

SINGAPORE: COUNTRY BRIEF

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Space operations have become increasingly global. Whereas only a few decades ago, a couple of major government powers dominated space, now over 70 countries own or operate active satellites in orbit. One of these spacefaring nations is the Republic of Singapore, a country that has characteristics that suggest it could play a more prominent role in the domain in the years ahead. This brief is part of a series of country profiles that the Center for Space Policy and Strategy is publishing on emerging space nations, which will highlight each country's domestic and regional context, space development, diplomatic activity, and opportunities for collaboration with the United States.

Introduction

In February 2022, the trade and industry minister for the Republic of Singapore announced that the government would be investing over US\$110 million in a program centered on space and technology development.¹ The investment builds on a national space program and commercial industry already involved in a diverse range of space activity.

Singapore has all the makings of a serious space nation. A wealthy country with a highly educated workforce, it is situated in a region full of growing space actors, creating plenty of opportunity for collaboration. As a maritime and aviation hub located in a region with volatile weather, the nation has a demand for tailored space services, which could also serve its ambitious goals for climate change. For both its space development and space diplomacy, Singapore's space program could help address some of the country's unique challenges and leverage some of its comparative advantages. Governments and space actors,

including the United States, should stay attentive to Singapore's space growth because the country may be a promising one to target for cooperative and collaborative efforts for the domain.

Domestic and Regional Context

Singapore's domestic circumstances are conducive for space development. A leader in advanced manufacturing with an extremely productive workforce, it ranks first in the world in export totals per capita.² Moreover, it has cultivated a rich university culture, having two of the top-ranked universities in Asia.³ The country is one of the biggest aviation and maritime hubs in the world: from 2016 through 2020, its airport ranked among the top 10 in the world for international passenger traffic and, in 2020, its port ranked number two in the world for the volume of shipping imported in and exported out of the country.⁴ It is, per capita, one of the wealthiest countries in the world.⁵

Singapore's geographic location and the geography of the region provide benefits for potential future increases in space activities. Because equatorial islands are at latitudes particularly useful for several types of space launches, there are opportunities in the region for growth in the number of space launch facilities.⁶ As of 2022, the nearest spaceports and launch facilities to Singapore were in China, India, Japan, and the Marshall Islands.⁷ However, Indonesia has been planning to build a new spaceport, Thailand is reportedly considering opportunities for a spaceport, and even Singapore has proposed "Spaceport Singapore" as a base for suborbital flights for Virgin Galactic.⁸

The geography also poses severe weather challenges for which some space applications could be particularly useful. Singapore's proximity to the Pacific "Ring of Fire" results in hazards such as volcanic eruptions, earthquakes, and tsunamis. Neighboring Indonesia, for example, reports the highest natural disaster rates worldwide.⁹ As a low-lying coastal equatorial nation, Singapore is particularly vulnerable to climate change effects such as rising sea levels and flooding from extreme rainfall.¹⁰ Mitigating climate change is therefore a priority for Singapore; in a February 2022 speech on the budget in Parliament, the Minister of Finance announced the country's goal to achieve net zero emissions by or around the mid-century.¹¹ Space capabilities can help monitor climate change and predict—and coordinate responses for—natural disasters, suggesting an opportunity for Singapore to align space pursuits with broader national interests.

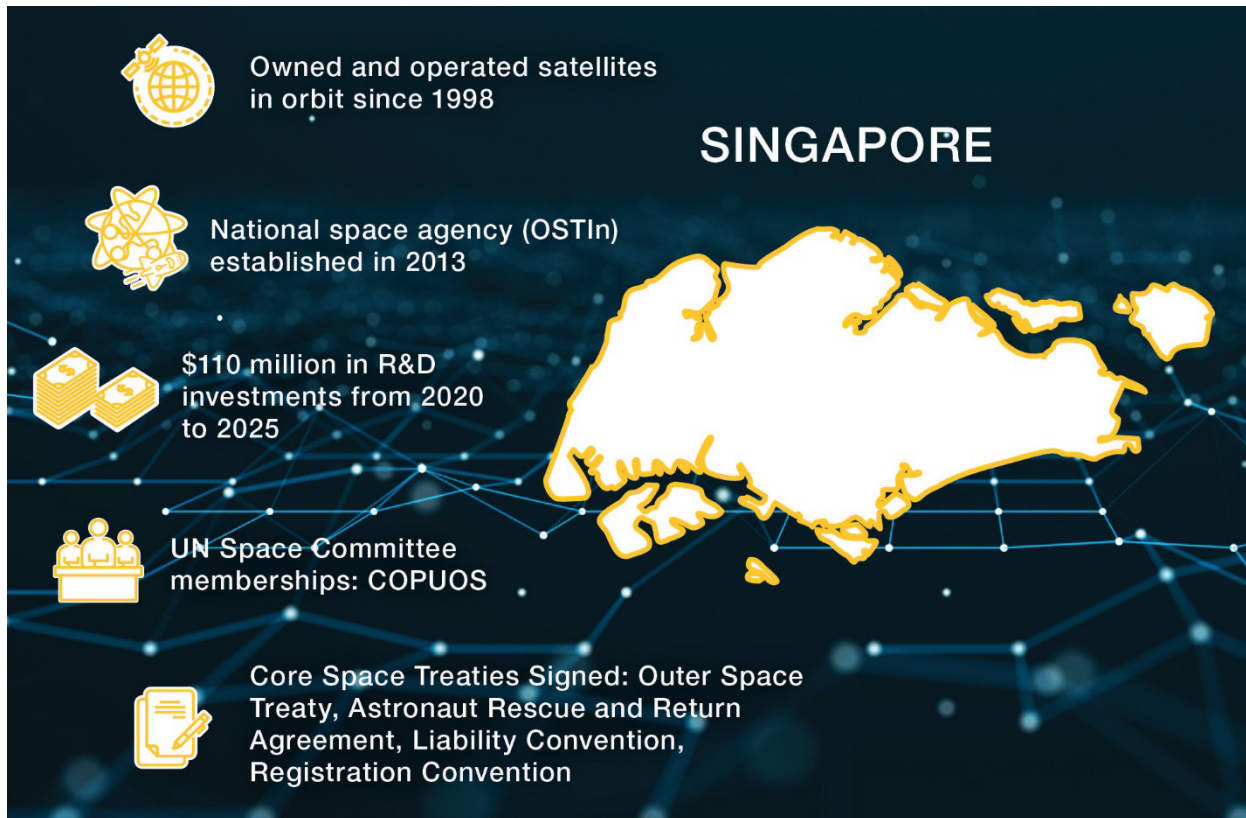
Regional neighbors have shown a growing interest in participating in space activities, both diplomatically and on orbit. Indonesia is very active in the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS), has launched several small satellites primarily for Earth and natural disaster observation, and has begun developing national regulations for space activities.¹² Thailand, despite describing itself as a "non-spacefaring nation," has several new projects underway for Earth observation satellites, small satellites for national security, and experiments in space science and technology.¹³ Malaysia recently passed the Malaysian Space Board Act 2022 in

order to, among other efforts, fulfill treaty obligations to register all space objects.¹⁴ Given this uptick in regional interest in space, Singapore could develop greater capabilities in collaboration with neighboring countries.

Singapore's Space Program

Singapore launched its first satellite in 1998, and it now ranks among the top 25 countries in the world in the number of satellites it operates.¹⁵ Its active spacecraft include government and commercial Earth observation satellites in low Earth orbit (LEO), a commercial communications satellite in geostationary orbit (GEO), and multiple technology demonstration environmental monitoring satellites built by Nanyang Technological University and the National University of Singapore. TeLEOS-1, an electro-optical imagery satellite launched in 2015, was Singapore's first commercial Earth observation satellite.¹⁶ Singapore's space industry includes telecommunications companies, a laser satellite communications company, and multiple companies focusing on satellite components, leveraging Singapore's expertise in electronics, aerospace, and supercomputing.

In February 2022, Singapore's Minister of Trade and Industry gave a speech that unveiled the country's three-part strategy for space. The investment of US\$110 million in space capabilities ties to the first part of the strategy—supporting the country's push for developing space capabilities for national priorities, including aviation, maritime, and sustainability, and in emerging technologies, such as very low Earth orbit satellites.¹⁷ The second part of the strategy focuses on the growth of local space industry, to include translating government research and technology into commercially viable solutions. The third part of the strategy includes partnerships with other spacefaring nations and building a talent pipeline for the space sector. Although a formal version of this strategy has not been published, the speech indicates that Singaporean leaders are interested in expanding the nation's involvement in space activities, supporting local commercial space actors, and building connections internationally and across the workforce.



Singapore’s national space agency, the Office for Space Technology and Industry (OSTIn), established in 2013 and part of the government’s Economic Development Board, will lead this space initiative. Other agencies that play a role in Singapore’s space efforts include the National Research Foundation, a department within the Prime Minister’s Office that sets the national direction for government research and development, the Ministry of Defense, the Ministry of Foreign Affairs, and the Ministry of Education.¹⁸ Figure 1 includes some information on Singapore’s space efforts.

Singapore’s prospects for future space program development can be explored across four categories: build nationally owned and operated space systems, partner with other countries’ space actors, support the development of its commercial space industry, and use existing commercial space capabilities and services to address national needs.

Building National Capabilities. Building national capabilities could be important for security reasons, for niche purposes that other foreign or commercial systems may not provide, and for stimulating growth in domestic

industry. In selecting capabilities to develop, a country may want to consider where it has unique needs and where it can offer unique value. Given Singapore’s focus on climate change, space-based environmental monitoring satellites may be an attractive area for the government to invest in. Such capabilities, which could build on some of Singapore’s planned and demonstrated space capabilities, could collect data on climate change, monitor weather events, and even help prevent disasters. For example, in a flood, satellites that can characterize materials (e.g., dirt versus pavement) can improve urban runoff models, which could be particularly helpful for a country in which flooding is a common occurrence.¹⁹ Radio frequency collection, synthetic aperture radar, and electro-optical imagery could also be useful for monitoring the exceptional levels of maritime activity in and around Singapore.

Partnering on Space Capabilities. Partnering with other nations or companies to develop capabilities collectively offers significant advantages. Hosting payloads on foreign or commercial systems could offer affordable means to expand a country’s space systems.

Countries can also simply contribute to the cost of a space asset that would be much more challenging to build unilaterally. For example, through multilateral agreements, Canada, Denmark, Luxembourg, the Netherlands, and New Zealand provided funding for the U.S. Wideband Global SATCOM-9 satellite that launched in March 2017, which they all use and benefit from.²⁰

Singapore's government has shown an interest in partnering on space capabilities. In October 2021, it signed a memorandum of intent with the European Space Agency to collaborate on initiatives relating to space technologies.²¹ Universities and industry in Singapore have also worked with foreign commercial providers, partnering with Japanese and Taiwanese non-governmental organizations and companies on space ventures. For example, Singapore Technologies Electronics Limited (ST Electronics) has signed a memorandum of understanding (MOU) with the French Space Agency (CNES) for TeLEOS-2, a synthetic aperture radar satellite.²²

Attracting Space Companies. Attracting commercial space companies is another way to build a country's space capabilities. One potential model for Singapore to consider is Luxembourg. Although most countries have built their space capabilities through government-directed activities, the government of Luxembourg has focused on promoting and supporting commercial space activities. It has prioritized awarding grants to commercial firms rather than funding the development of government-driven projects.²³ The government has also extensively adopted public-private partnerships, attenuating some of the financial risk for commercial firms operating in the country.²⁴ This general approach has been successful, as shown in the prominent role Luxembourg plays in satellite communications.

Singapore's government and industry have already taken steps to encourage commercial space development. For example, in November 2021, OSTIn—the national space office—and Amazon Web Services signed a Statement of Strategic Intent and Cooperation, through which Amazon

will support Singapore's attempts to "explore the potential of space as a new industry for economic growth and technology development."²⁵ Astroscale, a leading space-debris removal company, has a subsidiary based in Singapore.²⁶ Singapore Space and Technology Ltd, established in 2007, has sought to provide space start-ups in the region access to funding, business advice on refining their productions, and connections to broader space networks.²⁷ According to officials, Singapore has more than 50 space companies, and more than 1,800 space professionals work in the country.²⁸

Leveraging Commercial Space. In addition to incentivizing local commercial space development, Singapore has used existing commercial space systems and services, local or foreign, to meet government needs. Commercial space services span across many space capabilities—including space-based weather; remote sensing imagery; radiofrequency collection; communications; positioning, navigation, and timing; and space situational awareness—so procuring commercial space services could be a less expensive option to leverage the domain.²⁹ According to officials, Singapore's Ministry of Defense has procured commercial satellite communications services and Earth observation imagery. In addition, the country's civil aviation agency, among others, is working with Startical, a Spanish company, to perform a proof-of-concept on the use of space-based voice communication between pilots and air traffic controllers for air traffic management.³⁰ The agreement reflects the country's willingness to contract with foreign companies, not just invest in domestic commercial ventures.

Singapore's space leadership will need to continue grappling with its desired balance of investment in government-driven space projects, support to local industry, and use of foreign commercial systems. A focus on achieving prominent national space capabilities may mean different investments than a focus on extracting the most value from the domain for terrestrial purposes or on building domestic commercial space activity for the short or long term.

Delicate Balance: Singapore's Relationship with China and the United States

Singapore has long had a unique relationship with the most powerful country in the region, the People's Republic of China. Most of the population of Singapore is ethnically Chinese and long-time Singaporean Prime Minister Lee Kwan Yew had a close personal relationship with Chinese premiers Deng Xiaoping and Jiang Zemin.³¹ These ties were bolstered by the synergy between the two rapidly developing countries in the late twentieth century: the rise of China as a global trading power and Singapore's strategic position by the Strait of Malacca led to an increase in maritime traffic passing through Singapore. Chinese leaders also reportedly viewed Singapore as a model for economic growth under single-party leadership.³²

Singapore and China are still economically close—China is Singapore's main trading partner for both imports and exports—and the two countries pursue military cooperation through high-level dialogue and joint exercises.³³ However, the relationship has encountered several friction points in recent years. Singapore's connections with both the United States and Taiwan have caused consternation in China, with China seizing nine Singaporean armored vehicles on their way back from an exercise in Taiwan in 2016.³⁴ Furthermore, China's economic diversification through overland trade in the Belt and Road Initiative and pursuit of an increased domestic supply of electronic integrated circuits could undermine several of Singapore's pillars of international trade.³⁵

Unlike China, the United States does not share deep historical and cultural ties with Singapore but does have strong military and economic partnerships. The United States has had a bilateral free trade agreement (FTA) with Singapore since 2004 and Singapore is now the United States' largest Southeast Asian trading partner and 18th largest trading partner overall.³⁶ Since 1990, Singapore has provided the United States access to military facilities on a rotational basis, including for a squadron of fighters, littoral combat ships, carrier fleet visitation of Changi Naval Base, and U.S. Navy Poseidon P-8 maritime surveillance aircraft.³⁷ The 1990 MOU received a 15-year extension in 2019 and a Defense Cooperation Agreement in 2015 expanded cooperation in military, policy, technology, and non-conventional security cooperation.³⁸

These pairs of bilateral relationships put Singapore in a unique geopolitical position with ties to both countries in ways that sometimes cause tension. This geopolitical context could have greater bearing on Singapore's space activities, particularly in the field of space diplomacy, an area in which the United States and China alternate between cooperation and competition and in which Singapore has a steadily increasing presence.

Space Diplomacy

International space diplomacy represents another area in which Singapore could engage on important space issues, such as through the United Nations and other multilateral fora. For the last 30 years, Singapore has voted “yes” on many space-related resolutions in the General Assembly of the United Nations, including on Prevention of an Arms Race in Outer Space, Transparency and Confidence Building Measures, No First Placement of weapons in space, and, more recently, resolutions on developing norms, rules, and principles of responsible, irresponsible, and threatening behavior in space. Singapore is also a member of the International Telecommunication Union

(ITU) and therefore participates in that organization's efforts to prevent harmful radiofrequency interference in space. Just as Singapore maintains relations with both the United States and China in non-space diplomacy, Singapore has also been positioned to support and maintain discussion on U.N. space diplomacy initiatives proposed by the United States and like-minded nations as well as by Russia and China. This positioning provides an opportunity for Singapore to participate and help lead U.N. space discussions on issues that cut across both U.S. and Chinese interests.

Singapore is still a relative newcomer with a light footprint in some of the main U.N. space fora, having joined the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS) as a member in 2019.³⁹ Singapore is not a member of the Conference on Disarmament, which discusses most space security issues. However, the nation has already begun to use national statements in the Scientific and Technical Subcommittee, Legal Subcommittee, and Plenary of COPUOS to make known its interest and investment in space.⁴⁰

Singapore is well positioned to encourage broad groupings of support and discussion among states, especially on issues related to preserving space safety and sustainability so that countries like it can continue to rely on space services. Singapore has indicated interest in topics related to space sustainability such as space resource exploration and utilization, reducing orbital congestion and debris, and improved satellite data exploitation, which also ties to commercial ventures in the country.⁴¹ While some of these issues feature similar perspectives across the international community, others have been more contentious, leaving room for Singapore to make meaningful contributions and bring parties with conflicting views to find common ground.

Although there is room for growth in direct participation in negotiations and debates on specific space topics, Singapore has managed to use U.N. participation to highlight other cooperative space activities, such as joining the Asia-Pacific Regional Space Agency Forum's National Space Legislation Initiative, signing the Artemis Accords, setting up a laboratory as a member of Space Climate Observatory, and concluding the Memorandum of Understanding with the European Space Agency on space technology collaboration.⁴² These efforts indicate further paths for space cooperation and diplomacy Singapore could pursue, particularly on issues important to Singapore's capabilities and interests, such as monitoring

climate change and potential natural disasters, legal capacity-building, and technological innovation.

View from the United States

From the U.S. perspective, Singapore could represent a compelling partner for space endeavors in a region that is on the precipice of greater space growth.

Singapore and the United States cooperate closely in a number of areas with direct significance to the space sector, namely on climate change, cybersecurity, and technological innovation and capacity-building. When Vice President Kamala Harris visited Singapore in August 2021, the two countries announced the launch of a new U.S.-Singapore Climate Partnership to develop climate standards, support technology R&D, and improve sustainable finance.⁴³ They also announced three MOUs on cybersecurity cooperation for the financial sector, defense, and regional capacity-building as well as new bilateral partnerships and dialogues on innovation and supply chain management.⁴⁴ At the same meeting, the United States and Singapore discussed mutual interest in "Reinforcing International Norms on the Peaceful Exploration of Space," given common interest in responsible and sustainable space activities, especially when using space in the fight against climate change.⁴⁵

In March 2022, this bilateral cooperation progressed further when the Singaporean Minister for Trade and Industry signed the Artemis Accords, stating: "I look forward to seeing more exciting collaborations among companies, officials and researchers between Singapore and the U.S. as well as other Artemis Accord signatories, leading to a robust space sector in Singapore."⁴⁶ The manner in which Singapore supports the Artemis program through the Accords in the future can help set the tone, both for specific types of capability collaboration and for leadership in developing norms and principles of responsible behavior in outer space.

Conclusion

Singapore is well positioned to play a more important role in space and to exploit the domain for national benefit. By leveraging the comparative advantages of its established high-tech manufacturing sector and its highly skilled workforce, Singapore can both support its existing role as an aviation and maritime hub as well as further its development of space capabilities. Additionally, both in space development and space diplomacy, Singapore could align its space pursuits with its national interest in mitigating climate change. How the country takes advantage of these opportunities will depend on decisions made by its space leadership, including decisions on how it should build its space capabilities and what role it envisions for space diplomacy. Other space players should take note of Singapore's potential for development because it may be a compelling partner for future space endeavors.

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