



Consulting Canadians on a Modern Regulatory Framework for Space

Submission from the Outer Space Institute

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“The future space race will be won not by those whose technological advancements are superior but by the rule-makers—those whose economic, legal, social, and political institutions are most innovative, attractive, and popular to other spacefaring nations and entities.”¹

Preamble

The Outer Space Institute (OSI) is pleased to submit this document as part of the 2023 Canadian Space Agency (CSA) public consultation on Canada’s space regulatory framework.

The OSI is a global network of experts united by our commitment to transdisciplinary research that addresses grand challenges facing the continued use and exploration of space. We are physical scientists, engineers, social scientists, lawyers, industry leaders, and retired government officials. As a global network, the OSI is not part of the University of British Columbia, though both its co-directors are faculty members there.

Recommendations

1. Take a holistic approach: consider economic development, national security, diplomacy, scientific research, environmental protection, education, and international impacts in updating regulations and policy
2. Take an all of government approach: the sustainable development of space, necessary for ensuring long-term benefits, cannot be achieved through siloed thinking and actions. Consider a National Space Act, which can help to develop the ‘big picture’
3. Advance science opportunities by providing a licencing regime that accommodates innovation and space exploration, including by supporting non-governmental space missions

¹ Deganit Paikowsky, “The Space Race’s Shifting Center of Gravity”, Foreign Policy, March 8, 2023, at: <https://foreignpolicy.com/2023/03/08/space-race-moon-lunar-artemis-accords-united-states-russia-china/>

4. Require environmental impact assessments, including for orbital activities (space debris, re-entry risks, protecting dark and quiet skies for astronomy, Indigenous peoples, tourism, and the general public)
5. Ensure that there is approval and oversight for Canadian space companies working for/with non-NATO allies, especially during armed conflict.

Background

Space is no longer solely the domain of space agencies and defence departments. Many space activities are now carried out by corporations and other non-government entities, and this has resulted in an accelerated evolution of space technologies and applications. This shift from public to private does not, however, mean that states are less relevant in this era of ‘NewSpace’. Quite the contrary: as the operational role of the state has diminished, its regulatory role has correspondingly increased.

As they strive for success, these private actors push at the boundaries of a contractual environment that has, for decades, been controlled and managed by space agencies and defence departments funded by public budgets. As companies push down the cost of building, launching and operating payloads, we are witnessing an explosion of new technologies and applications. We are also encountering operational, safety, and environmental challenges, with the most immediate of these concerning a large and rapid growth in the number of objects in low Earth orbit. Space debris now puts at risk the future utilization of this invaluable and still largely unregulated domain. Light and spectrum pollution from satellites compromises astronomy and particularly our ability to detect asteroids and comets that pose potential Earth-impact threats. Meanwhile, the growing number of rocket body and satellite re-entries creates casualty risks and changes to atmospheric chemistry, with potentially large climate change impacts. Moving further into outer space, the issue of space resource utilization has become a matter of international debate, centred around both the Artemis Accords and a Working Group on Legal Aspects of Space Resource Activities established by the UN Committee on the Peaceful Uses of Outer Space. Poorly managed, this issue could, much like the issue of deep seabed mining in the 1970s and 1980s, cause a fracture between the industrial states of the Global North and the far more numerous developing states of the Global South.

By virtue of all these rapid changes, there is an urgent need for rational, coherent rule-making at both the international and national levels. States that fall behind on legislative and regulatory reform are unlikely to attract or develop internationally competitive space companies. Ensuring that space remains well-regulated, secure, safe, and sustainable is therefore in Canada’s national interest. Yet this country’s legislative framework has not kept pace with global developments.

In 2019, the Government of Canada recognized this weakness and released *Exploration, Imagination, Innovation: A New Space Strategy for Canada*. In his foreword to that document, then-Minister of Innovation, Science and Economic Development Navdeep Singh Bains wrote: “The Government is committed to helping unlock the full potential of the space sector and respond to the realities of the new and evolving space environment.”

The 2019 Strategy emphasized the socio-economic benefits of space. It included plans for: (1) policies and regulations to capitalize on the development of new space technologies; (2) designating the space sector as a national strategic effort; (3) strengthening the capacity of Canada’s space sector to compete globally; and (4) revitalizing Canada’s space program to ensure it remains responsive and relevant to its international partners. It promised a modern regulatory framework to keep pace with emerging technologies and new business models, maintain strategic oversight for national security, and enable innovative space companies to prosper in Canada.

Since 2019, the COVID-19 pandemic and other unforeseen developments have slowed the delivery on these plans. Meanwhile, the global political, economic, and technological landscape has been changing. The new 2023 consultation is both necessary and timely.

Analysis

In 1967, the ‘Chapman Report’ on *Upper Atmosphere and Space Programs in Canada* constituted the first significant government-initiated investigation into the opportunities afforded by space. Since then, the Canadian government has produced numerous studies, reports, policy documents, plans, strategies and frameworks.

As Canadian space activities grew, legislation became necessary. Space-related provisions were included in the Radiocommunications Act of 1985, Aeronautics Act of 1985, Canadian Space Agency Act of 1990, Broadcasting Act of 1991, Telecommunications Act of 1993, and Remote Sensing and Space Systems Act of 2005. Yet these six pieces of legislation, promulgated 38 to 18 years ago, have had only minor updates or revisions since then. The reason for this is simple: Until a few years ago, nearly all commercial space operations existed within the publicly-funded Canadian Space Agency and Department of National Defence. There has not been a need for legislation specifically directed at non-governmental space actors in Canada—until now.

Other countries have already updated their legislative frameworks to embrace current realities and trends. At the 2023 meeting of the Legal Subcommittee of the UN Committee on the Peaceful Uses of Outer Space, a number of states reported on updates to national legislation. This included, *inter alia*, the United States, United Kingdom, France, Luxembourg, Italy, Japan, Israel, Switzerland, New Zealand, Australia, and China.²

One modern approach to space legislation and regulation involves the adoption of a sustainability framework that enables a joined-up approach to addressing competing uses of space as well as instances of over-use or negative externalities. These include orbital congestion and space debris, spectrum allocation and interference, and light and spectrum interference with consequences for astronomy, planetary defence, recreational sky-watchers and nocturnal animals. Indeed, the Council of the European Union recently produced a draft document on *Fair and Sustainable Use of Space* that encourages EU member states to implement the *Guidelines for*

² UN Committee on the Peaceful Uses of Outer Space, Legal Subcommittee, 62nd session, March 20-31, 2023, Statements, at: <https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/2023/statements.html>

the Long-term Sustainability of Outer Space Activities developed by the UN Committee on the Peaceful Uses of Outer Space over the course of the past decade.³ A well-developed sustainability framework would include environmental impact assessments for proposed space activities—on Earth, in orbit, and beyond.

Priority areas for legislative and regulatory reform

Space debris

Spent rocket bodies and defunct satellites are contributing to a fast-growing crisis of space debris. The widely-accepted guideline of 25 years from the end-of-life of a satellite to its de-orbiting is now considered insufficient. In 2023, the US Federal Communications Commission adopted a new rule for US space companies, who now have just five years in which to remove their satellites from low Earth orbit, usually through active (i.e., propelled) deorbiting.⁴ Existing Canadian legislation is silent on this issue.

Uncontrolled re-entries

Recent research has demonstrated that the casualty risks from uncontrolled re-entries of rocket bodies, while still small, are growing.⁵ New research is exploring the lower but potentially more consequential risks to aircraft in flight.⁶ Today, uncontrolled re-entries are unnecessary in most circumstances due to new technologies and mission designs. Controlled re-entries into remote areas of ocean represent the new ‘best practice’.

The US Federal Aviation Administration is considering moving to a controlled re-entry regime, and the US Space Force, when contracting with SpaceX for launches, requires the company to bring back both the first and second stages of its rockets in a controlled manner. Although Canadian legislation is currently silent on this issue, any legislative or regulatory reform will have to address it, especially as Canada moves toward launching objects from its territory.

Environmental Impact Assessment

Space activities can have environmental impacts in the atmosphere and on the Earth’s surface and should therefore be subject to environmental impact assessments (EIAs) during the planning and licencing stage. Launches and re-entries are activities with clear environmental consequences, including the re-entry of satellites because of the alterations to atmospheric

³ Council of the European Union, “Draft Council Conclusions on ‘Fair and Sustainable Use of Space’,” January 24, 2023, at: <https://data.consilium.europa.eu/doc/document/ST-5576-2023-INIT/en/pdf>

⁴ Jeff Foust, “FCC approves new orbital debris rule,” September 29, 2022, at: <https://spacenews.com/fcc-approves-new-orbital-debris-rule/>

⁵ 2022 *International Open Letter on Reducing risks from uncontrolled reentries of rocket bodies and other space objects*, at: [http://outerspaceinstitute.ca/docs/OSI%20Open%20Letter%20on%20Uncontrolled%20Reentries\(19_12_2022\).pdf](http://outerspaceinstitute.ca/docs/OSI%20Open%20Letter%20on%20Uncontrolled%20Reentries(19_12_2022).pdf)

⁶ 2023 *Montreal Recommendations on Aviation Safety and Uncontrolled Space Object Reentries*, at: <https://outerspaceinstitute.ca/docs/Montreal%20Recommendations%20on%20Aviation%20Safety%20and%20Uncontrolled%20Space%20Object%20Reentries.pdf>

chemistry that can result during the demise (burn-up) phase. Light pollution from satellites also has environmental consequences, for example, disruption caused to nocturnal animals.

For these reasons, any legislative or regulatory reform should require an EIA as part of the planning and licencing process for all space activities. Given the specialized nature of space and space technologies, federal EIAs – not provincial ones – should be used.

Climate Change Impacts

Very recent research has revealed that some space activities may have serious climate change impacts.⁷ Depending on the fuel being used, rockets produce different kinds of by-products and deposit them throughout the atmosphere. Solid rocket fuel appears to be the worst type of fuel from a climate change perspective, but even ‘clean burning’ hydrogen-fuelled rockets deposit water vapour in the dry upper reaches of the atmosphere, creating clouds there and potentially altering other atmospheric processes.

Then, there are re-entries. When a space object “burns up”, its mass does not disappear, but rather becomes large numbers of particles which are injected into the upper atmosphere. In the case of satellites from mega-constellations such as SpaceX’s Starlink, most of these particles will be aluminum compounds, with alumina expected to be a major constituent, and the amount of alumina injected into the atmosphere in this way will greatly exceed the natural deposition of aluminum by meteoroids. The climate effects of this artificial process are not yet fully understood, but in the future re-entries might constitute a major driver of climate change. For this reason, as well as the climate impacts of launches, any updated regulatory regime will have to include provision for environmental impact assessments during the planning and licencing phase of any proposed space activity.

Radio and Light Pollution

Astronomy is a fundamental science and the foundational form of space exploration. It is a principal tool used to test for new physics, and is essential to humanity’s survival, whether through understanding solar activity or detecting Earth impactors. The effects of satellites and debris on terrestrial and space-based astronomy should not be taken lightly. Images are now regularly polluted by satellite streaks, as well as ‘glints’, i.e., flashes of light due to mirror-like reflections of sunlight off even small satellites and debris. Even the Hubble Space Telescope has images regularly ruined by orbital light pollution.

Due to Canada’s latitude and the orbital configurations of satellites, Canadian sky will be heavily impacted by satellite brightness during certain times of year,⁸ which could limit the types of astronomy that can effectively be done in Canada. Nor can the impacts on natural and cultural

⁷ Aaron C. Boley and Michael Byers. “Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth.” *Scientific Reports* 11.1 (2021): 10642, at: <https://www.nature.com/articles/s41598-021-89909-7>

⁸ Samantha Lawler, Aaron C. Boley, and Hanno Rein. “Visibility Predictions for Near-future Satellite Megaconstellations: Latitudes near 50° Will Experience the Worst Light Pollution.” *Astronomical Journal* 163 (2022): 21, at: <https://iopscience.iop.org/article/10.3847/1538-3881/ac341b>

heritage be ignored, as well as access to the night sky for non-professional astronomy, such as stargazing, astrophotography, and citizen science.

Radio astronomy is also facing major challenges from satellites. While terrestrial radio interference can be partially mitigated by using remote and radio-quiet locations on Earth, most satellites have global influence. Radio telescopes are also different from optical telescopes in that they have sensitivity to regions of the sky far from where they are ‘pointing’. If a radio-bright satellite is in the sky, it could affect observations. As a result, radio telescopes cannot avoid satellites, and while satellite operators can helpfully avoid transmitting while directly above an observatory, such actions are insufficient.

Radio astronomy has specific spectrum bands that are protected, but at least two things must be kept in mind: (1) The internationally protected radio astronomy bands are not the only regions of the spectrum of interest. Much of radio astronomy makes use of unused or underused areas of the spectrum to conduct science. As such, while coordination and cooperation are necessary among all users of the spectrum, cutting-edge research could be heavily impacted or precluded by opening up more and more spectrum to satellites. (2) The protected bands are not interference free. Indeed, some are seriously impacted due to issues with transmitter noise, as well as negligence.

Canada has large astronomy investments nationally, internationally, and in space. Examples include the Square Kilometer Array Observatory (radio)*, Canadian Hydrogen Intensity Mapping Experiment (radio), Gemini (optical/infrared), Canada-France-Hawaii Telescope (optical), Thirty-Meter Telescope (optical/infrared)*, Mont Mégantic Observatory (optical), the Dominion Astrophysical Observatory (optical), and CASTOR (a Canadian-led space observatory)*, with the starred examples being in development. All these facilities are or will be impacted by satellite development.

Canada needs to have a forward-leaning approach to developing space to ensure that such development is sustainable. This includes building in basic considerations for light and radio pollution into the legislative and regulatory regime (e.g., for licencing requirements), and leading or supporting national and international efforts to protect dark and quiet skies. Radio and light pollution considerations further need to be included in the development of the Moon.

Liability

The international rules concerning liability are different in space than in other domains. One difference is that states are legally responsible for the actions of their national space actors, including companies incorporated, acting under license from, or contracted by them. Another difference is that damage caused on the surface of Earth by a returning space object is subject to absolute liability; as a result, liability does not require negligence. If a person or airplane is struck by a piece of re-entering rocket body or satellite owned or operated by a Canadian company, or even just launched from Canada, the Government of Canada will be fully liable.

Other spacefaring states have laws and regulations that require companies, as part of the licensing regime, to indemnify the government for any such liability. In some cases, limits are

put on the amount of indemnification so as to not overburden smaller and developing companies. Canada does not yet have laws and regulations specific to liability for space activities, and one could expect them to be part of any updated regulatory framework.

Non-governmental space science missions

With the exception of CubeSats, Canadian space science missions have always been led by government. However, as launch costs decline and new technologies and smaller components enable low-cost robotic spacecraft, non-governmental space science missions are becoming a reality worldwide. Non-governmental space science missions have a great deal to contribute to basic science and education, while having economic spinoffs of all kinds.

Some spacefaring states have legislation and regulations that readily enable the licensing of non-governmental space science missions, subject to conditions on matters such as planetary protection. Canada does not have such a mechanism, and for this reason, should modify the licencing regime to encourage and facilitate such missions in any new regulatory framework.

Remote sensing

The remote sensing sector has seen significant recent developments, particularly in technologies and business operations. Companies like US-based Planet and Finland-based ICEYE have quickly capture large market shares with constellations of small, mass-produced, low-cost satellites. MDA's Radarsat2 remains operational into its sixteenth year of service, but the era of only very large remote sensing satellites is over. Meanwhile, Norwegian-based KSAT has built the world's largest commercial ground-station, now with more than 100 satellite dishes, while the equally attractive site in Inuvik, NWT, fell far behind.

Part of the problem is that, in Canada, the sector is governed by the 2005 Remote Sensing Space Systems Act (RSSSA). The Act has gone through three mandated independent reviews (2012, 2017 and 2022), with the findings and recommendations of each being essentially the same: The RSSSA has become outdated due to rapidly evolving technologies, applications, and business operations. Among other things, Canada continues to license satellites, and the downloading of data from them, on a satellite-by-satellite basis instead of treating constellations as single entities for regulatory purposes.

Space security

Space is playing an increasingly important role in national and international security. Canadian policy should continue to be guided by the Outer Space Treaty, which specifies that space should be for "peaceful purposes" and "for the benefit and in the interests of all countries". The treaty prohibits any claim of sovereignty in space, bans the placement of weapons of mass destruction and commits its parties to refrain from actions that would cause "harmful interference" to the space activity of others.

In the 2017 Defence Policy Review, *Strong, Secure and Engaged*, the Department of National Defence states: "We actively support Global Affairs Canada's participation in international

diplomatic efforts to ensure that space does not become an arena of conflict”. At the UN, Canada has supported the current Open-Ended Working Group on “Reducing Space Threats through norms, rules and principles of responsible behaviours”. Canadian statements supporting agreement on responsible behaviours have specified that “Responsible behaviours increase the predictability and general transparency of operations and therefore reduce the potential for hostilities in, from, or through space”.⁹

One very recent development concerns several Canadian satellite companies providing communications support and remote imagery to a non-NATO country involved in an armed conflict against an opponent, namely Russia, with a proven anti-satellite weapons capability. This creates the risk of a strike against a Canadian privately-owned, publicly-licensed satellite; a strike that might actually be legal under the international law governing the conduct of armed conflict, the so-called ‘*jus in bello*’. There is nothing in existing Canadian legislation or regulations concerning this sort of situation, and one would expect any updated regulatory framework to include something on this.

Conclusion

We particularly emphasize the promotion of space science, which is an area of strength in Canada, and the environmental sustainability of the development of space.

It is our conviction that the Canadian Government should treat space regulation as an integrated system that deals with national security, operational sustainability, environmental protection and economic development in a coherent, flexible and transparent fashion. Efforts should be made to improve intra-governmental mechanisms to ensure a more holistic and ‘joined-up’ approach to managing both the policy and operational aspects of Canada’s engagement in space.

We would also like to emphasise the national security aspects of a future framework and to encourage that legislation covers both the peaceful and defence/military aspects of space utilization. As an example, Canadian laws and regulations should, in keeping with Article VI of the Outer Space Treaty, ensure that Canadian non-governmental entities are in conformity with our obligations under international law and contribute to the peaceful uses of space.

⁹ *Canada’s Views on Reducing Space Threats through norms, rules and principles of Responsible Behaviour*, A/AC.294/2022/WP.7, May 6, 2022, at: <https://documents.unoda.org/wp-content/uploads/2022/05/EN-Canada-working-Paper-on-Norms-75-36.pdf>

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¹⁰ Available at: <https://escholarship.mcgill.ca/concern/theses/736669429>