. Additionally, there is value in understanding the same with respect to the military space operational models for some potential enemies, adversaries and competitors.

CHAPTER 5: INTERNATIONAL MILITARY SPACE STATEGIC REVIEW

Introduction

For decades, outer space was a domain occupied and exploited by the privileged. As powerful nations invested more into the exploration of space, benefits began to emerge, and they wove their way into each space faring nation's national strategy. Technology was new, expensive and required cooperation. Because of this, space exploration has been largely a collaborative and peaceful enterprise. With time, space technology has advanced, improved and become more economically feasible, as such the number of space actors has increased substantially and with this increase in participation so too has come an increase in the congestion, competition and contestation in the space domain. International space policy has not evolved in equal measure, thus the mechanisms for governance are ill adapted to account for this operating environment.

National strategies have evolved to include military space defence policy to protect their own national interests. These strategies and the military action they drive are what have pushed outer space away from mutually beneficial and transparent collaboration toward what is now a war-fighting domain. Alliances, coalitions and relationships are also emerging, in many cases along historically traditional and predictable military lines. Accordingly, this chapter will examine the strategies of both Canada's allies and potential opponents.

National Space Strategy

Space forms a major part in most nations' grand strategy and forms an ever-increasing component of their military strategy. While space is accepted as its own

domain and to some is a legitimate warfighting environment, not all nations have created identical defence space strategies. Great powers appear to be much more focused on establishing space dominance, while smaller powers, including Canada, seem to be more focused on relationships and contribution centric strategies for the defence of space. In some cases, there is a clear identification that the domain of space is evolving and changing and as such, space capabilities need to posture now to account for the challenges that are emerging. In other cases, the current suite of challenges are the focus and driver for space defence force generation and employment priorities. Central to all of these strategies are the theories of space control first as well as information centric defence. The more comprehensive and agile strategies seem to be building on these theories for the purposes of posturing for a technologically enabled presence in space, up to and including human presence on orbit, for the purposes of both offensive and defensive operations to, in and from space.[187]

US Strategy

In June of 2020, the United States Government released its updated Defense Space Strategy. It contends that operating in outer space is central to a nation's ability to generate national power. This has resulted in space becoming the venue for great power competition in the modern age.[188] The strategy is focused on achieving departmental advancement of the US space power in such a way as to ensure its ability to compete, deter, and win in the complex security environment of great power competition.[189] The

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[187] Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma*48
[188] *Ibid.*
[189] US DoD, *Defense Space StrategySummary, 1;* Townsend, "Strategic Choice and the Orbital Security Dilemma," 75

strategy acknowledges that dependence on space-based platforms has become both indispensable and integral to the US way of life and the preservation of these assets is critical to the maintenance of US military superiority.[190] As such, this dependence exposes a vulnerability that the US Government seeks to protect.

The US Strategy identifies specifically China and Russia as the greatest strategic threats due to their recent adversarial behaviours, activities and testing and deployment of counter-space technologies. This activity reveals an intent to extend hostilities and conflict into the space domain. In so doing, it reduces the US's effectiveness and threatens its freedom of operation in the space domain. The strategy further identifies the recent and rapid increase in both commercial and international space activities pose both opportunities and challenges. New technologies and services will serve as economic and security drivers which can be harnessed and leveraged for greater effectiveness in the space domain. At the same time, these entities present challenges to protect critical infrastructure, technologies, operational security and maintaining an operational and strategic advantage.[191]

The strategy is designed to create the favourable conditions of a secure space domain that is both stable and accessible. The use of space, by the US and its allies, is supported by sustained and comprehensive U.S. military strength. The strategy states

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[190] US DoD, *Defense Space Strategy Summary, 1;* Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma*43

[191] US DoD, *Defense Space Strategy Summary, 1.* This strategy defines four lines of effort (LoE) necessary for the management of this new security environment. 1) Build a comprehensive military advantage in space; 2) integrate space into national, joint, and combined operations; 3) shape the strategic environment; and 4) cooperate with allies, partners, industry and other US Government departments and agencies.

that, “The US is able to leverage its use of space to generate, project and employ power across all domains throughout the spectrum of conflict.”[192]

The advancement of U.S space power will be achieved through three defence objectives. The first is maintain space superiority by ensuring US freedom of operations in space. Critical to this is the ability to protect and defend US, allied and commercial space capabilities and the defeat of adversaries in space. Second is to provide space support to National, Joint, and combined Operations though the delivery of advanced space effects to achieve sustained military and domestic commercial advantage. The third objective is to ensure space stability though a partnered, persistent presence in space to deter aggression in outer space, provide for safe transit to, in and through space. This objective aims to enforce rule of law, space stewardship and long-term sustainability of the space environment.[193]

US space strategy appears to be in lock step with its national strategy and foreign policy. Rules based rule of law is the foundation of this strategy and it is stabilized through the exertion of its own might and demonstration of its dominance in the domain. Relationships, partnerships and allies are essential to the success of the strategy. It is likely that nations, including Canada, that desire to have preferential arrangements with the US will need to ensure that a certain degree of interoperability and value-added is represented in their own national and space strategies.

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[192] US DoD, *Defense Space Strategy Summary (WA*SHINGTON: United States DoD,[2020])*., 2*

[193]Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces*4,14,15,16; US DoD, *Defense Space Strategy Summary, 2*

UK Strategy

The United Kingdom released its most current defence space strategy (DSS) in 2018. Much like its US counterparts, the UK acknowledges the ubiquity of space and the growing importance of and reliance on space based platforms and technologies. It identifies clearly that the space domain is currently undergoing a period of increased complexity and risk and identifies that the UK will leverage existing military structures toward increased investment and development in a comprehensive space defence capability. Nominally, the Air Command is tasked with the responsibility of command and control of UK military space operations. It lists the development of a cadre of trained personnel and international engagement as top priorities for these developmental efforts.[194] The focus for this strategy appears to diverge from the US strategy in that it focuses entirely on the defence of the space domain in its current form and bound by its current technological limitations.

The UK DSS accounts for defence of space, as the environment exists now. It also postures to contend with the rapidly approaching defence challenges that will define the domain in the near future. This strategy lists secure freedom of action in space and the ability to fully exploit its military and civilian potential as the aim of this strategy. Its mission is "To ensure that Defence has the capabilities, skills and operational plans to protect and defend its space assets and interests in an increasingly contested environment, working closely alongside the rest of Government, international partners and the private sector."[195] The strategy defines three strategic objectives to support the mission. First, to enhance space resilience and operational effectiveness.

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[194] UK Ministry Of Defence, *Towards a Defence Space Strategy, 1*
[195] *Ibid,,* 2.

The second objective is to optimize space support to the front line and ensure that the armed forces can take full advantage of the opportunities offered by space-based technology. The third objective is to support wider Government activities.[196]

The UK military space strategy is tightly coupled with its space strategy in general. Partnerships with allies as well as commercial partners are essential to its military space strategy. This is clearly to achieve efficiencies through shared intellectual, technological and economic capabilities. The UK space defence strategy is focused on the space domain, as it exists now, and there is minimal reference to the changing nature of the space domain and the possibilities of the space domain of tomorrow. As a key ally to the US, it is likely that the UK space strategy will evolve to better represent complimentary capabilities and interoperability.

France Strategy

France's current Space Defence Strategy (SDS) was published in 2019 and it has some similarities as well as some striking differences from both the US and UK strategies. While France also acknowledges that space is a separate and distinct domain,

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[196] UK Ministry Of Defence, *Towards a Defence Space Strategy (UK: UK Min*istry Of Defence,[2020]).2. The strategy articulates the following: The ability to protect and defend space interests, develop the plans, capabilities, skills and relationships needed. The maximization of the benefits of national space activities hinges on international co-operation with allies and partners. This optimization will serve to integrate space issues into a wider range of activity, including operational planning, doctrine, capability development and training. It will establish the right focus and balance of investment in space capabilities, account for increased threats and new opportunities. Defence will actively support the work of the UK space agency by providing capabilities, infrastructure and personnel, and will derive benefit from these activities for space defence partners. It will strengthen partnerships across Government and support international initiatives to promote the responsible use of space. It will identify opportunities to support growth of the UK space sector and expansion of UK space exports. It will work with the owners and operators of critical national space infrastructure to enhance their resilience, including by developing co-ordinated plans to respond to threats and hazards.

the focus of the strategy is directed more toward technology than the environment.[197] It states that this evolution and technological innovations are changing the tone and nature of space operations.[198] The strategy further posits that existing space regulatory treaties, policy and mechanisms for governance are sufficient and do not require re-draft or revision.[199]

Interestingly, the French Government identifies the requirement for policy change internally and has sanctioned the creation of a major space command attached to the air force. The nuance of this creation is that rather than creating a subordinate command under the air force, France will combine the two equally important and powerful entities under a joint air and space force.[200] This is a very interesting and important distinction because it simultaneously acknowledges the value of leveraging existing structures while at the same time recognizing that the space defence enterprise is too large, important and different to be subordinated to another domain. This creative innovation both accounts for economically addressing current space threats while posturing to evolve in the face of what those threats will become in the future as driven by technological innovation and advancement.[201]

This strategy focusses on the theoretical space of industrial and strategic competition as the technologically enabled threat environment.[202] In equal parts, this

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[197] The French Ministry for the Armed Forces, *Space Defence Strategy8.*
[198] The French Ministry for the Armed Forces, *Space Defence Strategy (France*: Government of France,[2019])., 10.
[199] *Ibid,* 8.
[200] *Ibid*, 11.
[201] The French Ministry for the Armed Forces, *Space Defence Strategy (France*: Government of France,[2019]).31.
[202] The French Ministry for the Armed Forces, *Space Defence Strategy (France*: Government of France,[2019]).30.

strategy identifies the importance of having a balanced approach including key strategic and traditional relationships, partners and alliances while pursuing space defence expertise and autonomy.[203] The strategy goes so far as to define a roadmap toward operationalizing this strategy, which includes development of qualified and quantified national ambitions synchronizing security and industrial responses to perceived challenges, force generation and doctrine creation.[204] The strategy is focused on operating within a known legal framework and designing space defence capabilities agile enough to achieve success within it. This could be a logical model for the CAF to adopt. It maximizes the benefits to be gleaned from partnership with the much more mature domain of air while acknowledging the importance of the space domain in its own right.

Russian Strategy

Since the collapse of the Soviet Union, the Russian Federation has lost much of its great power status on the world stage.[205] Nonetheless, it remains a nuclear power and an active participant in great power competition.[206] Its military strategy is offensive in nature and, as an extension of Russian foreign policy and military strategy in general, Russian military competition in space is offensive as well.[207] Russia's space strategy contributes to what has always been central to the Russian strategic aim: international

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[203] The French Ministry for the Armed Forces, *Space Defence Strategy (France*: Government of France,[2019]).32.
[204] Cohen, "Building the New Space Coalition," ; *Ibid,* 35.
[205] N. J. Jackson, *Outer Space in Russia's Security Strategy* (USA: Simon's papers In Security Development,[2018]).5;Defense Intelligence Agency, *Challenges to Security in Space23*
[206] *Ibid,* 6. Defense Intelligence Agency, *Challenges to Security in Space (US*A: DIA Military Power Publications,[2019]).23
[207] Jackson, *Outer Space in Russia's Security Strategy*,12.

prestige and authority rather than global security and pacification of space.[208] Russia sees international interactions as being inherently adversarial and competitive and as such space is treated the same.[209]

The US has established technological overmatch and dominant military might not only on earth, but also in the space domain. In the spectrum of military action below the threshold of combat, Russia has found its ability to remain competitive through asymmetric tactics and inexpensive space technology. Using a focus on electronic and cyber warfare as well as investments in ASAT technologies and techniques, Russia has created confusion in determining its intentions. Industrial and military cooperation, dual use technology and a continued space launch capability contribute to Russia as a legitimate and formidable actor in the space domain. The aim of Russia's space defence strategy does not appear to focus on achieving space dominance, but rather to deny that status to the U.S. and its allies.[210]

The Russian military strategy for space will likely seek to offset the US technological and fiscal overmatch through grey zone aggression and destabilizing activities. Clear lack of transparency will continue to erode international trust and complicate efforts for cooperation.

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[208] N. J. Jackson, *Outer Space in Russia's Security Strategy* (USA: Simon's papers In Security Development,[2018]).18.
[209] Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma*43,44.; *Ibid,* 13.
[210] Jackson, *Outer Space in Russia's Security Strategy*18; National Academies Press, *National Security Space Defense and Protection*
Public Report, 29

China Strategy

Central to China's Military Space strategy are the concepts of achieving space and information dominance.[211] This includes space dominance in and of itself but also as a mechanism for establishing broader information dominance both from a security and defence perspective, as well as industrially and commercially. Unification or the creation of a unified space capability is the desired mechanism for achieving this dominance.[212] Unified operations are defined as the synchronization of unified forces, unified techniques and unified operational activities for the purposes of establishing China as the dominant actor in space. China has always derived much of its economic and technological success through the combination of state sponsored industry and private commercial initiatives. Under this new strategy, this approach is as apparent as ever.

Unified Forces are the combination of both civilian and military space systems during both pre-war preparation and planning as well as during periods of war. The advantage in doing this is the increased research and development capacity at dispersed cost. The second aspect of unified forces is the combining of all domains (sea, land, air, information and space) for joint purposes.[213] Each domain is simultaneously capable of being the main effort and supporting effort to all others and, as such, facility in cooperation, interoperability and efficiency are achieved in pre-war periods and leveraged in times of conflict.

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[211] Tellis, "China's Military Space Strategy," 62; Defense Intelligence Agency, *Challenges to Security in Space,13*

[212] Tellis, "China's Military Space Strategy," 66; Defense Intelligence Agency, *Challenges to Security in Space,13*

[213] Tellis, "China's Military Space Strategy," 67.

Unified techniques are the combination of what is termed soft-kill and hard-kill techniques. These can be extremely effective while much less likely to incur foreign retaliation or cause escalations of hostilities between nations as attribution and intent can be difficult to assess and prove for these types of attacks. Hard-kill techniques are destructive, permanent and can be extremely effective in terms of coercive and deterrent effect.[214] Unified operational activities are the combination of offensive and defensive operations utilizing both active and passive measures.[215] The unified operational activity approach can contribute to the degradation of US dominance in space, while contributing to China's increased strength in this arena all while destabilizing the domain and generating confusion about whom is the source of said de-stabilization.[216]

Doctrine and Organization

NATO and the US are two of Canada's most important military relationships and it is useful to examine the doctrine of these two entities and determine where Canada is interoperable and poised to contribute and benefit. Each of these doctrines share many similarities; however, there is a key difference between them.

USSF space capstone publication, *Space Power Doctrine For Space Forces,* identifies that space operations are global in nature and, because of this; they too are multi-domain from a military perspective.[217] Space is broken down into three essential and cooperative segments: land or terrestrial segment, space segment, and the link segment. The threat to any of these segments is a threat to operations in space and as

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[214] D. Cheng, "China's Military Role in Space," *Strategic Studies Quarterly*, no. spring (2012), 55-77.67.
[215] *Ibid*, 67,68.
[216] *Ibid*, 68.
[217] United States Space Force, *Space Power Doctrine for Space Forces*, vii.

such a threat to US space power. The protection of all three segments is critical to achieving security in the space domain.[218]

The doctrine identifies the US Space Force as the custodian of the US military space power and assigns three cornerstone responsibilities to the space force. The first is preserve freedom of action, which is the unencumbered ability to accomplish diplomatic, information, military, and economic activity to, in and from space. Military space forces exist to protect, defend, and preserve this freedom of action.[219] The second responsibility is to enable joint lethality and effectiveness. The joint functions and military operations in other domains are strengthened by space. Space is critical to the US's ability to project power in all domains. In addition, space forces rely on the other domains to preserve space freedom of action. Military space forces are integrated into a Joint Force in support of the full range of military operations. Third is to provide independent options. Space power must be capable of independently achieving strategic effect. As such, military space power is more than a supportive addition to land power, sea power, air power, and cyber power. Military space forces achieve national objectives by projecting power in, from and to space.[220]

In order to execute these core responsibilities, space force must develop and maintain five core competencies. First is space security in order to create and sustain safe and secure to access to space activities for civil, governmental, commercial and international partners. The second competency is combat power projection and it

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[218]United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])., xii

[219] Townsend, *Security and Stability in the New Space Age : The Orbital Security Dilemma*82; United States Space Force, *Space Power Doctrine for Space Forces*xiv.

[220] Joint Force Development, *Joint Publication 3-14*
*Space Operations (US*A: US DoD, 2020)I-8.; United States Space Force, *Space Power Doctrine for Space Forces,* 29.

integrates defensive and offensive operations to maintain freedom of action. Combat power projection enhances freedom of action by deterring aggression or compelling adversaries to act in certain ways. Third is space mobility and logistics (SML). This enables movement and support of military equipment and personnel in, to and from the space domain. Fourth is information mobility. This provides timely, rapid and reliable collection and transportation of data in support of tactical, operational, and strategic decision making. Fifth is space domain awareness (SDA). This competency includes identification and understanding all safety, security, economic and environmental aspects of the space domain.[221]

In order to develop and employ these competencies, space force must select, recruit, equip and train personnel capable in seven space defence/warfighting disciplines. The first is Orbital Warfare. Second is Space Electromagnetic Warfare. Third is Space Battle Management. Fourth is Space Access and Sustainment. Fifth is Military Intelligence. Sixth is Engineering and Acquisition. Seventh is Cyber Operations.[222]

The combination of all of these responsibilities, competencies and disciplines enables the US space force to not only engage in, but also dominate the physical,

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[221] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])., 34.

[222] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020]).51, 52. The first is Orbital Warfare. This is the ability to conduct offensive and defensive manoeuvre on earth's orbit. Second is Space Electromagnetic Warfare. This is the combination of spectrum awareness, manoeuvre within the spectrum and denial of adversary freedom of action within the spectrum. Third is Space Battle Management. This is the ability to identify, coordinate, control and, if required, target space based platforms. Fourth is Space Access and Sustainment. This is the ability to support and sustain long-term operations on orbit. Fifth is Military Intelligence. This is the ability to leverage intelligence assets from across all domains, including space to conduct intelligence led operations to in and from space. Sixth is Engineering and Acquisition. This is the ability to develop and acquire the necessary technologies and equipment to thrive and excel in space. Seventh is Cyber Operations. This is the ability to employ cyber security and cyber defense of critical space networks and systems.

cognitive and network dimensions of the space domain.[223] The doctrine clearly identifies the importance of defence in and from space as a component of space warfare.[224] Warfighting domains require a fulsome and detailed application of the warfighting art and science both defensively and offensively. This must be attained in order to preserve freedom of access and action in space while upholding and enforcing international legal policy and treaties for the fair and peaceful use of space.[225]

Space has a defensive role in all types of warfare, be it land, sea, air, cyber as well as in space. Space is the ultimate high ground and is capable of international, cross border/boundary influence and effect.[226] The medium of space ensures military dominance on earth. In addition to this, there are aspects of outer space that can only be detected and observed from orbit.[227] As such, this high ground is essential to dominating and operating freely inside the space environment.[228] This enhancement of military effectiveness and lethality within earth's atmosphere as well as the ability to operate freely outside earth's atmosphere provides multiple independent options for the US government to accomplish their national strategy.[229] This doctrine identifies clearly that

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[223] Joint Force Development, *Joint Publication 3-14 Space OperationsI-8*; United States Space Force, *Space Power Doctrine for Space Forces*, 5,6,7,8.
[224] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])., 21.
[225] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])..,, 24.
[226] Strapp, "Space Dominance can the Air Force Control Space?" 6; United States Space Force, *Space Power Doctrine for Space Forces,* 28.
[227] United States Space Force, *Space Power Doctrine for Space Forces* (United States: Space Capstone Publictaion,[2020])., 22.
[228] *Ibid,* 16.
[229] US DoD, *Defense Space Strategy Summary, 32.*

space force is a unique and distinct force with specific challenges and responsibilities that can only be undertaken by well-trained, equipped and led space operators.[230]

Space operators are broken down into two separate professions within the domain. These are 1) warfighting, and 2) space mastery.[231] Warfighters embody a warfighting culture and are the protectors of US space interests.[232] The mastery of space is the technical knowledge and understanding of the domain.[233]

This US space doctrine represents a commitment to developing forces, independent of any other military mandate or budget. They are capable of dominating the space environment and are postured to develop the understanding and technology necessary for maintaining this dominance into the future. There are three essential elements to this doctrine: 1) space is a warfighting domain; 2) space operations are changing rapidly due to advances in technology driven by the increased number of actors in space; and 3) space is essential to the maintenance of US power. US military capability is both, focused on dominating the space domain of today while developing capabilities to continue doing so in the space domain of tomorrow.[234]

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[230] *Ibi*d, 46; Strapp, "Space Dominance can the Air Force Control Space?" 610
[231] US DoD, *Defense Space Strategy Summary*, *49*.
[232] US DoD, *Defense Space Strategy Summary (WA*SHINGTON: United States DoD,[2020])., 48. Warfighters embody a warfighting culture and are the protectors of U.S. space interests. This is accomplished not by simply operating space but rather employing credible military power in the space domain. This credibility is dependent on joint and combat capable forces that are continuously engaged in the military competition of deterrence and coercion, ready at all times to both fight and win in space.
[233] *Ibid*, 49. The mastery of space is the technical knowledge and understanding of the domain. This is the combined knowledge of the physical, network, and cognitive dimensions of operating in space.
[234]"The Future of Security in Space: A Thirty-Year US Strategy," 2021, https://www.atlanticcouncil.org/content-series/atlantic-council-strategy-paper-series/the-future-of-security-in-space/.

NATO Doctrine acknowledges the same segmentation of the space domain and the combination of space control and info centric space defence requirements.[235] However, both of these doctrines focus more on the advantage of space, as the ultimate high ground, to the continued military dominance and freedom of action on earth as opposed to viewing space as its own warfighting domain. As such, both these doctrines focus on the planning and inclusion of space considerations in a multi-domain and joint context.[236] This leads to the lack of accounting for dedicated warfighting and technological expertise and the training, equipping and leadership of bespoke space operators. While the NATO doctrine does identify many of the space defence priorities for the known nature of space defence in the modern era, it falls short of defining any capability necessary for the emerging nature of space defence or space warfare of the future.

While Canada is a smaller world power that derives much of its power and standing from soft power perceptions, it does have certain interoperability, especially with the US, and military contribution requirements under NATO and various other arrangements and treaties. Space, in general because of the cooperative nature of space exploration, has historically been a source of soft power. Canada's ability to influence more powerful nations through technological and scientific cooperation is important. However, Canada's ability for independent and autonomous operation in space is threatened if it cannot provide for its own security and defence to, in and from space.

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[235] Ministry of Defence, *Joint Doctrine 0-30 UK Air and Space Power*, 2nd ed. (UK: UK Ministry Of Defence, 1-138.72.
[236] NATO, *Nato Standard Ajp-3.3 Allied Joint Doctrine for Air and Space Operations, 1-1003-3,* 5-1

Conclusion

The strategies and doctrines of both Canada's closest allies and most threatening adversaries are shaped by not only theories of space defence, but also theories of warfare in general. It is clear that space is its own warfighting domain and it is continuously evolving. Canada's space defence policies and doctrine need to both account for defensive needs as well as offensive imperatives if it wants to maintain autonomy in space.

So far, this paper has discussed space threats, policy, strategy, theories and the international community. With all of this in mind, it is time to look at the Canadian space defence enterprise and evaluate if it is sufficient to account for Canada's space defence needs in the known and future threat environment of the space domain.

CHAPTER 6: CANADIAN SPACE DEFENCE CAPABILITY

Introduction

Space defence is a Canadian national and military priority. Space is defined as an operational domain, yet CAF doctrine, policy and literature seem to fall somewhat short of declaring it a warfighting domain. In much the same way as the early treatment of the air domain, it is new, not fully understood and largely enabling in terms of its military value. Intuitively, space has been added to the mandate of the RCAF and under its command the creation of the Canadian military space defence capability.

Despite gaps in the space military strategy, the CAF has taken great steps to creating a Space Defence Capability that is postured to accomplish all identified initiatives in SSE. A close examination of the proposed military space capability will show where the CAF is postured for success and where potential future investment may need to focus in order to create a formidable, interoperable and sustainable Canadian space defence capability. Accordingly, this chapter will first explore the treatment of the domain of space in the CAFs contemporary policy and literature. Then it will study the organization and command structure & relationships of the CAF space capability, followed by a discussion of how this new entity will execute the necessary force enabling functions, including force development, generation, management, sustainment and employment. Finally, this chapter will review the current and future employment concepts and potential for international cooperation and growth in the domain of space.

Space and SSE

SSE acknowledges the strategic and operational importance of space infrastructure both from a civilian and military perspective.[237] It identifies technological advancement and evolution as being essential to any future space defence capability and asserts that cooperation and collaboration with allied militaries, commercial industry, international governance bodies and treaties are necessary.[238] It identifies that space is a major element of information, network and cyber security and is information centric in nature. What is omitted, however, is any strategic guidance for space control, military space presence, freedom of operation and physical deterrence in the environment of space. While it is understandable that this strategy is an iteration of a perpetually evolving national and military strategy, it presents a few major issues for the efficient development of a Canadian military space capability.

The result of a military strategy that does not fully acknowledge the space domain as a war-fighting domain is that the full suite of considerations, priorities and tasks does not benefit from the collective military consideration. As such, while the Canadian military space capability does enjoy the benefits of some priority and resourcing identified in SSE, it is condemned to a developmental path that is not complete, optimized or fully resourced for growth and advancement for the future.[239]

As stated in SSE, the CAF "actively support[s] GAC's participation in international diplomatic efforts to ensure that space does not become an arena of

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[237] Department of National Defence, *Strong Secure Engaged Canada's Defence Policy* (Ottawa, Ontario , Canada: Government of Canada,[2017]).71
[238] *Ibid;* Weeden, "Strong, Secure, Engaged in a Threatened Space Domain," 3
[239] Ibid, 39

conflict."[240] The issue with this restriction is that it ignores the well-evidenced assertion that space already is an arena of conflict. Allies and adversaries alike have identified this and developed strategies and doctrine to enable the robust and persistent military presence on orbit, not only for the purposes of enhancing lethality and effectiveness of earth based defence, but to ensure freedom of operations in space.

Organization & Supported vs. Supporting

The CAF has programmed the development of a space defence capability to occur over a ten-year period.[241] This development is deliberate and synchronized with allies and partners.[242] The primary result of this slowly developing capability is that there is not a pre-existing space command and leadership entity. As such, the CAF decided to leverage the currently existing command, research, development, generation, support, management and employment constructs already employed by the CAF.[243] The CAF chose the RCAF to be the parent command, inside of which military space capabilities will come into existence, develop, grow and operate at least until 2028.[244]

The concept of nesting one distinct domain under the command of another distinct domain is a challenging one. The very nature of subordinating space to air is that the natural order of precedence puts air above space rather than identifying them as equally important and strategic. In this hierarchy, during FG, space is always the supporting command and even when identified as the main effort, the supported command will be

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[240] Department of National Defence, *Strong Secure Engaged Canada's Defence Policy*71
[241] Royal Canadian Air Force, *RCAF Space CONOP*, 8.
[242] *Ibid,* 11,12.
[243] The Royal Canadian Air Force, *The CAF Joint Space Force Restructure Master Implementation Plan (MIP)* (Ottawa, Ontario , Canada: Department of National Defence,[2020]).23.
[244] *Ibid,* 8.

air.[245] From a priority, resourcing and expertise perspective, it is perceptible that this command structure lacks clarity, simplicity and objectivity.[246]

A natural counter-argument to this assertion is that, at least under the RCAF, space is the benefactor of continuity, experience and institutional credibility during its long road to full operational capability. The leveraging of such a strong and well-established command will serve to expedite much of the developmental milestones necessary for any nascent military capability.[247] Therefore, while admittedly awkward and sub-optimal, this construct offers the most efficient and expedient development of a credible space defence capability.

There are two main counters to this logical argument. The first is that fiscal restraint is a very real consideration for all Level one (L1) commands.[248] DND represents the single largest, in terms of people, and most financially resourced government department.[249] In an era of economic challenges borne out of COVID-19, competition for crown funds is stiff. As such, all CAF domains have needed to seek cost saving measures and prioritize investments. Growing a new capability is expensive in both terms of financial and staffing. At the same time, the air force must maintain and grow its current capabilities and have had to make some hard decisions in recent years, such as reductions in tactical airlift and aerial delivery capabilities, in order to remain within budget.[250] As Space capabilities continue to evolve, they will require more resources to remain credible

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[245] Royal Canadian Air Force, *RCAF Space CONOP*, 11.
[246] *Ibid,* 13.
[247] *Ibid,* 6,7.
[248] Department of National Defence, *Strong Secure Engaged Canada's Defence Policy*, 44 and 96.
[249] *Ibid*, 19.
[250] RCAF placemat, https://www.canada.ca/en/department-national-defence/corporate/reports-publications/transition-materials/defence-101/2020/03/defence-101/rcaf.html

and viable. This creates an imbalance to the resource competition within the RCAF for the purposes of air and space priorities.

The second counter is that the lack of expertise is also a significant friction. While materiel, procurements, engineering, and training are all institutionally mature entities within the RCAF and broader CAF, the domain mastery and environmental expertise that informs the execution of FD policy is absent from these institutional entities.[251] Simply listing something as air and space does not necessarily mean it is capable of treating both credibly, equally and impartially.[252]

Interestingly, France's mechanism to economize on all of the benefits while minimizing the potential for conflict and competition is to create a combined Air and Space Force.[253] This important and nuanced approach acknowledges the equality between the two separate domains while conceding that the senior domain has much to offer the junior one in terms of credibility, experience and institutional strength.[254] Therefore, rather than subordinating space capabilities to an air command, at least until the space capabilities mature, both space and air capabilities fall under a shared air and space command structure.

Five Force Enabling Functions of the CAF Joint Space Program

In 2017, SSE identified Space as an operational domain and dedicated policy provisions for its emergence and development over a ten-year period. A component of

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[251] Canadian Armed Forces, *DM/CDS Initiating Directive for Space Operations* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2020a]).7.
[252] Royal Canadian Air Force, *RCAF Space CONOP*, 18.
[253] The French Ministry for the Armed Forces, *Space Defence Strategy41*
[254] *Ibid.*

this was the appointment of a Director General (DG) Space with the mandate of managing the creation of the CAF Space program.[255] The Canadian Force Integrated Command Centre (CFICC) had already incorporated Space Operations, providing a 24/7 space situational awareness, into the CAF operational command and management mandate with the stand-up of the Canadian Space Operations Centre (CSpOC) in 2012. This "space watch" works closely with allies and partners to provide domain awareness on: 1) debris and collision threats, 2) missile warning, 3) space weather, and 4) status of space mission systems. This Centre works in close cooperation with allies contributing to CSpOC. CANSpOC works in concert with the Sensor Systems Operations Centre and the Canadian Air Defence Sector (CADS) to optimize the satellite operations for SAPPHIRE and satellite communications operations.[256]

The CAF launched its space based situational awareness satellite SAPPHIRE in 2013.[257] It tracks deep space objects between 600 and 40,000 km altitude. It is nearing the end of its operational life expectancy and will be replaced under the Surveillance of Space 2 project.[258] The Protected Military Satellite Communications System (PMSC) is a program currently in the implementation phase initial operational capacity (IOC). It is the dedication of almost five percent of the US department of Defense (DoD) Advanced extremely high frequency (AEHF) constellation. It provides secure satellite communications that are anti-jamming, enhanced survivability and Q-Band. This

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[255] M. Lalumiere., "CAF Space ProgrammeProgramme Spatiale Des FAC" An Air Force Symposium Discussion on the Near Term Ottawa, Ontario , Canada, 2014).3.
[256] http://www.rcaf-arc.forces.gc.ca/en/space/operations.page.
[257] M. Lalumiere., "CAF Space ProgrammeProgramme Spatiale Des FAC" An Air Force Symposium Discussion on the Near Term Ottawa, Ontario , Canada, 2014).32
[258] *M. Lalumiere., "CAF Space ProgrammeProgramme Spatiale Des FAC" An Air Force Symposium Discussion on the Near Term Ottawa, Ontario , Canada, 2014).* 33.

capability has low-probability of detection and interception.[259] The PMSC is re-enforced by Tactical Narrowband Satellite (TNS) Communications, which is in early implementation phase and provides guaranteed access to global and arctic narrowband ultra-high frequency (UHF) to support tactical beyond line of sight (BLOS) communications. This provides tactical and secure data and voice for command and control for land, sea and air applications.[260]

In 2020, the RCAF proposed a main implementation plan (MIP) and concept of operations (CONOP) for the CAF Joint Space Program. These two documents define a comprehensive, if not limited, proposal for the development, resourcing and maturation of a military space capability. The CONOP lists the following vision for CAF space capability: "A highly trained Joint space cadre will develop, deliver, and assure an operationally relevant space program that integrates innovative and resilient space capabilities into pan-domain operations (PDO) to meet the needs of the constantly evolving global security environment."[261] The CONOP goes on to state the following of the CAF Space mission: "The CAF will maintain Space Domain Awareness (SDA) and will develop, deliver and assure space-based capabilities in order to enable the joint warfighter at home and abroad."[262] Both the stated vison and mission of the CAF Joint Space Capability are focused on the military employment of the space domain as an enabling domain to be leveraged for the enhanced operational lethality and effectiveness within earth's orbit. They fail to account for space as an independent warfighting domain.

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[259]M. Lalumiere., "CAF Space ProgrammeProgramme Spatiale Des FAC" An Air Force Symposium Discussion on the Near Term Ottawa, Ontario , Canada, 2014)., 37

[260]*Ibid*, 39.

[261] The Royal Canadian Air Force, *The CAF Joint Space Force Restructure Master Implementation Plan (MIP)*6.

[262] Royal Canadian Air Force, *Concept of Operations for the CAF Joint Space Program* (Ottawa, Ontario , Canada: Department of National Defence,[2020a]).6

These documents define an initial command and organizational structure as well as key integration and synchronization of the five force enabling functions (5F) which are: 1) Force Development, 2) Force generation, 3) Force management, 4) Force employment, and 5) Force sustainment/support. It is important to note that while these documents clearly identify criteria for transitions from IOC to Full Operational Capability (FOC), there is no definition of any separation criteria that would identify when and how the CAF Space program would mature into its own command as an independent war fighting operational domain.[263]

The MIP establishes the aim of developing the joint ability for the CAF to operate in space in much the same way it does on land, sea, air and cyber.[264] It further concludes that there is a rapid rate of change in the space environment both technologically and politically.[265] This pace of change renders the lifespan of the current CONOPS under the RCAF inadequate to address the future of the operational environment and identifies that the MIP has the task and responsibility to map out the transition from current force structure to the one it will adopt in the future.[266]

The MIP identifies that the command structure for the space program is designed specifically to nest within the currently existing RCAF one, as shown

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[263] Royal Canadian Air Force, *RCAF Space CONOP*, 6
[264]The Royal Canadian Air Force, *The CAF Joint Space Force Restructure Master Implementation Plan (MIP)*, 16.
[265] *Ibid*, 3.
[266] Royal Canadian Air Force, *RCAF Space CONOP*, 25.

below in Figure 5.1.[267] continue sentence here

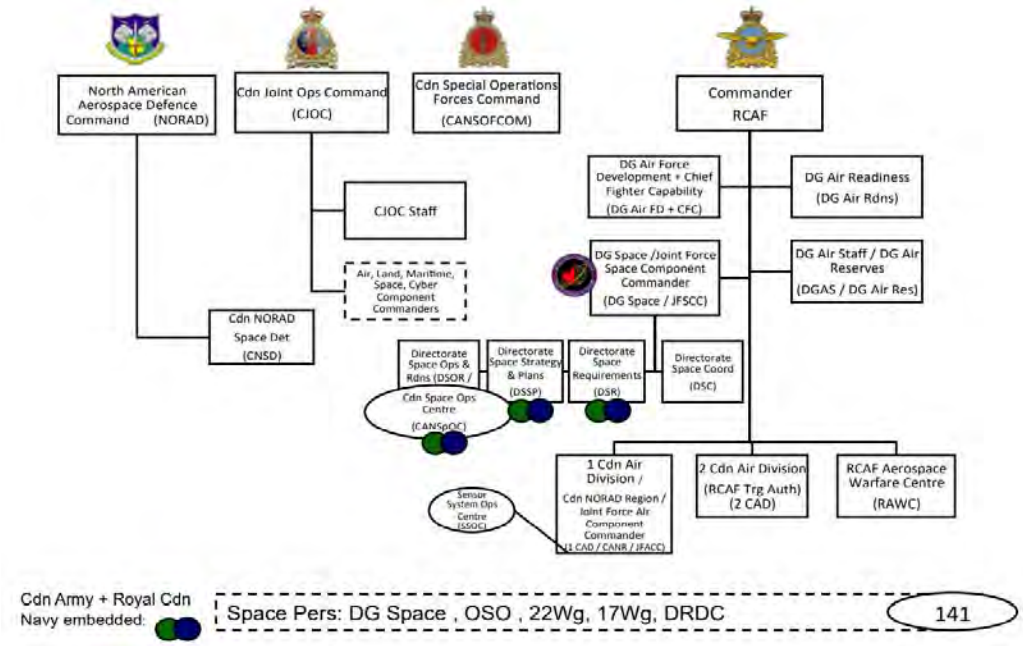

Figure 5.1 – CAF Joint Space Organization

(Royal Canadian Air Force,Concept of Operations for the CAF Joint Space Program 2020)

This achieves the economies of managing the Space FD, FS and readiness under the air FD, FS and readiness entities reinforced with dedicated space staffs and re-branded as air and space FD and readiness.[268]

The C2 of space will be executed as a level two (L2) command within the RCAF and this organization will be called 3rd Canadian Space Division (3 CSD).[269] This sees the transition of DG Space into the Commander of 3 CSD and empowering them with the

[267] The Royal Canadian Air Force, *The CAF Joint Space Force Restructure Master Implementation Plan (MIP)*16.
[268] Royal Canadian Air Force, *RCAF Space CONOP*, 19.
[269] *Ibid*, 9 and 14.

authorities and responsibilities commensurate with any division-sized formation.[270] This division will be responsible as the primary force generator (PFG) for military space capabilities. The coordination of collective training and core, primary combat function training will be the responsibility of 3 CSD.[271] Commander 3 CSD will be wholly responsible to Comd RCAF for all tactical and operational FG.[272] Simultaneously, 3 CSD will be double hatted as a FE entity under CJOC and holding the designation in that capacity as the Joint Force Space Component Command (JFSCC).[273] This is a very similar construct employed within the CAF for division-sized formations, shown in Figure 5.2.

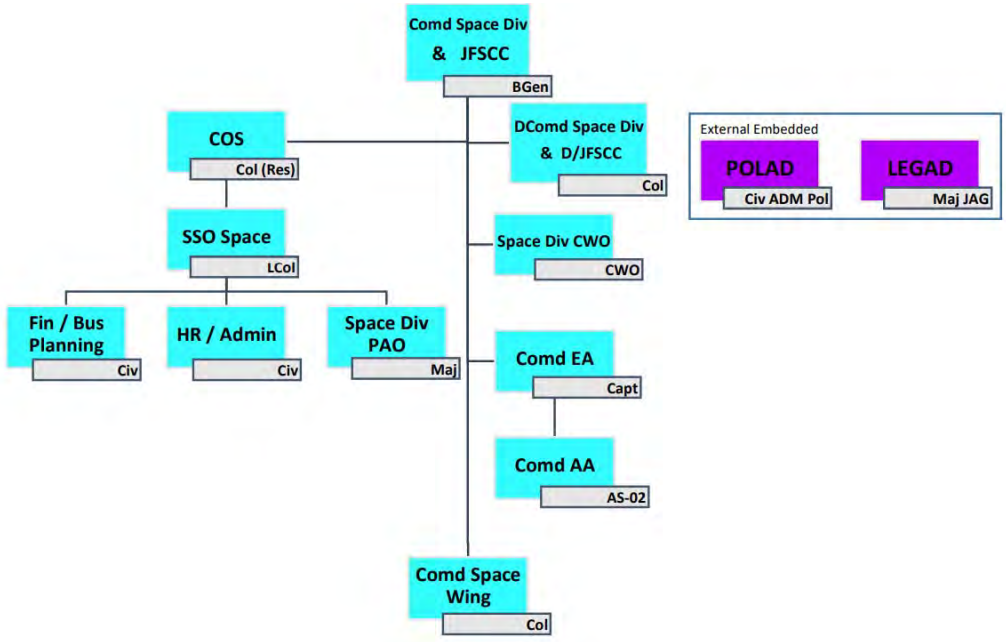

Figure 5.2 – Canadian Space Division HQ Organization

[270] The Royal Canadian Air Force, *The CAF Joint Space Force Restructure Master Implementation Plan (MIP)*20.
[271] *Ibid*, 21.
[272] *Ibid*, 24.
[273] *Ibid*, 23.

(Royal Canadian Air Force,Concept of Operations for the CAF Joint Space Program 2020)

2 Canadian Air Division (CAD) will be responsible for space related individual training (IT) and RCAF Aerospace Warfare Centre (RAWC) will manage both air and space doctrine and education development and evolution.[274]

3 CSD will be a fully staffed division headquarters entity charged with the full spectrum of command, control and force management functions both as 3 CSD and as the JSCC. Currently the division has a single Wing-sized formation under its command.[275] This wing is called Space Wing, will be commanded by a Colonel, and has three units under its command: 1) Operational Support Squadron, which is responsible for planning and exercises, strategy analysis and satellite operations; 2) Advanced Space Effects Unit; and 3) The Mission Support Squadron, which manages the operational training, mission systems management, data exploitation and mission assurance.[276] The space wing is the space domain equivalent of an operational formation. This capability and its future synchronization and interoperability is enabled through space operations staff member contributions to CSpOC, NORAD and NATO.[277]

Present and Future Canadian Space Defence Environment

In their infancy, air assets were seen as being largely enabling in nature. As their merits became better understood, the technology became more reliable and the clear

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[274] Royal Canadian Air Force, *RCAF Space CONOP*, 20.
[275] *Ibid,* 14.
[276] Royal Canadian Air Force, *RCAF Space CONOP* (Ottawa, Ontario , Canada: Department of National Defence, 2020b).16.
[277] *Ibid, 12*.

advantage identified, the air environment became its own battleground and air assets evolved to adopt direct combat roles.[278] This recent example helps us to understand the likely future of space, not only as an enabling entity, but also as a war-fighting domain and its inevitable status as an arena for military competition.[279] There will always be a role for diplomacy and Canada will likely remain the benefactor of rules based multi-lateral partnerships and arrangements; this applies equally to all of the global commons including air, sea and space. However, as has been learned about all commons, military security is essential to the preservation of peace and achievement of mutual benefit for all in and from those commons.[280]

It is true that Canada derives much of its national security through alliances and partnerships, and that much like terrestrial security, security in space will likely benefit from a similar strategy.[281] However, there is a degree of autonomy essential for the CAF to achieve Canada's space defence priorities. Critical to achieving this is developing a force capable of protecting national assets and sovereign territory from earth to space, from space to earth and from space to space. This requires a physical presence, not only to protect space assets on earth, but also in space to ensure freedom of operation there.[282] In lieu of this, Canada must accept that other nations will dominate the space environment and dictate the terms for its use.[283] Comparatively, would Canada consider

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[278] Kleinberg, "On War in Space," 12
[279] Klein, *Understanding Space Strategy: The Art of War in Space*, 48
[280] Caton, *Impacts of Anti-Access/Area Denial Measures on Space Systems: Issues and Implications for Army and Joint Forces*, xii.
[281] "The Shared and Competing Interests of Space Coalitions," , accessed Jan, 2021, https://amuedge.com/the-shared-and-competing-interests-of-space-coalitions/.
[282] Townsend, "Space Power and the Foundations of an Independent Space Force," , 11-2219.
[283] B. Townsend, "Space Power and the Foundations of an Independent Space Force," *Air and Space Power Journal*, no. winter (2019), 11-22.17; Townsend, "Strategic Choice and the Orbital Security Dilemma," 66

its seaborne trade and transoceanic economy adequately defended without its navy? Certainly, Canada has alliances and partnerships that contribute to its naval security but maintains an autonomous capability to conduct military operations to, in and from the sea. Similarly, Canada is the benefactor of NORAD, NATO and other military alliances that contribute to its defence to, in and from the air environment. However, it maintains a robust and autonomous defence capability. In the pan-domain operating environment, the defence of all domains is conducted jointly but never is the defence of a domain the sole responsibility of other domains.[284]

Another interesting comparison is to consider The Canadian Special Operations Forces Command (CANSOFCOM). There are, unquestionably, similarities between Special Operations Forces (SOF) and conventional forces; but SOF does not fall under any of them. SOF has a mandate separate and distinct from conventional forces. CANSOFCOM faces FD, FG, FS, FM and FE challenges that are unique to itself and the attainment of mastery and understanding of the SOF operating environment is essential to its relevance, credibility and effectiveness. It is not enough for CANSOFCOM staff to be knowledgeable of CAF policy but it is also necessary to have expertise in SOF operations so that those policies can most effectively and efficiently be applied.[285]

The MIP and CONOP both refer to the development of a space defence cadre.[286] This is an astute assertion and is complementary with the space defence trends of Canada's military allies. The current issue with the organizational design for the creation of this capability is that it is focused on assembling joint force capabilities already

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[284] Canadian Armed Forces, *Pan-Domain Force Employment Concept Prevailing in an Uncertain World*17.
[285] Department Of National Defence, *CANSOFCOM Future Operating Concept* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2019]).5
[286]Royal Canadian Air Force, *RCAF Space CONOP*, 7.

resident within the CAF and fails to identify what would be required for the creation of a cadre of professionals who specialize not only in warfare, but also in space warfare. The aspect that is missing is a clearly defined list of trades, streams, capabilities and expertise required to create a true military space capability.[287] The US doctrine characterizes this by breaking the force down in the two space defence professions: 1) Space mastery, and 2) warfighting.[288]

The development and evolution of a Canadian space defence capability needs to identify the training and education necessary to establish a baseline for mastery of the space environment as well as the conduct of war in that environment. The current MIP and CONOP simply identify the creation of an organization that is capable of C2 as well as the five force enabling functions but fails to address the reason for being for that organization. In not identifying the reason for this organization's existence, it falls short on defining how to ensure it is capable of conducting its core business. While the MIP and CONOP are logical and achievable with clear milestones and transition criteria, some fundamental questions need to be asked before its implementation. What is a Canadian military space operator? What do they do? What trades, specialties, streams, training and education do they require? How should they be lead and supported to be successful?

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[287] J. Coates, "AIRMINDEDNESS:An Essential Element of Air Power," *RCAF Journal* 3, no. 1 (2014)73.; Gladman, Dr. Brad, Dr. Richard Goette, Dr. Richard Mayne, Colonel Shayne Elder, Colonel Kelvin Truss, Lieutenant-Colonel Pux Barnes, and Major Bill March., "Professional Airpower Mastery and the Royal Canadian Air Force: Rethinking Airpower Education and Professional Development," *RCAF Journal* 5, no. 1 (2016)15. http://www.rcaf-arc.forces.gc.ca/en/cf-aerospace-warfare-centre/elibrary/journal/2016-vol5-iss1-04-professional-airpower-mastery-and-the-royal-canadian-air-force.page.

[288] United States Space Force, *Space Power Doctrine for Space Forces*, 48, 49

Opportunities for Combined Development and Growth

Current CAF defence policy emphasizes the importance of combined and cooperative development of space defence capabilities in partnership with allies and private industry. This overarching ideal is called Combined Space Operations or CSpO.[289] This is a theoretical entity and, while it has a similar acronym to the Combined Space Operations Centre CSpOC, the two should not be confused. Under the concept of CSpO, Canada has agreed to work with partners, under the leadership of the US, to achieve four major lines of effort (LoE): 1) information sharing, 2) integrated and combined space operations, 3) interoperability for command and control in space, and 4) combined space architecture.[290] Each of these LoE strengthen Canada's military ability to protect National strategic space priorities through cooperative pursuit of interoperability, synchronization and economization. These LoEs are the mechanism through which the CAF best addresses the initiatives identified in SSE.

The proposed RCAF CAF Space Program MIP has designed a structure that allows the CAF to quickly interface with allies and partners, identify opportunities for cooperation and maximize shared military benefit in the space domain. One of the most important mechanisms for testing and expanding the effectiveness of the LoE is Op OLYMPIAN DEFENDER.[291] This is a US designed multi-national space operation focused on a collaborative and integrated approach to the deterrence of hostile actions in

[289]Canadian Armed Forces, *DM/CDS Initiating Directive for Space Operations*, 5.
[290] U.S. Strategic Command, Department of Defence, Letter from General Hyten USAF Commander to LGen Meinzinger RCAF Commander, 2018, 1,2.
[291] U.S. Strategic Command, Department of Defence, Letter from General Hyten USAF Commander to LGen Meinzinger RCAF Commander, 2018, 1,2.

space.[292] This deterrence contributes to the reduction of the spread of orbital debris. In 2020, Canada also participated in the Schriever War-game (SW20), which has proven to be an ideal mechanism to encourage the exploration of future policy, authorities, and capability improvements.[293] These types of cooperative training events not only contribute to the professional growth, domain mastery and enhanced credibility of the CAF, but they also encourage interoperability and mutual influence between Canada and the US so as to ensure that the Canadian strategy remains a consideration throughout the development of this nascent operational capability.

Canada's Space Doctrine

In June 2017, the RCAF developed and published RCAF Doctrine Note (DN) 17/01, Space Power. It draws from some of the conventional space warfare theories and defines the space environment, the current policies and treaties that govern its use, threats and concept of space power.[294] All of this data is complimentary and similar to the doctrines and theories adopted by Canada's allies and many of its adversaries.[295] The DN identifies three principles for the employment of space power:

1) Centralized Control. Space systems are used for strategic, operational as well as for tactical applications across all services and for a multitude of users. Because of their scarcity and importance however, space assets are not allocated directly to the control of an operational commander in a regional theatre. Commanders must nonetheless understand what capabilities can be delivered through the application

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[292] Canadian Armed Forces, *DM/CDS Initiating Directive for Space Operations* (Ottawa, Ontario , Canada: Canadian Armed Forces,[2020a]).7.
[293] *Ibid.*
[294] Department Of National Defence, *Royal Canadian Air Force Doctrine Note 17/01 Space Power (Ottawa*, Ontario , Canada: Canadian Armed Forces, 2017a), 1-43.
[295] NATO, *Nato Standard Ajp-3.3 Allied Joint Doctrine for Air and Space Operations, 1-100;* Ministry of Defence, *Joint Doctrine 0-30 UK Air and Space Power*, 1-138*;* United States Space Force, *Space Power Doctrine for Space Forces*

of space power along with their constraints so they can request and exploit fully the services they are provided;[296]

2) CAF SCC retains C2. Space assets often support multiple CAF operations simultaneously; in all cases the CAF SCC retains operational and tactical command and control of all space assets at his disposal;

3) Functional alignment. CANSpOC is functionally aligned with CJOC, is under the Command of DG Space/SCC and coordinates critical space power requirements for CAF operations at home and abroad.

The DN further lists four core functions for space power: 1) Space Force Enhancement; 2) Space support; 3) Space control; and 4) Space influence. These functions are intuitive, logical and if operationalized, comprehensive enough to drive the creation of a comprehensive space defence capability.[297]

Space Force Enhancement (SFE) represents the combination of all activity associated with space operations for achieving strategic effect. The listed activities and aims of SFE include ISR, SATCOM, SIGINT, PNT and BM warning and detection.[298] The DN further identifies that this military function is a cooperative and collaborative one. What is absent in its definition and explanation is any reference to the protection of these assets on orbit or the requirement to achieve FoM, if not, dominate the physical environment of outer space. Further, this explanation of SFE communicates a fundamental reliance on not only OGDs, but also allies and commercial partners.[299] While it is acceptable that the optimization of SFE is reliant on such symbiotic

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[296] Department Of National Defence, *Royal Canadian Air Force Doctrine Note 17/01 Space Power, 1-43*
[297] *Ibid,* 5; K. Whale, "RCAF Defence Space Program" Ottawa, Ontario , Canada, 2018).33
[298] *Ibid;* M. S. Thompson, *Separating "Space" from "Aerospace: A Case for Canadian Forces Space Doctrine* (Toronto, ON: Canadian Armed Forces, 2016)2,3.
[299] Department Of National Defence, *Royal Canadian Air Force Doctrine Note 17/01 Space Power, 1-43,9*

relationships, to identify a military capability with such dependencies negates the capability as viable and credible in a warfighting scenario. The CAF space doctrine will need to evolve such that, despite not having the capability in the early developmental stages, it at least is observant of physical space presence to complete its doctrine.

Space Support functions are further subdivided into two smaller categories: 1) Space launch, and 2) Satellite Operations. The DN accurately identifies the geographical limitations to developing a nationally independent space launch capability. However, an independent launch capability is a strategic and operational priority for the development of a nationally autonomous space defence capability. It is precisely these areas of technological innovation and advancement, which would benefit from greater Canadian investment, research and development. In the interim, relationships and alliances with partners can and should continue to be leveraged. The category of satellite operations represents the most relevant and current space operations capability in Canada to date. However, the DN identifies this as the current operating space of the CSA and makes no clearly identified line of operation (LoO) for military space capabilities. This is an oversight and negates the importance of the CAF being able to operate to, in and from the physical environment of space.[300]

The Space Control Function is the first portion of the DN that treats the space domain as a physical environment.[301] There is the identification of a requirement to be able to conduct defensive counter-space (DCS) and offensive counter-space (OCS) operations. However, the DN defines the criticality of partnerships and alliances to the

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[300] Department Of National Defence, *Royal Canadian Air Force Doctrine Note 17/01 Space Power (Ottawa*, Ontario , Canada: Canadian Armed Forces, 2017a), 1-43., 9; Whale, "RCAF Defence Space Program" 32

[301] *Ibid*.

achievement of this and makes no progress toward defining any form of Canadian autonomous capability. Additionally, the consideration of the physical environment is addressed in terms of defending space-based assets and ground terminals by other domains such as air, sea, land and cyber. The DN also accounts for defending space-based assets from earth using cyber and from space using allies,[302] but there is no mention of any intent to create a Canadian space-to-space defence and warfighting capability.

The final function referenced in the DN is Space Influence. This is the least defined function in the doctrine as it is listed as a military space defence function, but mostly defines non-military mechanisms to achieve it. The single reference to a Canadian ability to contribute to Space Influence from a military perspective is through contributions to CSpO, which is a concept for multi-national partnered space defence.[303] There is no identified criteria or road map for organizing efforts toward achieving this.

The DN develops a logical narrative for the importance of developing, nurturing and synchronizing efforts toward harnessing and delivering Canada's space power. It emphasizes the assertion that space power is simply a force enabler.[304] This assertion, consistent with Rumbaugh's "keeping the Plumbing running" school of thought, assumes that space will remain simply an enabler into the future. The historical comparison of the air domain as an enabling one and its rapid evolution into a warfighting domain characterized by air power dominance suggests that this assumption is flawed.[305] Space defence and security as well as C2 need to be considered and organizational design needs

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[302] *Ibid,,* 10, 11; K. Whale, "RCAF Defence Space Program" Ottawa, Ontario , Canada, 2018).12
[303] *Ibid,* 11
[304] Department Of National Defence, *Royal Canadian Air Force Doctrine Note 17/01 Space Power, 1-43*
[305] Townsend, "Space Power and the Foundations of an Independent Space Force," 21.

to be such that the CAF is both capable of addressing the space defence reality of today while posturing and leading the institution to be capable of doing the same for the space defence potential of the future.

Conclusion

Space is a physical environment and, as a war-fighting domain, militaries will seek to dominate this environment. This means that the presence in space by humans is likely. Technological advancements are happening at such a pace that, while not the current reality, a near future that sees a physical human military presence in space capable of conducting military operations to, in and from space is going to happen. This needs to be a strategic military consideration now to organize, resource and task the Canadian military space capability accordingly. This is what many of Canada's allies and adversaries are already doing. Failing to keep pace puts Canada at a significant military disadvantage, which threatens future interoperability potential.

Canadian military doctrine, CONOP and MIP address the functions necessary for cooperation, collaboration and planning for addressing the current environment of space threats in a combined and partnered manner. This current concept fails to identify space as an evolving domain, which is a physical space requiring a persistent military presence, what skills, trades and expertise is required to execute those tasks and most importantly there is no accounting for a nationally independent military space defence capability. While this current construct is adequate for the demands of today, it will quickly become overtaken by events driven by technological advancement. It must have the focus, expertise and resources commensurate with ensuring that Canada's space defence

capability continues to grow, develop, remain credible and viable. The achievement and protection of Canada's national strategic goals depend on it.

CHAPTER 7: CONCLUSION

Canada has been a major space-actor for nearly 70 years. Despite its status as a smaller world power, Canada has established itself as a world leader and major contributor in the space domain. Canada's way of life, economy and entire national grand strategy is dependent on outer space. Space technologies are evolving daily and as a result, the cost of operating in space is becoming increasingly cheaper; a fact that has driven an increase in space actors. The increase of space faring parties has contributed to the space environment becoming congested, contested and competitive. This adversarial tone has led to the reduction in transparency and increase in threat development for operations on orbit. Unfortunately, the evolution and advancement of international policy, governance and treaties has not matched pace with technology and as such, the instruments for ensuring fair, equal, peaceful and cooperative space operations are woefully inadequate.

Threats on orbit abound; from physical, cyber and electromagnetic ASAT technology to the proliferation of space debris and emission pollution on orbit, the strategic national assets on orbit have emerged as national vulnerabilities. Criminal, rogue nation, state and non-state competition as well as industry have all contributed to an atmosphere that is adversarial and untrusting. The nation that dominates in space will also dominate on earth and the military power that enjoys superiority on orbit will have significant advantage in all arenas for modern warfare.

Space is a global common that has historically been accessible to the few and dependent on cooperation and collaboration for the benefit of all. This has changed in recent years and all space actors have identified the requirement to better synchronize

their national space strategies with their military strategies. Canada, like many of its enemies, adversaries and allies has done the same. NATO and many of the world's nations have declared space an operational domain. Some have declared space to be a warfighting environment.

Canada has taken many steps toward developing a CAF space defence program. This nascent military capability has been plagued by the confusion surrounding the declaration of space as a peaceful global commons that needs to be preserved as such and not allowed to become an arena for military competition. Space is strategically critical to most nations. The loss of space capability for any individual actor would be catastrophic. The US and China have declared military strategies that hinge on space dominance. Canada has concluded that it needs a military space defence capability.

The conclusion drawn for these deductions is that Canada must, not only develop a defensive space capability, but a military entity capable of the full spectrum of operations in the warfighting domain of space. Canada's military strategy is historically one of contributions where partnerships and alliances are critical. However, Canada must posture its forces to be fully capable and autonomous in all domains of war. As such, the CAF needs to consider space a warfighting domain and organize toward achieving the ability to conduct war in that environment.

The currently proposed Canadian military space program addresses many of the priorities defined in SSE, but it focuses too much on the creation of a capability to contribute to the space defence priorities of today at the expense of developing a viable capability for tomorrow. If space is an environment that requires defending, then that environment requires a Canadian capability to enjoy military freedom of operation both

in times of peace and war. Better definition of a plan to grow and evolve this capability needs to happen and the objective needs to be the development of a force that has the environmental and warfighting expertise sufficient to conduct warfighting activities to, from and on orbit. This means developing a better understanding of what military space operations are, de-conflicting them with civilian space operations and professionalizing space operators as a trade. These priorities cannot be accomplished as a sub-set of another L1. Space is separate, distinct and requires resourcing and expertise unattainable in the RCAF, CA or RCN. This endeavour will be expensive and time consuming, but it is essential and the success of all CAF operational domains depends on it.

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