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FORESIGHT BRIEF

Space Commercialization

The last decade brought unprecedented growth and change in commercial space activities. Non-state actors have started to overshadow state actors and now lead over 70% of space activities. The satellite sector dominates commercial space activities, making up about 75% of the emerging "new space economy." Satellite data is already indispensable to everyday activities such as telecommunications, climate forecasting, disaster relief, and national security.

The space commercialization landscape has been shaped over the last decade by cheaper access to space, the emergence of new business models and new kinds of commercial space activities, the overcrowding in low-Earth orbit, and the intensification of concern over commercial and national security.

The economic significance of the commercial space sector could more than double by 2040 and see new services emerge such as deep-space exploration, space mining, and power generation. The continued commercialization of space has many potential policy implications. Geopolitical tensions may arise from state and commercial competition in space. New sensing data may bring scientific and economic benefits but securing that data may present new challenges. A handful of dominant firms may become the gatekeepers to space for some nations as well as other businesses. Improved access to space resources may enable new activities in space but may also create environmental challenges. Overcrowded orbits could threaten communications and vital Earth-imaging data. Competing international approaches to regulating space activities could spark conflict, limit innovation, or encourage illicit activities.

This brief aims to deepen readers' understanding of space commercialization and its implications for a range of policy areas, including some that may be unexpected. Anyone who engages with the following areas might find this brief relevant to their work: space, security, industry, research and development, trade, international, energy, environment, and infrastructure and transport. Thinking about the changes shaping the future of space commercialization can help decision-makers understand some of the forces already influencing their policy environment. Considering the potential implications of such changes can also help policymakers identify opportunities to make decisions today that may benefit Canada in the future.

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Introduction

The last decade brought unprecedented growth and change in commercial space activities. As discussed during the recent "The future of space" session at Policy Horizons Canada's Futures Week 2023, these changes suggest that the future of space commercialization will have important policy implications.

In recent years, non-state actors have started to overshadow the state actors that once dominated space activity—e.g. Russia, the United States, the European Union, and China. According to the United Nations, private companies lead over 70% of space activities.[1] They are also involved in ambitious ventures that only governments could tackle in the past, such as building spaceports[2] and space stations. Space commercialization[3] and "new space economy" are both terms that describe this process, which often sees private firms driving change rather than acting as junior partners.

Today, the satellite sector is at the core of commercial space activities, making up about 75% of the space economy.[4] It generates the majority of profits, with low-Earth orbit being the focus of business activity.[5]

Many daily activities depend on space technologies and especially satellite data. Without it, some remote areas would have no Internet access and there would be no weather alerts for extreme weather events for anyone. There would also be severely limited capabilities for real-time Earth imagery, and for long-distance telecommunications and broadcasting.

During the Cold War, the desire for prestige and strategic advantages drove the development of space capabilities. Today, state and non-state actors alike see space as a source of economic opportunities. The space economy grew by 70% from 2010 to 2020, reaching $469 billion in 2021.[6] Financial forecasts indicate it will more than double by 2040, reaching annual revenues of $1 trillion.[7] This could generate hundreds of thousands of high-skill and high-wage science, technology, engineering and mathematics jobs, according to the Organisation for Economic Co-operation and Development.[8]

Traditionally, the space sector has also been a source of technological breakthroughs and spinoffs. Space technologies are transferable to different sectors of the economy. A surprising number of today's familiar technologies are spinoffs

from space programs,[9] including GPS navigation, LASIK eye surgery, and the innovative surgical microscope Modus V,[10] which is an application of Canadarm robotic arm technology.[11]

Awareness of these trends has led more governments worldwide to frame space as a national resource,[12] with a handful of new players especially active in this regard.[13] They have invested in research and development, incubated space start-ups, partnered with private firms, and purchased commercial space services in hopes of making space a central pillar of growth and/or security.

Going forward, the continued commercialization of space will likely depend on both the pace of technological innovation and the potential resolution of several key challenges.

Over the last decade, changes in the space sector have driven the growth of commercial activities in space.

Democratization of space. For years, the cost of launching equipment and astronauts limited the scope of economic activity in space. Cheaper launches and miniature, more cost-effective satellites have reduced the cost of space access by a factor of 10.[14] Additionally, venture capitalists looking to profit from growing demand for space data are providing new investments to support commercial satellite activities.[15]

Diversifying business models. The space sector is changing rapidly, in terms of both its size and the types of services it offers. Earth observation is growing by 7% a year[16] thanks to business models like satellite-as-a-service and space-data-as-service."[17] These models have revolutionized access to sophisticated remote-sensing data that enables firms to track maritime activity,[18] manage forestry resources, detect threats to agricultural yields,[19] and monitor pipelines.[20]

Broadening scope of activities. The range of space activities is also expanding far beyond the established satellite-driven business model. The first steps towards space tourism, logistics, and manufacturing industries have already been taken.[21] Thanks to falling launch costs, space mining and power generation may soon emerge as viable businesses.[22] Private and public sector support is also growing

for visionary space projects, such as building commercial space stations or exploring the Moon and Mars.[23]

Overcrowding. Easier access to space has driven the growth of satellites and space junk in low-Earth orbit. There are already about 7 700 active satellites and 36 500 pieces of debris in this vital orbital zone.[24] Ambitious satellite constellation projects, such as Starlink,[25] may put tens of thousands more satellites into orbit over the next decade. However, space within orbital zones is limited, and overcrowding increases the chance of collisions and resulting debris cascades[26] that could leave portions of those zones unusable.

Increasing focus on security. Space is of such strategic importance that military and political factors inevitably shape commercial space activities. State-sponsored cyberattacks against space infrastructure and tests of anti-satellite technologies[27] are on the rise. These activities could raise concerns about the vulnerability of commercial space assets. This has encouraged individual countries and international blocks[28] to expand their current military capabilities in space.[29] It has also inspired numerous states, such as Australia, Azerbaijan, Bahrain, Brazil, South Africa, and the United Arab Emirates, to develop such capabilities for the first time.

Policy implications

The implications listed below emerged through an exploration of plausible futures for space commercialization. They represent policy considerations that might emerge but are not inevitable. Failing to reflect on them could lead to policy failure.

This list is not exhaustive, and policy makers are encouraged to further reflect on the challenges and opportunities listed here. Based on these policy implications, decision makers could ask themselves the following questions:

- How might changes in space commercialization challenge specific policies or programs?
- How would the assumptions built into today's policies and programs fare in the face of challenges and opportunities created by this future?
- What actions could be taken now to maximize opportunities and mitigate challenges related to space commercialization in the future?

Great power competition

Heightened geopolitical tensions between great powers may create obstacles to commercial activities in space. Tensions already make global collaboration difficult by inhibiting attempts to share scientific data or address key regulatory gaps. Shows of force, such as jamming or hacking attacks on satellites and anti-satellite weapon tests, could worsen relations and make investments in commercial space ventures seem risky. On the other hand, history shows that the Cold War space race drove a technological boom. If current competition produces similar results, knock-on effects could accelerate some of the more visionary aspects of space activity—including deep-space exploration, as well as space mining and power generation.

Data and cybersecurity

Satellite-sensing technologies are providing new and richer streams of Earth and space observation data, which might drive growth in the new space economy. Widespread knock-on benefits seem likely to follow for the insurance, agriculture, logistics, forestry, oil and gas, fishing, intelligence, and security sectors. As a result, space data could become a top-tier strategic resource for state and non-state actors. Securing strategically valuable data streams could become a major concern for firms and governments in the future. Two challenges stand out: accessing cutting-edge satellite sensing technologies, and protecting digital communication channels from attack. Intellectual property rules and export restrictions could help limit rivals' access to new kinds of data, but they may also provoke industrial espionage campaigns. Likewise, malicious actors may try to hack or jam digital communications between satellites and the Earth.

Natural resources

Young industries focused on resource extraction or production in space could create major opportunities and advances. For instance, rocket fuel production using compounds extracted from the Moon could supercharge deep-space exploration.[30] Such projects could also produce technological breakthroughs with spinoff benefits for economic growth on Earth, not to mention water and energy systems, and healthcare. Terrestrial mining expertise might give some nations a competitive advantage in a sector with massive economic and strategic possibilities. Early mover status in space-based resource extraction—e.g. fuel production on the Moon—might guarantee access to other ventures with scientific and reputational upsides, such as deep space exploration.

Debris and crowding

As orbital zones become even more crowded with functional satellites and debris, collisions may become unavoidable. Each collision would make the problem worse and make space-based services less reliable and more expensive. If major insurers refuse to underwrite business activities in low-Earth orbit, young space businesses may find it much harder to secure investments or contracts.[31] On the other hand, public-private partnerships in Asia[32] and Europe[33] are framing space junk removal as an opportunity.[34] This could drive technological development while decluttering space for other activities.

State and non-state actors

If a few powerful companies continue to dominate essential parts of the global space economy (e.g. launch and satellite Internet services), the entire sector could be vulnerable to service interruptions and price hikes. Should these firms experience or encourage periods of volatility, the operations of state and non-state actors that rely on them to secure their advantageous positions in space robotics, manufacturing, or mining could be jeopardized. States could also see important security or infrastructure projects jeopardized due to unexpected costs imposed by dominant firms, including those from other countries. Building a self-sufficient national space sector is an alternative to relying on these firms for essential services, but that might be impractical for most states due to costs or lack of expertise.

Governance

The fast-growing space industry, with its complex network of private and public actors, is already outpacing the existing regulatory and legal frameworks that govern space activity. Without clear rules for all players, the increasing pace and intensity of space activity could provoke conflict. For instance, unilateral efforts to mine the Moon’s resources could lead to conflicts among state and non-state actors over lunar territory, orbital zones, or the disposal of mining by-products. Multiple incompatible legal frameworks could deepen international competition. This could also make it more difficult for companies to reach critical size, and make international cooperative ventures more challenging. It might also encourage entrepreneurs and start-ups to move their operations to jurisdictions with weaker regulations. A new international framework could bring certainty and improve safety. But if it was more stringent than alternatives, it could also limit innovation and raise costs, which might encourage illegal activities.

Conclusion

More efficient launch technologies and new business models have driven a wave of commercial activity in space. A new space economy led by corporations is growing rapidly, bringing new data and revenue streams, as well as spin-off technologies with consumer applications. States, including many that are new to space endeavours, are rushing to capitalize on this growth both for economic and security reasons. Some hope that it could provide the foundation for more ambitious space ventures such as mining and power generation, not to mention the next stage of space exploration.

The commercialization of space also brings challenges. Space debris already threatens satellites and vehicles in low-Earth orbit. Intensifying geopolitical competition among states has already sparked a new space race with a strong military element. As the economic importance of space grows and more non-state actors take a bigger role, the potential for conflict rises. **The next few decades of space commercialization could spark a variety of technical, business, and diplomatic challenges, but meeting them may provide an additional wave of benefits beyond those anticipated by today's key players.**

Learn more

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Oz Gurtuna
Founder
Turquoise Technology Solutions
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Walter Peeters
ISU President Emeritus and Professor in Space Business and Management
International Space University

Michal Ziso
Founder
ZISO

Project team

Marcus Ballinger, Manager, Foresight Research
Christopher Hagerman, Senior Analyst and Project Lead, Foresight Research
Jennifer Lee, Analyst, Foresight Research
Simon Robertson, Director, Foresight Research
Klavdiia Tatar, Analyst, Foresight Research
Tieja Thomas, Manager, Foresight Research
Kristel Van der Elst, Director General

Communications

Mélissa Chiasson, Communications Advisor
Laura Gauvreau, Manager, Communications
Nadia Zwierzchowska, Senior Communications Advisor

Endnotes

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