LIBRARY OF PARLIAMENT
BIBLIOTHÈQUE DU PARLEMENT

HillStudies

In-depth reads on Canadian topics

THE GROWING COMPLEXITY OF SPACE: IMPLICATIONS FOR SECURITY AND STABILITY

Publication No. 2022-10-E

26 July 2022

Allison Goody and Ariel Shapiro

Parliamentary Information, Education and Research Services

AUTHORSHIP

26 July 2022	Allison Goody	Economics, Resources and International Affairs Division
	Ariel Shapiro	Economics, Resources and International Affairs Division

ABOUT THIS PUBLICATION

Library of Parliament HillStudies provide in-depth studies of policy issues. They feature historical background, current information and references, and often anticipate the emergence of the issues they examine. They are prepared by Parliamentary Information, Education and Research Services, which carries out research for and provides information and analysis to parliamentarians and Senate and House of Commons committees and parliamentary associations in an objective, impartial manner.

The Growing Complexity of Space: Implications for Security and Stability
(HillStudies)

Publication No. 2022-10-E

Ce document est également publié en français.

CONTENTS

EXECUTIVE SUMMARY

Governments dominated the space age that emerged during the Cold War, primarily those of the United States (U.S.) and the Soviet Union. They largely treated the domain with military restraint given both the fragility of the space environment and the importance of satellites for reconnaissance and early warning of any long-range nuclear missiles.

However, the role of satellites evolved to enable conventional military operations, as was shown with U.S. military action in the 1991 Gulf War and in other operations thereafter. Space assets, therefore, came to be seen not only as a source of operational military advantage but also as a potential vulnerability. Other shifts that have taken place in recent decades include the growing number of states with capabilities and interests in space. There has also been a significant expansion of private-sector activity. Technology continues to improve and endeavours that had been prohibitively expensive are now within reach.

Over time, the number of objects and the amount of debris in orbit around Earth have increased exponentially. So has the risk of accidents, misinterpretation of intent or escalatory actions. Amid what is considered an increasingly congested, contested and competitive environment, states have struggled to build on agreements reached during the Cold War that kept space free from conflict. A diplomatic process has been initiated at the United Nations that is seeking some form of understanding in relation to responsible behaviour in space.

As is the case with its allies, space-based capabilities and space-enabled systems are key contributors to Canada's national security and defence, and essential to its prosperity. That reliance, amplified by Canada's vast geography, makes space a strategic concern for Canada, which informs activity in multiple domains. Canada is involved in diplomatic efforts to keep space cooperative, which ultimately involves identifying measures that could dampen strategic competition in space. At the same time, Canada's defence posture recognizes that some states are developing capabilities that could limit access to, and the use of, the space domain.

THE GROWING COMPLEXITY OF SPACE: IMPLICATIONS FOR SECURITY AND STABILITY

1 INTRODUCTION

This HillStudy explores why space is a strategic concern and how it can affect stability between and among states. It begins with an overview of the space age that emerged during the Cold War, followed by an examination of the shifts in strategic perceptions that occurred in the 1990s and 2000s. In addition to discussing the trends of crowding and competition, the paper describes how the space domain has become more contested, including through the pursuit of what are known as "counterspace" capabilities (i.e., things that can interfere with, damage or destroy space objects, the platforms on which they rely and the connection between the two). It then examines the legal framework and certain diplomatic initiatives relevant to space security and stability, and the complexities they involve. The final section of this HillStudy is focused on Canada's international and defence policy in relation to space.

2 OVERVIEW: THE STRATEGIC RELEVANCE OF SPACE

Space is a domain in which assets are both highly valuable and vulnerable. The behaviour of one actor in space, whether accidental or deliberate, can have a considerable impact on the interests of another, or even all others. That impact could be immediate or persist as a hazard for years.

The overview that follows shows that, while space is not a new strategic domain, the dynamics informing it appear to be shifting and becoming less predictable.

2.1 SPACE DURING THE COLD WAR: STABILITY FROM RESTRAINT

The space age began in 1957 with the Soviet Union's launch of the first artificial satellite, *Sputnik*. Despite the object itself having little inherent military value, the demonstration of the new capability had a psychological and political impact on the United States (U.S.), which launched its first satellite the following year. With the Soviet Union's successful use of a rocket to place a satellite in orbit around Earth, building on its test of the world's first intercontinental ballistic missile two months earlier in 1957, distance – and the sense of security that came with it – essentially collapsed.

Being in orbit, beyond national airspace, satellites not only had freedom of overflight but also were able to cover more ground than aerial reconnaissance and had image resolution that improved over time. Although the information they collected could be used to establish targets, it appears that satellite reconnaissance of strategic capabilities had an overall stabilizing effect during an era in which surprise attacks and nuclear arms imbalances were feared.[1] By providing a means of verification, satellites also contributed to the realization of nuclear arms control agreements between the Cold War superpowers.[2]

One scholar has observed that, in comparison to the significant expansion of U.S. and Soviet nuclear warheads from the early 1960s through to the mid-1980s, there was "a sharp *decline* in deployed weapons" in space [emphasis in the original]. Instead, competition was channelled

> mainly into civilian and military support (and later force enhancement) realms, with devoted weapons research taking place on the margins, but resulting in little testing and almost no deployments.[3]

The fragility of the space environment provides one explanation for this restraint.[4] Another focuses on the connection between satellites and nuclear deterrence. The disabling or destruction of early warning satellites and the communications functions associated with nuclear plans was considered high risk because it could have signalled the first stage of a nuclear war.[5]

2.2 SPACE AFTER THE COLD WAR: NEW APPLICATIONS, ACTORS AND ACCESS

The 1991 Gulf War established the importance of satellites in modern conventional military operations.[6] An early version of the Global Positioning System (GPS) was one of the factors that allowed U.S.-led forces to achieve a quick victory, with minimal casualties on their side, against Iraqi forces that were heavily equipped but had less advanced weaponry and defensive systems.[7] Space assets supported tasks that included acquiring targets, guiding some munitions, navigating and coordinating manoeuvres, and clearing mines.[8]

Nevertheless, the integration of space assets into terrestrial military operations has had strategic consequences.[9] Essentially, the same space systems that provided the United States with battlefield advantages also came to be seen as "multiple vulnerable single points of failure," which adversaries could target during conflict.[10] In early 2001, a U.S. commission highlighted the country's "relative dependence" on space and warned that the United States was "an attractive candidate for a 'Space Pearl Harbor.'"[11]

From the perspective of some observers, 1991 – a year that began with the Gulf War and ended with the Soviet Union's dissolution – marked the beginning of a "second space age," one that is "more diverse, disruptive, disordered, and dangerous" than what took place between 1957 and 1990.[12] Space is no longer dominated by two superpowers whose relations came to be informed by relatively stable notions of deterrence and controlled escalation.[13] Satellites continue to provide early warning and reconnaissance of strategic capabilities; however, they can also now be used to enable the projection of conventional military power over distances or as part of a military campaign to deny regional access to an adversary.

Furthermore, in the contemporary space age, private-sector companies are increasingly involved and, in many technological respects, are playing a leading role, including through the development of reusable launch vehicles and the miniaturization and proliferation of satellites. Journalists, researchers and others can now more readily acquire imagery from commercial satellites, which can influence policy debates when the information collected pertains to military activity and state behaviour.[14]

3 CONGESTED, CONTESTED AND COMPETITIVE

In 2011, a U.S. intelligence assessment determined that space had become increasingly "congested, contested, and competitive,"[15] phrasing that was repeated in Canada's 2017 defence policy.[16] While these concepts have been defined differently by various governments and observers, with some questioning the utility of the phrase altogether,[17] they can be used to examine trends.

3.1 CONGESTED

The congested nature of space refers to the exponential increase in the number of human-made objects orbiting Earth. There were 5,465 operational satellites in orbit as of 1 May 2022, an increase of more than 1,500 from the year before.[18] While the number of states with interests in space has grown, U.S. actors – governmental and military, but mostly commercial – continue to own or operate more than half of the satellites in orbit.[19] One reason for the increase in overall numbers is that the costs associated with satellites have declined significantly since their advent.[20]

Space appears set to become only more crowded and driven by private-sector innovation. The U.S. company SpaceX has plans to place as many as 30,000 additional satellites into orbit as part of what is known as a "mega-constellation."[21] Other companies are pursuing their own constellations, including Telesat, a Canadian-based company that in November 2021 applied to launch 1,373 communications satellites.[22]

In addition to the growing number of operational satellites, several thousand obsolete satellites continue to orbit Earth. In all, there are "approximately 23,000 pieces of debris larger than a softball orbiting the Earth," and many more debris pieces of smaller sizes.[23] Due to the high speeds at which objects orbit Earth, debris with a mass of less than one kilogram can hit a satellite with the same force as a truck speeding down a highway.[24] In general, the more objects there are in orbit, the greater is the danger. For example, in 2009, an inactive Russian military communications satellite and an active U.S. satellite used for commercial communications accidentally collided at a speed of 11.7 kilometres per second, destroying both and generating more than 2,300 fragments of trackable debris.[25]

As space becomes more congested, the concern is that a collision could produce thousands of pieces of debris, potentially causing further collisions, which could trigger a chain reaction. In the worst-case scenario, entire segments of low Earth orbit could become unusable to both military and civilian operators.[26]

3.2 CONTESTED

Some capabilities that could be used to threaten satellites have existed for decades, while new technologies and techniques are also reportedly under development.

To date, no country has deliberately destroyed a satellite belonging to another country. The last significant destructive test during the Cold War was carried out by the United States against one of its own satellites in 1985 using an air-launched missile. Following a pause in such activities, in 2007, China used the kinetic energy generated by a ground-to-space missile – known as a "direct ascent" anti-satellite (ASAT) capability – to destroy an aging weather satellite.[27] Due to the estimated altitude at which the operation was conducted, many pieces of the debris remain in orbit.[28] It is believed to have created "the largest debris cloud ever generated by a single event in orbit."[29] In 2008, the United States modified the software of a missile interceptor, which it fired from an Aegis naval cruiser, to destroy one of its reconnaissance satellites that was in a degrading orbit and carrying toxic fuel.[30] The timing and purpose of, and relationship between, these two events have been the subject of debate.[31] In 2019, India used a ballistic missile defence interceptor to destroy one of its satellites in low Earth orbit.[32]

None of Russia's suspected tests of a direct ascent ASAT system were known to have hit an object until 15 November 2021, when Russia used a missile to destroy one of its inactive satellites.[33] The U.S. Department of State characterized this action as "reckless" and "irresponsible" because it had generated more than 1,500 pieces of trackable orbital debris.[34] The test was also condemned by the North Atlantic Council and the European Union, while Japan, Australia and South Korea made their concerns known.[35] Moreover, the U.S. civilian space agency, the National Aeronautics and Space Administration (NASA), indicated that personnel aboard the International Space Station had to undertake "emergency procedures for safety" as the station passed "through or near the vicinity of the debris cloud."[36] Russia's foreign ministry challenged these statements.[37]

The most well-known – and demonstrated – ASAT capability is a missile launched from the ground, sea or air, as described above.[38] Other physical threats to satellites could include an explosion, crash or rendezvous operation initiated by one object near to or against another in space. Such an operation could also involve the release of a projectile from one satellite toward another.[39] The ground stations through which satellites are controlled and data are transmitted could also be attacked.[40]

Some states also appear to be developing capabilities that could be used to interfere with satellites or the information being exchanged between satellites and ground stations. Such interference would have the advantages of not creating a debris field in space and of being harder to attribute to the attacker. It is believed that a satellite could be temporarily disabled or permanently damaged with a laser or microwave weapon. Alternatively, an operation could be designed to jam communications between a satellite and a receiver, spoof a receiver or the satellite linked to it (i.e., introduce a fake signal or command), or intercept or corrupt data through cyber means.[41]

Depending on the type and severity of an attack and the sensitivity of the target, threats can be understood as being either strategic or tactical in nature.

In response to the various emerging threats, the U.S. Vice Chief of Space Operations told a Canadian audience in November 2021 that the priority of the U.S. Space Force is developing new designs, systems and architecture that are less vulnerable.[42]

3.3 COMPETITIVE

Competition in space refers to the growing number of actors that are launching and operating satellites and other space infrastructure, including positioning and timing services that rival GPS. While the United States and the Soviet Union were responsible for some 93% of the satellites launched into orbit before the 1990s, the United States and Russia were responsible for 57% of the satellites launched between 1991 and 2016.[43]

Competition is not, however, the only trend that has been observed.[44] A partnership of civilian space agencies from Canada, Europe, Japan, Russia and the United States has enabled the operation of the International Space Station since its launch in 1998. Interdependence is inherent to the research station's design. For example, the Russian segment and Russian cargo spacecraft provide propulsion, including station reboost and altitude control, while the U.S. solar arrays transfer power to the Russian segment.[45] Even amid the significant geopolitical tensions that have been generated by Russia's full-scale invasion of Ukraine on 24 February 2022, NASA and Roscosmos, the Russian space agency, were able to reach an agreement in July 2022 to send integrated flights of crew members to the research station.[46] However, subsequently, a Russian official announced the country's intention to withdraw from the research station after 2024.[47] Nevertheless, no official notification has been provided.[48] NASA wants to continue using the research station through 2030, at which point it aims to transition to commercial platforms in low Earth orbit.[49]

In 2003, China became the third country "to achieve independent human spaceflight,"[50] and has been constructing its own space station, which will be completed in late 2022.[51] Arrangements are also being pursued in relation to space exploration beyond Earth's orbit.[52] China and Russia have announced agreements on Moon exploration.[53] Canada is one of the signatories to the U.S.-led Artemis Accords, a political commitment concerning the safe and sustainable exploration and use of outer space.[54] Canada is also contributing to the U.S.-led initiative to establish a space station – or "gateway" – in lunar orbit.[55]

One observer has argued that the contemporary space race is not focused on a particular destination or accomplishment. Rather, it is a race "to see who can build the broadest and strongest international coalition in space."[56]

4 ADVANCING SPACE SECURITY AND STABILITY THROUGH DIPLOMACY

Diplomacy in relation to space security and stability is complicated by differing state interests and perceptions, as well as by complexities related to definitions and concepts. Objects and activities in space are not easily separated into non-military and military – or peaceful and weaponized – categories. Many are dual use or could be used with differing intent. An object that could be used to service a satellite could also be used to interfere with or damage one. That situation contrasts with the singular nature of a nuclear warhead or chemical nerve agent. Nor are "space weapons" confined to space; as noted previously, objects in space can be threatened both within space and from Earth. Even when a capability is designed for a military purpose, it could be used in more than one way. For example, a system that is designed to intercept an incoming missile could also be reconfigured to destroy an object in space.

4.1 THE LEGAL FRAMEWORK

Space has been on the diplomatic agenda since the late 1950s. Diplomacy allowed the Cold War superpowers to preserve their use of space for activities – including military reconnaissance – that were perceived as being more valuable than the weaponized contestation of space.

The first arms control agreement of the Cold War – the 1963 Partial Test Ban Treaty – extended U.S.–Soviet restraint to space. The treaty prohibits nuclear weapon test explosions and any other nuclear explosions in the atmosphere, under water and in outer space.[57]

Broader discussions at the United Nations (UN) culminated in the 1967 Outer Space Treaty, the cornerstone of space governance. Among other provisions, the treaty specifies that outer space – including the Moon and other celestial bodies – is to remain free for exploration and use by all states and is not subject to national appropriation. Furthermore, the treaty prohibits the placement in orbit around Earth of any objects carrying nuclear weapons or any other weapons of mass destruction, as well as the installation of such weapons on celestial bodies or their stationing in outer space in any other manner. The Moon and other celestial bodies are reserved for peaceful purposes. States parties are to conduct their activities in outer space "with due regard to the corresponding interests of all other" states parties. They also bear international responsibility for national activities that are carried out in space by governmental agencies and non-governmental entities. In general, the treaty requires states parties to operate in accordance with international law, including the *Charter of the United Nations*.[58]

Other treaties adopted in the late 1960s and 1970s address the rescue and return of astronauts, liability for damage caused by space objects and the registration of objects launched into outer space.[59] None of these instruments are designed explicitly to restrict non-nuclear forms of space weapons or their buildup.

4.2 THE PURSUIT OF GUARDRAILS FOR SPACE CONDUCT[60]

Certain states have focused on what they perceive to be gaps and ambiguities in the legal framework governing space security. Others see greater opportunities in the development of shared norms and confidence-building measures. All negotiating tracks are affected by geopolitics and by technological advancements.

Resolutions on the prevention of an arms race in outer space have been adopted in the annual sessions of the UN General Assembly.[61] Such documents express the political recommendations of that body, but they are not legally binding. In 2008, Russia and China put forward a draft treaty that would oblige states parties to refrain from placing any weapons in outer space and from resorting to the threat or use of force against the outer space objects of other states parties.[62] The proposed treaty, which was revised in 2014, was submitted through the UN Conference on Disarmament, a consensus body that has, for various reasons, “not been able to agree on a sustainable program of work for over 20 years.”[63]

Apart from the challenges involved in defining a “weapon in outer space” that does not unduly constrain civil or commercial activities, the United States has expressed concern that the draft treaty would not cover ground-to-space weapons and would not contain verification measures, which would only be negotiated afterward through an additional protocol.[64] The United States has focused on voluntary measures, which it argues can be built upon.[65] In April 2022, the United States committed “not to conduct destructive, direct-ascent (ASAT) missile testing,” and is seeking to establish this restraint as a norm.[66] The European Union does not exclude “the possibility of a legally binding instrument in the future,” but it believes that “voluntary measures constitute a pragmatic way forward at the moment, starting with norms, rules and principles of responsible behaviours, through an incremental and inclusive process.”[67]

Momentum has been building to advance a common understanding of such responsible behaviours through the work of the UN General Assembly. In December 2021, 150 states[68] voted in favour of a resolution that created an open-ended working group tasked, among other things, with making recommendations

> on possible norms, rules and principles of responsible behaviours relating to threats by States to space systems, including, as appropriate, how they would contribute to the negotiation of legally binding instruments, including on the prevention of an arms race in outer space.[69]

While the significance of this consensus-based working group will ultimately be determined by the level of state engagement it elicits, and any resulting outcome, it has been noted that the resolution supports "a shift in approach to consider and value behaviours – instead of technological hardware and capabilities – as the basis for international norm-setting."[70]

4.3 POSSIBLE PATHS FORWARD

Over the years, observers have made various proposals that they believe could reinforce or expand guardrails around state competition in space.[71] Canadian academics, civil society organizations, former officials and foreign ministers are among the signatories to a letter urging the UN General Assembly to pursue a treaty that would ban kinetic anti-satellite tests (i.e., tests involving some form of a physical strike).[72]

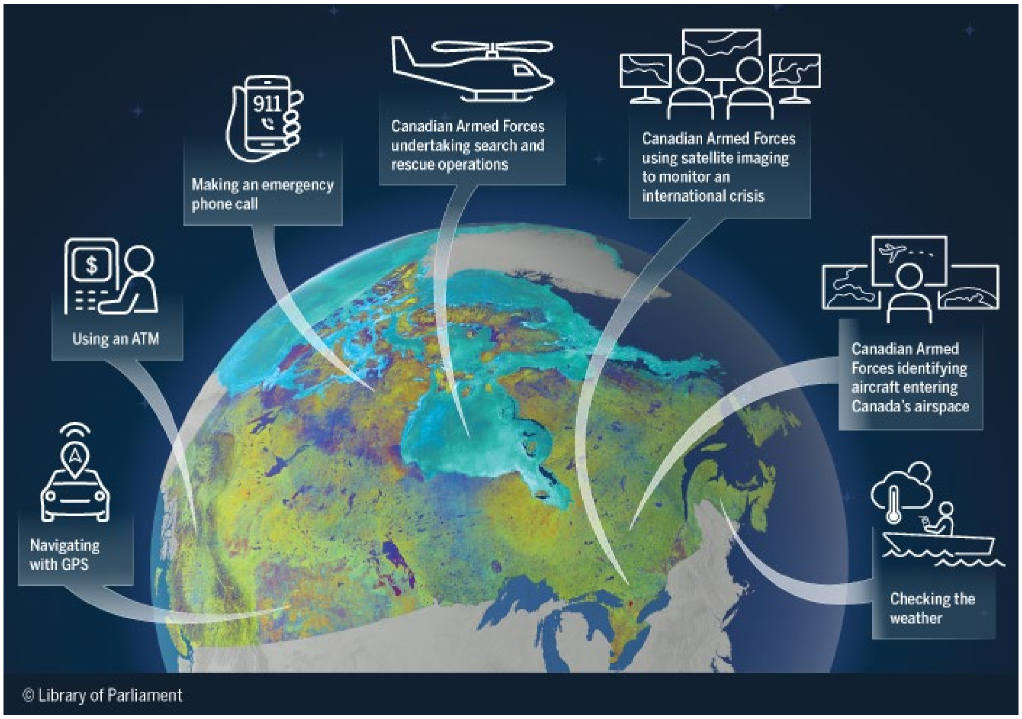
In addition to the procedural and technical complexities it involves, the diplomacy of space security is entwined with strategic considerations. Whereas, for example, China and Russia have drawn attention to the United States' establishment of a Space Force and declaration that space constitutes a warfighting domain,[73] the United States sees China and Russia promoting the non-weaponization of space in the diplomatic realm while continuing to pursue counterspace weapons outside of it.[74]

5 IMPLICATIONS FOR CANADA

5.1 CANADA'S RELIANCE ON SPACE AND SPACE COOPERATION

Many aspects of Canadian life depend on space. Financial transactions, telecommunications, weather forecasting and navigation using GPS are all connected to space infrastructure.[75] So are government functions that must reach and cover the country's vast territory, including through environmental monitoring, disaster response, and search and rescue. Space infrastructure helps to maintain the connections between Northern and remote communities and the rest of the country.[76] For example, the Government of Canada's announcement of an investment of more than $1.4 billion in a commercial satellite project indicated that satellites are the "only economical way" to provide high-speed Internet access to many rural and remote communities.[77] For these reasons, the Government of Canada has recognized the space sector, which contributed $2.5 billion to the country's gross domestic product in 2019, as "a strategic national asset."[78] Figure 1 depicts some of the ways Canadians and the Government of Canada rely on space.

Figure 1 – The Importance of Space to Canada



Source: Figure prepared by the Library of Parliament using an image obtained from Government of Canada, *Canada from space*, RADARSAT-2 Data and products © MDA Geospatial Services Inc., 2014; and data obtained from Government of Canada, *10 ways that satellites helped you today*.

With the launch of the *Alouette* from a U.S. military base in 1962, Canada became the third country to design and build a satellite.[79] Today, and in addition to its own capabilities, Canada relies on the satellites of foreign governments and the private sector. For example, the 31 GPS satellites used for navigation in Canada are owned and operated by the U.S. Department of Defense. A September 2020 Government of Canada report acknowledged that there are "no clear options to best support private and public sector delivery of critical services in the event of disruptions" to the GPS network.[80] Canada does not have its own space launch capability; consequently, its satellites must be sent to space from facilities in other countries.[81]

Canadian space activities depend on cooperation: between Canada and other countries; between and among Government of Canada entities; and among Canadian governments and communities, private companies and academic institutions. One example of cooperation was the June 2019 launch of Earth observation satellites to form part of the RADARSAT Constellation Mission (RCM). In comparison to the preceding generation of satellite, RADARSAT 2, the three RCM satellites provide an enhanced capability, including the capacity to "cover areas in the Arctic up to four times a day."[82] The RCM was funded by the Government of Canada through the Canadian Space Agency and constructed in Quebec by MDA Ltd., with parts made by another private corporation in Manitoba. The satellites were then driven to California, where they were launched from a U.S. Air Force Base aboard a rocket owned and operated by SpaceX.

The RCM project took 15 years between approval and launch.[83] It now provides 250,000 images per year to 12 Canadian federal departments and agencies.[84] In a May 2021 interview, the Director General for Space at the Royal Canadian Air Force warned that the RCM was "oversubscribed," which can create difficulties in managing the competing needs of entities that rely on the RCM for satellite images.[85]

5.2 CANADA'S NATIONAL DEFENCE

According to Canada's 2017 defence policy, "space capabilities are critical to national security, sovereignty and defence."[86] The policy also conveys that, while Canada will work to promote "the military and civilian norms of responsible behaviour in space required to ensure the peaceful use of outer space," the Canadian Armed Forces will prepare for the possibility of attacks by other states against space systems.[87] According to one observer, the range of counterspace threats that exist "toss out the notion that space is a sanctuary for Canadian defence assets."[88] On 22 July 2022, the Canadian Armed Forces established the 3 Canadian Space Division within the Royal Canadian Air Force. This new division is intended to "streamline, focus and improve how space-based capabilities support critical [Canadian Armed Forces] requirements."[89]

During its overseas military operations in the 1990s, including in the former Yugoslavia and in Somalia, Canada did not have reliable, secure satellite communications connecting deployed units with commanders in Ottawa. In the context of Canada's mission in Afghanistan in the 2000s, and to address this gap, Canada used – and made financial contributions to – secure U.S. satellite communications systems.[90]

The use of other countries' satellites – primarily those of the United States – can be seen as both an asset and a vulnerability for the Canadian military. Canada gains access to a much wider range of satellites than it could field on its own but without necessarily meeting all of Canada's distinct defence needs. For example, one observer has noted that some of the U.S. communications satellites on which the Canadian military relies do not transmit at high latitudes, which would hinder military communication in the Arctic.[91]

Canada's first dedicated military satellite, *Sapphire*, was launched in 2013. It provides space situational awareness (i.e., the ability to monitor objects in space) and contributes to the U.S. Space Surveillance Network.[92] However, some satellites have a limited lifespan before they become obsolete; the expected lifespan of *Sapphire*, for example, extends to 2024.[93]

Recognizing that Canada has "niche" space capabilities that both complement and contribute to the capabilities provided by the United States, commentators have made various proposals regarding how Canada should prioritize its investments in security-relevant space systems.[94] The 2018 Defence Investment Plan allocates funding for new military satellite systems, with a focus on systems that will provide satellite communications, including for classified information.[95]

5.3 CANADA'S INVOLVEMENT IN DETERRENCE AND DEFENCE COOPERATION

Canada's two principal defence alliances – the North American Aerospace Defense Command (NORAD) and the North Atlantic Treaty Organization (NATO) – rely on satellites to accomplish missions.

NORAD uses a network of satellites, radars and fighter jets to "detect, intercept and, if necessary, engage" airborne threats to Canada and the United States.[96] On 14 August 2021, the two countries issued a joint statement outlining a shared commitment to modernize NORAD "over the coming years," including through investments in "a network of Canadian and U.S. sensors from the sea floor to outer space."[97] In June 2022, Canada's Minister of National Defence announced a multi-billion-dollar plan for investment in NORAD modernization, part of which will be used to strengthen the Canadian Armed Forces' space-based surveillance capabilities and to enhance satellite communications in the Arctic.[98]

Regarding Canada's transatlantic allies, in December 2019, NATO leaders declared space an "operational domain,"[99] and in June 2021, they declared that an attack against the space assets of NATO members could lead to a collective military response against the aggressor under the terms of Article 5 of the NATO treaty.[100] NATO officials stress that the Alliance's aims in space are defensive in nature.[101] In January 2022, NATO published its "overarching" space policy, which outlines several principles and tenets, including that space "is essential to coherent Alliance deterrence and defence."[102] Others are that Allies "will retain jurisdiction and control over their objects in space" and that "NATO is not aiming to become an autonomous space actor."[103] While NATO has established a space centre in Germany, the Alliance itself does not possess any satellites. The intention is for NATO members to share, on a voluntary basis, "the space data, products, services or effects that could be required for the Alliance's operations, missions, and other activities."[104]

5.4 CANADA'S APPROACH TO DIPLOMACY

The Government of Canada has suggested that there is a need for "careful governance" of space given the dual-use nature of space and the many benefits derived from it.[105] Moreover, the Government has welcomed the development of norms of responsible behaviour in space and was one of 37 co-sponsors of the UN resolution that established the open-ended working group on reducing space threats.[106] According to the statement it delivered during the working group's first session, Canada "has called for a ban on ASATs" for 40 years.[107] More specifically, Canada "supports discussions, in the context of the [UN] Conference on Disarmament, on a possible ban on testing and use of anti-satellite weapons that cause space debris."[108]

The Government of Canada views "responsible" behaviours in space as those that "increase the predictability and general transparency of operations and therefore reduce the potential for hostilities in, from, or through space."[109] Such behaviours could include the timely exchange of information and the communication of intent. In Canada's view, irresponsible behaviours could include actions leading to damage of the space environment through the creation of debris, interference with the command and control of a satellite, and the approach or following of a satellite in a non-cooperative manner.[110] It is Canada's belief that the development of norms of responsible behaviour "will support more security and stability in space, thereby creating momentum for more ambitious steps, including the possibility of an eventual comprehensive, verifiable and legally binding regime."[111]

6 CONCLUSION

Since the late 1950s, space has evolved from being a domain of specialized and extraordinary government activity to something that is embedded in daily life. Space launch has become easier and less expensive, as has the operation of satellites. While there have been efforts to establish guardrails around state conduct in space, the risk of intentional or accidental disruption to space services and capabilities exists. In this context, Canada is advocating the responsible use of outer space while also addressing the implications of space having become an increasingly congested, contested and competitive environment.

NOTES

1. The United States (U.S.) intelligence community had estimated in 1957 that the Soviet Union could have had up to 500 intercontinental ballistic missiles (ICBMs) deployed by the middle of 1961. Following the launch of the CORONA satellites, however, an intelligence report from November 1961 estimated "that the Soviets likely had between 10 and 25 ICBMs deployed." Nevertheless, satellite imagery on its own could not determine how a military asset was being incorporated in military strategy. See Aaron Bateman, "Technological Wonder and Strategic Vulnerability: Satellite Reconnaissance and American National Security during the Cold War," *International Journal of Intelligence and CounterIntelligence*, Vol. 33, No. 2, 2020, pp. 336–337.

2. The agreements the United States and the Soviet Union reached in 1972 to limit strategic offensive nuclear arms and nationwide missile defence systems stipulated that "national technical means of verification" – understood as including satellites – would be used for verification; at the same time, the agreements prohibited interference with those means of verification. Other agreements negotiated by the United States and the Soviet Union also protected satellite functions. See United States, Department of State, *Treaties and Agreements*; and Laura Grego, *A History of Anti-satellite Programs*, Union of Concerned Scientists, January 2012, pp. 3–4.

3. James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed., 2019, p. 45. This point is supported by another report, which notes that between 1945 and 2013, 1,790 tests of nuclear devices were carried out by the United States, the Soviet Union and China (most by the U.S. and the Soviet Union), compared to 61 anti-satellite (ASAT) tests. See Michael Krepon and Sonya Schoenberger, "Annex: A Comparison of Nuclear and Anti-satellite Testing, 1945–2013," in Michael Krepon and Julia Thompson, eds., *Anti-satellite Weapons, Deterrence and Sino-American Space Relations*, Stimson Center, September 2013, pp. 131–137.

4. James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed., 2019, p. 49.

5. Michael Krepon and Christopher Clary, *Space Assurance or Space Dominance? The Case Against Weaponizing Space*, Stimson Center, 2003, pp. 37–38.

6. Within the intelligence community, the role of military-support satellites had already become a concern by the 1970s. The Soviet Union was developing a radar satellite that "could track and pinpoint the location of NATO naval vessels." The data "was then transmitted in near-real-time to Soviet naval units that could use it for attacking naval targets." See Aaron Bateman, "Mutually assured surveillance at risk: Anti-satellite weapons and cold war arms control," *Journal of Strategic Studies*, Vol. 45, No. 1, 2022, p. 124.

7. Larry Greenemeier, "GPS and the World's First 'Space War'," *Scientific American*, 8 February 2016.

8. United States Space Command, *United States Space Command: Operations Desert Shield and Desert Storm Assessment*, January 1992, p. 27. Less than 8% of the munitions used in the air campaign during the 1991 Gulf War were guided, a figure that had grown to more than 60% by the time of Operation Iraqi Freedom in 2003. See Barry D. Watts, *The Evolution of Precision Strike*, Center for Strategic and Budgetary Assessments, 2013, p. 14.

9. Brad Townsend, *Security and Stability in the New Space Age: The Orbital Security Dilemma*, 2020, p. 116.

10. Robert O. Work and Greg Grant, *Beating the Americans at their Own Game: An Offset Strategy with Chinese Characteristics*, Center for a New American Security, June 2019, p. 7.

11. "Executive Summary," *Report of the Commission to Assess United States National Security Space Management and Organization*, 11 January 2001, pp. viii and xii.

12. Todd Harrison et al., *Escalation and Deterrence in the Second Space Age*, Center for Strategic and International Studies, October 2017, pp. 2–9.

13. Ibid., p. 9.

14. See, for example, Hans M. Kristensen and Matt Korda, "China's nuclear missile silo expansion: From minimum deterrence to medium deterrence," *Bulletin of the Atomic Scientists*, 1 September 2021. For further discussion, see Erik Lin-Greenberg and Theo Milonopoulos, "Private Eyes in the Sky: How Commercial Satellites Are Transforming Intelligence," *Foreign Affairs*, 23 September 2021 [SUBSCRIPTION REQUIRED].

15. United States, Office of the Director of National Intelligence, *National Security Space Strategy*, News release, 3 January 2011.

16. National Defence, *Strong, Secure, Engaged: Canada's Defence Policy*, 2017, p. 56.

17. For a discussion of the subsequent popularity of the phrase "congested, contested, and competitive," see Joan Johnson-Freese, "Chapter 2 – Congested, Contested, and Competitive," *Space Warfare in the 21st Century: Arming the Heavens*, 2017.

18. Union of Concerned Scientists, "UCS Satellite Database," accessed 25 July 2022.

19. Ibid.

20. Using 2021 U.S. dollars, one study found that it cost the United States as much as $177,900 per kilogram to launch a satellite in 1965, compared to as low as $1,500 per kilogram in 2018. See Thomas G. Roberts, "Space Launch to Low Earth Orbit: How Much Does it Cost?," *Aerospace Security*, Center for Strategic and International Studies, 2 September 2020.

21. Aaron C. Boley and Michael Byers, "Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth," *Scientific Reports*, Vol. 11, 2021, p. 6. Victoria Samson of the Secure World Foundation notes that, while slots for satellite orbits "in geosynchronous Earth orbit are set by the International Telecommunication Union, there is no international entity coordinating orbital slots at low Earth orbit." Consequently, she suggests that certain orbits "may be effectively taken over by a handful of entities." See Victoria Samson, "The complicating role of the private sector in space," *Bulletin of the Atomic Scientists*, 17 January 2022 [SUBSCRIPTION REQUIRED].

22. "Telesat, Astra and Hughes Request 3 New Mega-constellations," *SpaceWatch.Global*, 5 November 2021.

23. National Aeronautics and Space Administration (NASA), "Space Debris and Human Spacecraft," *Space Station*, 26 May 2021.

24. Charles Powell, "Saving Space from 'Star Wars'–Style Misperceptions," *War on the Rocks*, 14 July 2020.

25. European Space Agency, "About space debris," *Space Safety*.

26. This phenomenon is referred to as the "Kessler Syndrome." See Hugh Lewis, "Space debris, Kessler Syndrome, and the unreasonable expectation of certainty," *ROOM*, Vol. 5, No. 3, 2015; and Raffi Khatchadourian, "The Elusive Peril of Space Junk," *The New Yorker*, 21 September 2020.

27. Brian Weeden, *Chinese Direct Ascent Anti-satellite Testing*, Secure World Foundation, April 2021. A representative of the Chinese government characterized the action as an "outer space experiment." See Embassy of the People's Republic of China in the United States of America, *Foreign Ministry Spokesperson Liu Jianchao's Regular Press Conference on 23 January, 2007*, 24 January 2007.

28. Timelines for the decay of orbital debris vary depending on altitude, owing to differences in atmospheric drag, solar pressure and gravity. For example, while experts indicate that debris decay above 1,000 kilometres could take centuries, the estimated time lessens to decades, years, months, weeks and hours with lower and lower orbits. See Katrina Manson and Max Seddon, "Space debris cloud threatens satellites after Russia missile test," *Financial Times*, 18 November 2021 [SUBSCRIPTION REQUIRED].

29. Brian Weeden, *2007 Chinese Anti-Satellite Test Fact Sheet*, Secure World Foundation, 23 November 2010.

30. Brian Weeden, *Through a Glass, Darkly: Chinese, American, and Russian Anti-satellite Testing in Space*, Secure World Foundation, 17 March 2014, pp. 26–27. The U.S. government framed the operation as a "one-time" modification of the Aegis system and necessary to protect human life. See United States, Department of Defense, Missile Defense Agency, "One-Time Mission: Operation Burnt Frost," *Aegis Ballistic Missile Defense* (via Internet Archive Wayback Machine); and NASA, Office of Public Affairs, *Media Briefing: "Reentry of U.S. Satellite"*, 14 February 2008.

31. According to James Clay Moltz, "[t]he late Pentagon decision to destroy the spacecraft, following earlier statements that the satellite had represented no threat, led analysts to wonder about the action's possible role as an ASAT test or as a signal to China (or both)." At the same time, the United States provided an advanced briefing to foreign governments at the United Nations (UN) and conducted the collision at a low altitude so that "the resulting debris de-orbited within a matter of months." See James Clay Moltz, *The Politics of Space Security: Strategic Restraint and the Pursuit of National Interests*, 3rd ed., 2019, p. 301.

32. Marissa Martin, Kaila Pfrang and Brian Weeden, *Indian Direct Ascent Anti-satellite Testing*, Secure World Foundation, April 2021. India's Ministry of Foreign Affairs indicated that the "test" had been conducted "to verify that India has the capability to safeguard [its] space assets." At the same time, the ministry emphasized that "India has no intention of entering into an arms race in outer space." See India, Ministry of External Affairs, *Frequently Asked Questions on Mission Shakti, India's Anti-Satellite Missile test conducted on 27 March, 2019*, News release, 27 March 2019.

33. Christian Maire, "Réflexions sur l'essai anti-satellite russe du 15 novembre 2021," *Notes de la FRS*, Fondation pour la recherche stratégique blog, 1 December 2021. For information on Russian tests prior to 15 November 2021, see Brian Weeden and Kylee Dickinson, *History of Anti-Satellite Tests in Space*, Spreadsheet, Secure World Foundation, 8 February 2022; and Renata Knittel Kommel, Marissa Martin and Brian Weeden, *Russian Direct Ascent Anti-satellite Testing*, Secure World Foundation, April 2021. Soviet ASAT tests from the 1960s to 1980s used what is known as "co-orbital" technology. It involves placing an interceptor into orbit, which then manoeuvres toward a target satellite. See Marissa Martin, Kaila Pfrang and Brian Weeden, *Russian Co-orbital Anti-satellite Testing*, Secure World Foundation, April 2021.

34. United States, Department of State, *Russia Conducts Destructive Anti-Satellite Missile Test*, News release, 15 November 2021.

35. North Atlantic Treaty Organization (NATO), *Statement by the North Atlantic Council on the recent anti-satellite missile test conducted by the Russian Federation*, News release, 19 November 2021; and European Council, Council of the European Union, *Statement by the High Representative of the Union for Foreign Affairs and Security Policy on behalf of the EU on the Russian anti-satellite test on 15 November 2021*, News release, 19 November 2021. For the responses of Japan, Australia and South Korea, see Japan, Ministry of Foreign Affairs, *An anti-satellite test conducted by the Government of Russia*, News release, 18 November 2021; Australia, Minister for Foreign Affairs and Minister for Women, *Russian anti-satellite weapons testing*, News release, 17 November 2021; and Park Si-soo, "Japan, Australia condemn Russia for 'irresponsible' anti-satellite missile test," *SpaceNews*, 19 November 2021.

36. NASA, *NASA Administrator Statement on Russian ASAT Test*, News release, 15 November 2021.

37. Nivedita Raju, *Russia's anti-satellite test should lead to a multilateral ban*, Stockholm International Peace Research Institute, 7 December 2021.

38. For a detailed overview of counterspace capabilities, see Brian Weeden and Victoria Samson, eds., *Global Counterspace Capabilities: An Open Source Assessment*, Secure World Foundation, April 2021.

39. In 2020, the U.S. Space Command reported that a Russian satellite had released a "new object" in proximity to another satellite. See United States Space Command, *Russia conducts space-based anti-satellite weapons test*, News release, 23 July 2020.

40. Todd Harrison et al., *Space Threat Assessment 2021*, Center for Strategic and International Studies, April 2021, pp. 4 and 6.

41. Ibid., pp. 5 and 7.

42. Halifax International Security Forum, "Halifax Chat with General David Thompson," YouTube, 20 November 2021.

43. Todd Harrison et al., *Escalation and Deterrence in the Second Space Age*, Center for Strategic and International Studies, October 2017, pp. 2 and 6. For further information on launch capabilities, see Thomas G. Roberts, "Spaceports of the World," *Aerospace Security*, Center for Strategic and International Studies, 3 January 2022.

44. Michael Byers, "Cold, dark, and dangerous: international cooperation in the arctic and space," *Polar Record*, Vol. 55, No. 1, 10 June 2019.

45. NASA, *International Space Station Frequently Asked Questions*, 15 March 2022.

46. According to NASA, such integrated flights (i.e., crew swaps) are necessary to ensure the station is properly maintained and appropriately crewed, while protecting against contingencies. See Kenneth Chang and Anton Troianovski, "In Space, U.S.–Russian Cooperation Finds a Way Forward," *The New York Times*, 15 July 2022 [SUBSCRIPTION REQUIRED].

47. Wendy Whitman Cobb, "Russia's withdrawal from the International Space Station could mean the early demise of the orbital lab – and sever another Russian link with the West," *The Conversation*, 26 July 2022.

48. Jeff Foust, "NASA: no notification by Russia to end ISS participation," *SpaceNews*, 26 July 2022.

49. Jeff Foust, "Other ISS partners start planning for extension to 2030," *SpaceNews*, 9 January 2022; Brian Dunbar, "Biden–Harris Administration Extends Space Station Operations Through 2030," *NASA Blogs*, 31 December 2021; and NASA, *NASA Selects Companies to Develop Commercial Destinations in Space*, News release, 2 December 2021.

50. United States, Defense Intelligence Agency, *2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion*, 2022, p. 12. Furthermore, China was "the third country to place a robotic rover on the Moon and was the first to land a rover on the lunar far side in 2019." Ibid., p. 14. China also landed a rover on Mars in 2021, and the country has doubled the number of satellites it has in Earth's orbit in the past 10 years. See ibid., p. 8.

51. Since 2011, U.S. law has limited cooperation between NASA and China. See Leonard David, "Can the U.S. and China Cooperate in Space?," *Scientific American*, 2 August 2021; and Steven Lee Myers, "The Moon, Mars and Beyond: China's Ambitious Plans in Space," *The New York Times*, 15 October 2021 [SUBSCRIPTION REQUIRED].

52. Andrew E. Kramer and Steven Lee Myers, "Russia, Once a Space Superpower, Turns to China for Missions," *The New York Times*, 16 September 2021 [SUBSCRIPTION REQUIRED].

53. Svetla Ben-Itzhak, "Space Blocs: The future of international cooperation in space is splitting along lines of power on Earth," *The Conversation*, 21 April 2022.

54. The Artemis Accords are being pursued in accordance with the tenets of the 1967 Outer Space Treaty. See Government of Canada, *A framework for future space exploration activities – background information*. For the agreement itself, see NASA, *The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes*, 13 October 2020.

55. Government of Canada, *The Lunar Gateway*; and Government of Canada, *Canada's role in Moon exploration*.

56. Todd Harrison, *Statement before the House Science, Space, and Technology Committee: Subcommittee on Space and Aeronautics – NASA's Future in Low Earth Orbit: Considerations for International Space Station Extension and Transition*, Center for Strategic and International Studies, 21 September 2021.

57. UN, Office for Disarmament Affairs (UNODA), "Status of the treaty," *Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water*. The treaty has 125 states parties. For a timeline of diplomatic initiatives and milestones in relation to arms control in outer space, see Jessica West and Lauren Vyse, *Arms control in outer space: Status, timeline, and analysis*, Project Ploughshares, March 2022.

58. UNODA, "Status of the treaty," *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*. This treaty, known in short form as the Outer Space Treaty, has 112 states parties.

59. There is also the 1979 Moon Agreement, which has not been widely ratified. See UNODA, *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*.

60. The idea of "guardrails" is expressed in Michael Krepon, "How Much Longer for a Space Code of Conduct?," *Arms Control Wonk*, Blog, 21 September 2021.

61. For the most recent example, see UN General Assembly (UNGA), *Resolution adopted by the General Assembly on 6 December 2021: 76/22 – Prevention of an arms race in outer space*, 8 December 2021.

62. Alexey N. Borodavkin, Ambassador, Permanent Representative of the Russian Federation, and Wu Haitao, Ambassador for Disarmament Affairs of China to the Conference on Disarmament, *Letter dated 10 June 2014 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament addressed to the Acting Secretary-General of the Conference transmitting the updated Russian and Chinese texts of the draft treaty on prevention of the placement of weapons in outer space and of the threat or use of force against outer space objects (PPWT) introduced by the Russian Federation and China*, 12 June 2014. The draft treaty, an earlier version of which was submitted in 2008, built on a working paper that China and Russia had submitted to the Conference on Disarmament in 2002. The paper was submitted the same month – June 2002 – that the U.S. withdrawal from the 1972 Anti-ballistic Missile Treaty took effect. See Paul Meyer, *Ballistic Missile Defence & Outer Space Security: A Strategic Interdependence*, Space Dossier 6, United Nations Institute for Disarmament Research, June 2020, p. 15.

63. Paul Meyer, *Arms Control in Outer Space: Mission Impossible or Unrealized Potential?*, Policy perspective, Canadian Global Affairs Institute, October 2020.

64. UN, *Conference on Disarmament: Note verbale dated 2 August 2018 from the Delegation of the United States of America to the Conference on Disarmament addressed to the Secretary-General of the Conference transmitting the United States response to CD/2042 (14 September 2015), titled "Letter dated 11 September 2015 from the Permanent Representative of the People's Republic of China to the Conference on Disarmament and the Chargé d'affaires a.i. of the Russian Federation regarding the United States of America analysis of the 2014 updated Russian and Chinese texts of the draft treaty on prevention of the placement of weapons in outer space and of the threat or use of force against outer space objects (PPWT)"*, 16 August 2018.

65. UNGA, *Reducing space threats through norms, rules and principles of responsible behaviours*, Report of the Secretary-General, 13 July 2021, pp. 95–102. In July 2021, the U.S. Department of Defense was instructed to follow "tenets of responsible behaviour in space," including limiting the generation of long-lived debris and maintaining safe separation. See United States, Department of Defense, *Memorandum for Secretaries of the Military Departments, Chairman of the Joint Chiefs of Staff, Under Secretaries of Defense, Chiefs of the Military Services, Commanders of the Combatant Commands, General Counsel of the Department of Defense, Directors of Defense Agencies (Subject: Tenets of Responsible Behavior in Space)*, 7 July 2021.

66. United States, The White House, *FACT SHEET: Vice President Harris Advances National Security Norms in Space*, 18 April 2022. The U.S. has acknowledged that its commitment "does not cover all ASAT threats, including space-based ASAT systems nor does it involve the elimination of any weapons," something the U.S. believes "would be challenging from a definitional and verification perspective." See Eric Desautels, United States Acting Deputy Assistant Secretary of State, *U.S. Statement to the Open Ended Working Group on Reducing Space Threats through Norms, Rules and Principles of Responsible Behavior*, 9 May 2022.

67. The European Union also believes that any legally binding framework would need to be verifiable and cover threats within space, from Earth to space and from space to Earth. See Delegation of the European Union to the United Nations in New York, *EU Statement – United Nations 1st Committee: Thematic Discussion on Outer Space*, 11 October 2021.

68. The UN General Assembly adopted the resolution by a recorded vote of 150 in favour, 8 against and 7 abstentions. Among the states voting against were China, Iran, North Korea and Russia. India, Israel and Pakistan were among the states that abstained. India voted, with eight other states, against the specific paragraph creating the open-ended working group, which was retained in the final version of the resolution. See UN, *Approving $3.12 Billion Programme Budget, General Assembly Adopts 26 Resolutions, 2 Decisions, as Main Part of Seventy-Sixth Session Concludes*, News release, 24 December 2021. This 2021 resolution built on a 2020 resolution that was sponsored by the United Kingdom. See UNGA, *Resolution adopted by the General Assembly on 7 December 2020: 75/36. Reducing space threats through norms, rules and principles of responsible behaviours*, 16 December 2020.

69. UNGA, *Resolution adopted by the General Assembly on 24 December 2021: 76/231. Reducing space threats through norms, rules and principles of responsible behaviours*, 30 December 2021, para. 5(c), p. 3. The first substantive meeting of the open-ended working group was held in May 2022. For further information, see UNODA, *Open-ended working group on reducing space threats*.

70. European Space Policy Institute, *UN resolution on norms of responsible behaviours in space: a step forward to preserve stability in space?*, Executive Brief No. 54, 30 November 2021.

71. For discussion of a proposal for a new legal instrument, see Paul Meyer, "Could an optional protocol be the way to stop the weaponization of outer space?," *International Journal*, Vol. 76, No. 2, 2021, pp. 336–338. Another perspective focuses on the benefits of clarifying and restating space law "to apply to modern contexts and space applications and technologies." See UNGA, *Written Contribution to the Open-Ended Working Group (OEWG) on Reducing Space Threats Through Norms, Rules and Principles of Responsible Behaviours, Submitted by the Institute of Air and Space Law of McGill University, Canada*, 16 May 2022.

72. Michael Byers et al., Letter addressed to H.E. Mr. Volkan Bozkir, President of the United Nations General Assembly (Re: Kinetic ASAT Test Ban Treaty), 2 September 2021. According to the proposal, "'Fly by' tests would still be permitted."

73. See United States, Department of Defense, *Defense Space Strategy Summary*, June 2020.

74. United States, Defense Intelligence Agency, *2022 Challenges to Security in Space: Space Reliance in an Era of Competition and Expansion*, pp. V, 9 and 21.

75. See Government of Canada, *10 ways that satellites helped you today*.

76. For example, in 2011, a Canadian communications satellite experienced a technical failure; as a result, Nunavut was largely cut off from telecommunications services for some 16 hours. See "Northern telcom service restored after 16-hour Telesat Canada satellite glitch," *Nunatsiaq News*, 7 October 2011.

77. Innovation, Science and Economic Development Canada (ISED), *Government of Canada announces $1.44-billion investment in Telesat supporting the future of connectivity for rural and remote communities*, News release, 12 August 2021.

78. Government of Canada, *2020 State of the Canadian Space Sector Report – Facts and Figures 2019*; and ISED, *Exploration, Imagination, Innovation: A New Space Strategy for Canada*, 2019, p. 9.

79. Government of Canada, *Canadian space milestones*. The United Kingdom's first satellite, the *Ariel 1*, was launched a few months before the *Alouette*; however, the *Ariel 1* was designed in the United States, making Canada technically the third country to design its own satellite.

80. ISED, *Canadian Risk Assessment and Risk Mitigation Assessment Project: Information and Guide*, 15 September 2020, p. 3.

81. A commercial spaceport has been approved with conditions for Canso, Nova Scotia; the facility is scheduled to launch its first satellite, on a Ukrainian-built rocket, near the end of 2023. See The Canadian Press, "Proposed N.S. spaceport announces payload client for 1st rocket launch," *CBC News*, 22 November 2021; and Nova Scotia, Environment and Climate Change, *Canso Spaceport Facility Project*.

82. Government of Canada, *Frequently asked questions – RADARSAT Constellation Mission (RCM)*.

83. Dean Beeby, "Canada's key satellite system hit with another launch delay," *CBC News*, 13 November 2018.

84. Canadian Space Agency, *To stay at the cutting edge of Earth observation, Canada is seeking ideas from industry*, News release, 7 February 2020; and Government of Canada, *Resourceful, Resilient, Ready: Canada's Strategy for Satellite Earth Observation*.

85. Marc Boucher, "Standing Up a Canadian Armed Forces Space Division," *SpaceQ*, Podcast, 17 May 2021 [SUBSCRIPTION REQUIRED]. A defence project to replace and improve upon the RCM has already been established, but the capability is not anticipated to be available until at least 2032. See Government of Canada, *Defence Enhanced Surveillance from Space – Project (DESSP)*.

86. National Defence, *Strong, Secure, Engaged: Canada's Defence Policy*, 2017, p. 70.

87. Ibid., p. 57.

88. Charity Weeden, Strong, Secure, Engaged *in a Threatened Space Domain*, Policy update, Canadian Global Affairs Institute, May 2018.

89. National Defence, *Establishment of 3 Canadian Space Division*, News release, 22 July 2022.

90. Elinor Sloan, "Communications satellites in Canadian security policy: History and prospects," *International Journal*, Vol. 76, No. 2, 18 May 2021, p. 214.

91. Ibid., p. 215.

92. Government of Canada, *Space Situational Awareness and the Sapphire Satellite*, Backgrounder, 30 January 2014.

93. Cam Stoltz, Director Space Requirements, Royal Canadian Air Force, *'Strong, Secure and Engaged': The Next Generation of Canadian Space Domain Awareness*, Presentation, 28 April 2021. There is a defence project to replace the *Sapphire* satellite's capability, which is anticipated to begin delivery in 2026–2027. See Government of Canada, *Surveillance of Space 2*.

94. See Jeff Dooling et al., *Revitalizing Canada's Visions for Space*, Policy perspective, Canadian Global Affairs Institute, June 2022; and Kevin Budning, Alex Wilner and Guillaume Cote, "A view from above: Space and the Canadian Armed Forces," *International Journal*, Vol. 76, No. 4, pp. 594–605.

95. Government of Canada, *Projects by Defence Capability Investment Area: Satellites and Space-based Vehicles*.

96. North American Aerospace Defense Command (NORAD), *North American Aerospace Defense Command*.

97. National Defence, *Joint Statement on Norad Modernization*, 14 August 2021.

98. National Defence, *Minister Anand announces continental defence modernization to protect Canadians*, News release, 20 June 2022; and Government of Canada, *Fact sheet: Funding for Continental Defence and NORAD Modernization*.

99. NATO, *NATO's approach to space*, 2 December 2021.

100. NATO, *Brussels Summit Communiqué*, News release, 14 June 2021; and NATO, *NATO's overarching Space Policy*, 17 January 2022. NATO leaders elaborated that "[a] decision as to when such attacks would lead to the invocation of Article 5 would be taken by the North Atlantic Council on a case-by-case basis."

101. NATO, *Keynote address by NATO Deputy Secretary General Mircea Geoană at the NCI Agency's NITEC Connect 2021 conference*, 16 June 2021.

102. NATO, *NATO's overarching Space Policy*, 17 January 2022.

103. Ibid.

104. Ibid.

105. Government of Canada, *Canada's statement to the general debate of the First Committee of the 73rd session of the United Nations, delivered by H.E. Ms. Rosemary McCarney, Ambassador and Permanent Representative of Canada to the Office of the United Nations and to the United Nations Conference on Disarmament in Geneva*, 16 October 2018.

106. Leslie Norton, Ambassador and Permanent Representative of Canada to the United Nations in Geneva and the Conference on Disarmament, *Statement by Canada – General Debate*, 76th Session of the United Nations General Assembly – First Committee, 5 October 2021.

107. Government of Canada, *Agenda item 5. General exchange of views on all matters*, Canadian statement to the Open-ended working group on reducing space threats, First session, 9–13 May 2022.

108. UNGA, *Reducing space threats through norms, rules and principles of responsible behaviours*, Report of the Secretary-General, 13 July 2021, p. 26.

109. Ibid., p. 25.

110. Ibid., p. 26–27

111. Ibid., p. 28.